STUDENT ATTITUDES TO COMPUTERS IN THE CLASSROOM

by

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TABLE OF CONTENTS

	Page
CHAPTER 1. INTRODUCTION	1
Significance of the Study	1
Background to the Use of Computers	3
Guidelines for the Study	6
Research Questions	8
Structure of the Report	10
CHAPTER 2. LITERATURE REVIEW	11
Introduction	11
Use of Computers in the Classroom	13
Importance of Attitudes.	33
Student Attitudes to Computers in Education	37
Student Personality and Computers	39
Gender Differences and Computers	40
Computer Experience and Computers	43
Student Attitudes to Technology in Education	44
Computer Use in Australian Schools	47
Conclusions	51
CHAPTER 3. TOWARDS A CAUSAL MODEL	55
Development of the Proposed Causal Model	55
Defining the constructs	58
CHAPTER 4. RESEARCH METHODOLOGY	64
The Sample	64
Previous Development of Instruments	65
The Preliminary Study	71
The Major Study	75
CAHPTER 5. DESCRIPTIVE ANALYSIS OF STUDENTS	78
Student Background	78
Student Use of Computers	82
Student Attitudes	66
Student Attitudes to Computing	84
CHAPTER 6. CAUSAL ANALYSIS	89
Introduction	89
Applying the Model	90
CHAPTER 7. DISCUSSION OF RESULTS	104
Responses to Research Questions	104
CHAPTER 8. CONCLUSIONS	114
Research Questions	116
Educational Implications	119
Future research	121
REFERENCES	123
APPENDICES	135
1. Pilot Study Questionnaire and Factor Loadings	135
2. Major Study Questionnaire and Factor Loadings	143
3. Unrestricted Causal Models	153

LIST OF TABLES

	Page
TABLE 3.1	56
TABLE 4.1	74
TABLE 5.1	80
TABLE 5.2	82
TABLE 6.1	90
TABLE 6.2	93
TABLE 6.3	98

LIST OF FIGURES

	Page
FIGURE 1.1	6
FIGURE 3.1	57
FIGURE 3.2	63
FIGURE 6.1	92
FIGURE 6.2	97

ABSTRACT

Student attitudes toward computers are important to the success of the many computer-assisted programs that are currently being run in Australian schools. This study of 379 Year 10 students examined the effects of age, sex, personality, previous computer use (home, school, and other), attitudes to school subjects (English, Mathematics, and Science), attitudes to teachers, and attitudes to technology on students' attitudes to computers (computer liking, and computer confidence).

Previous computer use and attitudes to technology were found to be significantly related to more positive attitudes on each of the two computer scales. Attitudes to science was found to be significantly related to computer confidence. Sex, age, and personality, were found to indirectly affect students' attitudes to computers. No relationship was found between students' attitudes to teachers and their attitudes to computers.

DECLARATION

This thesis contains no material which has been submitted for examination in any other course or accepted for the award of any other degree or diploma in any university or college and, to the best of my knowledge and belief, contains no material previously published or written by another person except where due reference is made in the text.



P.J. Beamish

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I gratefully acknowledge the help, guidance and advice given me by Dr. Sid Bourke. I have appreciated his expertise, patience, and good humour. Thanks a lot Sid.

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DEDICATION

To Debra, my wife.

Thanks for being so patient.

CHAPTER 1

INTRODUCTION

Significance of the Study

None would argue that society is going through an age of rapid technological advance. In the forefront of development the silicon chip, printed circuit, and the accompanying computer revolution are changing the way in which society moves and operates.

The home and the classroom have felt the impact of changing technology. As economic, social, and technological conditions continue to change, educators need to be preparing children to take their place amongst an ever changing society.

> Technological change involving the invention of new products and processes, or new applications of older ones is a constant feature of human societies, an aspect of their cultural development and response to their own environment. The rapidity and pervasiveness of current change, however, accompanied by economic recession, international tension and job insecurity, are giving rise to greater public concern. Australia is now engaged in an effort to understand and deploy new technologies, to shape their impact on social life, to upgrade workforce skills, and to promote positive

community attitudes to innovation and assimilation of new technologies.

(L.Arnold, p2, 1985)

Of all the new technologies that have been introduced into Australian society, none has made a greater impact than computer technologies. Educators, at all levels of education in Australia, have been working to introduce their students to computer technologies. A recent survey of Australian schools by Fitzgerald, Hattie and Hughes (1985) indicated that 89 per cent of the secondary schools and 55 per cent of primary schools surveyed were actively using computers.

It is important that children have a positive attitude to computers and their many uses. It is only then that they can gain the best possible background for their future lives as independent citizens within Australian society. These positive attitudes can best be encouraged by making children aware of the many uses of computers in society. Confidence can be built by using computers in every day education.

This study is attempting to clarify those factors that contribute to students' attitudes towards computers and their uses. It is only by identifying these factors, and subsequently adapting teaching practices to encourage positive attitudes, that educators can hope to have an effect upon student attitudes in this area. The situation is complicated as many of the variables with which the study deals are

intangible perceptions. However, these perceptions are important regardless of any objective reality as what the students perceive is real to them. Positive student attitudes to computers are desirable and any progress made toward to the understanding of student attitudes will be beneficial to both educators and students alike.

Background to Use of Computers in Education

No one is in any doubt that the computer era has arrived. The world of computers has expanded explosively since the invention of the microchip. Computers are now used for such diverse tasks as guiding rockets into outer space, home computer games, controlling assembly line robots, and instruction in schools.

While computers have been used in some areas of work and play for some time, it is only recently that decreasing production costs, decreasing physical size, and increasing capabilities have meant that computers have become economically feasible in the home and classroom.

The increasing dependence of society on computers is illustrated by Cane (1984). He details figures of a million small computers sold in America in 1982 and two and a half million sold in 1983. It is clear that, with this increased availability and presumed use of the computer at home and at school, the current

generation of children is growing up in a computer era and needs to become familiar with the "flashing beast". (Leiblum, 1984)

This need may be far more urgent than many people realise. Several writers have noted that by the end of this decade, schools at all levels will be equipped with microcomputer systems (Critchfield, 1979). Molnar (1978) has stated that the next great crisis in American education is computer literacy. He even suggests that such literacy will be;

> "a prerequisite to effective participation in an informative society and as much a social obligation as reading literacy." (p.17)

In Australia, similar trends are evident. The 1985 Australian Education Council Task Force on Education and Technology reported that:

> "a watershed has been reached in Australian education. Changes in technology, combined with economic and social pressures, are altering traditional patterns of learning in the community and providing the most significant challenge to institutional provisions for education since the establishment of public education a century ago." (p.1)

The Australian workforce is changing due to the introduction of new technologies and schools need to educate for this change. In every state of Australia significant amounts have been spent providing computer hardware for schools with over half of all schools now offering computer activities (Arnold, 1985). As students interact with computer technologies they will be better prepared to take their place in society and the workforce.

Several important issues arise owing to this need to know about computers and the increased use of computers in the school. One of these is the attitude of students towards the use of computers at home, and at school. These attitudes are important in that maximal effective learning can only occur when students have a positive and receptive attitude towards their work. Also, positive attitudes while at school increase the quality of the student experiences while at school. An awareness of student attitudes, therefore, will assist educators in evaluating the role of computers in the classroom, and guide future development of teaching practices that utilizes these machines, while maximizing student experiences while at school. It is with these aims in mind that this study is undertaken.

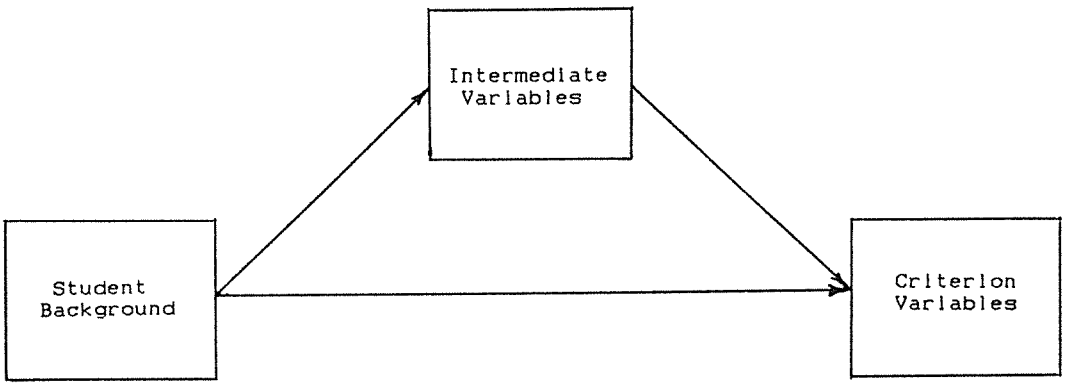
Guidelines for the Study

The subject area of Computing, and more specifically, Year 10 student attitudes to the use of computers in education in the Hunter Valley and surrounding areas, was chosen for the present study. The study was designed to consider the factors that could affect student attitudes to computers and in particular, the complex relationships that exist between students' attitudes to computers, the students' background, students' attitudes to technology, their attitudes to teachers, and to their school subjects.

Two student outcomes were assessed and measured: computer liking and computer confidence. As it was considered possible that student background and attitude variables could be related differently to each of the two outcome variables, they were treated separately.

Research Model A causal model, based on the simplified model in Figure 1.1, was developed for testing.

FIGURE 1.1



The model, with attitudes to the use of computers in the classroom as the criterion variables, incorporated measures of the following constructs as independent and intermediate variables: student background, previous computer experience, attitudes to school subjects, attitudes to technology, attitudes to teachers, and attitudes to computers.

Research Questions There were five general research questions tested during the study. All were concerned with student attitudes to computers. As attitudes to computers should not be looked at in isolation, the research questions addressed students' backgrounds and experiences and the factors that affect students' attitudes to computers.

The five general research questions addressed were:

1) To what extent are student attitudes to the use of computers in the classroom related to their attitudes to the classroom teacher?

2) To what extent are student attitudes to the use of the computer in the classroom related to their attitudes to individual school subjects?

3) To what extent are student attitudes to the use of computers in the classroom related to their attitudes to technology?

4) To what extent are student attitudes to the use of computers in the classroom related to background variables such as sex, age, and personality?

5) To what extent are student attitudes to the use of computers in the classroom related to previous computer experience?

As there were two student attitude measures (computer liking and computer confidence) each of the

above research hypotheses was tested for each outcome variable.

Some of the more important specific subsidiary questions that will be addressed by this study were:

1) Is the instrument developed by Ainley, Miller, and Reed (1986) a reliable measure of student perceptions of their relationships with their teachers for the students involved in this study?

2) Is the instrument developed as part of this study a reliable measure of student attitudes to technology?

3) Is the instrument developed by Gable and Roberts (1983) a reliable measure of student attitude toward school subjects for the students involved in this study?

4) Is the ammended version of the instrument developed by Eysenck & Eysenck (1964) a reliable measure of extraversion in student personality?

5) Is the instrument developed for this study a reliable measure of students' liking for, and confidence in, computers in schools?

These research questions were all posed at the individual student level. The data necessary to complete the study and to answer the research questions were collected by means of a student questionnaire.

Structure of the Report

This chapter has attempted to provide a background to the study by giving a brief outline of the position of computers in education today and the trends their use is likely to follow. It also sets out the general research questions this study attempted to answer as well as listing some of the specific subsidiary research questions.

Chapter 2 provides a detailed look at the previous research in the area of student use of computers in education and the other relevant research questions to be addressed by this study.

Chapter 3 consists of a detailed development of a causal model to be tested in this study and a discussion of the constructs of the model.

In the fourth chapter the research rationale and methodology for both the preliminary and major studies are given.

Chapters 5, 6, and 7 consist of the analysis of the results of the study with the first of these chapters giving a descriptive analysis of the data, the second an analyses of the causal model, and chapter 7 answers the research questions proposed in Chapter 1.

The final chapter, chapter 8, attempts to draw the study together by providing a summary of the results of the study. Some conclusions are made and areas of future research examined.

CHAPTER 2

LITERATURE REVIEW

Introduction

In the recent history of education, many different strategies and methods have been used to facilitate learning. Over the years educators have adopted many new methods and innovations in an attempt to provide the most complete, and efficient, education for their students. Some of these changes have been helpful and effective and, consequently, have been expanded and developed. Others have been found to be ineffective and have been discarded.

The use of computers in the classroom is one of the major innovations to take place in education during the past decade and is rapidly becoming one of our most timely basic skills (Sklarz, 1984). Computers have entered the home, school, and classroom, at an amazing rate. Many schools have purchased computers however, not because of educational demands, but because of the expectations of their local communities. Time magazine, January 3, 1983, reported that 68 per cent of registered voters felt that the microcomputer would improve the quality of their child's education. With community expectations high, the increasing popularity and use of computers in the classroom has not evolved from within education circles, but rather, is the result of highly successful mass marketing strategies

employed by the producers of computer hardware and software (Chandler, 1983). Many schools have been forced into purchasing computers, not because of research establishing their effectiveness, but rather because of pressure from parents who wish to see their child receive what they see to be the best possible education.

Computers cost money, and before much needed educational resources are spent buying expensive hardware and software, time should be spent studying the educational effectiveness of computers to determine if this is an area that is worth expanding and developing or whether it should receive less emphasis because of its relative ineffectiveness in applications.

Once the educational effectiveness of an instructional method has been confirmed, in this case the use of computers, it is important to look at student attitudes to the method. This is important for two reasons. Firstly, there is evidence to support a link between student attitudes and student achievement (see Chapter 2). Secondly, as students' school careers are a significant component of their lives, they deserve consideration in their own right. Student attitudes to school subjects and methods of instruction are important as they will have a direct effect on the quality of student experiences while at school (Ainley, Reed, and Miller, 1986).

The Use of Computers in the Classroom

Educators in both public and private sectors have demonstrated an increasing interest in the role of computers in education. This is due mainly to the development of low-cost personal computers. A few years ago computers were only available in universities and scientific establishments to those people involved in research. Now computers are readily available to the smallest of schools (Burns and Bozeman, 1981). The question still remains, however, as to whether computers are an educationally effective tool?

Computer technologies can be used in the classroom to perform a large number of activities. Robert Taylor (1980) provided a framework from which computers in education can be studied by suggesting that computers can be used as either tutor, tool, or tutee. It is this framework that is to be adopted for the present review.

The Computer as a Tutor

For the computer to function as a tutor it must be first programmed by experts in the field of study. The student is then tutored by the computer as it executes the program. This form of computer use in the classroom has been given many names, the most common being Computer Assisted Instruction. The three most common forms of CAI are tutorial, drill and practice, and simulation programs.

Early advocates of CAI proposed many advantages offered by this method of instruction. These included the promise of greater student achievement, more efficient use of human and material resources, improved attitudes toward the learning process, and a general improvement in the levels of education (Burns and Bozeman, 1981). Now that we are several decades down the CAI road it is necessary, and of interest, to pause and consider if these forecasts have been met. Unfortunately one is hampered in this process due to the lack of empirical research on the effectiveness of computers in education. In a study of factors that prevent more pervasive utilization of CAI, Anastasio and Morgan (1972) found that lack of evidence of CAI effectiveness to be among the most critical. This result is not surprising as in the early 1970's educational use of computers was not widely developed. Additional years of research efforts since that time however have failed to alleviate the dilemma (Avner, Moore, and Smith, 1980).

Much has been written about the use of computers in education. As articles are reviewed it becomes obvious that many are descriptive discussions of the benefits of using computers, reports on the experiences of the authors, and suggestions of new uses and applications for computer technology. For example, Cyert (1986) describes how a computer network system, coupled with appropriate software, should facilitate remedial learning, increase problem solving capacities, deepen comprehension, improve motivation, and stimulate learning. Sklarz (1984) describes the benefits that resulted for both teachers and students when a computer room was established at the East Ridge Junior High School. Shane (1982) outlines a history of the computers use and speculates on its future. Bear (1984) discusses CAI and the implications for school effectiveness. Melmed (1984) suggests methods for successful computer applications.

Even though this work is important it does little to validate empirically the effectiveness of CAI. As computers enjoy a high profile and maintain popularity, there is a danger that the validation of the effectiveness of computers will be overlooked (Tanner, 1984).

The confusion over the validation of the effectiveness of CAI is compounded as empirical studies comparing the effectiveness of CAI to traditional methods of instruction report inconsistent results. Most studies, however, generally conclude that a

program supplemented with CAI is at least as effective as, and frequently more effective than, an instructional program that uses traditional methods of instruction only (Magidson, 1978).

Resulting from a review of literature on the effectiveness of CAI, Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975) concluded:

1) All studies reviewed showed normal instruction supplemented by CAI to be more effective than normal instruction alone.

2) When CAI was substituted in part or in whole for traditional methods of instruction, 45 per cent of the studies showed greater achievement gains by CAI students, 40 per cent found little or no difference, while 15 per cent showed mixed results.

3) All studies showed that it took less time for students to learn through CAI than other methods.

4) There is some evidence that learning retention levels of CAI students were not as high as those of traditionally taught students.

From the literature reviewed by Edwards and his colleagues, it seems that CAI can be effective in a classroom.

Although CAI can be used effectively to supplement normal instruction, this does not indicate that CAI is a superior method of instruction to normal teaching methods. In general, when CAI is used as a supplement, the total time on the task is increased, and any increase in effectiveness over normal instruction may

be attributed to this increased time on task (Clark, 1985). It is from the results summarized in conclusion 2, where Edwards examines the substitution of CAI for normal instruction, that one can obtain an idea of the effectiveness of CAI as compared to normal instruction with both methods of instruction receiving equal learning time. The results are not unequivocal, although it does seem clear that CAI is at least as effective as normal instruction.

It would appear, from conclusion 3, that CAI is more efficient than normal instruction in that students need to spend less time on task to learn than with normal instruction methods. This increase in efficiency needs to be balanced with the fact that retention levels may not be as high for those students using CAI (conclusion 4). Edward's four conclusions suggest that although the literature gives insights into the nature and uses of CAI, one cannot conclude that CAI is more effective than normal instruction. At best it concludes that CAI may be as effective as normal instruction.

