

**AN INTERPRETIVE STUDY OF THE FACTORS AFFECTING  
THE COMPUTER LITERACY  
OF SECONDARY SCHOOL STUDENTS**

**By**

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## ABSTRACT

This study used interpretive research techniques to investigate the factors which affect the computer literacy of secondary students. The necessity that students to be prepared for life and work in a computer technology based society is widely acknowledged and has highlighted the importance of computer literacy in the high school curriculum. While the definition of computer literacy varies widely, this study defined computer literacy in terms of the knowledge, skills, and attitudes required to use computers to facilitate the completion of necessary tasks presently associated with life and required to enhance perceptions of the future use of computers. If schools are to achieve the aim of encouraging students to use computers to help them solve problems and complete tasks, it is important that educators know the factors which affect this use. This study involved an investigation of: student-computer interaction; the development of knowledge, attitudes and skills associated with computer use; and the present and perceived future utilization of computer technology.

A variety of data were collected from a Year 8 class which was observed for a year as it participated in a computer literacy course. The data sources were: classroom observation; student interviews at the beginning and end of the course; an attitudes questionnaire; a background questions sheet; and student mathematics and computing class grades. In addition, to test assertions which emerged during the study, a group of Year 12 students was interviewed and data were collected from four Year 8 students who were given experience on a more state-of-the-art computer system than those used by the computer literacy class. All students involved in the study were drawn from a large,

secondary senior high school situated in a middle to upper class suburb of Perth, Western Australia. From the analysis and interpretation of these data, nine assertions emerged. The assertions were classified in terms of: students; computers; learning environment; and concept development.

The study found that students entering secondary school tend to have attitudes which are conducive to the use of computers. The Year 8 students enjoyed using computers and showed little anxiety in terms of computer-phobia. These students valued the use of computers and were confident in using computers when clearly instructed and not confronted by major obstacles. However, almost half of this group of students indicated a lack of confidence in some situations, particularly where they felt that they may do something to damage the computer. Almost all students were keen to learn about computers. As a result, most students in this group of Year 8 students had the attitudes most educators would recommend for enhanced learning and computer use.

Three assertions were concerned with factors relating to computer hardware and software. The major obstacles to students' use of computers were: unreliability of hardware; lack of student keyboarding skills; and the use of abstract concepts in software design. Students lost confidence in using computers and undervalued their use when unreliable hardware was used. The use of a mouse by the students using the state-of-the-art computer demonstrated a means of overcoming a lack of keyboard skills. Finally, students had difficulty when using command driven software which incorporated abstract naming and design structures. Where concrete design features were incorporated in the software design, as was the case in the software used by the students on the state-of-the-art computer, students found the computers easier to

use, thereby enhancing their perceptions of the value of computers.

Four assertions concerned student learning environments. The environments which made significant contributions to student computer literacy were the school and home, with school being the dominant environment. Prior experience with, and learning about, computers at school and home were found to be associated with feelings of confidence and enjoyment with regard to using computers. The major influence of the home on student computer literacy was through the attitudes communicated by parents, which largely reflected their own use of computers at work. In addition, it was found that the perceptions students have of the value of the activities they are required to complete using computers, and the extent to which the computer improves the completion of those activities, are determinants of students' perceptions of the overall value of computer technology.

The final assertion concerned student learning and concept development. Students entering secondary school have little knowledge of how computer systems work or how they are used. Therefore, they do not have a well developed concept of a computer and computer use. Students are amenable to the concept of computers as information processors as they develop knowledge from their interaction with computers. It was found that an important facet of this interaction concerned the degree to which students anthropomorphized computers and differentiated themselves from computers. As a result, students develop knowledge relevant to computer use with little understanding of how computer systems work.

The findings of this study have implications for educational policy, teaching practice, and further research. It was recommended that schools

need to develop computer literacy policies that provide students with specialist courses and, at the same time, give students experience at using computers across the curriculum. In addition, schools need to consider the purchase of more state-of-the-art computer hardware and software even where this may reduce student hands-on time. This study stressed the need for teachers to utilize and enhance the positive attitudes displayed by students towards the use of computers. At the same time, computer literacy teachers need to be concerned with the development of useful knowledge which is not based on technical knowledge of computer systems. Finally, this study recommended the need for further research to verify the findings and to further investigate student-computer interactions and student perceptions of future uses of computers.

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## CHAPTER ONE

### INTRODUCTION

Never in history has technology developed as rapidly as it has in the years associated with computers (Molnar, 1981). There are strong arguments that technological development needs a technologically informed population (Maddison, 1983; Molnar, 1978). Further, the development of technology has an associated impact on the social fabric of our society (Maddison, 1983). As a result, to cope with this impact, and to fully utilize the development of technology, people such as Maddison (1983), Klassen, Anderson, Hansen, and Johnson (1980), Michael (1968), Molnar (1978), Carleer (1984), Naron and Estes (1985), and Vogler (1984) have felt that it is important for all members of our society to have some knowledge of, and familiarity with, computers. Many educators such as Molnar (1978) feel that those who do not keep up with the development of computer technology will be lost in today's society. Stonier (Vogler, 1984) makes this point very clearly, saying, "An educated workforce learns how to exploit technology; an ignorant one becomes its victims." (p. 84)

Throughout history, technology has often been slow to develop, and its benefits have only been partially realized due to the general unpreparedness and lack of acceptance by the population. For example, men like Blaise Pascal and Charles Babbage invented early calculating devices and envisaged widespread use of their technology. However, the people in their society did not use the devices because they could see no benefit in doing so. In the Industrial Revolution, many people, such as the

infamous Luddites, were afraid of the changes occurring and responded by rejecting and, in some cases, destroying the implements of the developing technology. Orwell (1949) saw good cause for some fear and demonstrated how the control of technology can be used as a strategy for seeking power over the 'technologically illiterate' of society. For many such reasons, technology needs an educated and sympathetic population if it is to develop rapidly and benefit society.

Educators such as Maddison (1983) argue that the previous slow development of technology was primarily due to poor education systems. He stated that: "... in the case of the first industrial revolution it is generally recognized that the failure of the educational system to meet the demands, human and economic, of industrial change worked eventually to the great disadvantage of Britain and her position in the world." (p. 20) The argument of such educators is that all members of our society will have access to computer technology and be affected by it. If they are going to benefit from this access and thereby give motivation for further development, then they need some knowledge and appreciation of the developing technology. This means that our education systems need to change in response to the developing technology.

A range of computer literacy and awareness courses has been developed around the world since the early 1970s in response to the need for change in education to complement the development of computer technology in society. In most cases these courses have been designed for students aged between 10 and 15 years of age, a time when it is thought they have sufficient intellectual maturity but are still impressionable enough to learn about the new technology. However, in many places computer literacy and awareness programmes have been

implemented with students of pre-primary and primary age. This echoes Molnar's (1978) thoughts when he comments: "It's a new way of thinking. The kids who don't get indoctrinated to computers by seventh grade are not going to develop the same proficiency." (p. 35)

There is a wide variety of definitions of the terms computer literacy and computer awareness (these are discussed in detail in Chapter 2). This study uses the term computer literacy to refer to the possession of skills and abilities which enable people to use computer technology to benefit themselves and others by solving problems related to necessary tasks. Computer awareness refers to the possession of an understanding by people of the role of computer technology in society and the social implications associated with the use of computers in society. The distinguishing difference is that computer literacy involves the 'hands-on' use of computers whereas computer awareness requires knowledge and understanding without necessarily involving the 'hands-on' use of a computer.