Saracho (1982), in a study of the effects of CAI on achievement and attitudes of Spanish-speaking migrant children, found that those students who participated in the CAI program had greater achievement gains than did those students who had regular classroom instruction. This result is fairly consistent with other studies. She also found, however, that students in her study did not prefer the CAI environment over

the regular classroom environment. This unexpected result was explained in terms of the different learning styles of the subjects. This may be an indication that CAI is not suitable for all students.

A number of researchers have used meta-analysis to intergrate the findings of studies on computer effectiveness. Burns and Bozeman (1981) conducted a meta-analysis of 40 studies on computer-assisted mathematics instruction. Studies had to meet 6 criteria for inclusion into the meta-analysis. The criteria were:

1) The study was one in which CAI was utilized in conjunction with mathematics instruction.

2) The study was one in which CAI was utilized as a supplement to, rather than as a replacement for, traditional classroom instruction.

3) The study was one which was conducted at the elementary and / or secondary school level(s).

4) The study was one in which respective performances of a treatment and control group were compared or in which data relative to control group predicted performance were available.

5) The study was one in which the outcome variable was a measure of student achievement.

6) The study was one in which the CAI supplementary program employed was of drill/practice or tutorial mode.

After conducting the meta-analysis Burns and Bozeman concluded:

> " While no ultimate final answers related to CAI effectiveness or guarantors of success can be presented, the analysis and synthesis of many studies do point to a significant enhancement of learning in instructional environments supplemented by CAI ..."(p37)

Kulik, Bangert, and Williams (1983) used meta-analysis to intergrate 51 independent studies that used Computer Based Instruction in grades 6 through 12. Studies had to meet 3 criteria to be included. Firstly, studies had to take place in actual classrooms in grades 6 through 12. Secondly, studies had to report on measured outcomes in both CBI and control classes. And thirdly, studies had to be free from crippling methodological flaws. The analysis revealed that, on average, students who used CBI raised their scores on final examinations by 0.32 standard deviations. In addition they reported that those students who used CBI demonstrated more positive attitudes toward school subjects and computers, and the time required for learning was reduced substantially, with increased retention levels in those students who used CBI. This is in contrast to the findings of Edwards et al. (1975) who found diminished retention levels in those students using CAI.

Hasselbring (1986) reviewed the research on the effectiveness of computer-based instruction over the last two decades. He used student achievement as the outcome measure and concluded that when CBI and traditional instruction are compared, students receiving CBI demonstrate equal or better achievement that is obtained in less time. The use of CBI also improved students' attitudes toward the use of computers.

As one considers the above analyses collectively, several trends are evident. Firstly, CAI appears to be more, or at least equally, as effective as regular teaching methods. Secondly, students require less time to learn using CAI than with regular teaching methods. There still appears, however, to be inconsistency in results about students' retention levels and students' attitudes to using computers.

Clark (1985) sounds a warning that inconsistency in the results of research into the effectiveness of computers in education may be due to the affects of 'confounding'. When comparing computerized instruction to regular classroom instruction, care needs to be exercised that the same instructional methods and same curriculum material are used so that only the medium of instruction can vary. In many of the studies cited not enough detail is given of the treatment of the control and experimental groups to determine if this is the case. Clark also suggests that novelty effects are responsible for the increased motivation shown by many

CAI groups over regular classes. This suggests that before comparisons can be properly made between groups using CAI, and those using regular methods of instruction, sufficient time must be allowed for the disappearance of any novelty effect. In the above studies this may not have been the case as many students were introduced to a computer for the first time as they participated in the study. To minimize inconsistency in research data, future researchers need to keep these points in mind when planning additional studies.

Another factor that may explain mixed results obtained from studies on the effectiveness of CAI is the effect of student personality on the learning process. Students with high affiliation have been found to achieve better in an interpersonal setting while students with low affiliation achieve better alone (Geeseman Sutter,1967). As CAI instruction normally involves individual work, it would favour those students with low affiliation. Hoffman and Walters (1982) also found that student personality affected learning with CAI. They found that CAI favours those students who have the ability to concentrate quietly, are able to pay attention to detail, have an affinity for memorizing facts, and can stay with a single task until completion. A sample of students taken from an average classroom would contain pupils with characteristics that span across these qualities. It is reasonable to expect, therefore,

differing attitudes to CAI and differing levels of achievement using CAI. Inconsistency in CAI effectiveness data may simply indicate that success with CAI is personality dependent and that confusion has resulted by researchers looking at overall student populations.

Computers are playing an ever-increasing role in the education system. Even though the effectiveness of CAI is by no means above question, it is clear they provide many potential benefits for schools as a flexible and sophisticated vehicle for instruction and testing (Clark 1985). A major question of interest is the extent to which the potential of computers in education can be realised.

The Computer as a Tool

For the computer to function as a tool it need only to have some useful function programmed into it. This can be achieved when a computer is used as a calculator in Mathematics; used to perform statistical analysis on results in Science; used as a database in such subjects as Social Science; or as a word processor in many subjects.

Two of the most common examples where computers are used as tools in the classroom are in the areas of word processing and data base activities.

For the past several years, a great deal of attention has focused on word processing as a facilitator of writing. As successful writing is a skill needed by students in most subjects, word processing has aroused considerable interest in schools.

It is widely recognized that writing and the writing process is not a simple task.

> "Even a casual analysis makes it clear that the number of things that must be dealt with simultaneously in writing is stupendous: handwriting, spelling, punctuation, word choice, syntax, textual connections, purpose, organisation, clarity, rhythm, euphony, the possible reactions of various readers, and so on. To pay conscious attention to all these

would overload the information processing capacity of the most towering intellects."
(Scardamalia, 1981)

It is claimed by advocates of word processors that the task of writing is made easier in that word processors change the physical process of writing by replacing handwriting with typing and by making revision quick and convenient. Word processors and computer networks can change the social context for writing by supporting publishing for a variety of audiences and by facilitating collaborative writing projects and sharing of work in progress. Computers can also enhance instructional interactions between teacher and student by providing the teacher a window onto the writing processes of individual students (Macarthur, 1988).

The ability to revise successfully is a characteristic of good writers (Faigley and Witte, 1981; Monahan, 1984). Studies of student writers have shown that they do little revising during the writing process (Wall and Petrosky, 1980). A number of researchers have praised word processors for providing a vechicle by which students revise and edit text more readily (Withey, 1983; Womble, 1984). These researchers claim that word processors help students to revise by reducing the frustrations of recopying, by assisting in the reading of text during the writing process, by producing neat copies from the printer, and

by the easy production of draft copies that can be shared with peers and teachers. Kurth (1987) found that while working with word processing will not automatically increase the quantity and quality of student compositions, the use of computer word processing seems to have motivational value, seems to facilitate group discussions about writing, and may help foster peer editing.

Writing is a very important activity in schools. As argued above, computers used as word processors can greatly facilitate the writing process. This application of the computer as a tool must surely rate as one of the most important computer uses in schools.

Another example of the computer being used as a tool in schools can be found in the use of databases. We live in a society that is becoming more dependent on information and information technologies. Current social and economic factors are increasingly demanding that schools include in their curriculum information skills programs. The two most common approaches adopted by schools to meet these demands involve the accessing of remote data bases via telecommunication facilities and the using of simple data base software on microcomputers.

Because of finance restrictions the first of the two approaches has not always been widely available to all schools. With the introduction of the microcomputer and the later introduction of the modem this situation is slowly changing. Education

departments in some states of Australia are working to make this type of database more readily available. An example of this is the establishment of the Tasnet computer network in Tasmania in 1975. This network has grown from the 20 terminals that were initially connected to the current figure of 500. Currently schools can access through the Tasnet system; library units, ABC programs, the AAP news service, electronic mail, The Scholastic Text and Retrieval System, and other information units. (Bell, 1985)

The second database approach involves the use of simple database software on microcomputers. Two main types of microcomputer databases are commonly found in schools. The first type are those such as the 'The First Fleet' database which contain their own data file through which students may search. The second type are those such as Appleworks or Personal Filing System in which students are required to enter their own records to create their own data files.

Are databases an educationally effective tool? Many researchers believe so. Databases have been found to encourage children to create mental categories and concepts, hypothesize and generalise, interact with others, and ask questions (Ross, 1984), encourage enquiry learning (Wills, Bunnett, and Downes, 1985), encourage the development of flexible thinking skills (Labbett, 1985), develop decision making skills (McClelland, 1986), and enhance problem solving skills (Clyde and Kirk, 1987).

While being supportive of the use of databases, some researchers point out that databases are not without their problems. Freeman, Hawkins, and Char (1985) noted that databases can be difficult and inflexible tools for novices, and because of poor teacher exposure to databases many teachers were uncomfortable with them and lacked the ability to use databases in creative ways. This is particularly important as investigations into the potential of computer based learning conclusively reinforce that it is the teacher who most contributes to the effectiveness of computer applications, not software or hardware, though they are important secondary concerns (Guttormsen, 1986). Guttormsen (1986) also found that students needed a basic level of computer awareness before being introduced to databases and many months were needed before students felt comfortable with them. Also manipulation of databases required a range of problem solving abilities that were not very well developed in primary school children.

Overall most researchers agree that databases have the potential to be a highly effective educational tool. The fact that this potential is not being fully realized at the moment is due to a general lack of understanding of the structure of a database and a lack of confidence in using them (Guttormsen, 1986).

We can be certain that as these problems are addressed and databases are developed that are better suited to the needs of the student, databases will remain as a worthwhile computing tool in the classroom.

The Computer as a Tutee

For a computer to be used as a tutee, it must be tutored by the student. To accomplish this the student must learn to communicate with the computer in a language that it understands. Many potential benefits have been given for this type of computer use. Taylor (1980) argues that firstly, because you can't teach what you don't understand, the human tutor will learn what he is trying to teach the computer. Secondly, by constructing programs through the narrow capabilities of computer logic, the human tutor will learn something about how computers work and about how his own thinking works. Thirdly, because no expensive predesigned software is needed, no time is lost searching for the software and no money is spent acquiring it. The overall effect of the use of computers as tutees is to shift the focus of education from end product to process, and from acquiring facts to manipulating and understanding them (Taylor, 1980).

Woodhouse and McDougall (1986) give two main reasons why students should learn how to program computers. The first is so that students come to appreciate that the computer is not intelligent, but logical. The second reason is to gain an understanding of and ability at problem-solving. It is widely recognized that students will not have finished their education when they leave the school system. One of the major emphasis of primary and secondary school education, therefore must be to prepare students for a

wide variety of experiences. Many of these experiences will require problem solving abilities. It is argued that learning to program a computer will greatly enhance these problem solving skills.

One of the greatest advocates of the use of the computer as a tutee is Seymour Papert. He is a Piagetian psychologist and mathematician and argues:

1. Learning environments should allow children to learn on their own and to discover things for themselves.
2. Preadolescent children think in concrete terms and their educational experiences should involve direct contact and manipulation of materials.
3. Children should be provided with opportunities to interact with other children at the same stage of cognitive development.
4. Teacher/pupil interaction should take place on an individual basis.
5. Children must be given opportunities to develop their own mental models of the world (Willis, Johnson, and Dixon, 1983).

Papert believes that the future of educational computing lies in allowing the child to teach the computer. To this end he developed the computer language Logo. Using this language children of all ages can learn to program and interact with the computer.

"We reverse the usual relationship between the computer and the student that is found in the conventional CAI situation. There, the clever program teaches the 'dumb' student. In contrast, in the Logo system, the student is required - gets a chance to - teach this dumb computer how to carry out the task in question." (Weir, 1981)

The most well known aspect of Logo is Turtle graphics. Using Turtle graphics, students control the movement of a small turtle on the computer screen by typing various commands into the computer. The main focus of this form of activity is the student teaching the computer to do something. Consider a student who wishes to create a triangle. By use of the Logo language the student can manipulate the external world to create such a shape. A student's initial attempts at the shape may not be perfect. The student is then required to rethink the program and attempt another way to attain the required shape. It is this style of learning, one that involves a process of creating, testing, modifying, and retesting, that Papert argues is the natural road to understanding.

"By building Logo in such a way that structured thinking becomes powerful thinking, we convey a cognitive style, one aspect of which is to facilitate talking about the process of thinking... In this way

the Logo culture enriches and facilitates the interaction between all participants and offers opportunities for more articulate, effective, and honest teaching relationships." (Papert, 1980, p180)

Importance of Attitudes

Students' attitudes to school and their experiences there are important. This is particularly so in recent years as students are spending more time at school. Jencks, Smith, Acland, Bane, Cohen, and Gintes (1972) commented that, as students are in school for one fifth of their lives, it would be a significant accomplishment if the quality of students' lives could be improved. Fifteen years later, the average length of a student's stay at school has increased. More than half the students who start year seven are now expected to complete six years of secondary school (Ainley,Reed and Miller,1986). Ainley et al. (1986) recognized this fact and suggested that the experience in school is a significant component for a large number of people deserving consideration in its own right. Educators need to consider students' attitudes, therefore, as they attempt to maximize the level of student experiences and increase the quality of the students' school life.

Attitudes are also important in that there is a relationship between attitudes to, and achievement in, school, although not as strong as one may at first expect. After a review of the literature on attitudes and school achievement, Jackson (1968) concluded that nearly all investigations have found no statistically significant relationship between attitudes toward school and school achievement. Maddock (1979)

conducted a study to investigate the relationship between environmental science attitudes and environmental science achievement. Little relationship was found between the attitude towards the conservation of the environment, and achievement based on classroom tests in science.

More recent studies, however, have shown that a relationship between achievement and attitude does exist. Walberg and Tsai (1985) in a study on reading achievement and attitude scores, in which data were used from 1459 nine-year old students taken from the National Assessment of Educational Progress, found that achievement and attitude correlated at 0.34. This was the largest correlation out of all the variables in the study, even though it was less than had been expected. Cannon and Simpson (1985) in a study designed to determine if seventh-grade life science students demonstrate different attitudes and different achievement levels in science concluded that science attitude was a good predictor of science achievement. Hough and Piper (1982) in a study that investigated the relationship between elementary pupil's attitudes toward science and their science achievement concluded that there was a significant relationship between the pupil's scores on the "Hough Pupil Process Test" and their scores on the "Hough Attitude Inventory" ($r=0.45$), that is, there was a significant relationship between student achievement and student attitude in science.

Wilson (1983) conducted a meta-analysis of 43 studies to determine the correlation between science achievement and attitude in students in elementary school through to undergraduate college level. The overall relationship was only moderate (0.16), however, there was a significant relationship in grades up to year eight, with mixed results thereafter. This suggests that the relationship between achievement and attitude may be age based. One explanation of this is the existence of sex differences in both attitudes and achievement in high school, while similar differences due to sex are very small during the primary years (Wilson,1983).

The literature, therefore, suggests that there is a relationship between student attitudes and achievement, even though it may not be as strong as first expected.

It should be noted that those studies discussed have all been confined to various single subject areas, and are not examining the relationship between general attitudes to school with general school achievement. It is possible that the relationships that have been found between attitude and achievement may be confined within subject boundaries. Neale, Gill, and Tismer. (1970) supported this idea when they found that attitudes toward specific subjects were more related to school achievement than is a general attitude toward school. Attitudes toward computing, therefore, may be

more closely related to attitudes toward specific subjects than it is to general school attitudes.

Students' Attitudes to Computers in Education

Many researchers studying the use of computers in education have concluded that students respond positively to CAI. Rothbart and Steinberg (1971) observed that children using CAI were enthusiastic as they proceeded at their own rate, worked at their own level of understanding, and enjoyed the immediate feedback that accompanies CAI. In general student attitudes toward CAI have been found to be positive at all levels of education: for example, Wells and Bell (1980) for primary school; Smith (1973) for junior high school; Asay and Scheider (1973) for high school; Knapper (1978), Knerr (1978), and Magidson (1978) for college students. Most studies report a 90 percent acceptance level of CAI by students.

Tatsuoka (1978) reported that in studies on Air Force trainees, those using computers displayed positive attitudes toward their course. Reasons given for these positive attitudes were that computers : a) were self paced, b) did not embarrass students who made mistakes, c) gave immediate feedback, d) left a general feeling that students learned better through the computer system, and e) were more objective than teachers.

This does not mean that the computer is the ultimate instructional tool. Personal attitudes toward using the computer in the classroom, can be critical to the success of a CAI program (Clement, 1981). Many

students have negative attitudes to computers and their use in the classroom (Pulos and Fisher,1986). It has been observed that students resistant to computer-implemented instruction at the beginning of a course learn less than they would with traditional instructional methods (Knapper, 1978). Positive attitudes are, therefore, important if optimum learning is to occur using CAI.

Several of the main factors that appear to influence student attitudes to computers are student personality, gender differences, and previous computer experiences.

Student Personality and Attitudes to Computers

Vermette, Orr and Hall (1986) found that attitudes to computers reflected personal rather than educational issues. It is not surprising, therefore, that studies have found that student personality does influence CAI effectiveness (Duby and Giltrow, 1978; Caffarella, Cavert, Legum, Shtogren, and Wager, 1980). An explanation of this may be found in a study by Charkins, O'Toole and Wetzel (1985). They noted a link between instruction styles and learning styles that affects learning and attitude towards a subject. It would seem that students with different learning styles will react in different ways to new instruction and teaching methods such as that offered by the use of computers. As mentioned above, Hoffman and Walters (1982) found that learning by means of CAI would seem to favour those who have the ability to concentrate quietly, are able to pay attention to details, have an affinity for memorizing facts, and can stay with a task until completion. These are basically characteristics of persons with a more introverted personality. Those students with more extroverted personalities were found to be more likely to drop out of CAI programs (Hoffman et al., 1982). This is probably due in part to the fact that this type of student likes variety and action, tends to pay attention to broad outlines rather than to detail, and likes team competition. This tends to make the CAI format of many programs difficult for them (Lawrence,1979).

Gender Differences in Attitudes to Computers

One of the more perplexing problems facing educators is that of sex discrepancies in students' attitudes to computers and consequent computer use. The empirical evidence for this phenomenon is a little inconsistent. Some researchers have found little or no sex differences in student attitude towards computers (Loyd and Gressard, 1984; Harvey and Wilson, 1985; Piele, 1981). Other researchers, however, have found significant sex differences in computer use and attitudes to computers. Males were found to outnumber females in computer camp attendance by a margin of 3:1 (Hess and Miura, 1985). School computer facilities were dominated by males with a male to female ratio ranging from 20:1 to 3:2 (Lockheed, Nielson and Stone, 1983; McKelvey, 1984; Collis, 1984). Males report more frequent use of computers and have greater access to them (Fetler, 1985; Fitzgerald et al. 1985; Demarest and McKenzie, 1984; Lockheed et al.,1983; Lockheed, 1985; Wilder, Mackie, and Cooper, 1985).

These sex differences in computer use are also paralleled by similar differences in attitudes toward computers. Studies have revealed that males have more positive attitudes toward computers than do females (Fetler, 1985; Chen, 1985; Collis, 1984; Demarest et al., 1984; Fitzgerald et al., 1985; Makros, 1984; Lockheed et al.,1983; Wilder et al., 1985).

These sex differences may be accounted for in a number of ways. Loyd and Gressard (1984) noted that positive attitudes to the computer were significantly related to computer experience. Males may have more enjoyable experiences on the computer as they spend significantly more time playing computer games and programming than do females (Kiesler, Sproull, and Eccles, 1983; Lockheed et al., 1983; Lockheed, 1985).

A bias in software may also explain the sex discrepancy in student attitudes and computer usage. Much of the software written today has a bias toward male preferences for competition, aggressiveness, violent action, loud noises etc... (Boss, 1982; Fisher, 1984; Sanders, 1984; Lockheed, 1985; Marrapodi, 1984). Males, therefore, will use this software more and also derive greater enjoyment from computer use.

Associations also may encourage the sex difference. Computers are usually associated with Mathematics and Science which many females feel are male activities (Hawkins, 1985; Marrapodi, 1984; Sanders, 1984). Computers are seen as machines and consequently as a male dominated and unfeminine area (Sanders,1984). Females also fail to associate women with computers because few women in print and in television media are shown using computers (Sanders, 1984; Ware and Stuck, 1985). Societal pressure on females to give way to males when working with computers is encouraged by many parents and peers and has been shown to be one of the strongest negative

influences on female attitudes to computers (Gilliland, 1984; Lookheed, 1984; Marrapodi, 1984; Sanders, 1985).

Winkle and Matthews (1982) noted that women's socialization makes them less receptive towards computers and, therefore, women require special treatment to reduce anxiety and enhance learning when using computers. Because of this socialization, females prefer human rather than machine rewards, avoid competition with boys, and have more interests that compete for their spare time, all of which enhance negative attitudes towards computers (Fisher, 1984; Sanders, 1984).

School logistics also influence female attitudes to computers. Because computers are usually placed in the Mathematics classroom; are usually arranged in regular rows that discourages the communication that girls prefer; are restricted in number and, therefore, suits the more aggressive computer users (usually boys); and mostly taught by male teachers, females are further influenced away from these machines (Boss, 1982; Hawkins, 1985; Marrapodi, 1984; Sanders, 1984).

If the problems that hinder female usage of computers and result in more negative attitudes toward computers by females can be solved, females can become as competent as males in programming and computer related skills (Linn, 1985).

Computer Experience and Attitudes to Computers

Experiences that students have with computers have an effect on their attitudes to computers. The amount of computer experience and exposure students have with computers is positively correlated with their attitudes to computers (Cartwright, 1976; Diem, 1985; Ellsworth and Bowman, 1984; Enochs, 1985; Loyd and Gressard, 1984). Clement (1981) supports this when he reported that student attitudes to computers were not the result of a "Hawthorne Effect". More positive attitudes were found with increased exposure to computers and did not seem to be related to the uniqueness of the experience. Harvey and Wilson (1985) in a study of gender differences in attitudes towards microcomputers concluded that there was a difference between owners and non-owners. This could be explained in terms of computer exposure. One would expect owners to have had more experience and exposure than non-owners.

The quality of the experience with computers is also important. Mathis, Smith and Hansen (1970) report that students' attitudes to computers were related to the type of experience they had while working with computers. More positive attitudes came from those students who had a higher quality of experience. This may in part explain some of the gender discrepancies. Girls usually do not have the same quality of experience as boys when using a computer as they are often performing tasks and using software that has a strong male bias.

Students' Attitudes to Technology in Education

Technologies are having a large impact on education in Australia. Although there are a large number of different technologies used world wide, those that are used in education can be grouped in five main categories. They are; print technology, telecommunications, motion picture and video technologies, computer technologies, and biological manipulation (Anandam and Kelly, 1981). Those having the greatest impact in education are in the microelectronics and telecommunications areas (Arnold,1985). The most obvious example of this is the introduction of the microcomputer into the classroom.

While many people view these new technologies positively, some people have a negative reaction towards them. In education, some people demonstrate negative attitudes to both telecommunications and microelectronics. Jay (1981) recognized one example of these negative attitudes when he defined "computerphobia" as a resistance to talking about computers or even thinking about computers, fear or anxiety towards computers, and hostile or aggressive thoughts about computers. Although Jay described this condition in relation to teachers and instructors, it is likely that some students may suffer from a similar reaction to technology. One of the main reasons listed for "computerphobia" is a failure by the person involved to keep up with the technology and/or the

lesson in which the technology is used. A solution may be found in adopting a mastery approach to learning in this subject. Using this approach, all students are required to have mastered the lesson before the class is allowed to proceed to the next lesson. This will ensure most students will keep up with the lesson and eliminate one of the main causes of "computerphobia".

Females in particular possess negative attitudes toward new technologies (Reiman, 1986). These attitudes often prevent them from maximizing the educational potential of the new technologies in their lives. Jackson (1985) found that enjoyment levels were very important in female's attitudes to technology. If females are to have more positive attitudes toward new technologies their enjoyment level must be raised. This can be accomplished by moving the image of new technologies away from that of a male dominated domain, using computer software that is less male biased, and improving the access of females to new technologies (Lockheed et al., 1984).

Diem (1985) in a study of children's attitudes to new technology concluded that student behaviour patterns while working with new technology, seemed directly related to previous experiences with computer games and other popularized forms of technology. To encourage positive attitudes to new technologies it is important, therefore, to facilitate student interaction with them. As over half of all Australian schools now possess microcomputers (Arnold, 1985), more students

should be interacting with new technologies and more positive attitudes should develop. This was noted by Jackson (1985) when she reported that younger women, who had more exposure to new technologies, had more positive attitudes to new technologies than older women who had less exposure.

Technological change, and people's attitudes to it, is important if any country is to remain competitive in our modern world. Arnold (1985) recognized this when he commented:

> "Technological change is a significant aspect of the major social and economic changes that are affecting all aspects of Australian life. Education is being challenged to respond: to provide the confidence and skill needed to benefit from what new technologies offer, while at the same time developing the understanding and commitment to protect those aspects of our lifestyle that are most valued." (p.1)

Computer Use in Australian Schools

Use of computers in Australian schools has changed markedly over the last few decades. Initially computers were only to be found in tertiary institutions. Since their introduction in the early 60's they have become a major asset to both undergraduate and postgraduate students. By 1972 the Universities Commission was able to report that:

> "The Commission made its first recommendations for grants for computing equipment in the 1961-1963 triennium. Since that period the importance of computing in the teaching and research activities of the universities has grown steadily. There are now few areas of academic work in which computing does not play some role."
> (University Commission Fifth Report, 1972)

Wearing, Carss, and Fitzgerald (1976) reported that computers were in wide use in tertiary institutions with the nature and extent of the instructional applications depending upon the computing resources available to particular institutions. They also noted that while there appears to be no activity in primary schools, all States of Australia were supporting the development of computer applications in secondary schools. These developments were mainly in

the field of computer studies, simulations, and computer managed instruction projects.

More current reports studying the use of computers in Australian schools have been conducted at the State level and therefore vary in detail and are difficult to collate. Anderson (1984) noted that the States differed in that some have supported computing in schools over a longer period than others. Those States that have been involved in computing for the longest periods have adopted a more centralised approach. The States differed in the amount of computer equipment in schools and the States differed in the amount they subsidised equipment purchased in their schools.

Fitzgerald, Hattie, and Hughes (1985) conducted a survey of a thousand schools throughout Australia. The sample was a proportional stratified random sample based on metropolitan / country, primary / secondary, government / Catholic / independent, and State or Territory. The response rate was 82 per cent. Of the schools surveyed, 67 per cent had some computer activities in their school. There were more secondary schools with computer activities (98 per cent) than primary schools (57 per cent).

At the student level it was found that in the schools that had computers 43 per cent of the students were regular users while only 20 per cent were classified as non-users. The distribution across the grades indicated that regular use of computers peaks in the latter years of primary school, and regular use of

computers is not maintained as students enter secondary school.

The type of computer use varied between primary and secondary schools. In primary schools, the most frequent activities were drill and practice (72 per cent of the schools who had computers), word processing (64 per cent), simulation and games (63 per cent), Logo (48 per cent), use in Mathematics and Science (48 per cent), and computer awareness (45 per cent). The least frequent activities were programming (15 per cent), computer clubs (15 per cent), computer managed learning (8 per cent), and spreadsheets (7 per cent).

In secondary schools, the most frequent activities were programming (83 per cent), word processing (76 per cent), computer awareness (71 per cent), data bases (61 per cent), simulation and games (59 per cent), in Mathematics and Science (59 per cent), drill and practice (56 per cent), and year 11 and 12 specialist courses (52 per cent). The least frequent activities were in computer clubs (44 per cent) and computer managed learning (16 per cent).

Besides from academic uses, schools are using computers for administration (40 per cent), and in libraries (19 per cent).

Fitzgerald et al. (1985) also reported that the trend in both primary and secondary education was a movement away from the 'tutee' role of the computer toward the 'tutor' role and even more so toward the 'tool' role. This is reflected in the increasing use

of word processing and databases and the high use of drill and practice strategies, and the declining use of computer managed learning and programming.

Conclusions

Computers have entered the classroom at a rapid rate during the last decade. This has not always been in response to educational demand but in part as a result of community pressure and the marketing strategies of large computer firms. Although these new technologies are reported to offer many benefits to education, their introduction needs to be kept in perspective. It is important that technological innovation is recognized as a means of providing a better education and does not become an end in itself. Technology should not be introduced unless educational benefits are sought as probable outcomes.

One needs to spend some time, therefore, examining the educational effectiveness of the use of computers. Although the promises of early advocates of CAI have not been fully met, it does appear that, at least, computers can effectively supplement regular teaching and thus release the classroom teacher for other duties. More empirical research needs to be conducted in this area.

Student attitudes are of importance in education. As students spend a significant component of their lives in school, their attitudes while at school deserve consideration in their own right. Increasing use of computers means that attitudes in this area should be carefully studied. There is also some evidence to support a link between attitude and

achievement. When individual school subjects are considered separately, the relationship between attitude and achievement appears much stronger than when general school attitudes and general school achievement are compared.

There is general agreement that student attitudes to computers have been positive at all levels of education. Attitudes to computers are critical in that they can directly affect the success that students have using computers. There are three main factors that appear to influence these attitudes, the first of these being student personality. Those students who are more introverted seem to be able to work better using CAI. Secondly, gender differences play a large role in determining students' computer attitudes. Males usually have been found to have much more positive feelings about using a computer than females. This can be attributed to increased exposure to computers by males over females, bias in software towards males, societal associations and pressure that encourages male use of computers, school logistics, and women's socialization patterns. Thirdly, previous computer experience was found to influence computer attitudes with those students with the most amount of computer experience having the most positive attitudes.

New technology is continually being introduced into the education system. Many people have positive attitudes to the use of any new technology, however, some people are found to have negative attitudes.

"Computerphobia" is one term used to describe negative attitudes toward computers and technology with computers likely to be the major representation of the new technology that will be encountered in education. This is caused primarily by failure of the phobic to keep pace with this technology. Females in particular are found to suffer from negative attitudes toward technology. This was found in part to be caused by low enjoyment levels experienced by females when using new technologies. This can be remedied in part by removing the male bias that is associated with a lot of new technologies and increasing female exposure to new technologies.

From this review of the literature it is obvious that there is evidence to suggest strong links between sex, age, personality, computer experience, attitudes to subjects, attitudes to teachers, attitudes to technology, and attitudes to computers.

The research further suggests that some of these links are causal in nature. Both sex and personality have been found to have definite causal relationships with computer experience, and also with students' attitudes, namely, attitude to school subjects, attitudes to technology and attitudes to computers. Computer experience has been found to have causal links with attitudes to technology and attitudes to computers. Finally, both attitudes to school subjects and attitudes to technology have been shown to have a causal relationship with attitudes to computers.

A causal model was developed to test the relationships between the above mentioned variables. The development of constructs of this proposed model, and the suggested paths, are discussed in detail in chapter 3.

CHAPTER 3

TOWARDS A CAUSAL MODEL

Development of a Causal Model Causal modeling has become a popular analytical tool in Education. Bourke (1984) outlined the functions of a causal model.

> "The model should specify the relationships between the independent and dependent variables and make explicit the hypothesized relationships between the independent variables themselves. In particular, causal modeling has the potential for increasing our understanding of these relationships." (p30)

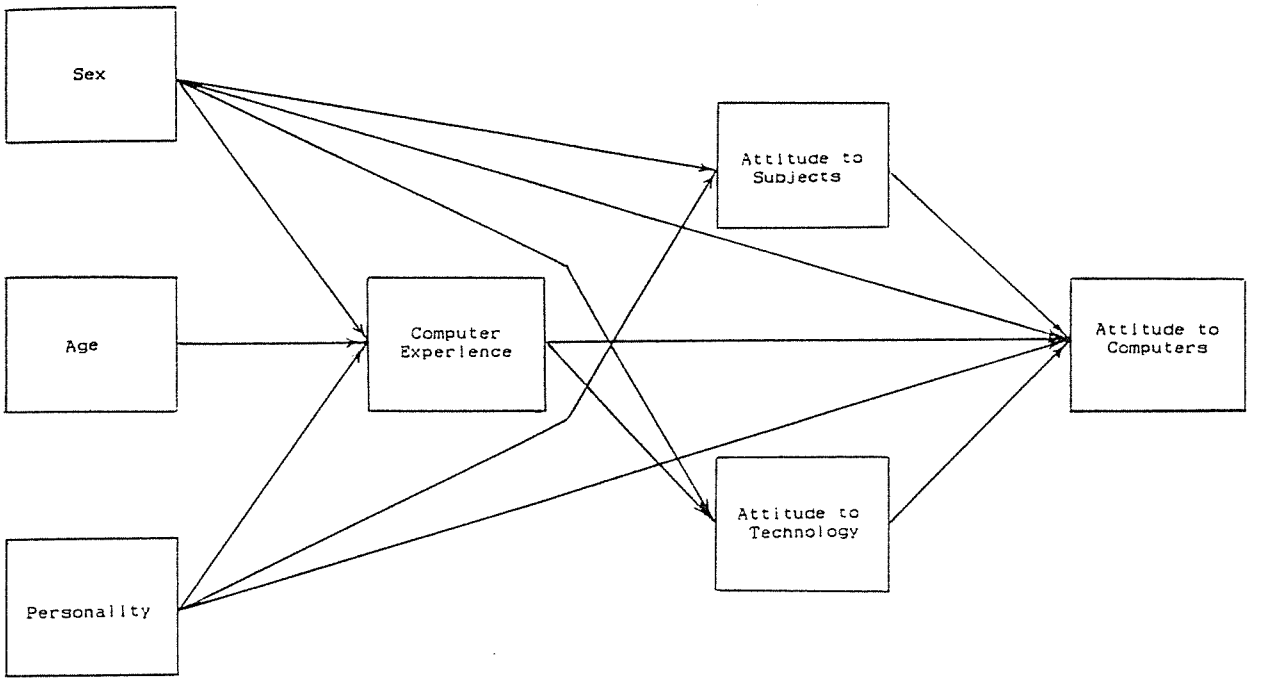
After considering the results of previous studies (see chapter 2), and relevant conceptual relationships, it was decided that evidence existed to support the inclusion of a range of background and intermediate variables in a model that attempts to explain secondary students' attitudes to computers. The model was developed so that postulated causal relationships could be tested. Within the model, prior events may influence subsequent events. It should be understood that this model is but one of several that could be developed to test the relationships of interest. Eleven variables were included in the model: five manifest variables, and six latent variables. They are listed in Table 3.1.

TABLE 3.1

Manifest Variables	Latent Variables
Sex	Personality
Age	Attitudes to Technology
Home use	Attitudes to Mathematics
School use	Attitudes to English
Other use	Attitudes to Science
	Attitudes to Computers

Manifest variables are specific variables about which data will be gathered. Latent variables are comprised of a number of manifest variables which have been postulated to measure different aspects of the latent variable. The manifest variables that finally make up each latent variable were selected using a factor analytic method, with those manifest variables having high commonalities and factor loadings being accepted for inclusion.

FIGURE 3.1



For discussion purposes, some of the variables have been grouped into blocks. Three manifest variables have been grouped in a Computer Experience block, and three latent variables have been grouped in an Attitudes to Subjects block. The proposed causal model is found in Figure 3.1.

The remainder of this chapter will be spent defining the manifest variables, latent variables, blocks, and the causal paths, found in the proposed model.

Defining the Constructs

Sex Sex is a manifest variable that has been shown to have important relationships with several latent variables and blocks in the proposed model. A direct path is expected from Sex to Computer Experience as males have been found to spend significantly more time using computers than females (Demarest et al., 1984; Fetler, 1985; Lockheed et al., 1983; Lockheed, 1985; Wilder et al., 1985).

A direct path is also expected from Sex to Attitudes to Subjects as males are known to have more positive attitudes to Mathematics and Science than females (Brush, 1980; Fennema, 1980; Hawkins, 1985; Taylor, 1983).

As females possess negative attitudes toward new technologies, a direct path is expected from Sex to Attitudes to Technology (Reiman, 1986; Jackson, 1985).

As microcomputers are one of the latest forms of technology to find their way into the classroom, a direct path is expected from Sex to Attitudes to Computers. Studies have confirmed that males have been found to possess more positive attitudes toward computers than females (Chen, 1985; Collis, 1984; Demarest et al., 1984; Fetler, 1985; Makros, 1984; Lockheed et al., 1983; Wilder et al., 1985).