### Background

In Western Australia, the development of computer literacy/awareness courses has accelerated greatly over the past seven years. In the early 1970s, the Education Department had a mainframe computer. A relatively small number of schools had access to it via remote terminals. The emphasis in that period was on programming, mainly in the BASIC language. Later, in the 1970s, schools started to purchase microcomputers, but still the emphasis was on BASIC programming with some computer science studies added. Few students had access to these courses and fewer had the aptitude to cope with the content which

was taught. The early 1980s saw a concerted effort to give all students some computer education at the secondary level. The emphasis was on computer awareness and computer literacy spearheaded by the use of wordprocessor and spreadsheet software. The Education Department now has developed courses in computer education and has issued directives (Education Dept of WA, 1980) that all students should have some contact with computer equipment.

### Statement of Problem

Many educators such as Brumbaugh (1982) have seen the need for computer education to begin in school. To fully utilize computer technology in the way that Stonier (Vogler, 1984) indicates, students need to understand the ways in which their lives are affected by computers, and they need to develop skills and positive attitudes toward the use of computers. Unless students know how to use the technology and believe and feel that they can control it and use it for their own good, they will become Stonier's "victims". Therefore students need to learn about computers and learn to use them because the major technological developments today revolve about computers.

Computer education courses are being developed for schools, but 20 years after the initial impact of computers on our society. There is such a great demand for the courses that resources have been stretched to the limit (Oliver, 1985). Many courses, such as the course described by Oliver (1985), are run by poorly trained teachers. Further, the instructional strategies and materials employed often are not suitable (Oliver, 1985). Because these courses are a recent phenomenon, little is known of their effectiveness in preparing students for life in a society based on computer

technology (Oliver, 1985). Maddux (1984) alludes to the large number of questions surrounding the use of computers in schools and the lack of associated research.

Curriculum designers and implementors need to acknowledge the importance of the effect of student attitudes on their utilization of computers. Encouraging students to see the computer as a tool to help them solve problems involves providing students with the necessary knowledge, skills and attitudes. Where a variety of well structured courses may provide the necessary knowledge and skills, the development of helpful attitudes is difficult (Chapline & Turkel, 1986). The new technology has evoked a range of emotional responses from people, from seeing it as the provider of a better life, to regarding it as a threat to continued employment or an invader of privacy. Computer education courses need to be concerned with breaking down the alienation and perceived fear that many people have when confronted with computers.

### Rationale

This study was concerned with the computer literacy of secondary students. Simply providing secondary students with computers and computer courses may not be adequate to ensure they become computer literate. If schools are to achieve the aim of encouraging students to use computers to help them solve problems, it is important that educators should know the attitudes and feelings that students have toward the technology, the way students interact with computers, and the concepts and constructs which they develop to make sense of their interactions. Finally, educators need to evaluate the extent to which existing school courses change students' present and future uses of computers. This



study investigates all of these issues.

Very little research has been conducted into what should constitute a computer literacy/awareness course or how these courses influence students' use of computers now and in the future. Little is known of what knowledge, skills and attitudes are necessary to encourage students to use computers to solve problems. Educators have little understanding of the interaction which occurs when a student confronts a computer, the factors involved in that interaction, and other factors which may influence a students' present and future use of computers. No doubt there are a multitude of factors such as: motivation to learn, confidence, prior knowledge of computers and the design of computer systems (Shaw, Swigger, & Herdon, 1985). These and other factors will be discussed further in Chapter 2 and used as a basis for the analysis, presented in Chapter 5, of the data collected in the study.

To identify the factors affecting the computer literacy of a student, this study investigated the types of school experiences students are given with computers, and the effects of these experiences. It also endeavoured to relate these experiences and effects to the attitudes and personal attributes of students which are relevant to computer use. Such investigations required an understanding of students' previous experience with computers, how students viewed the technology in the past, and how this view changed as a result of their present experiences. An understanding of the students' home backgrounds and general academic achievement was also necessary.

To set computer literacy curriculum and formulate policies for computer use in schools, an understanding of the student-computer

interface and the other factors influencing the student use of computers must be brought to bear in answering questions such as,

- . How much 'hands-on' time should students have and how should it be structured?
- . Is industry standard software required or is lesser quality software adequate?
- . Do students need to understand how a computer is designed and how it works in order to fully benefit from its potential?
- . Should students be exposed to a number of types and sizes of computer or just one?
- . Do students need to become proficient at using a select amount of software or should they be exposed to a wider range of software?
- . Does it matter what sorts of activities students are set to do on a computer? Should these activities reflect current relevance or future relevance?
- . Should the tasks set students be experimental and open-ended or is a form of programmed learning preferable?

### Purpose

This study's main aim was to investigate, from a constructivist perspective (von Glasersfeld, 1981), the characteristics concerned with how students use computer technology and the factors likely to affect perceptions of future use by secondary students. The study identified some of the concepts and attitudes about computers that were developed by lower secondary students as they used computer technology. Further, the study investigated the conceptual frameworks, associated with computers, that students developed and the effects of personal attributes, and personal and public experiences, on student utilization of computer technology.

The study identified characteristics of the utilization of computer technology by secondary students and factors affecting student perceptions of future utilization. As a consequence, the findings of the study have implications for educators on the types of experiences which should be provided to secondary students to increase the students' utilization of computer technology both now and in the future and to remove the barriers which prevent students from fully utilizing computer technology.

### Overview of the Study

This study used naturalistic approaches to investigate the computer related experiences of a class of Year 8 students completing a computer literacy course. These experiences were interpreted in terms of the students' present and perceived future utilization of computer technology using data sources which included: classroom observations; student interviews; and questionnaires.

A group of Year 12 students was drawn from the general Year 12 population of the school. Comparisons were made between the responses to questions given by the Year 8 students and the group of Year 12 students. The comparisons were designed to investigate any differences which may be attributable to secondary school experience in concepts about, and attitudes towards, the use of computers.

Four of the Year 8 students were given the experience of using a different type of microcomputer than those used in the computer literacy class. The students in the Year 8 computer literacy class used the small, cheap, nationally manufactured microcomputers which the State

Department of Education provided for the school. However, the school had purchased a more expensive microcomputer, mainly for staff use. This microcomputer differed from the cheaper student-use microcomputers in that it made extensive use of a mouse as an input device. It also used all menu driven and icon-selection software and hard covered floppy disks for mass storage. The four Year 8 students were given the experience of using this more 'state-of-the-art' microcomputer to allow an investigation of the effect of this type of software and hardware design on concepts about, and attitudes towards, the use of computers.

### Context

The main group of Year 8 students comprised one computer literacy class at a large metropolitan secondary school. The policy of this school was for all Year 8 students to complete a unit of study in computer literacy over the duration of the year. This computer course consisted of one 50 minute session per week for the whole year. The course was designed to introduce students to the use of computers and to the knowledge and skills needed to start to use computers. The course aimed to develop positive attitudes towards the use of computers and a sound awareness of the benefits and dangers of such use.

The course of study was planned and monitored by the computing coordinator for the school, who was the researcher for this study. The course was administered by 20 teachers allocated, by the administration, from the general staff of the school. These teachers were largely selected because they had spare time in their regular teaching schedules. However, some consideration was given to teacher backgrounds and

interests. There were no full-time computing teachers at the school. The computing coordinator himself taught mathematics as well as computing classes. All teachers used in the course were specialist teachers in either mathematics, science or social science. Only two of the staff allocated to computing classes had any training in computer education or any formal qualifications in computing.

### Significance

This study highlighted important characteristics of the interface between student and computer and thus increased the understanding of what occurs when students encounter computers. Factors which have an effect on the perceptions secondary students have of their own future use of computers were identified. Some of the questions concerned with encouraging students to use computers to facilitate the completion of necessary tasks encountered in their lives were addressed and suggestions for some areas for further areas of research were made.

The identification of the factors affecting the computer literacy of secondary students will allow educators to design more effective computer literacy courses, and provide students with experiences designed to increase their computer literacy. Also, by developing a better understanding of the interface between student and computer and the effect of computer experiences on the computer literacy of students, educators will be better able to formulate general policies for the use of computers in schools.

### Remainder of the Thesis

This chapter has outlined the context, nature and purposes of the study. The emphasis of the study is on the present and perceived future utilization of computer technology by secondary students. Chapter 2 reviews the literature on computer literacy and the constructs and concepts of computer education. Chapter 3 provides a review of the use of naturalistic approaches in research on computer literacy and details on the sample, methods, and data used in the study. Finally, Chapters 4, 5 and 6 present an analysis and discussion of the results of the study and make recommendations for further research and for the design and implementation of computer literacy programmes in secondary schools.

## CHAPTER TWO

### LITERATURE REVIEW OF COMPUTER LITERACY

#### Introduction

This chapter reviews the literature on the place of computer literacy in secondary schools and the associated curricula. In addition, a review is presented of the literature on the nature of learning from the constructivist viewpoint. Finally, factors which affect present and future utilization of computer technology by secondary students are discussed. These factors formed the basis for the research questions this study addressed.

#### Purpose of the Review

It is important to set a research study in the context of the theoretical underpinnings of the study and in the light of related research. In so doing, a rationale is developed for the research questions to be addressed in the study. This study concerns the computer literacy of secondary students; therefore, the purposes of this review are to (a) present current theory on computer literacy and secondary education; (b) highlight significant research on computer literacy; and (c) develop a rationale for the research questions of this study.

#### Method

The papers included in this review are those published on computer literacy and associated topics in research journals, research papers presented at professional meetings, doctoral and masters dissertations,

published books, and teacher education journals. The procedures for identifying relevant papers, books and dissertations included a computer search of the ERIC database. The keyword computer literacy was used in this computer search. Other procedures included use of: the Current Index to Journals in Education; the Education Index; the Australian Education Index; the Science Citation Index; and manual inspection of the programmes for annual meetings of the American Educational Research Association for 1985 and 1986.

### Overview of the Chapter

The remainder of this chapter consists of: an introduction to computer literacy; four sections developing the issues concerning computer literacy curriculum; and a summary section. The introduction discusses the definitions of computer literacy and computer awareness and presents the debate over the need for students to be computer literate. The first of the sections developing computer literacy curriculum introduces theoretical arguments and research findings dealing with the objectives and student learning. The second section develops a theory of learning. The third section presents a structure to discuss learning with respect to computer literacy in terms of: the nature of interactions between students and computers; the learning environment; and concept development. In addition, this section deals with the controversy surrounding the place of programming in the computer literacy curriculum. The final section discusses factors affecting computer literacy in terms of the literature and the developed structure of learning. The research questions of this study were concerned with these factors.



### The Definition of Computer Literacy/Awareness

There is little agreement between computer educators concerning the definition of the term, computer literacy (Ganske & Hamamoto, 1984; Seidel, 1982; Troutner, 1985). In much of the literature the terms computer literacy and computer awareness are used almost interchangeably to "denote some basic understanding of computers" (Klassen et al., 1980). Klassen describes computer literacy in terms of "the ability to communicate with computers". Johnson (1980) lists eight statements representing definitions of these concepts in education but admits to not finding any "official definition". Even where educators and curriculum programmes appear to have similar aims, the way they are defined and grouped can often lead to very different interpretations of computer literacy. The diversity of definitions of the terms computer literacy and computer awareness is illustrated in the contradictions evident between the aims of the curriculum devised by Cupertino Union School District (1983) and those of Lyons Township High (Bristol, 1982).

In a K-8 computer literacy programme devised by Cupertino Union School District (1983), computer literacy is defined as : "the skills necessary to communicate with computers and recognize the computer's capabilities and limitations." (p. 7) Later this programme refers to, 'a specific course in Computer Awareness and Introductory Programming' (p. 7), as being something different from computer literacy. The aim of this programme was to prepare students to make wise choices in secondary school. In a similar programme at Lyons Township High (Bristol, 1982), four elements of computer instruction are defined : literacy, competency, speciality, and computer assisted instruction. Of these, the programme defined literacy as "a basic understanding of how computers work, a view

of the sociological and psychological questions they raise, and experience in using computers in a variety of subject matter applications" (p. 40). Competency was defined in terms of being able to use the computer, which was what Cupertino Union School District (1983) defined as computer literacy. The definitions of the terms competency and literacy used in these programmes appear to be the reverse of each other.

The differences between definitions provided by educators and programmes may result from an attempt to be over prescriptive and develop specific operational objectives. Before operational objectives are generated there is a need for general definitions of the terms computer literacy and computer awareness. Such general definitions are developed by Hunter (1983), who defines computer literacy as:

... the skills and knowledge needed by all citizens to survive and thrive in a society that is dependent on technology for handling information and solving complex problems. (p. 9)

...whatever a person needs to be able to do with computers and know about computers in order to function in an information-based society. (p. 9)

... the ability to use suitably programmed computers in appropriate ways to assist in learning, handling information, and solving problems: and the ability to make informed judgements about social and ethical issues involving computer and communications systems. (p. 9)

The third of these definition statements was designed specifically for application to a K-8 curriculum. Hunter started with general definitions and refined these to become more specific to an environment. She focussed definitions of computer literacy from the general to the specific.

The author believes that although the concepts of computer literacy and computer awareness are related they do not represent the same thing. As with Klassen et al. (1980), the author sees the main emphasis of computer literacy in terms of being able to use computer technology. This refers to the use of a variety of technologies based on the silicon chip, not just the use of microcomputers and mainframe computers. Unlike Klassen, the author distinguishes computer literacy from learning about how other people use computers and the implications of this use for our society. These are encompassed in the authors definition of computer awareness.

In each case the author believes it is possible to be either computer literate, or computer aware, without being both. A person can be computer literate (eg. computer programmers are very literate) but may not be very computer aware. For example many computer 'hackers' (ie. computer users who are fanatically dedicated to using computers for their own sake) use computer technology heavily (although perhaps in a narrow way) but have never thought about the possible effects of the technology on their lives (Zimbardo, 1980). Although less likely, a person who is well read and has an intellectual understanding of computer technology but has never actually used a computer may be termed computer aware but not computer literate.