Age Age is the second of the manifest variables, and a direct path is expected between Age and Computer Experience. It is impossible to remove an experience

from one's life once it has occurred. With over half of all Australian schools now possessing computers, and offering some form of computerised instruction, it is assumed that as students spend more time in school, their total amount of computer experience will increase.

At the present time this relationship may not be as well defined as first expected. Because computers are a relatively new innovation, some students were already in upper high school before they had exposure to these machines. At present the situation exists, therefore, where students of different ages have had equal amounts of computer experience. As time continues this confusing result should disappear as students are able to interact with computers from the earliest years of school and increase their total amount of computer experience as they continue through school.

Personality Personality, included as an extroversion / introversion scale in the model, is a latent variable and direct paths are expected between Personality and Computer Experience and Personality and Attitudes to Computers. More introverted students were found to have more positive attitudes toward computers than extroverted students (Hoffman et al., 1982). Overall, introverted students were found to have more computer experience. In contrast to this, extroverted students were found to be more likely to drop out of computer

classes (Hoffman et al., 1982; Lawrence, 1979). A direct path is also expected from Personality to Attitudes to Subjects (Holder and Wankowski, 1980).

Computer Experience Computer Experience is a block that contains three manifest variables representing different types of experience, namely; School use of computers, Home use of computers, and Other use of computers (not at home or school). These three variables are expected to cover the entire range of computer experiences available to students.

The amount of computer experience students have is positively correlated to their attitudes to computers (Cartwright, 1976; Diem, 1985; Ellsworth et al., 1984; Enochs, 1985; Loyd et al., 1984). Also students' attitudes to technology were found to be directly related to their previous experiences with computers and other popular forms of technology (Diem,1985). Direct paths, therefore, are expected from Computer Experience to Attitudes to Computers and from Computer Experience to Attitudes to Technology. As the different types of computer experience may be related to attitude in different ways, they have been kept separate. It may prove subsequently possible to group them into a single latent variable.

Attitudes to Subjects Attitudes to Subjects is a block containing three latent variables. These are; Attitudes to English, Attitudes to Mathematics, and Attitudes to Science. These three subjects were chosen

for inclusion in the study as there may be differential effects for subjects. Computers are often associated with Mathematics and Science (Hawkins, 1985; Marrapodi, 1984; Sanders, 1984). Because of this close association it is reasonable to expect that attitudes toward these subjects will be reflected in attitudes to computers. Computers are operated by means of a computer language. English was included in an attempt to determine if students' attitudes to a language will influence their attitudes to computers. Direct paths are consequently expected from Attitudes to the various Subjects to Attitudes to Computers. If no differential effects are found between the three subjects it may be possible to combine them in a single latent variable.

Attitudes to Technology The use of technology is becoming more extensive in our present society. In education, one finds that technology is used in five main ways: print technology; telecommunications; motion picture and video technologies; computer technologies; and biological manipulation (Anandam and Kelly, 1981). As computers are one of the most extensively used kinds of technology in education, one can expect that attitudes to technology and attitudes to computers to be related. A direct path, therefore, is expected from Attitudes to Technology to Attitudes to Computers.

Attitudes to Computers Attitudes to Computers is the latent outcome variable in the proposed model. As students may have different attitudes to different

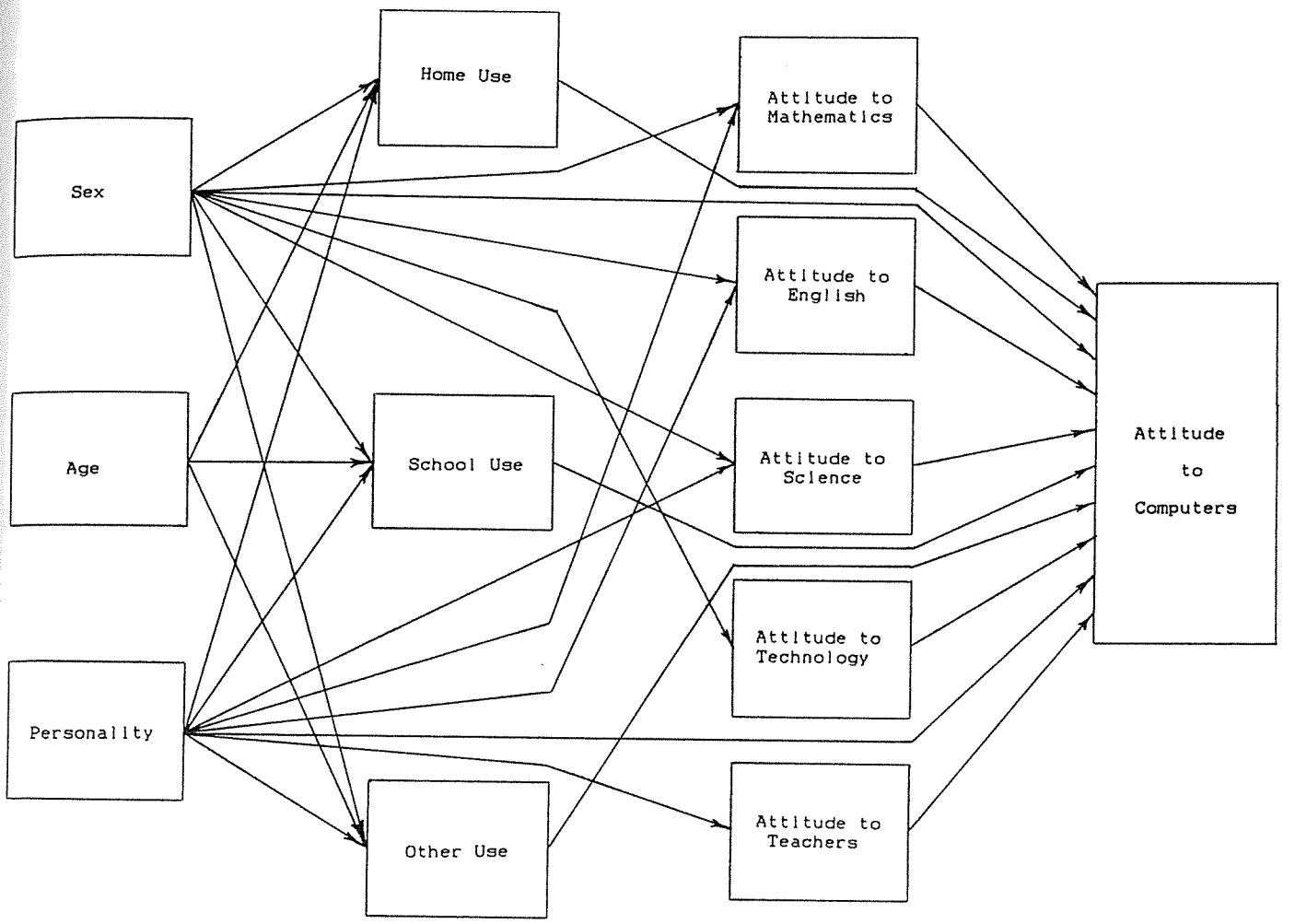
aspects of computing, it is possible that this outcome variable may need to be split into several constituent outcome variables in the analysis of the model. In particular, computer liking and computer confidence are investigated. A separate analysis may need to be conducted for each.

It expected that Attitudes to Computers will have direct paths leading to it from Sex, Personality, Computer Experience, Attitudes to Technology, and Attitudes to Subjects. These paths were previously discussed in this chapter.

Causal modelling is intended to reveal both direct and indirect effects (Bourke, 1984). The more complex model showing all manifest and latent variables is shown in Figure 3.2. In this more detailed model, it can be noted that most of the variables have direct paths to the outcome variable. Some also have indirect paths to the outcome variable.

The model in Figure 3.2 formed the basis for the collection and analyzing of data in this study. This model was further developed as relationships between the variables emerged from the data.

FIGURE 3.2


Home Use
Attitude to Mathematics
Sex
Attitude to English
Attitude to Computers
Age
School Use
Attitude to Science
Attitude to Technology
Personality
Other Use
Attitude to Teachers

CHAPTER 4

RESEARCH METHODOLOGY

The Sample

One sample of Year 9 and 10 students, and one sample of Year 10 students only were used in this study. The first sample was made up of 228 Year 9 and 10 students obtained from three secondary schools in Sydney and the Hunter Valley. This sample was used in the preliminary study. The second sample was made up of 379 Year 10 students obtained from three secondary schools in the Hunter Valley and was used in the major study. It was decided to concentrate on Year 10 students only in the major study. Year 10 is the last year of compulsory education for most students in N.S.W. and although the time when students can leave the N.S.W. education system is age-based, most students stay at school until the end of Year 10 and thereby complete their school certificate. For example in 1983, in Australia, 94 per cent of the males and 95 per cent of the females, that commenced Year 7 continued into Year 10 (Karmel, 1985). A Year 10 sample, therefore, should be relatively unbiased and representative of the general school population.

Schools were selected for the study to provide a range of educational institutions representative of those in N.S.W. In all, six schools (four private and

two state), 29 classes, and 607 students were involved in both the preliminary and the major studies.

Previous Development of Instruments

Attitudes to Computers One of the main purposes of this study was to develop a reliable instrument that can be used to determine students' attitudes to computers in Australian schools. To this end, some of the more interesting and useful studies conducted outside Australia, where the majority of work in this area has taken place, are discussed below. It is by synthesizing these studies that it was hoped a valid and reliable measure of attitudes to computers would be gained.

Loyd and Gressard (1984) developed a 30 item computer attitude scale. It consisted of three 10 item subscales namely: anxiety about computers, liking of computers, and confidence with computers. These 30 items were selected from a pool of 78 items by a panel of judges. The items were then given to 155 students in Years 8 through 12 in a reliability and factorial validation study. The scales were found to be reliable with alpha coefficients of 0.86, 0.91, 0.91, 0.95, for computer anxiety, computer liking, computer confidence, and the total score, respectively. The scale usually takes about 10 minutes to administer and, therefore, was found to be a convenient means of measuring student attitudes toward learning about and using computers.

Loyd and Loyd (1985) took this scale and added another 10 item scale to measure computer usefulness. This last scale was a measure of teacher attitudes to computers. A study was carried out to validate the now 40 item computer attitude scale. The subjects for this study were 114 teachers of children from Kindergarten through to Year 12. With this fourth scale added the alpha reliability for the total test still remained at 0.95. Because of a high correlation between the computer anxiety and computer confidence subscales, a three factor solution was specified which accounted for 48% of the total variation.

Reece and Gable (1982) developed a 10 item scale to measure general attitudes to computers. Continuing from the work of Triandis (1971) in which he stated that attitudes have three components, cognitive, behavioural, and affective, Reece and Gable constructed 36 items based on these three aspects. The items were reviewed by five judges who edited the items and assigned them to one of the three attitude components. This activity resulted in 30 items. A five point Likert scale was then used to gauge responses. The scale was then given to 233 junior high school students and from the analysis a ten item scale measuring general attitudes to computers was obtained. The reliability of this scale was found to be 0.87 .

Ellsworth and Bowman (1982) developed a 17 item scale to measure student beliefs about computers. A series of questions about computers developed by Ahl

(1976) was administered to a sample of 31 college students and to a sample of 109 students taking an introductory biology course. The students were asked to respond to the questions using a five point Likert scale. Based on the results, a 17 item scale was developed to measure student beliefs about computers. The reliability of this scale was found to be 0.85.

Bannon, Marshal, and Fluegal (1985) developed two seven item scales, one cognitive and the other affective, to determine attitudes to computers. The computer attitude scale consisted of 11 items drawn from Ahl (1976) and six items developed by Bannon and colleagues. Nine of the items were cognitive and eight were affective. The scale was then administered to 1811 students and 714 educators and participants were asked to respond on a four point Likert scale. A two factor solution was obtained, one cognitive and one affective, with seven items loading on each factor. The reliability of both scales was near 0.90 .

Moore (1985) developed a questionnaire to measure secondary school pupil's attitudes to computers and robots. From a large initial pool of items, 110 were selected as best representing the eight scales of school, leisure, career, employment, social, threat, future, and people, as they relate to computers and robots. All items used a five point Likert scale with approximately equal numbers of positive and negative statements. After a pilot administration to 994 pupils, the instrument was revised to contain 72 items

and to use a four point Likert-type response scale. After field testing of the revised instrument on 320 pupils, it was again modified, and the final instrument contained 64 items with reliabilities for the eight scales ranging from 0.711 to 0.885. The reliability for the whole instrument was found to be 0.949.

Overall the standard of instruments mentioned above seems to be very good with all the studies reporting acceptable face validity, and high reliabilities for their scales. Unfortunately none of the instruments has been used in Australian schools and, therefore, a cultural bias within the items of the instruments cannot be discounted. While some of the instruments have been designed for secondary school students (Loyd and Gressard (1984), Reece and Gable (1982), Bannon et al. (1985), and Moore (1985)), other studies used samples from universities and from educators at all levels of education. These latter studies are likely to contain an age bias and would need trialling at the secondary level to remedy this. These studies, however, form a strong basis for the development of an instrument that will measure some of the different aspects of students' attitudes to computers in Australia.

Attitudes to School Subjects Gable and Roberts (1983) developed a measure to determine attitudes toward school subjects. Thirty items were written to reflect two dimensions of attitudes towards school

subjects: General Interest and Usefulness. The 30 items were then reviewed by four faculty members from the University of Connecticut and the scale was edited to a 23 item scale. The scale was then administered to 893 high school students and they were asked to respond to a five point Likert scale. A three factor solution was obtained to measure: general interest, usefulness, and relevance, which explained 53% of the variance. The alpha coefficients were 0.94, 0.70, and 0.59 respectively. The scale was tested in the Social Science area, however, it has been written so that it can apply to any subject area. In the present study the general interest scale, which contains 11 items, was used. This scale was considered to be of most use and also reported a high reliability of 0.94. The other two scales in the instrument were not used as it was felt the information supplied by these scales was not required. Also the reliabilities of these latter scales was borderline for acceptability.

Personality Eysenck developed the Maudsley Personality Inventory (Eysenck, 1959). This inventory was based on the factor analysis of various different sets of items. The Eysenck Personality Inventory (Eysenck, 1964) developed from this instrument and contains three scales to measure two major dimensions of personality, extroversion and neuroticism, and a Lie scale. The reliabilities of the three scales were found to be between 0.84 and 0.94. The extroversion

scale consisting of 13 items was included in the present study.

Attitudes to Teachers Ainley, Reed and Miller (1986) further developed a scale first proposed by Williams and Batten (1981) to measure different aspects of school life, including secondary students' perceptions of their relationships with their teachers. This scale contained six items and used a Likert response scale. The reliability of the scale was found to be 0.83. This scale was included in the study without alteration and, as it had been developed and used in Australia, was not trialled in this study.

The Preliminary Study

Of the eight scales used in the major study, four were existing scales, three were modifications of existing scales, and one was an original scale. A preliminary study was conducted to trial the original and modified scales and enable further development of them as necessary.

Instrument The preliminary instrument (Appendix 1) contained introductory instructions and questions to determine the subjects' sex, age, year at school, and previous computer experience. This was followed by a 48 item instrument to determine student attitudes to computers. This instrument was based on the four scales of computer liking, computer anxiety, computer confidence, and computer usefulness (Loyd and Loyd, 1985). It used a four point Likert response scale. Items for these scales had been compiled from the various computer attitude measures listed earlier in this chapter plus some original items written for the study. The computer liking scale contained 13 items, the computer confidence scale contained 10 items, the computer anxiety scale contained 10 items and the computer usefulness scale contained 15 items.

Following the computer attitude scale was an original eleven item scale to determine student attitudes to technology. This instrument also used a four point Likert response scale.

The last scale in the instrument was a 24 item scale to measure personality extroversion. This scale had been taken from the Eysenck Personality Inventory (Eysenck, 1964) and used a two point (yes or no) response scale.

Sample A sample of Year 9 and 10 students was used in the preliminary study. It was made up of 228 students from 10 classes in three schools in the Hunter Valley and Sydney Metropolitan areas.

Analysis and Development of Scales The data collected from students involved in the preliminary study were analysed using a principal components factor analysis and alpha reliability testing (SPSSx Users Guide, 1986). T-tests were used to establish that there were no significant differences between the levels of responses to the respective scales of the Year 9 and Year 10 groups and, therefore, they did not need to undergo separate analyses in the study.

The factor loadings for each of the retained items in each of the scales in the preliminary study are listed in Appendix 1. Items were discarded if they failed to load on the appropriate factor for which they were designed or load on more than one factor. After a factor analysis of the 'attitudes to computing' instrument, two factors were obtained with an eigenvalue greater than one. The first (computer liking) contained eight items and had a reliability of

0.86. The second factor (computer confidence/anxiety) contained six items and had a reliability of 0.81.

Of the original 13 items intended to form the computer liking scale, numbers 11, 14, 15, 19, and 21 were discarded. The coalescence of the computer confidence/anxiety scales was not surprising as Loyd and Loyd (1985) found a high level of correlation between the computer confidence and computer anxiety scales with items from the two scales loading at opposite ends of the same factor. The same phenomenon occurred in this study with the computer confidence and computer anxiety scales combining in one factor to form a computer confidence/anxiety scale. Of the items originally intended to form the confidence and anxiety scales, numbers 5, 7, 12, 16, 18, 20, 27, 28, 29, 31, 32, 34, 45, and 47 were discarded as the single confidence/anxiety scale was formed.

The items intended to form the computer usefulness scale failed to load on one factor only, and the scale, which included items number 2, 4, 10, 13, 17, 23, 24, 26, 33, 35, 36, 40, 43, 44, and 46, was removed from the study. These items were developed from items used to determine American college students' and teachers' perceptions of the usefulness of computers and obviously need a different type of development before they are ready to be used with Australian secondary school students.

Factor analysis of the technology scale gave one factor with an eigenvalue greater than one. Items

number 2, 3, 4, 8, and 9 were removed from those intended to form the scale to give one factor that contained six items and had a reliability of 0.73 .