### The Need for Computer Literacy

Since the early development of the electronic computer, there have been calls to educate our population to cope with living in a technological society. Such calls are heard more and more frequently from groups in society. Klassen et al. (1980) outlined the important role played by computer based technology in American society. As he puts it: "There is little doubt, it seems that life in the U.S. and in the rest of the industrial world, and eventually all

over the planet, will be incalculably changed by computer technology." (p.12) He went on to show the need for computer literacy and awareness for all of society's members using similar arguments to those presented by educators such as Engle & Longstreet (1978), Press (1974), and Michael (1968).

Response has been slowly gathering momentum from educational circles to the need for a computer literate population. Many educators, such as those listed by Klassen et al. (1980), advocate a priority for schools to attend to the need for all students to be computer literate and aware by the time they leave secondary education. Molnar (1981) sums up this priority well when he says:

In summary, if we are to have equity in our society, all citizens, not just specialists, must have access to information, and all citizens must have an understanding of computers, since they are the tools that make information useful and productive. In an information society, a computer-literate populace is as important as energy and raw materials are to an industrial society. Conversely, the general level of computer illiteracy may be the limiting factor to growth and productivity in an information society. (p. 26)

There are those who argue against computer literacy being a priority for schools. Suhor (1983) who, while he was the Deputy Director of the National Council of Teachers of English in America, held the view that computer literacy was of little consequence and should not be incorporated into the K-12 curriculum. He drew the analogy between the automobile and the computer, and pointed out that the changes brought about in society by the invention of the automobile resulted in few changes to the curriculum in schools. Therefore, he felt that, since computer technology was having a similar effect on society to that of the automobile in the past, the effects on education should also be minimal.

Those who see computer literacy as a priority for schools can answer Suhor's (1983) arguments in many ways. For instance, the comparison of the development in technology represented by the automobile and that represented by the computer can be argued to be a gross simplification. Computers, unlike automobiles, are processors of information. Suhor's arguments also demonstrated a number of common misunderstandings about the nature of computer literacy. The four "caveats" implicit in his car/computer metaphor each demonstrated such a misunderstanding. In his arguments, Suhor appeared to have in mind computer assisted instruction and learning and used the very specific language based concept of literacy.

The author is convinced, along with others such as Molnar (1978), Klassen et al. (1980), Engle and Longstreet (1978), Press (1974), Michael (1968), and Vogler(1984), that it is important for all members of our society to be both computer literate and computer aware. Therefore, to prepare students for life in our society, school's must incorporate the use of computers into their curriculum. All students need to be given access to the hardware, software, and knowledge necessary to ensure they are adequately computer literate and aware. While this may be seen as a priority by many educators, this does not mean that it is happening in schools.

In a research study conducted in the USA by the Minnesota Educational Computing Consortium, most teacher respondents agreed that every student should have some minimal understanding of computers and should learn about the role that computers play in society (Hansen, Klassen, Anderson, & Johnson, 1978). However, after surveying what teachers did with computers in classrooms the writers concluded that,

"general computer literacy topics are currently not being covered to any great extent in their courses." (p. 472) This finding clearly indicates that computer literacy is not afforded the high priority in the curriculum of secondary schools which many educators suggest it should.

### Computer Literacy/Awareness Curriculum

Just as there is no general agreement over the definition of the terms computer literacy and computer awareness there is a diversity of opinion over the curriculum required to produce computer literate and aware students (Calfee, 1985). Usually the introduction of computers to schools in the past was done through teaching students programming, particularly in the BASIC language. However, even in the earlier days of computer usage in schools, attempts were made to use CAL (Computer Assisted Learning) and CAI (Computer Assisted Instruction). Recently, educators have been arguing that general awareness and literacy should be the major priority for schools. They see other uses of computers such as: the provision of specialist computer science courses; and the use of computers as an educational medium and director in other subject disciplines, as having lower priorities to that of computer literacy education.

The curriculum recommended by educators and computer literacy education programmes varies greatly in intended student outcomes, content, structure, teaching strategies and environments. Calfee (1985) highlighted the lack of coherence in the development of a computer literacy curriculum. He saw the need to closely look at the question of what students need to know. To some extent this process of developing

curriculum is evident in the curriculum presented by Hunter (1983). She outlined a clear set of goals for her K-8 computer literacy course based around the student's immediate environment. The emphasis was on using the computer to solve problems that arise immediately in the student's own environment. Her goals were organised into six "strands" related to her definition of computer literacy. An interesting facet of her explanations was that she referred to general skills and understandings needed for living and then showed how these relate to computer technology. Therefore, instead of focussing on the computer, she focussed on the user and, in particular, showed how computer technology influences the work, home, and community environments of the user.

Educators need to address the objectives of computer literacy before progressing into curriculum content and design. There is also a need for other important issues to be addressed, such as: the nature of the relationship between students and computers; and the way students learn about computers, and how to use them. Even where objectives are well defined, rarely is the rationale for curriculum developed from these objectives argued in terms of: models of student learning; the nature of computers; and the nature of the relationship between students and computers.

The remainder of this chapter discusses the objectives of computer literacy, models of student learning, and the relationship between computers and students. Learning objectives, content and other specific curriculum questions then flow out of, and are supported through, an understanding of these factors.

### General Objectives for Computer Literacy

This section will investigate the general objectives for computer literacy and the implications these have for curriculum design. Exactly what should be included as part of computer literacy will continually change as the technology and society change. Indeed, the relevance of computer literacy may change with time and circumstance (Shavelson & Salomon, 1985). Consequently, the general objectives of computer literacy need to be continually addressed.

The lack of agreement over the definition of computer literacy, which has been presented in an earlier section, is reflected in the variety of objectives listed for computer literacy programmes (e.g. Johnson, Anderson, Hansen, & Klassen, 1980). For example, the Cupertino Union School District (1983) K-8 computer literacy curriculum lists very prescriptive categories of objectives and then subdivides to a myriad of specific student learning objectives. Self (1983) also presented a list of objectives for computer literacy courses but listed two major objectives not included in the Cupertino curriculum. These were: the development of an abstract concept of how a computer works; and the ability to communicate with computer specialists by using correct computer terminology. Similarly, the study by Klassen et al. (1980) outlined 'dimensions of computer literacy' which were used to write specific instructional objectives. One of these dimensions involved data processing, which was not mentioned in either the Cupertino Union School District (1983) or the Self (1983) programmes. Even where programmes proposed by different educators have similar content and objectives, other important differences are evident. For example, in recommending a course in computer literacy, Johnson (1980) listed content areas but pointed out



the difficulty of setting a minimum knowledge level and of assessing computer literacy.

The general objectives presented by many computer educators, while varying considerably, can usually be reduced to a fairly standard list, largely those outlined in the study by Klassen et al. (1980). The fundamental objective is usually that students should acquire the knowledge, skills, and attitudes required to use computers to complete tasks and solve problems, both now and in the future. Most educators indicate that this general objective of computer utilization requires that students have some knowledge of hardware, software, and applications. Usually they include the need for students to develop skills in using the hardware and software, such as keyboarding, caring for disks, and following instructions. Finally, they typically indicate that the general objective requires students to develop positive attitudes towards the use of computers. They see it as important that students not only have the knowledge and skills, but that they also have the desire to use computers. What these educators do not usually agree on is the place of programming in the required curriculum for computer literacy. The question of the place of programming in the curriculum will be considered later in this chapter.

### Student Learning

Educational theory needs to be grounded in a psychological model of learning. To evaluate and comprehend the work, findings, and recommendations of any research in education, it is crucial to develop an understanding of the model of learning which underlies the research. Therefore, it is important to outline the theory of learning which this study

assumed. This section outlines the constructivist theory of learning which underlies the interpretation of the results and reviews literature in terms of constructivist theories applied to learning about computers.

## Constructivism and Cognitive Psychology

The models of learning alluded to by educators have changed at various times, largely reflecting changes in popular psychological theory. Until recently, educators had been concerned with teaching rather than learning (Bodner, 1986). This was due to the behaviourist assumption that knowledge could be transferred between the minds of the teacher and the students (Bodner, 1986). Since the onset of developmental psychology, particularly that attributable to Piaget (1970), education has progressively been more concerned with learning, not so much teaching (Bodner, 1986; Shuell, 1986; Smock, 1981). Constructivist models of learning developed from the psychology of Piaget, which Bodner (1986) sums up as, "Knowledge is constructed in the mind of the learner" (p. 2). Many educators today argue for constructivist models of learning. The model closest to the author's is presented by Pines and West (1986).

Basically, constructivist theories of learning involve active learning where the learner has to construct meaning out of knowledge presented or experiences encountered (Pines & West, 1986; Driver & Bell, 1986). In this way, different learners may construct different meaning from or have a different understanding of the same knowledge. These theories demand that learners develop frameworks of understanding to make sense of the information they are receiving. Thus, prior knowledge is important in constructivist theories because the learner has developed frameworks to

deal with prior knowledge which will clearly operate in attempting to develop new understandings.

Pines and West (1986) developed what they call a 'sources-of-knowledge' model of learning based on constructivism and an understanding for the theories proposed by Vygotsky (1962). They discriminated between two sources of knowledge for school children: knowledge spontaneously acquired from interactions with the environment; and knowledge acquired formally through the intervention of school. These two sources of knowledge are represented as vines in a metaphor based on the writings of Vygotsky. The former source originates from the learner and thus is known as the upward growing vine. The latter source is formal knowledge imposed on students and therefore is known as the downward growing vine. Therefore, education in schools is concerned with intertwining these vines so that they become indistinguishable. In this way the student will have come to use the "correct" framework, presented by the ideal curriculum, to make sense of knowledge.

While it may be seen to be the ideal that the two vines of Pines and West (1986) gradually intertwine, realistically no one claims that this happens to a great extent. Therefore, educators are interested in what happens when these two vines meet. Pines and West (1986) outline four possible scenarios for this meeting, largely based on the relative strengths of the existing and imposed frameworks and the degree to which the frameworks are different.

Education has to be concerned with conceptual development and conceptual conflict resolution. Schools are involved in the presentation of

conceptual frameworks regarded by educators as being "correct". However, attention must be paid to the frameworks which students have already developed. Where they exist there may be substantial conflict with the frameworks the school wishes to impose. As a result, students may need to adjust or discard their own frameworks to assimilate new information. In effect, students may need to develop new frameworks based on those presented to organise both the prior and new knowledge. In some instances, this process may be simple because they are either not committed to a framework or their own is congruent to that presented. In other situations this process is very complex and difficult. No matter which scenario is likely to occur, the interaction between the two frameworks has important considerations for student learning.

The place of conceptual frameworks in student learning has implications for both teachers and researchers. The role of the teacher in learning will be significantly different if (s)he is involved in more than just the presentation of information. The learning environments used and the materials and activities used should be chosen to match the conceptual structure of the knowledge being taught and the existing frameworks of the students. Many educators (Pines & West, 1986) believe that teachers need to allow students to develop their own frameworks by providing appropriate knowledge and experiences. In short, adherence to constructivism has important ramifications for the intended curriculum in schools and its implementation.

In research, the popularity of the constructivist view of learning has led to interest in what is known as "misconceptions" or "alternative frameworks". Certainly the researcher who believes in constructivism must be concerned with: conceptual frameworks; prior knowledge; the

relationship of formal knowledge to spontaneous frameworks; and the attitude of the learner to formal knowledge (Osborne & Wittrock, 1985). In general this often leads researchers to the use of more qualitative forms of research than quantitative (Pines & West, 1986). This study of the factors effecting computer literacy was qualitative in nature and concerned itself with conceptual frameworks, prior knowledge, and attitudes.

## Constructivism and Computer Education

The complex nature of the conceptual frameworks pertinent to the interaction between user and computer is investigated in this section in terms of the nature of: students; computers; the relationship between computers and students; the learning environment; and concept development. This provides the framework for the discussion of the factors characterizing the use of computers by students which follows this section.

Very little theory has been developed from a constructivist viewpoint on computer education. Papert (1980) is a constructivist who used computer technology as a tool to develop mathematical and scientific concepts best seen in the development of the LOGO programming language. In so doing he developed theory on the conceptual frameworks relevant to computer use. His wife, Turkel (1984) developed these further in studies with a variety of people, largely lower primary students.

## The Nature of Students and Computers

Formulation of general objectives is necessary to develop a computer literacy curriculum, however, it is not a sufficient condition. It is equally important to consider the nature of students, computers, and the relationship between students and computers in designing such a curriculum. This section considers each of these keeping in mind the general objectives of computer literacy concerning present and future utilization of computers.

The student is by nature an individual, a thinking and feeling person who, in the constructivist framework, constructs reality from experience and prior knowledge. The student interacts with the environment and, to cope with this environment, develops a conceptual framework to explain the interaction. This framework is active whenever the student interacts with similar environments. There is a communication occurring here between the student and the environment whether that environment involves animate or inanimate objects. The developing conceptual frameworks determine what the student thinks and feels about the objects in the environment and how the student uses those objects.

Many of the environments students are likely to encounter today involve computers. The aim of computer literacy programmes is to put students into environments involving computers. In such programmes, we hope to help students construct frameworks for thinking and feeling which allow them to make use of computers. That is, we want students to develop frameworks which allow them to make use of computers in their life environments and include the attitudes which encourage them envisage computers in those environments.

Previously, the computer may have been considered to be an inanimate object in our environment. However, as the power of the computer for logical processing and communication increases, this notion is being challenged (Maas, 1983). There is a definite, two-way communication between the user and computer which is, in many regards, a person-person communication. As Palme (1981) states, "Every communication between a human and computer is in reality a communication between humans " (p. 176). The machine was designed and is programmed by human beings and therefore the constructs it relies on are primarily those determined by these designers and programmers. While the human constructs a framework to cope with interactions with the environment the computer has a framework of interaction built in by its designers and programmers (Hedberg & Mumford, 1975). When the frameworks of a person and computer interact the computer's framework is basically unchangeable so that it is the person's framework which must adapt to any incongruities presented by the interaction. Therefore, to investigate the interaction between user and computer, consideration must be given not only to the machine and the user and their environments, but also to the intentions of the machine's designers and programmers. Some constructs and concepts may be universal to computer use and some may be specific to either hardware or software, or both.

In the communication process between user and computer, the development of the computer has gone ahead at a rapid pace, far exceeding the development of the user end of the communication (Evans, 1981; Green, Payne, & van der Veer, 1983). As a result, the operating power of the computer is largely underused (Evans, 1981). For

people to make more use of computers to solve the problems they encounter and complete tasks for them the difficulties the user encounters in communicating with and understanding the computer must be addressed. Evans (1981), and Hedberg and Mumford (1975) maintain that educators, psychologists and computer system designers have failed to come to grips with computers and recognize that the main problem in the use of computers is psychological.