Factor analysis of the personality scale gave a one factor solution. Of the 24 items intended to form the scale, numbers 1, 3, 7, 9, 13, 14, 15, 16, 18, 20, and 22 were removed to leave one factor containing 13 items with a reliability of 0.71 .

Summary statistics for these final scales, as developed in the preliminary study, are found below in Table 4.1.

TABLE 4.1

SUMMARY STATISTICS FOR FINAL SCALES

Scale	No. Items	Reliability
Computer Liking	8	0.86
Computer Confidence	6	0.81
Technology	6	0.73
Personality	13	0.71

The Major Study

Instrument The instrument used in the major study (Appendix 2) contained introductory instructions and questions to determine the subjects' sex, age, and year at school. Following these were six questions designed to determine the students' previous computer experience. Two of the questions asked about home computer use, three asked about school computer use and the final question asked about the use of computers other than at home or at school. Of the six questions, three used a two point response scale, while three used a five point response scale.

This was followed by the revised 14 item 'Attitude to Computers' instrument. It contained the two scales of Computer Liking (8 items) and Computer Confidence (6 items) and used a four point Likert response scale.

Three 11 item scales to determine student attitudes to school subjects (Gable and Roberts, 1983) were next in the instrument. These scales were used to determine student attitudes to Mathematics, English, and Science. Each of these scales used a four point Likert response scale.

An introductory paragraph on technology and the six item Technology scale followed the Attitude to Subject scales. This scale also used a four point Likert response scale.

The instrument concluded with a six item scale to determine student attitudes to their teachers

(Ainley,1986), which used a four point Likert response scale, and the revised 13 item personality scale, which used a two point response scale (yes or no).

Sample A sample of Year 10 students was used in the major study. As the researcher had to travel to each of the schools to administer student questionnaires, the sample was restricted to a total of three government and non-government schools in the Hunter Valley. Permission to conduct the study was received from the N.S.W. Department of Education's Research in Schools Committee, and each of the Principals of the selected schools was approached with a request for the participation of their Year 10 students in the study. Copies of the student questionnaire were delivered to schools, before giving the questionnaire to the students, so that the principal and staff would more fully understand the purpose and nature of the study and the demands that would be placed upon them and their Year 10 students.

The sample was eventually made up of 379 students from 19 Year 10 classes in three schools in the Hunter Valley.

Analysis Once the data from the students were collected and coded, a descriptive analysis of all the items was carried out and a correlation matrix was used to study bivariate relationships. Multivariate analyses were then undertaken to develop scales using factor analysis and reliability testing. Multiple linear regression

was used to investigate possible causal relationships in the block-recursive model outlined in Chapter 3. Standardized partial regression coefficients were calculated to test the model and to indicate the strength of both direct and indirect relationships found within the model.

Detailed discriptions of all variables measured by the questionnaire and found within the model are discussed in Chapter 5.

CHAPTER 5

DESCRIPTIVE ANALYSIS OF STUDENTS

Before proceeding to consider relationships between variables and blocks in the proposed model, it is necessary and informative to look at the responses to the individual questionnaire items. These items have been grouped into four categories: student background, student use of computers, student attitudes to subjects and to technology, and student attitudes to computers.

Student Background

School Student responses were collected from three schools in the Newcastle and Hunter Valley region. School 1 was a co-educational government high school. It had a single computer room which contained 16 Apple 2e microcomputers. School 2 was a non-government male only school for Years 7 through 10, and a co-educational school for Years 11 and 12. This school had a single computer room which contained 26 apple 2e microcomputers networked to a hard disk. School 3 was a co-educational government high school. It had a single computer room which contained 13 apple 2e microcomputers. Thus the schools were similar in their provision of computing with the non-government school having a slightly better provision. In each of the

three schools teachers were free to reserve the computer room for the use of their respective classes.

It was necessary to determine whether the data collected from the three schools had to be analyzed separately due to differences between the schools in key areas. T-tests were conducted using a 0.05 confidence level to determine if there were significant differences. Variables that were found to have a significant difference are shown in Table 5.1.

Although some significant differences existed, overall it was evident that there was little significant difference between the three schools and, therefore, all student responses were treated as one sample for the remainder of the study.

The fact that School 2 had only boys in Year 10 could have led to some of the other significant differences between the schools. The most obvious of these was a significant difference between School 2 and the other two schools in attitudes to teachers with School 2 boys having a less favourable attitude. Also, significant differences between School 2 and the other schools in attitudes to Mathematics and Science could be attributed to sex related factors, with School 2 students again having less favourable attitudes. Significant differences in the amount of student computer use at school can be directly related to the ratio of computers to students at each of the schools in the study.

TABLE 5.1

SUMMARY STATISTICS FOR SIGNIFICANT DIFFERENCES BETWEEN SCHOOLS

Variable	School	Mean	S.D.	2-Tail Prob
Sex	1	1.48	0.5	
	2	1.00	0.0	0.00
Sex	2	1.00	0.0	
	3	1.57	0.5	0.00
School Use of Computers	1	2.55	1.5	
	2	2.00	0.5	0.00
School Use of Computers	1	2.55	1.5	
	3	2.11	1.5	0.02
Attitude to Science	1	2.86	0.7	
	2	2.57	0.7	0.00
Attitude to Mathematics	1	2.29	0.7	
	3	2.55	0.7	0.00
Attitude to Mathematics	2	2.35	0.8	
	3	2.55	0.7	0.04
Relationship with Teachers	1	2.57	0.6	
	2	2.23	0.7	0.00
Relationship with Teachers	2	2.23	0.7	
	3	2.53	0.7	0.00
Extroversion / Introversion	2	1.69	0.2	
	3	1.60	0.2	0.00
Computer Liking	2	2.83	0.6	
	3	2.62	0.7	0.01

Note 1. School 2 had only boys enrolled in Year 10.

Sex Of the 379 students who participated in the study, 158 (42%) were female , and 221 (58%) were male. The increased number of male students over female students was to be expected because, of the three schools surveyed, two were co-educational schools while one was a male only school.

Age The students' age ranged from 180 months to 208 months with a mean of 189.8 months and a standard deviation of 4.7 months. With an exception of three older students this meant that all students were aged between 15 and 16 years during the study.

Personality A 13 item scale was used to measure student extroversion / introversion (see Chapter 4). The items were first factor analysed and 12 of the items were retained as measures of a single factor. Reliability for the scale was found to be 0.69 (N = 352).

The scale had a potential range from 1, indicating an introvert personality, through to 2, indicating an extrovert personality. The actual range covered the entire potential range with a mean personality of 1.6 (S.D. = 0.2) indicating a slight trend toward students with more extroverted personalities. Statistics for this scale are shown in Table 5.2.

TABLE 5.2

STATISTICS FOR STUDENT BACKGROUND AND ATTITUDE SCALES

Scale	No. Items	Potential Range	Actual Range	Mean	SD	Rel.	N
Personality	12	1-2	1-2	1.6	0.2	0.69	352
Attitude to Mathematics	11	1-4	1-4	2.4	0.7	0.94	368
Attitude to English	11	1-4	1-4	2.7	0.8	0.96	365
Attitude to Science	11	1-4	1-4	2.7	0.3	0.95	368
Attitude to Teachers	6	1-4	1-4	2.5	0.7	0.90	369
Attitude to Technology	6	1-4	1-4	2.7	0.7	0.79	364
Computer Liking	8	1-4	1-4	2.7	0.6	0.89	351
Computer Confidence	6	1-4	1-4	3.0	0.6	0.76	351

Student Use Of Computers

Home use of Computers To determine home computer usage, students were first asked if they had a computer at home. 157 (41%) responded that they had a computer at home while 222 (59%) responded that they did not.

They were then asked to indicate how frequently they used their home computer. Students did this by circling a number on a computer use scale. On the scale, 1 indicated they never used their home computer (all students who did not own a home computer used this response), 2 indicated rare use of their computer (less

than once a month), 3 indicated occasional use (about once a month), 4 indicated frequent useage (about once a week), and 5 indicated very frequent useage (more than once a week). When all student responses were considered the mean response was 2.0 (SD = 1.4 , N = 379). This indicates that, overall, students rarely use computers at home.

When only those responses from students who had computers at home were considered, the mean response was 3.3 (SD = 1.3, N = 157). This indicates that, on average, those students who do own home computers are only using them on an occasional basis, that is, slightly more than once a month.

School use of Computers To determine the extent of student knowledge of the availability of computers at school, students were asked to indicate if their school had any computers. 375 (99%) indicated that they knew that their school had computers.

They were then asked if they had been taught anything about computers at school. 243 (64%) indicated that they had been taught something about computers at school while 135 (36%) indicated that they had not.

Students were then asked to indicate, by using the same five point scale used to determine their home computer use, how often they used a computer at school. 141 (37%) indicated that they never used the computer at school, and 130 (34%) indicated that they rarely use

the computer at school. The remaining 108 (29%) were fairly evenly distributed across the remaining three responses. This gave a mean response of 2.2 (SD = 1.3) indicating that on average students use the school computer less than once a month.

Other Computer Use The same five point scale used to determine the extent of use of computers at home and school was used to determine the extent to which students may use computers other than those found at home and school. The mean response was 2.1 (SD = 0.9). This indicates that, on average, students use computers outside of their home or school less than once a month.

Summary of Computer Usage It would seem that even though 41% of students surveyed had a computer in their home, and all the schools in the study were in possession of computers (admittedly at very small computer to pupil ratios), on average students rarely interact with computers.

Student Attitudes

Attitude to Mathematics As outlined in Chapter 4, an eleven-item scale was used to determine student attitudes to Mathematics. The items were first factor analyzed and one factor was found with an eigenvalue greater than one. The scale was found to have a high reliability (alpha = 0.94, N = 368). The scale had a potential range of 1, indicating a very negative

attitude to Mathematics, through to 4, indicating a very positive attitude to Mathematics. The mean attitude of 2.4 indicated a slightly negative attitude to Mathematics. Statistics for this scale are shown in Table 5.2.

Attitude to English An eleven-item scale was used to determine student attitudes to English (see Chapter 4). The items were first factor analyzed and one factor was found with an eigenvalue greater than one. The scale was found to have a high reliability (alpha = 0.96, N = 365). The scale had the same potential range of 1 through to 4, as the previous Mathematics attitude scale. The mean attitude of 2.7 indicated a slightly positive attitude toward English. Statistics for this scale are shown in Table 5.2.

Attitude to Science An eleven-item scale was used to determine student attitudes to Science (see Chapter 4). The items were first factor analyzed and one factor was found with an eigenvalue greater than one. The scale was found to have a high reliability (alpha = 0.95, N = 368). The scale had the same potential range of 1 through 4 as the previous subject attitude scales. The mean attitude of 2.7 indicated a slightly positive attitude toward Science. Statistics for this scale are shown in Table 5.2.

Attitude to Technology A six-item scale was used to determine student attitudes to technology (see Chapter

4). The items were first factor analyzed and one factor was found with an eigenvalue greater than one. The reliability of the scale was found to be 0.79 (N = 364). The scale had a potential range of 1, indicating a very negative attitude to technology, through to 4, indicating a very positive attitude to technology. The mean attitude of 2.7 indicated a slightly positive attitude toward technology. Statistics for this scale are shown in Table 5.2.

Attitude to Teachers A six-item scale was used to determine student attitudes to teachers (see Chapter 4). The items were first factor analyzed and one factor was found to have an eigenvalue greater than one. The reliability of the scale was found to be 0.90 (N = 369). The scale had a potential range of 1, indicating a very negative attitude toward teachers, through to 4, indicating a very positive attitude toward teachers. The mean attitude of 2.5 indicated a neutral attitude toward teachers. Statistics for this scale are shown in Table 5.2.

Student Attitudes To Computing

Origin of Scales As outlined in Chapter 4, a 14 item instrument was used to determine student attitudes to computers. The items were factor analyzed and a two factor solution was obtained. Each of these factors is described below.

Computer Liking The first of these factors contained eight items and was used as a measure of student liking of computing. Examples of the items in the scale are; I would like working with computers, and; Having computers in every classroom would be fun for me. The reliability of this scale was found to be 0.89 (N = 351). When formed, the scale had a potential range of 1, indicating a strong dislike of computers, through to 4, indicating a strong liking for computers.

The mean attitude of 2.7 indicated a slightly positive liking for computers. Statistics for this scale are shown in Table 5.2.

Computer Confidence The second factor of the two factor solution contained six items and was used as a measure of student confidence in using computers. Examples of items in this scale are; Computers do not scare me at all, and; Working with a computer would make me very nervous. The reliability of this scale was found to be 0.76 (N = 351). The scale had a potential range of 1, indicating low confidence in using computers, through to 4, indicating high confidence in using computers. The mean score of 3.0 indicated positive confidence levels in computer use. Statistics for this scale are shown in Table 5.2.

Summary Because of overall similarity between the schools, it was decided to combine the data from the three schools in subsequent analyses. Although there were some differences between the three schools, these could mostly be explained in terms of the sex differences inherent in a sample that contained a male only school.

Students' use of computers were lower than expected. On average, students are only rarely interacting with computers in the school, home, and community.

Most student attitudes were found to be slightly positive. Attitudes to Mathematics, and Attitudes to Teachers were the only exceptions to this, with the first being slightly negative and the second being neutral.

Students showed positive attitudes to computers. Their confidence in using computers was reasonably high, while their liking for computers, although not as high, was still positive. It should be remembered at this stage that some students had not as yet used a computer. The perceptions these students hold, however, are still important in determining student attitudes to computers.

CHAPTER 6

CAUSAL ANALYSES

Introduction

The development of a causal model for the analysis of student attitudes to computer use in schools is discussed in chapter 3 and the methodology for the causal analysis is discussed in chapter 4. This model was applied to the data separately for each of the two outcome measures (computer liking and computer confidence). Multiple linear regression was used in three stages to analyse the model.

The stages, criterion variables, and independent variables have been listed in Table 6.1. and shown in the model illustrated in Figure 3.2.

In stage 1, there were three separate criterion variables. In stage 2, there were five separate criterion variables, and in stage 3, there was a single criterion variable.

It can be seen that up to 50 regression coefficients needed to be estimated in this model for each of the two outcomes.

TABLE 6.1

Stage	Criterion Variable	Independent Variables
1.	Home use School use Otheruse	Sex Personality Age
2.	Att. to Mathematics Att. to English Att. to Science Att. to technology Att. to teachers	Home use School use Otheruse Sex Personality Age
3.	Outcome	Att. to Mathematics Att. to English Att. to Science Att. to technology Att. to teachers Home use School use Otheruse Sex Personality Age

Applying the Model

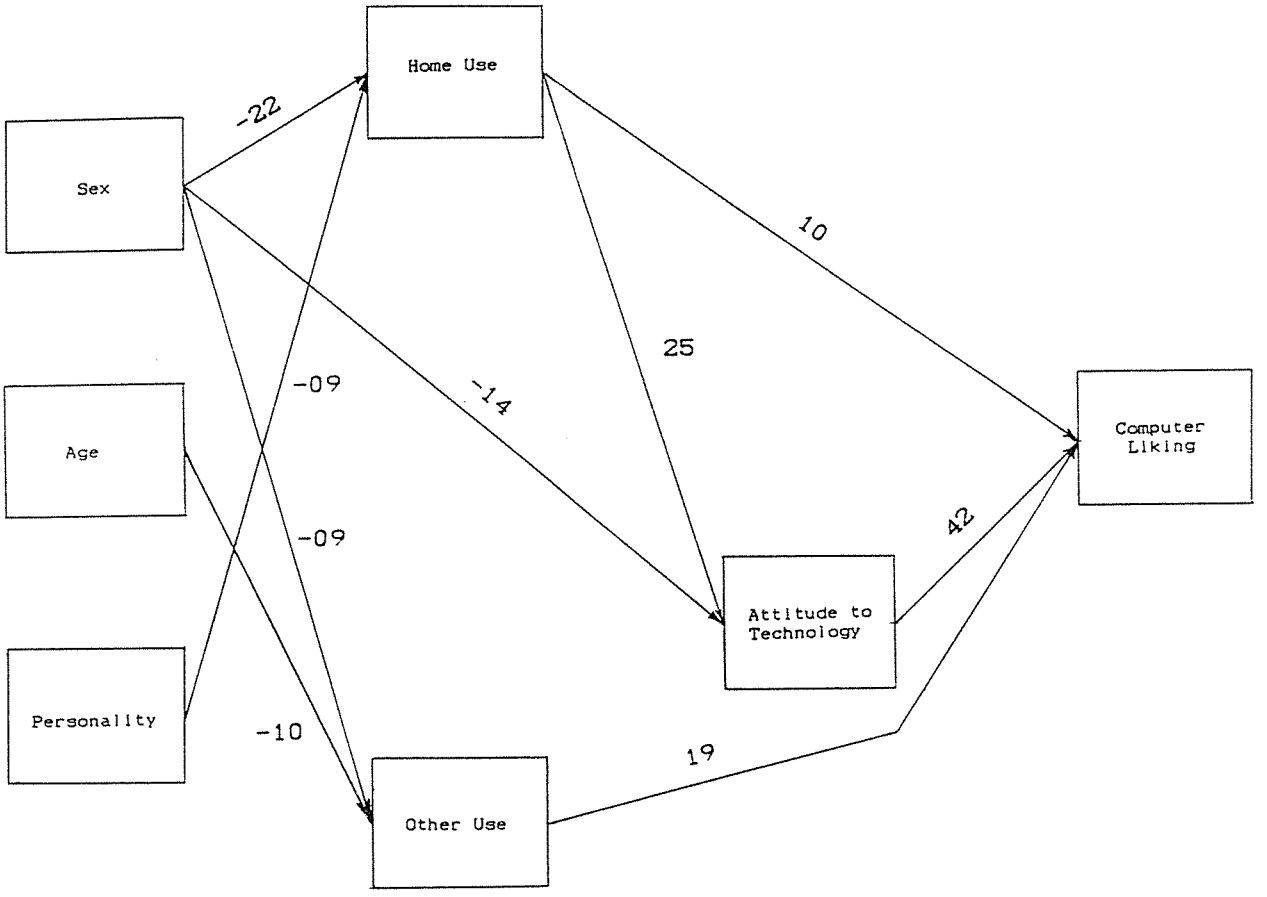
Separate analyses were undertaken for each of the two outcome variables. The results of each analysis have been described in turn. As the full model with all paths included was very complex, it was decided for discussion purposes, to restrict the model to those variables that had either a significant direct path or indirect path to the outcome variable. (Path diagrams and tables listing the standardized regression coefficients and their standard errors for the significant paths in the full models of both outcome variables, are shown in Appendix 3.)