As educators and psychologists investigate person-computer communication, they will need to know what uses computers can be put to (Evans,1981) and they will have to work with computer designers and programmers to develop appropriate dialogue to improve this communication (Maas, 1983; Hedberg & Mumford, 1975). Computer systems are designed to suit particular task environments and "models of man" (Hedberg & Mumford, 1975). Therefore, to develop computer literacy, computer systems are needed which have been designed for use by students to complete necessary tasks in the school environment. This will involve computer software being designed to suit the conceptual frameworks and communication norms of most student users. In addition, students will need to learn about the nature of the machine and its communication design appropriate to the user (Hedberg & Mumford,1975). That is, the machine needs to be developed to suit students and the students need to develop an understanding of what the machine can do and an appreciation of the limitations under which it operates. In this way students will come to perceive the computer as a useful tool rather than feeling that they themselves are the tools of the machine (Maas,1983).



## The Learning Environment

Just as an understanding of the nature of students and computers is important in developing the curriculum for computer literacy, an understanding of the role of the learning environment is necessary. The environments that students find themselves in can be categorised as: school, home, and community. This study is largely concerned with the school environment but does not overlook the home and community as learning environments. Little research has been done to investigate computer literacy in these latter two environments (Carey & Gall, 1986).

In the home environment, some research has been done to investigate the effect of ownership of a home computer. Carey and Gall (1986), found that students use a wide variety of computer applications at home. However, they concluded that this largely reflected a transfer of learning from school. This connection between school and home also was emphasized by McGarvey, Okamoto, and McDevitt (1986) who concluded that increased learning gains were possible when home computers were used concurrently with use at school by kindergarten students. Moon, Tung, and Hui (1986), found that owning a home computer had a significant effect on learning in a computer literacy course. However, they concluded that owning a home computer increases the confidence of students but is of little value otherwise. Carey, and Gall (1986) also found that when home computers were used primarily for games, students tended to avoid using computers for other purposes at school.

Schools need to develop learning environments which allow students to be given the necessary understanding, knowledge, skills and

experiences. The study by Klassen, Anderson, Hansen, and Johnson (1980), showed that, according to their definition, a variety of course types improved students' computer literacy. They examined programming, computer science, Computer Assisted Instruction (CAI), computer appreciation, and other subject specific classes. In all cases, students' computer literacy improved, with specialist computer science classes showing the best improvements. However there has been a tendency to link computer learning with mathematics classes which many educators feel is not appropriate (Parish, 1984).

Because of the related nature of computer literacy and computer awareness it should be possible to deal with the aims of both within one curriculum programme. In fact, many programmes not designed to cater for computer literacy or computer awareness partially or fully satisfy their aims. For instance, students gain some computer literacy by using Computer Assisted Learning (CAL) packages in a variety of subject disciplines or by learning to use a wordprocessor in business education courses. Also, students may become more aware through watching television programmes or discussion held in social science classes on a variety of topics.

The school environment consists largely of the people involved in it: the teaching staff; and the peer group of students. Calfee (1985) sees the teacher as the key to computer literacy education, both in terms of the necessary role of the teacher and the shortcomings of most teachers with respect to technology. He sees the teacher as a model for the interactions that need to be handled in modern life and as a mediator of learning to relate to a machine. The importance of peer group in the lives of students is well documented by sociologists and largely influences the attitudes

and motivations held by students.

### Concept Development

An understanding of the concepts in computer use and the way in which students develop computer related concepts is important for the development of curriculum. This has been highlighted earlier in this chapter when discussing the nature of the interaction between computers and humans. In the terms of Pines and West (1986), it is important that the nature of the desired downward growing vine imposed on students and the types of upward growing vines that are likely to exist in the classroom are known. An understanding is required of the effects that spontaneous conceptual frameworks students develop, and their interactions with the formal, imposed knowledge have on the utilization of computers by students.

Olson (1985) suggested that children ascribe mental states to computers and themselves, but that these states are different. He felt that these differences allowed students to succeed in using computers. So, the way in which students perceive computers and the constructs they develop to assimilate experiences with, and knowledge about, computers is crucial to the way in which they learn about computers. Turkel (1984) supported this and showed how two different conceptual bases, which she named soft and hard, led to different uses of computers and different values being ascribed to the use of computers. Also, Mayer(1982) demonstrated the need for the use of concrete models in understanding computers to overcome students' lack of domain-specific knowledge.

It is common for users to anthropomorphise computers although Maas (1983) saw this as being potentially dangerous in that it may lead to an over-estimation of the capabilities of the machine. However, with the emphasis on artificial intelligence, some may say that this conceptual framework is not far from the truth (Kugel, 1985). Users may either see computers as tools which they control or beings that control them. The latter often occurs when users have little information about how a computer system operates and simply follow set, standard procedures, determined for them by the system (Maas, 1983; Palme, 1981).

The conceptual framework which users develop to cope with using computers seems to be determined by: the user's previous experience with computer systems; the user's knowledge of the workings of a computer system; the concepts which the designers of computer hardware and software have incorporated into a computer system; and the task environment in which the computer is being used (Hedberg & Mumford, 1975). These factors were highlighted in a study reported by Evans (1981) which investigated the use of an interactive computer system in a hospital to interview patients in the first stages of diagnosis. The software for this study was designed to simulate a friendly, sympathetic and tolerant doctor although the users were clearly told that they were interacting with a computer. Although many patients refused to believe they were being interviewed by a computer they accepted the system well as a sort of "surrogate" doctor. In this case the conceptual framework built into the computer matched the expectations of the users for the task it was performing. In addition, potential barriers to the use of the system due to users' previous concepts of computers, human nature, and computer specifications were attended to in the software design and user procedures. This is often not the case, as computer designers build

into computers models of man which are incongruous with those of the users (Hedberg & Mumford, 1975).

Papert (1980) introduces the role of cultural background in learning and in the development of concepts concerning the use of computers. He claims that most people, particularly children, have in their culture or environment very little of the systematic and process thinking incumbent on computers with which to assimilate knowledge from experiences with computers. He proposes that many people are hampered by their beliefs about their own lack of capabilities in these areas of thinking. He claims that, through programming computers, students will develop procedural knowledge and the necessary intuitive thinking to use the potential of the new technology. Papert insists that students' attitudes towards such learning are crucial and tend to be negative at present. Therefore, students need to be supplied with non-threatening computer environments in which they can explore and manipulate their own potential and that of the computer. To this end he developed the LOGO programming language.

### The Place of Programming

There is no doubt that the biggest controversy in computer literacy education surrounds the position of programming (Hansen, Klassen, Anderson, & Johnson, 1978). Programming was the basis of early computer courses in the 1960s and 70s. At that time, it was felt that many students would become programmers and that existing software was sparse, complicated and often not very useful. Since then, most people have come to realise that the need for programmers at even the high language level will not be anything like that predicted. Today, software is

much more readily available and very user friendly, requiring no knowledge of programming to use. In short, most students will never need to program; a few top quality programmers write the main programs which everyone then uses. Even so, the controversy over the place of programming has continued.