Standardized regression coefficients and their respective standard errors for each equation in the restricted model have been shown in Table 6.2 and Table 6.3. All the standardized regression coefficients shown in the restricted model were significant at the 0.05 confidence level. Path diagrams for the restricted models, showing significant standardized path coefficients for both outcome variables, are found in Figure 6.1 and Figure 6.2.

Outcome: Computer Liking

The results of the analysis with the computer liking scale as outcome are shown in Figure 6.1 and Table 6.2.

FIGURE 6.1



There were three direct paths to the outcome variable. Attitudes to technology had the strongest direct path with a positive path coefficient indicating a positive relationship between the students' attitudes to technology and the students' liking of computers. This is not a surprizing result. In the study,

technology was defined for the students as a means of supplying the wants of mankind by tools and machinery, instead of doing everything by hand. Most students see computers as the prime example of technology at work. A student who then has a positive attitude to technology would also be expected to have a liking for computers.

TABLE 6.2

Computer Liking as Outcome: Standardized Regression Coefficients, Standard Errors of All Significant Paths in the Restricted Model

Dependent Block	Independent Block	Beta	SE Beta
Home Use	Sex	-0.22	0.050
	Personality	-0.09	0.050
Other Use	Sex	-0.09	0.052
	Age	-0.10	0.052
Technology	Sex	-0.14	0.051
	Home Use	0.25	0.051
Computer Liking	Home Use	0.10	0.048
	Other Use	0.19	0.047
	Technology	0.42	0.046

It is of interest to see what factors influence a student's attitude to technology as these will have an indirect influence on a student's liking of computers. There were two paths that were found to have significant relationships to attitudes to technology. Firstly, sex was found to be negatively related to attitudes to technology which indicated that males have

much more positive attitudes to technology that females. Secondly, home use of computers was positively related to attitudes to technology. Those students who used their computers more at home had more positive attitudes to technology.

Several factors were found to have a direct relationship to home use of computers and therefore an indirect relationship with attitudes to technology. Sex was found to be negatively related to home use of computers with males using computers more at home than females. Also, personality was found to be negatively related to home use of computers with more introverted students using their computers more at home than extroverted students. Because of the positive path between home use of computers and attitudes to technology, sex has a negative indirect path to attitudes to technology with males having more positive attitudes to technology than females. This reinforces the direct negative relationship between sex and attitudes to technology discussed earlier. Personality has a negative indirect path to attitudes to technology with more introverted students having more positive attitudes to technology than extroverted students.

The second direct path to the outcome variable was from home use of computers. It was found to have a positive relationship to computer liking. Those students who made use of their computers at home had a greater liking for computers than those students who did not. This may be in part due to the fact that some

students use their computers at home for entertainment purposes in the playing of computer games. This type of activity will obviously enhance the students liking of computers. It is of interest to note that there is no direct path from school use of computers to computer liking. This may be due to the fact that the school use of computers is often directed toward educational ends as teachers make use of the computer as a tutor, tool, and tutee. The playing of computer games is often restricted in the classroom and computer liking in this environment may suffer as a result.

As previously discussed, sex and personality have direct negative paths to home use of computers. This indicates that males use computers at home more than females and have a greater liking for computers as a result. Introverted students use computers more at home than extroverted students and have a greater liking for computers as a result.

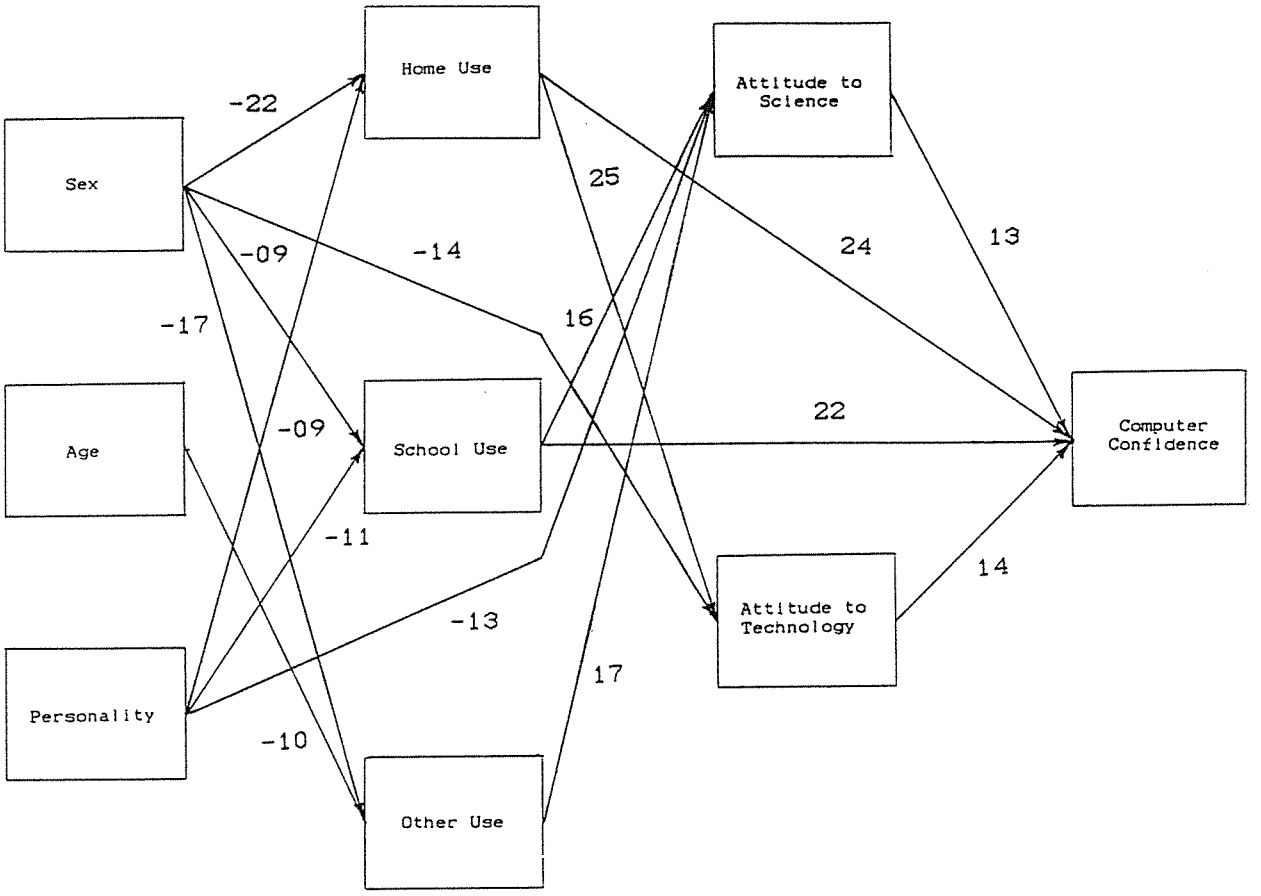
The third direct path to computer liking was from other uses of computers. The positive path coefficient indicated that the more students are using computers outside of the classroom and home, the greater liking they have for computers. This result in some ways parallels the direct path from home use of computers to computer liking. Because students who use computers outside the classroom often do so on a voluntary basis, they are much more likely to engage in activities that enhance their liking for computers.

There were two direct paths from background variables to other use of computers. Sex had a negative relationship to other use of computers once again reinforcing the fact that males are using computers more than females. Age also had a negative relationship to other use of computers indicating that younger students were using computers more outside the home and classroom than older students.

Outcome: Computer Confidence

The results of the analysis with the computer confidence scale as outcome are shown in Figure 6.2 and Table 6.3.

FIGURE 6.2



It will be noted that some of the intermediate relationships are the same as those found for the computer liking outcome. This is because the two models did not diverge until their final stages. Age, school use of computers, and attitudes to science were

absent in the computer liking model due to absence of any direct or indirect paths from these variables to the outcome measure (computer liking). With the exception of these three variables, and the outcome measures, all other variables in the two models are the same.

TABLE 6.3

Computer Confidence as Outcome: Standardized Regression Coefficients, Standard Errors of All Significant Paths in the Restricted Model

Dependent Block	Independent Block	Beta	SE Beta
Other Use	Sex	-0.09	0.052
	Age	-0.10	0.052
Home Use	Sex	-0.22	0.050
	Personality	-0.09	0.050
School Use	Sex	-0.17	0.051
	Personality	-0.11	0.051
Science	Personality	-0.13	0.050
	School Use	0.17	0.052
	Other Use	0.16	0.052
Technology	Sex	-0.14	0.051
	Home Use	0.25	0.051
Computer Confidence	Home Use	0.24	0.051
	School Use	0.22	0.050
	Science	0.13	0.048
	Technology	0.14	0.048

There were four direct paths to the computer confidence outcome variable. Home use of computers had the largest direct path to computer confidence and the positive path coefficient indicated that the more

students use computers at home, the higher their overall confidence in working with computers. As in the previous model sex and personality both had negative paths to home use of computers indicating that males were using computers more at home than females, and intorverted students were using their computers more at home than extroverted students. Because of the relationship between home use of computers and computer confidence, this implies that males have greater computer confidence than females, and the more introverted students have greater computer confidence than the more extroverted students.

School use of computers also had a direct positive path to computer confidence indicating that the more students used computers at school the greater their confidence in using computers. This result parallels the path from home use of computers to computer confidence and both results combine to indicate that the more students use computers, the greater will be their confidence in using them. As with home use of computers there were negative paths from both sex and personality to school use of computers. The path from sex to school use was not as large as the path from sex to home use of computers as students have less choice about being involved in computer activities in the classroom . Other use of computers was found to have no direct path to computer confidence.

The third direct path to the outcome variable was from attitude to technology. The positive path

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coefficient indicated that students who had positive attitudes toward technology had more confidence in using computers.

As in the previous model there were several variables that had either a direct or indirect path to attitutudes to technology and subsequently indirect paths to computer confidence. There were two paths that were found to have direct significant relationships to attitudes to technology. Firstly, sex was found to be negatively related to attitudes to technology indicating that males have much more positive attitudes to technology that females. Secondly, home use of computers was positively related to attitudes to technology. Those students who used their computers more at home had more positive attitudes to technology.

Consideration of background variables revealled that several factors had a direct relationship to home use of computers and therefore an indirect relationship with attitudes to technology. Sex was found to be negatively related to home use of computers with males using computers more at home than females. Because of the positive path between home use of computers and attitudes to technology, sex has a negative indirect path to attitudes to technology with males having more positive attitudes to technology than females. This reinforces the direct negative relationship between sex and attitudes to technology and the subsequent indirect relationship between sex and computer confidence

discussed earlier. Also, personality was found to be negatively related to home use of computers with more introverted students using their computers more at home than extroverted students. Because of the direct path from home use of computers to computer confidence, this gives a negative indirect path from personality to computer confidence indicating that more introverted students were more confident using computers.

The fourth variable found to have a direct path to computer confidence was attitudes to science. It is of interest to note that attitudes to science rather than attittudes to mathematics was found to have a significant path to computer confidence. Computers have traditionally been found in the mathematics classroom or tied fairly closely to the mathematics department of a school. This has probably come about due to the initial interest in computers arising from programing, which is a mathematical concern. In this study, however, attitudes to science formed a significant path to computer confidence, while a path from attitudes to mathematics to computer confidence was absent. This may mean that it is not mathematical ability only that determines if a student will be confident in using computers. Science is a discipline that involves investigation, apparatus, and technology. It may be these factors that influence a student's confidence in using computers rather than mathematical ability. Further study needs to be done in this area.

There were several variables that had direct or indirect paths to attitudes to science. Personality was found to have a negative path to attitudes to science. This indicated that the more introverted students were more likely to have more positive attitudes to science than the more extroverted students. This also gave an indirect path to computer confidence from personality via attitudes to science with the more introverted students having more positive attitudes to science and therefore more likely to have grater confidence in using computers. This parallels the indirect path from personality to computer confidence via home use. School use, and other use of computers were found to be positively related to attitudes to science. The positive path coefficients indicated that those students who used computers more at school, and outside the home and classroom were more likely to have positive attitudes to science and in turn more confidence in using computers. As discussed previously, sex and personality had negative paths to school use of computers and therefore negative indirect paths to attitudes to science and computer confidence. Sex and age had negative paths to other computer use and therefore, negative indirect paths to attitudes to science and computer confidence.

Summary

Overall, the above results indicated that males had greater experience in using computers than females. This increased computer use by males led to them having more positive attitudes toward technology than females. It also led males to show greater liking for, and more confidence in using, computers.

Those students who were more introverted used computers more at home and also had more positive attitudes to science. This in turn led them to have greater liking for computers and more confidence in using them.

Home use and other use of computers led to students having greater liking for the use of computers while home use, other use, and school use of computers all led to students having greater confidence in using computers.

Positive attitudes to technology led to greater computer liking and more confidence in using computers while positive attitudes to science led to students having more confidence in using computers.

CHAPTER 7

DISCUSSION OF RESULTS

Responses to Research Questions

Five general research questions were proposed in Chapter 1 for each of the two computer attitude measures included in the study. Each of these research questions will now be considered in turn. The information used to answer each of the research questions has been drawn from earlier chapters, however, it has been reorganised here for the convenience of readers. The 0.05 confidence level was used to determine the significance of relationships between variables in the study.

Question 1) To what extent are student attitudes to the use of computers in the classroom related to their attitudes to the classroom teachers?

As reported in Chapter 5, the average students in this study demonstrated neutral attitudes toward their teachers and positive attitudes toward computers. No significant relationship was found between students' liking of computers and their attitudes to their teachers. Similarly, no significant relationship was found between students' confidence in using computers and their attitudes to teachers.

Question 2) To what extent are student attitudes to the use of the computer in the classroom related to their attitudes to individual school subjects?

Three individual school subjects were included in the study. They were English, Mathematics and Science. On average, students reported slightly positive attitudes to English and Science, while they reported slightly negative attitudes to Mathematics. No significant relationship was found between general interest in these school subjects and students' liking of computers. This is a little surprising as computers are usually associated with the Mathematics department of a school, in at least a logistical way, and a relationship between Mathematics and computer liking was expected. In each of the three schools visited in the major study a separate computer room had been established for the use of all subject areas. Teachers of subjects other than Mathematics were free to use the room, even though most of the computing rooms were still located near the Mathematics classrooms. It may be as a consequence of this more interdisciplinary approach to use of the computer room that students are not associating Computing and Mathematics in the same way as they have previously.

The only significant relationship that was observed between the school subjects and computer confidence was a positive relationship between general interest in Science and students' confidence in using

computers. Those students who have a positive general interest in Science also indicated positive confidence levels when working with computers. This is an area that can be addressed by future research to more fully explore the relationship between these two areas.

3) To what extent are student attitudes to the use of computers in the classroom related to their attitudes to technology?

Students' attitudes to technology were found to be significantly related to students' liking of computers, and their confidence in using computers. Those students who reported positive attitudes toward technology also reported positive liking of computers, and positive confidence levels when using them.

This result is not surprising. Students are exposed to many new forms of technology, both in and out of school. For many students, however, the computer is the main type of new technology with which they interact. When students were questioned about technology many of them visualize this somewhat intangible concept in terms of experiences with computers. Even though they are exposed to many new forms of print technologies, telecommunications, and video technologies, at home and in the classroom, many students sill think of computers whenever technology is mentioned. Technology does, however, mean much more than use of computers alone. In a world in which technology is rapidly advancing and expanding, students need to be encouraged to expand their concept of technology and positive attitudes toward it. By doing this students' attitudes toward the use of computers would also remain positive.

4) To what extent are student attitudes to the use of computers in the classroom related to background variables such as sex, age, personality?

Sex No significant direct relationships were found between sex and liking of computers and sex and confidence in using computers. There were, however, indirect relationships between these variables.

There were four indirect relationships between sex and computer liking. All four indicate that sex has a negative relationship to computer liking, that is, males like working with computers more than females. Sex was found to be indirectly related to computer liking through home use and other use of computers, and through attitudes to technology.

Six indirect negative relationships were found between sex and computer confidence. All of these negative relationships indicated that males were more confident in computer use than females. Sex was found to indirectly affect computer confidence through each of the three diffrerent types of computer use discussed in this study. Sex was also found to indirectly affect students' confidence in using computers through its effect on students' attitudes to technology.

Age Age was found to be indirectly related to computer liking and computer confidence through its effect on other use of computers. Although not a very strong relationship, younger students were found to use computers more outside of the home and school than

older students. This directly affected their liking of computers and also their general attitude to Science which in turn affected their confidence in using computers.

Personality No direct significant relationships were found between personality and computer liking and personality and computer confidence. Personality was, however, found to be related to Home use of computers when the more introverted students reported greater home use of computers than the more extroverted students. Home use of computers had a direct positive relationship to computer liking and, therefore, personality was found to indirectly affect computer liking through its effect on home use which in turn affects computer liking. As well as being directly linked to computer liking, home use of computers was also found to affect students' attitudes to technology with those students who reported more home use of computers also having reported more positive attitudes to technology. Students' attitudes to technology were also positively related to computer liking and, therefore, a second indirect relationship was found to exist between personality and computer liking through personality's effect on home use of computers which in turn affects students' attitudes to technology which in turn affects computer liking.

Personality was found to be indirectly related to computer confidence in a number of ways. Firstly, as

previously mentioned, through home use of computers and attitudes to technology. Secondly, personality was found to have a number of indirect relationships to computer confidence through its effect on school use of computers, home use of computers, and attitudes to science. Introverted students were found to have had greater computer confidence as a result of greater school use and home use of computers, and more positive attitudes to science.

5) To what extent are student attitudes to the use of computers in the classroom related to previous computer experience?