Self (1983) saw fit to devote a large portion of the explanation of his views on computer literacy to why programming should be part of computer literacy courses. Watt (1982) presented an argument, similar to that of Linn (1985), based on programming assisting students to develop logic and intuition. He then showed programming as a means of showing mastery over the machine and of problem-solving. However, many educators include programming as an assumed part of computer literacy curriculum with little argued rationale. Even Hunter (1983) includes programming in her K-8 curriculum without a rationale. She acknowledged the diversity of opinion and lack of consensus over the purpose of programming but still included it in her curriculum.

While the arguments of Watt (1982) and Self (1983) have some merit, they, by and large, have nothing to do with computer literacy/awareness and are not easily traced back to the general objectives. In fact Chen(1986) found that the use of computers in other subject disciplines introduced computers to students in a better way than programming classes, particularly for female students. Perhaps it could be argued that a brief introduction to programming will help give students an understanding of the nature of a computer and dispel the non-machine mystic surrounding the computer. This relates to the objective concerning the need for positive and realistic attitudes towards computers. Simple programming may help reduce fear of the machine and demonstrate that

the user is the "master" of the machine. Papert (1980) extols the virtues of programming to give students mastery over a learning environment but deplores the use of BASIC. Therefore, while learning to program may not be an aim of computer literacy it may be included in some form to gain the spin-off benefits mentioned and to provide motivation for some students.

## Factors Affecting the Utilization of Computers

Anderson, Klassen, and Johnson (1981) said, "We need many minds to work on what contributes to the 'ability to do computing'." (p. 690) If the general objectives of computer literacy include encouraging students to use computers now and in the future, then it is important to identify the factors which may characterize present computer use and affect future computer use. Many educators and computer scientists have described such characteristics and postulated factors contributing to students use of computers. A number of studies have investigated some of these factors and characteristics, those referred to in this review are listed in Table 1. A major study by Turkle (1984) investigated the psychological characteristics of the interaction between a variety of people and computers such as: the extent to which human characteristics are attributed to computers; the emotional attachment to personal computers; the feeling of difference between humanity and computers, the feeling of control over the computer; anxiety associated with computer use; the place of programming a computer; the effect of gender on computer use; and conceptions of careers and computer use. These characteristics and others are discussed in this section.

Table 1

A List of Studies Whose Findings are Referred to in This Thesis

| Researcher                        | Year | Sample<br>Age(yrs)   | Size  |
|-----------------------------------|------|----------------------|-------|
| Carey & Gall                      | 1986 | Secondary            | 983   |
| Chapline & Turkle                 | 1986 | Pre-service teachers | 73    |
| Chen                              | 1986 | Secondary            | 1138  |
| Collis                            | 1985 | Grades 8 &12         | >1800 |
| Eason, Damodaran, & Stewart       | 1975 | Adult                | 254   |
| Evans                             | 1981 | Adult                | >500  |
| Klassen,Anderson,Hansen & Johnson | 1980 | Secondary            | *NS   |
| Loyd, Loyd, & Gressard            | 1986 | 12-13yrs             | 561   |
| McGarvey, Okamoto & McDevitt      | 1986 | Kindergarten         | 186   |
| Moon, Tung & Hui                  | 1986 | Secondary            | 838   |
| O'Loughlin                        | 1987 | 13-15yrs             | 201   |
| Turkle                            | 1984 | K-adult              | *NS   |

\*NS - Not Stated

In order to address the general objectives of computer literacy, consideration needs to be given to the circumstances under which a student is likely to make use of computer technology now and in the future. It could be argued that a person is likely to use computers when (s)he :

- . has activities which they want to do which a computer can help to do either more easily, to a higher standard, or more quickly.
- . is aware of how the computer could be used to help on these tasks.
- . knows how to go about getting the software/hardware for these tasks.
- . has the knowledge and skills required to use the software/hardware.
- . enjoys using the computer to fulfil the tasks and has a confident attitude.



This list of requirements sets the knowledge, skills, and attitudes required for the present use of computers by students. The perceptions students have of their future use of computers will be largely determined by their present use of computers. Therefore, arguments similar to those used for present use of computers may be used to determine the requirements for the development of helpful perceptions of the future use of computers by students. Students are likely to develop helpful perceptions of future use of computers if they:

- . are able to successfully use computers to help them complete activities which they perceive as necessary.
- . are aware of uses of computers in various careers and in the community.
- . are aware of software/hardware options and how to locate the right hardware/software for their purposes.
- . have the basic skills, and knowledge required to approach a computer solution to a task.
- . perceive using computers as an 'enjoyable' solution and have a confident attitude.

These two lists of requirements may be summarised in general terms as concerning: the activities students complete using computers, the awareness students have of the applications of computers, the access they have to hardware and software, the knowledge and skills they require to use the hardware and software, and the attitudes students have toward the use of computers. This section discusses the factors affecting the utilization of computers by secondary students under these six headings.

### The Activities

The importance of the nature of the activities students complete using computers is often overlooked. In a comparison of computer literacy with

book literacy, Calfee (1985) presents a list of the most often used software by adults and proposes that the reason why they are most often used is, "their usefulness to adults in meeting daily needs to handle information.". Maddux (1984) poses the question of what computer activities would be most beneficial to students. Fernie (1986) called for research to examine childrens' reactions and uses of computers in different forms. By this he was refering to the variety of types of activities which could be done using computers. Just using computers will not guarantee computer literacy (Anderson, Klassen, & Johnson, 1981); the activities students complete on computers is of fundamental importance.

While the importance of the activities given students to complete on computers is clear, what constitutes a good activity lacks clarity. For example, Anderson, Klassen, and Johnson (1981) argue that it is important that students be given "constructive computer experiences". However, Chen (1986) alludes to the need for further research into the activities students use computers for and the related "subjective task values". By this he means the attitudes and values associated by students with the tasks on which they are use computers. In a similar way, Eason, Damodaran, and Stewart (1975) discuss the "task fit" issues of: relevance; accuracy; completeness; and timeliness. By this they mean the degree to which the use of a computer facilitates the effective completion of the task (how worthwhile it is using a computer to complete the task). Chen believes that concern by teachers for subjective task values should be a particularly important consideration when girls need to be encouraged to use computers.

### Awareness of the Applications

Clearly, as the range of software available increases, it becomes not only important to have a knowledge of the applications of computers but, more important, to evaluate the applications and the software available for the applications (Anderson, Klassen & Johnson, 1981). Lewis (1984) sees software evaluation as an important part of the computer literacy of teachers. Coffin (1986) also sees this awareness and evaluation skill being important for principals of schools. For users to make maximum use of the computer's capabilities to help them they need to know what a computer can do and what hardware and software is available to be used.

### Access to Hardware and Software

The access students require to hardware and software can be viewed in terms of quantity and quality. How much time do students need to have access to computers, and what type of hardware and software is required? Maddux (1984) raises the question of the need for reasonable exposure for computers to have any "significant impact on children". It is not clear how much is reasonable exposure.

The communicative nature of the interaction between student and computer places requirements of the design of computer systems. Jorgensen, Barnard, Hammond, and Clark (1983) discussed the problem caused by the use of system-oriented command names and structures by designers which become obstacles for users not possessing specialist computer knowledge. They proposed the use of user-oriented, natural dialogue structures and vocabularies. To Hedberg, and Mumford (1975) these design features would better fit the naive user's task environments

and "model of man". Eason et al. (1975) highlighted the need for ease of use of computer systems and outputs that are easy to read and analyse which employ standardized software procedures. However, they argue that a balance is required because, in designing computer systems to be easy-to-use, the power of the system available to the user may be limited.