Significant relationships were found between students' computer experience and their liking of computers and confidence in using them. In particular, Home use of computers was found to have a significant positive relationship to computer liking. Other use of computers (not at home or school) also had a positive significant relationship to computer liking. School use of computers was not, however, related to computer liking. This may be because students use computers out of school for entertainment purposes (computer games etc...), however, this type of computer use is restricted in schools. Also with a high percentage of students (71 per cent) not having used, or rarely using, computers at school, the contribution of school computer use to computer liking was expected to be small.

Home use of computers and school use of computers were both positively related to computer confidence. The more students reported that they used computers the more confident they felt with them.

Summary From the data it was possible to answer all of the research questions. No relationship was found between students' attitudes to using computers and their attitudes to their classroom teachers. Significant relationships between school subjects and students' attitudes to using computers were also absent with the exception of a positive relationship between students' general interest in Science and their confidence in using computers.

Students' attitudes to computers were found to be related to their attitudes to technology. Those students who reported positive attitudes to technology also reported positive attitudes to computers.

The amount of previous computer experience a student had was found to both directly and indirectly affect their liking of computers and their confidence in using them in a positive way. Those students who had the most exposure to computers had the most positive attitudes towards them.

Students' attitudes to computer use were found to be strongly related to background variables. Personality was found to indirectly affect students' attitudes to computers with the more introverted students having the more positive attitudes to computers. Sex was another background variable that was found to have strong indirect effects on students' attitudes to computers. In every case males were found to have much more positive attitudes toward computers than females. Age was also found to have an indirect

effect on computer liking and computer confidence with younger students reporting more liking and confidence in using computers.

CHAPTER 8

SUMMARY AND CONCLUSIONS

This study investigated some aspects of the educational use of microcomputers, and more particularly, those factors that affected student attitudes to the use of computers in education. Two outcome measures of computer liking, and computer confidence, were investigated. Data were collected from 379 students by means of a student questionnaire, and were analysed using the individual student as the unit of analysis. A causal model was developed and used in an attempt to explain relationships, existing within the model, that might affect students' liking of computers, and their confidence in using them.

An instrument was developed to measure students' attitudes to computers. The instrument contained two scales, a computer liking scale which contained eight items with a reliability of 0.89, and a computer confidence scale which contained six items with a reliability of 0.76.

An instrument was also developed to measure students' attitudes to technology. This instrument contained six items with a reliability of 0.79.

Results This section is intended to give a brief overview of the results reported in Chapter 5.

Three schools were included in the main study, and as there was little significant difference between the schools in the variables being investigated by the study, the schools were combined as one sample for the analyses. A total of 379 students with a mean age of 189.8 months participated in the study. Of these, 42 per cent were female, and 58 per cent were male. A slight trend was shown toward the average student having an extroverted personality.

Forty-one per cent of the students in the study had a computer at home, however, most of these students only used their computers on an occasional basis. All of the schools in the study possessed computers, however, on average students used the school computers less than once a month. It could be concluded, therefore, that the students interacted with computers fairly infrequently.

Upon considering the various attitudinal measures used in the study, it was shown that on average, students demonstrated slightly positive attitudes toward English, Science, and technology, while they demonstrated slightly negative attitudes toward Mathematics. Students, on average, demonstrated a neutral attitude toward their class teachers. In both the computing attitude measures students showed positive attitudes. Their confidence in using computers was reasonably high, and their liking for

computers was positive, although not as high as the confidence measure.

Research Questions The five research questions involved in the study are addressed in Chapter 7. This section is intended to give a brief summary of the responses to those questions in terms of the causal model proposed and tested.

Students' attitudes to computers were not found to be related to their attitudes to their classroom teachers. Similarly, no relationship was found between student's general interest in Mathematics, Science, or English, and their liking of computers. Although no relationship was found between students' general interest in Mathematics, and English, and students' confidence in using computers, a relationship was found between general interest in Science and computer confidence. Those students who reported a positive general interest in Science also reported positive confidence levels when using computers.

Students' attitudes to technology were found to be closely related to their attitudes to computers. Strong positive relationships were found between students' attitudes to technology and to both their liking of computers and their confidence in using them.

Students' attitudes to computers were found to be significantly affected by their previous computer use. Those students who had the greatest previous computer use were found to have positive attitudes towards the

use of computers. In particular, home use of computers was found to be directly related to both computer liking and computer confidence. It also directly affected students' attitudes to technology which in turn affected computer liking and computer confidence. School use of computers directly influenced computer confidence as well as affecting students' general interest in science which in turn affected students' confidence in using computers. Other use of computers (not at home or school) directly influenced both computer liking and indirectly affected computer confidence through general interest in science.

A student's sex was also found to play an important role in students' attitudes to computers. Males were found to have much more positive attitudes to computer use than females as they reported greater computer liking and greater confidence in using computers than females. In particular, there were significant relationships between sex and each of the three computer use variables. In each case males used computers more than females. Home use and other use of computers were directly related to computer liking and home use and school use were directly related to computer confidence. Sex, therefore, was indirectly related to computer liking and computer confidence through these variables. Sex was also directly related to students' attitudes to technology, which in turn was directly related to computer liking and computer confidence. Sex, therefore, also affected computer

liking and computer confidence through attitudes to technology with males reporting more positive attitudes to technology and therefore more positive attitudes toward computers.

Personality was another of the student background variables that affected students' attitudes to computers. Those students who were more introverted were found to prefer working with computers than the more extroverted students. In particular, students' personality was found to affect both home use and school use of computers. Home use of computers directly affected students' liking of computers and their confidence in using them. Personality, therefore, affected computer attitudes through its influence on home use of computers. Personality was also related to school use of computers and also general interest in science. As both of these variables were directly related to computer confidence, students' personality affected students' computer confidence through them.

A student's age was related to computer liking and confidence through other use of computers. Younger students used computers more outside of the home or school. They, therefore, gained more liking and confidence in computers due to this increased use.

It was found, therefore, that students' background, previous computer use, attitudes to technology, and attitudes to school subjects, all contribute to students' attitudes to computers.

Educational Implications Educators have a responsibility to encourage students to have positive attitudes to computers because of the increasing importance of computers in everyday life and work. Resulting from this study, two areas which strongly influence students' attitudes to computers are attitudes to technology, and student background experiences.

Attitudes to computers and attitudes to technology were found to be closely related. Educators can assist students in acquiring positive attitudes to computers by encouraging positive attitudes to technology. This does not mean that educators need concentrate all their energies on microelectronic technologies. There are many new and varied technologies continually entering the classroom. Educators can encourage students to interact with, and enjoy using, all forms of technology. This will assist students as they learn to interact with the many new methods and machines that are entering the classroom. Computerphobia should be lessened as students become more familiar with new educational technologies. More positive attitudes to computers and associated technologies will result.

Educators can also help students to have positive attitudes to computers by directing some of their background experiences. It is obvious that some background variables such as sex and personality cannot be readily changed, however, allowances for sex and personality can be made. Males were found to have much

more positive attitudes to computers and their uses than females. This can be attributed to a number of factors. Males usually have had more experience using computers than females. A lot of the software presently available to schools has a male bias. Societal associations and female socialization along with school logistics all play a part in making computers more attractive to the male user. Here is one area in which educators can intervene. In the classroom, educators can make sure that females receive equal exposure to computers, and gain equal computer time, even though the males are usually the more aggressive users. Software can be purchased by schools that favours each sex equally. Educators can spend time countering the models that are often misportrayed in the media. Females can achieve positive attitudes to computers if they are helped to do so.

Similarly, those students who are more extroverted need to gain equal access to the computer as those who are more introverted. As this study has shown, there is a definite relationship between computer experience and attitudes to using computers. Educators need to make sure that some of the less enthusiastic groups of students are actively encouraged to gain computer experience so they have a chance to develop positive attitudes toward computer use.

Future Research There is still a considerable amount of research that needs to be conducted in the area of student attitudes to computers. One area of interest, arising from this study, is the extent of the relationship between student attitudes to computers and their general interest in Science. Computers have always been closely associated with Mathematics, however, students' attitudes to Science may offer insights into students' attitudes to computers not previously recognized. This relationship may exist because of the connection that is often made between science and technology. There is a popular conception that computers are usually used to perform some kind of scientific work. Students may now, therefore, be associating computers more closely with science than the traditional association that computers have had with mathematics.

Further research needs to be conducted on the sex differences that exist in students' attitudes to computers. Even though these differences are widely documented, they are not generally understood. More work needs to be done in this area.

Students' attitudes to technology were found to be closely related to attitudes to computers. Further work needs to be carried out to investigate student attitudes to the different types of technologies and how they are related attitudes to computers. Now that a reliable instrument to measure computer liking and

confidence exists, measures of such relationships will become possible and easier.

Further research could also be carried out to identify other aspects of students' attitudes to computers and attempt to devise ways to measure them reliably. Further work is needed to develop the Computer Usefulness scale that was removed from the study. A different type of development is needed to further remove any cultural and age bias to make the scale suitable for secondary school students in Australia.

This study has attempted to clarify some of the factors that affect student attitudes to computers. As society continues to undergo technological change and with the continually increasing number of computers that are being introduced into Australian schools, the understanding of such factors is both desirable and necessary.

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APPENDIX 1

PRELIMINARY STUDY

COMPUTERS AND YOU

We would like to know how you feel about computers and yourself. This is not a test, and there are no right or wrong answers. What we want is your opinion, so please try and answer the way you feel about the following statements.

Your answers will not be seen by anyone else, and you need not put your name on this form.

Please answer these questions by circling the numbers on the right.

1. YOUR SEX — Male..... 1
   Female.....2

2. YOUR AGE — Please write your age in years and months
   .....

3. YEAR AT SCHOOL — Please circle the current year you are in
   Year 9 10

4. Do you have a computer at home ?
   YES.....1
   NO.....2

5. How much do you use your home computer ?
   Never.....1
   Rarely (less than once a month).....2
   Occasionally (about once a month).....3
   Frequently (about once a week).....4
   Very Frequently (more than once a week)..5

6. Does your school have a computer?
   YES.....1
   NO.....2

7. Have you been, or are you being taught, anything about computers ay school ?

YES.....1

NO.....2

8. How often do you use the computer at school?

Never.....1

Rarely.....2

Occasionally.....3

Frequently.....4

Very Frequently.....5

9. Have you used any other computers? (Not at home or school)

Never.....1

Rarely.....2

Occasionally.....3

Frequently.....4

Very Frequently.....5

Following are a list of statements of which we would like your opinion. Remember this is not a test.

To indicate your opinion about each statement, you need to circle one group of letters from the following :

SA if you STRONGLY AGREE with the statement
A if you AGREE with the statement
D if you DISAGREE with the statement
SD if you STRONGLY DISAGREE with the statement

PRACTICE STATEMENT

I like using computers (SA) A D SD

If you STRONGLY AGREE with this statement you would circle the letters SA.

If you change your mind about an answer, just cross it out and circle another one. Please try and give an answer to every statement, but if you can't just leave it out.

ABOUT COMPUTERS

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
1.	Once I start working with computers I find it hard to stop.	SA	A	D	SD
2.	Australia would be better off if there were no computers.	SA	A	D	SD
3.	Having computers in every classroom would be fun for me.	SA	A	D	SD
4.	People who can't use computers could be easily cheated by others when doing business with them.	SA	A	D	SD
5.	I get more interested in work when it's time for computer class.	SA	A	D	SD
6.	I would like working with computers.	SA	A	D	SD
7.	I feel comfortable when I am working with a computer.	SA	A	D	SD
8.	I would like to spend more time using the school's microcomputers.	SA	A	D	SD
9.	I can only work on a computer if I have someone helping me.	SA	A	D	SD
0.	Computers can be used to save lives.	SA	A	D	SD
1.	I would never take a job where I had to work with computers.	SA	A	D	SD
2.	I enjoy computer classes.	SA	A	D	SD
3.	Only a few people need to be able to use a computer.	SA	A	D	SD
4.	Learning about computers is boring to me.	SA	A	D	SD
5.	I enjoy working with computers.	SA	A	D	SD
6.	I get good marks in subjects that use computers.	SA	A	D	SD
7.	I'll need a firm mastery of computers for my future work.	SA	A	D	SD
8.	Computers are beyond the understanding of many people.	SA	A	D	SD
9.	I don't understand how some people can spend so much time working with computers and seem to enjoy it.	SA	A	D	SD
0.	Working with computers requires mostly patience.	SA	A	D	SD
1.	Figuring out computer problems does not appeal to me.	SA	A	D	SD
2.	I would use computers more if I had the chance.	SA	A	D	SD
3.	Computing is of great use to me.	SA	A	D	SD
4.	Computing is useful in life even if you don't need it for your job.	SA	A	D	SD
5.	I'm think I could do advanced work with computers.	SA	A	D	SD

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGRI
26.	If I had the money, I would buy a computer.	SA	A	D	SD
27.	Computer classes do not cause me to worry.	SA	A	D	SD
28.	I feel confident when working with computers.	SA	A	D	SD
29.	You have to be very intelligent to be able to work with computers.	SA	A	D	SD
30.	Computers make my life enjoyable.	SA	A	D	SD
31.	I'm not the type to do well with computers.	SA	A	D	SD
32.	Working with a computer is very frustrating for me.	SA	A	D	SD
33.	Jobs are harder to find if you can't use a computer.	SA	A	D	SD
34.	I could help other people with computer problems.	SA	A	D	SD
35.	I can't think of any way that I will use computers in my career.	SA	A	D	SD
36.	I can get along well in everyday life without using a computer.	SA	A	D	SD
37.	I like, or would like, learning on a computer.	SA	A	D	SD
38.	Working with a computer would make me very nervous.	SA	A	D	SD
39.	Computers do not scare me at all.	SA	A	D	SD
40.	Computers are only important at school.	SA	A	D	SD
41.	I can only use the computer for very easy tasks.	SA	A	D	SD
42.	I like to take computer courses.	SA	A	D	SD
43.	I will use a computer outside school as soon as possible.	SA	A	D	SD
44.	A computing course is beneficial to everybody that takes it.	SA	A	D	SD
45.	I am anxious when it comes to using computers.	SA	A	D	SD
46.	Someday I plan to have a computer or computer terminal in my home.	SA	A	D	SD
47.	Working with a computer would make me very uncomfortable.	SA	A	D	SD
48.	I get a sinking feeling when I think of trying to use a computer.	SA	A	D	SD

ABOUT TECHNOLOGY

We live today in an age that depends on technology.

Technology means supplying the wants of mankind by means of tools and machinery, instead of doing everything by hand. It allows mankind to make a lot of new inventions as well as enabling mankind to make large numbers of things in a short space of time. Computers play a big part, and are closely tied to modern day technology. Technology could also contribute to some social problems, such as unemployment.

Please respond to the following statements concerning technology in the same way as before by circling a response.

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
1.	The introduction of more technology will improve society.	SA	A	D	SD
2.	In the future, computers will be running our lives.	SA	A	D	SD
3.	Man's freedom is being threatened by the increased use of technology.	SA	A	D	SD
4.	Business is becoming too dependent on technology.	SA	A	D	SD
5.	Computers will become an everyday device we use regularly in our homes.	SA	A	D	SD
6.	Technology will make life easier for all in the future.	SA	A	D	SD
7.	Technology is necessary to handle the many difficult problems of modern society.	SA	A	D	SD
8.	Increase in technology will mean the loss of many jobs.	SA	A	D	SD
9.	Computers are heartless machines without feeling.	SA	A	D	SD
10.	Use of technology will enable this country to remain competitive in the world scene.	SA	A	D	SD
11.	By using technology in the classroom we will receive a much better education.	SA	A	D	SD

ABOUT YOURSELF

Please respond to the following questions by circling either a YES or NO.

1.	Do you often long for excitement?	YES	NO
2.	Are you usually carefree?	YES	NO
3.	Do you stop and think things over before doing anything?	YES	NO
4.	Do you generally do and say things quickly without stopping to think?	YES	NO
5.	Would you do almost anything for a dare?	YES	NO
6.	Do you often do things on the spur of the moment?	YES	NO
7.	Generally, do you profer reading to meeting people?	YES	NO
8.	Do you like going out a lot?	YES	NO
9.	Do you prefer to have few but special friends?	YES	NO
10.	When people shout at you do you shout back?	YES	NO
11.	Can you usually let yourself go and enjoy yourself alot at a good party?	YES	NO
12.	Do other people think of you as being very lively?	YES	NO
13.	Are you mostly quiet when you are with other people?	YES	NO
14.	If there is something you want to know about, would you rather look it up in a book than talk to someone about it?	YES	NO
15.	Do you like the kind of work that you need to pay close attention to?	YES	NO
16.	Do you hate being in a crowd who play jokes on one another?	YES	NO
17.	Do you like doing things in which you have to act quickly?	YES	NO
18.	Are you slow and unhurried in the way you move?	YES	NO
19.	Do you like talking to people so much that you never miss a chance of talking to a stranger?	YES	NO
20.	Would you be very unhappy if you could not see lots of people most of the time?	YES	NO
21.	Would you say that you are fairly self-confident?	YES	NO
22.	Do you find it hard to really enjoy yourself at a lively party?	YES	NO
23.	Can you easily get some life into a rather dull party?	YES	NO
24.	Do you like playing pranks on others?	YES	NO

FACTOR LOADINGS FOR FINAL SCALES IN PRELIMINARY STUDY

COMPUTER ATTITUDE SCALE

Item Number	Factor Loadings	
	Computer Liking	Computer Confidence
C 22	0.77	
C 37	0.75	
C 6	0.75	
C 8	0.73	
C 3	0.71	
C 1	0.69	
C 42	0.65	
C 30	0.65	
C 38		0.85
C 47		0.77
C 48		0.75
C 39		-0.74
C 9		0.53

TECHNOLOGY SCALE

Item Number	Factor Loadings
T 7	0.76
T 6	0.74
T 10	0.70
T 1	0.68
T 11	0.63
T 5	0.50

PERSONALITY SCALE

Item Number	Factor Loadings
P 23	0.63
P 12	0.57
P 11	0.57
P 24	0.55
P 8	0.54
P 21	0.52
P 10	0.45
P 6	0.43
P 5	0.38
P 2	0.37
P 17	0.33
P 4	0.32
P 19	0.31

APPENDIX 2

MAJOR STUDY

UNIVERSITY OF NEWCASTLE
FACULTY OF EDUCATION

COMPUTERS AND YOU

We would like to know how you feel about computers, your school and yourself. This is not a test, and there are no right or wrong answers. What we want is your opinion, so please try and answer the way you feel about the following statements.

Your answers will not be seen by anyone else, and you need not put your name on this form.

Please answer these questions by circling the numbers to the right.

1. YOUR SEX
   Male.....1
   Female.....2

2. YOUR AGE
   Please write your age in years and months
   .....years .....months

3. YEAR AT SCHOOL
   Please circle the current year you are in
   Year 9 10

4. Do you have a computer at home ?
   YES.....1
   NO.....2

5. How much do you use your home computer ?
   Never.....1
   Rarely (less than once a month).....2
   Occasionally (about once a month).....3
   Frequently (about once a week).....4
   Very Frequently (more than once a week)..5

6. Does your school have a computer?
   YES.....1
   NO.....2

7. Have you been, or are you being taught, anything about computers at school ?

YES.....1

NO.....2

8. How often do you use the computer at school?

Never.....1

Rarely.....2

Occasionally.....3

Frequently.....4

Very Frequently.....5

9. Have you used any other computers? (Not at home or school)

Never.....1

Rarely.....2

Occasionally.....3

Frequently.....4

Very Frequently.....5

Following are a list of statements of which we would like your opinion. Remember this is not a test.

To indicate your opinion about each statement, you need to circle one group of letters from the following :

SA if you STRONGLY AGREE with the statement
A if you AGREE with the statement
D if you DISAGREE with the statement
SD if you STRONGLY DISAGREE with the statement

PRACTICE STATEMENT

I like using computers (SA) A D SD

If you STRONGLY AGREE with this statement you would circle the letters SA.

If you change your mind about an answer, just cross it out and circle another one. Please try and give an answer to every statement.

ABOUT COMPUTERS	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
Once I start working with computers I find it hard to stop.	SA	A	D	SD
Having computers in every classroom would be fun for me.	SA	A	D	SD
I would like working with computers.	SA	A	D	SD
I would like to spend more time using the school's microcomputers.	SA	A	D	SD
I can only work on a computer if I have someone helping me.	SA	A	D	SD
I would use computers more if I had the chance.	SA	A	D	SD
I get a sinking feeling when I think of trying to use a computer.	SA	A	D	SD
Computers make my life enjoyable.	SA	A	D	SD
I like, or would like, learning on a computer.	SA	A	D	SD
Working with a computer would make me very nervous.	SA	A	D	SD
Computers do not scare me at all.	SA	A	D	SD
I can only use the computer for very easy tasks.	SA	A	D	SD
I like to take computer courses.	SA	A	D	SD
Working with a computer would make me very uncomfortable.	SA	A	D	SD

YOUR SCHOOL SUBJECTS

Mathematics

Mathematics does not hold my interest.	SA	A	D	SD
I like to study Mathematics.	SA	A	D	SD
I find the Mathematics to be dull.	SA	A	D	SD
I wish I didn't have to take Mathematics.	SA	A	D	SD
Mathematics is interesting.	SA	A	D	SD
Mathematics is the most undesirable subject taught in school.	SA	A	D	SD
Mathematics fascinates me.	SA	A	D	SD
I am not interested in Mathematics.	SA	A	D	SD

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
I really enjoy Mathematics.	SA	A	D	SD
I look forward to my class in Mathematics.	SA	A	D	SD
I find Mathematics to be a real bore.	SA	A	D	SD
<u>English</u>				
English does not hold my interest.	SA	A	D	SD
I like to study English.	SA	A	D	SD
I find English to be dull.	SA	A	D	SD
I wish I didn't have to take English.	SA	A	D	SD
English is interesting.	SA	A	D	SD
English is the most undesirable subject taught in school.	SA	A	D	SD
English fascinates me	SA	A	D	SD
I am not interested in English.	SA	A	D	SD
I really enjoy English.	SA	A	D	SD
I look forward to my class in English.	SA	A	D	SD
I find English to be a real bore.	SA	A	D	SD
<u>Science</u>				
Science does not hold my interest.	SA	A	D	SD
I like to study Science.	SA	A	D	SD
I find Science to be dull.	SA	A	D	SD
I wish I didn't have to take Science.	SA	A	D	SD
Science is interesting.	SA	A	D	SD
Science is the most undesireable subject taught in school.	SA	A	D	SD
Science fascinates me.	SA	A	D	SD
I am not interested in Science.	SA	A	D	SD
I really enjoy Science.	SA	A	D	SD
I look forward to my class in Science.	SA	A	D	SD
I find science to be a real bore.	SA	A	D	SD

ABOUT TECHNOLOGY

We live today in an age that depends on technology.

Technology means supplying the wants of mankind by means of tools and machinery, instead of doing everything by hand. It allows mankind to make a lot of new inventions as well as enabling mankind to make large numbers of things in a short space of time. Computers play a big part, and are closely tied to modern day technology. Technology could also contribute to some social problems, such as unemployment.

Please respond to the following statements concerning technology by circling a response.

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
The introduction of more technology will improve society.	SA	A	D	SD
Computers will become an everyday device we use regularly in our homes.	SA	A	D	SD
Technology will make life easier for all in the future.	SA	A	D	SD
Technology is necessary to handle the many difficult problems of modern society.	SA	A	D	SD
Use of technology will enable this country to remain competitive in the world scene.	SA	A	D	SD
By using technology in the classroom we will receive a much better education.	SA	A	D	SD

ABOUT YOUR SCHOOL AND TEACHERS

Please continue by circling your response.

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
My school is a place where my teachers treat me fairly in class.	SA	A	D	SD
My school is a place where my teachers give me the marks I deserve.	SA	A	D	SD
My school is a place where my teachers take a personal interest in helping me with my school work.	SA	A	D	SD
My school is a place where my teachers listen to what I say.	SA	A	D	SD
My school is a place where my teachers help me to do my best.	SA	A	D	SD
My school is a place where my teachers are fair and just.	SA	A	D	SD

ABOUT YOURSELF

Please respond to the following questions by circling either a YES or NO.

1. Are you usually carefree?	YES	NO
2. Do you generally do and say things quickly without stopping to think?	YES	NO
3. Would you do almost anything for a dare?	YES	NO
4. Do you often do things on the spur of the moment?	YES	NO
5. Do you like going out a lot?	YES	NO
6. When people shout at you do you shout back?	YES	NO
7. Can you usually let yourself go and enjoy yourself alot at a good party?	YES	NO
8. Do other people think of you as being very lively?	YES	NO
9. Do you like doing things in which you have to act quickly?	YES	NO
10. Do you like talking to people so much that you never miss a chance of talking to a stranger?	YES	NO
11. Would you say that you are fairly self-confident?	YES	NO
12. Can you easily get some life into a rather dull party?	YES	NO
13. Do you like playing pranks on others?	YES	NO

FACTOR LOADINGS FOR FINAL SCALES IN MAJOR STUDY

COMPUTER ATTITUDE SCALE

Item Number	Factor Loadings	
	Computer Liking	Computer Confidence
C 6	0.85	
C 3	0.81	
C 2	0.77	
C 9	0.76	
C 4	0.75	
C 13	0.69	
C 8	0.65	
C 1	0.63	
C 7		0.75
C 10		0.73
C 5		0.70
C 11		-0.65
C 14		0.61
C 12		0.51

MATHEMATICS ATTITUDE SCALE

Item Number	Factor Loadings
M 8	0.86
M 5	-0.84
M 9	-0.82
M 2	-0.81
M 4	0.81
M 7	-0.80
M 3	0.79
M 11	0.78
M 1	0.78
M 10	-0.75
M 6	0.69

ENGLISH ATTITUDE SCALE

Item Number	Factor Loadings
E 9	-0.89
E 5	-0.87
E 1	0.86
E 8	0.86
E 11	0.85
E 4	0.85
E 2	-0.85
E 10	-0.84
E 3	0.82
E 6	0.78
E 7	-0.78

SCIENCE ATTITUDE SCALE

Item Number	Factor Loadings
S 5	0.88
S 9	0.87
S 3	-0.84
S 8	-0.83
S 7	0.82
S 1	-0.82
S 2	-0.82
S 11	-0.81
S 4	0.80
S 10	0.78
S 6	0.73

TECHNOLOGY ATTITUDE SCALE

Item Number	Factor Loadings
TH 1	0.75
TH 3	0.71
TH 6	0.71
TH 4	0.69
TH 2	0.66
TH 2	0.64

TEACHER ATTITUDE SCALE

Item Number	Factor Loadings
TR 1	0.84
TR 5	0.84
TR 6	0.82
TR 2	0.81
TR 4	0.80
TR 3	0.77

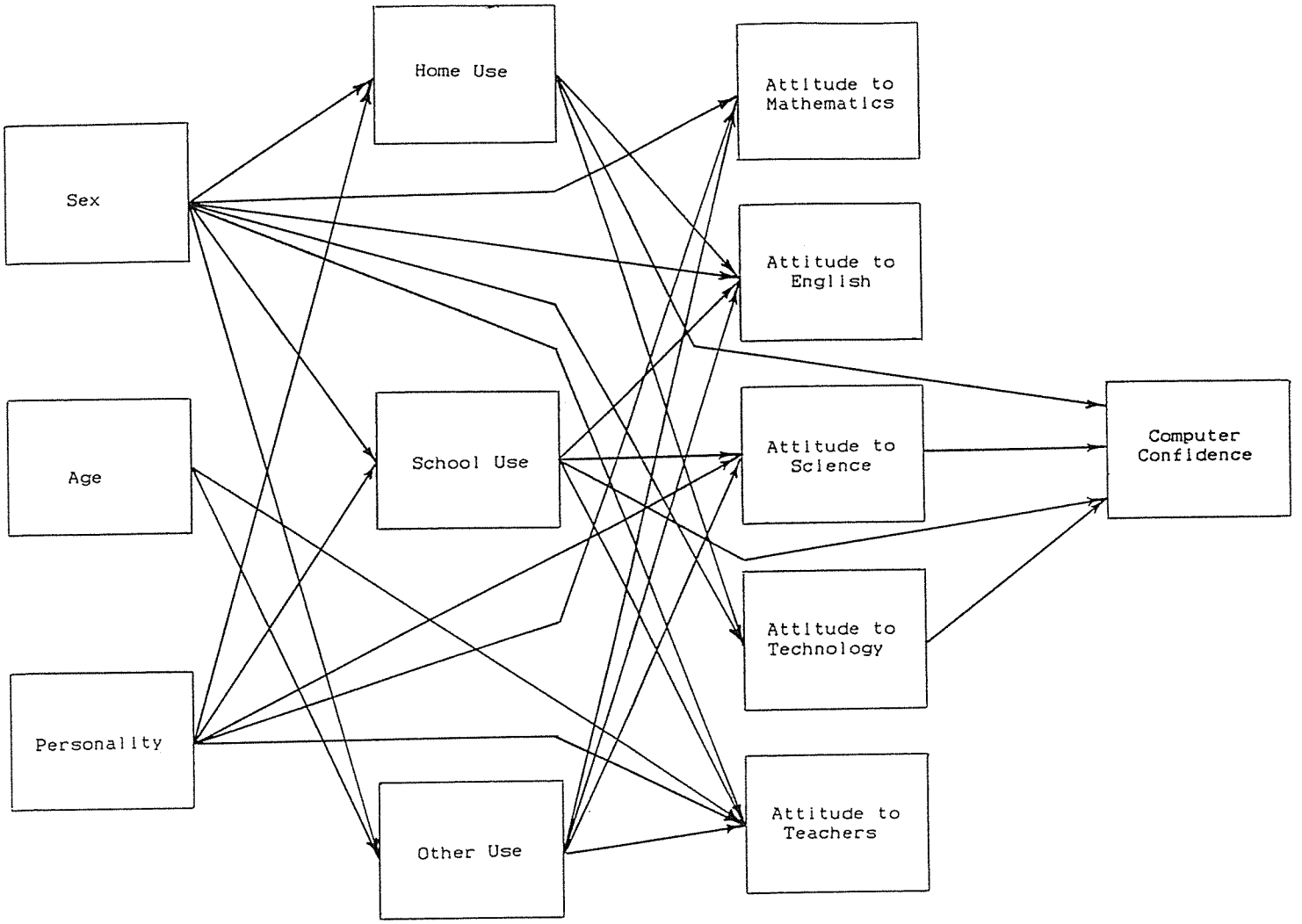
PERSONALITY ATTITUDE SCALE

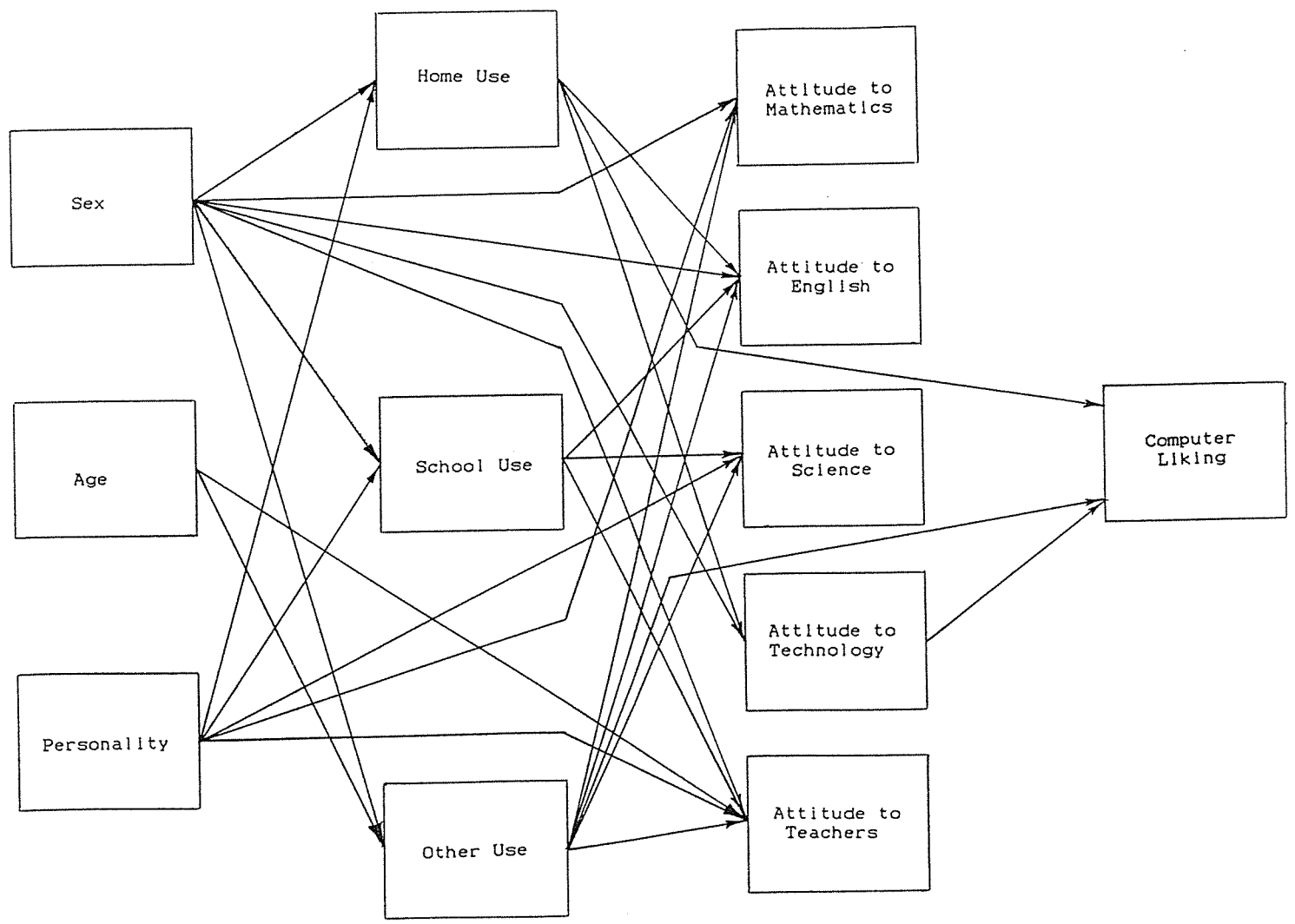
Item Number	Factor Loadings
P 5	0.65
P 8	0.63
P 12	0.57
P 7	0.54
P 4	0.54
P 1	0.50
P 6	0.44
P 13	0.43
P 3	0.38
P 11	0.35
P 10	0.34
P 2	0.33

APPENDIX 3

PATH DIAGRAMS AND STANDARDIZED REGRESSION COEFFICIENTS FOR THE UNRESTRICTED CAUSAL MODELS

PATH DIAGRAMS OF UNRESTRICTED GROUP MODELS





Standardized Regression Coefficients, Standard Errors of All Significant Paths in the Full Model

DEPENDENT BLOCK	INDEPENDENT BLOCK	BETA	SE BETA
Home Use	Sex	-0.22	0.050
	Personality	-0.09	0.050
School Use	Sex	-0.17	0.051
	Personality	-0.11	0.051
Other Use	Sex	-0.09	0.052
	Age	-0.10	0.052
Attitude to Mathematics	Sex	0.09	0.050
	Personality	-0.24	0.050
	Other Use	0.17	0.050
Attitude to English	Sex	0.24	0.051
	Home Use	-0.12	0.056
	School Use	0.10	0.054
	Other Use	0.10	0.054
Attitude to Science	Personality	-0.13	0.050
	School Use	0.17	0.052
	Other Use	0.16	0.052
Attitude to Technology	Sex	-0.14	0.051
	Home Use	0.25	0.051
Attitude to Teachers	Sex	0.19	0.049
	Age	-0.09	0.048
	Personality	-0.24	0.048
	School Use	0.17	0.051
	Other Use	0.10	0.050
Computer Liking	Home Use	0.10	0.048
	Other Use	0.19	0.047
	Attitude to Technology	0.42	0.046
Computer Confidence	Home Use	0.24	0.051
	School Use	0.22	0.050
	Attitude to Science	0.13	0.048
	Attitude to Technology	0.14	0.048