Chen (1986) points to the need for students to be exposed to "real world" applications which require up-to-date computer technology. Eason et al. (1975) stressed the importance of easy to use computer hardware. The tendency has been for up-to-date hardware to incorporate devices, such as the mouse, which make them easier to use. Practically, schools may not be able to afford to buy this level of hardware and software, but options need to be considered which may either simulate this hardware and software or give students limited access.

### Knowledge and Skills Required

It is not at all clear what knowledge and skills students require to use hardware and software. Calfee (1985) alludes to the debate over the use of "user friendly" systems. He is critical of those who claim that students do not need to know anything about computers to use them. He points to the need for knowledge in case of the occurrence of hardware or software problems and more importantly, to realise the power of the machine. He claims that, "as the 'user-friendliness' of a system is increased, the gap widens between what the user perceives and the underlying reality." Calfee feels that it is important to have a notion for the underlying reality to make full, and confident use of the computer. Perhaps this points to more than just the knowledge and skills students possess but more to the conceptions students have of computers. Most educators agree that

students have fundamental misconceptions about computers (Anderson, Klassen, & Johnson, 1981) which have ramifications for student learning. Fernie (1986) saw the importance of investigating the way in which children perceived computers to operate.

The knowledge and skills students learn need to be transferable to a variety of computer systems and applications (Anderson, Klassen, & Johnson, 1981). This probably means that students require exposure to a variety of computer systems and applications. However, that exposure alone will not ensure the development of transferable knowledge and skills. In a survey of users in commerce (Eason, Damodaran, & Stewart, 1975), a number of common skills and required knowledge were explained: skills to operate a terminal; procedures for operating the system; knowledge to ascertain which system facilities were appropriate to a task; knowledge of what to do in the event of system malfunction; knowledge of who to turn to when help was needed; the knowledge and language necessary to convey requirements to those responsible for system design. Coffin (1986) proposes skills in understanding computer terminology and the basic components of hardware and software as being essential for principals of schools in their task of approving purchases. His arguments could be extended to the general population which is gradually accepting the position of home computers.

Most experts believe that it is not possible for most users to learn all the necessary knowledge and skills required for their desired uses and therefore there is a need for user support systems (Eason, Damodaran, & Stewart, 1975). Computer systems need to incorporate appropriate documentation, internal help systems, and user backup support structures. In the school system this would appear to indicate the

importance of the role of computer literate teachers and support staff.

### Attitudes Required

Many educators argue that students need to have positive attitudes towards the use of computers (Loyd, Loyd, & Gressard, 1986). Although educators may state the attitudes under a variety of categories, the attitudes may be conveniently summarized in terms of : enjoyment, value, confidence, and anxiety. Students need to enjoy using computers, value the use of computers in society, have confidence in using computers and be free from anxiety when using computers. Many studies have found that students generally have positive attitudes towards using computers (Bergin & Ford, 1986; Loyd, Loyd, & Gressard, 1986; O'Loughlin, 1987).

A number of studies and educators point to the effect of gender on the attitudes of students (Collis, 1985; Chen, 1986; Loyd, Loyd & Gressard, 1986; O'Loughlin, 1987; Parish, 1984 ). Most studies find that males have more positive attitudes towards computers although Loyd, Loyd, and Gressard (1986) found the reverse to be true with seventh and eighth grade students. Therefore, perhaps age and gender need to be considered in relation to students' attitudes towards computers.

Previous use, experiences and learning about computers are usually thought to affect the attitudes of students (Loyd, Loyd, & Gressard, 1986). In general, experience with, learning about, and in particular hands-on use of computers is associated with positive student attitudes towards computers (Chen, 1986). Loyd, Loyd, and Gressard (1986) found greater amounts of computer experience was associated with less anxiety and greater liking of computers. Chen (1986) concluded that previous

experience probably explained why in many studies males have more positive attitudes than females.

### School Curriculum Course Modes

A major debate among educators centres around the types of courses which should be designed to ensure students are computer literate. Some advocate an "across the curriculum" approach where students confront the uses of computers in a variety of subject areas in ways relevant to that discipline. In doing so, students become familiar with the technology and see its use in a variety of situations (Chen, 1986). Others, such as Self (1983), advocate the need for specialist courses in computer literacy with associated curriculum and teachers. It is the author's belief, along with educators such as Hansen, Klassen, Anderson, and Johnson (1979), that the computer education of students in schools needs the two pronged attack of specialist and 'across the curriculum' courses.

The need for specialist courses in computer literacy/awareness may be supported with many arguments. Computer technology is by nature changing and developing very rapidly. It is more efficient to keep a select number of specialist computer education teachers up to date with the technology than to give computer education to all teachers. This will ensure students are given a more relevant view of the technology. The students are likely to be in school for a number of years before they get into a position to really use and affect the technology themselves. When they leave school it is likely that the technology they use is more up-to-date than that used in schools. Therefore students need to be kept in touch with the most up-to-date information on the technology. The specialist teacher can, in addition, attempt to supplement the inservicing

given to keep the general staff up to date.

Further, specialist courses are more likely to ensure a topic is covered at least adequately. Because of the importance to society of its citizens being computer literate and aware the computer education of students can not be left to the chance that an across the curriculum effort will succeed. Given that most teachers are not happy about an across the curriculum approach and that, in most education systems, coordination between the disciplines is not good, it is likely that the across the curriculum approach may be unbalanced, disjoint, confusing and in some places non-existent. Specialist courses can tie together the experiences and knowledge students gain from across the curriculum approaches.

Lastly, computer technology is a discipline in itself and as such is best learnt in an organised and defined way. Psychological models of learning can be used to optimise students' gaining in literacy and awareness. Once again the technology's importance to society demands that it be given status as a discipline.

## Summary

This chapter has outlined the debate over the definitions of computer literacy and awareness and the curriculum required. It has highlighted a number of factors affecting the utilization of computers by students. Generally, these factors fall in to the categories of: student attributes, computer attributes, the relationships between students and computers, student learning, and the learning environment.



A number of specific factors were highlighted : the quality of hardware and software used; the activities students are required to complete using computers; the amount of time students spend using computers and learning about them; the type of learning environment used; the attributes of and the role of the teacher in the learning environment; the previous experiences students have had with computers; gender; and the conceptual frameworks students develop as they interact with computers. These factors provide a basis for the categorization and interpretation of data and formulation of assertions in this study.

## CHAPTER THREE

### METHOD

#### Overview

The method used in the study is presented in this chapter. This includes descriptions of, and a rationale for, the: research methods; samples; data sources; analysis and interpretation of data used in this study. In addition, the computer literacy course studied by the students in the main sample is described and the role of the researcher/observer is discussed.

#### Research Methods

This section develops a rationale for the interpretive research methods from an understanding of the traditions of ethnographic research. The research methods used in a study develop from the psychological model of learning assumed, and the research questions posed. The psychological model of learning assumed in this study was based on constructivism. Adherence to constructivist models of learning often leads researchers to the use of more qualitative forms of research, which are involved with the meaning created as people interact with the world (Erickson, 1986; Pines & West, 1986). Therefore, this study was largely based upon qualitative, or interpretive, research traditions. The research traditions a study draws upon influence the methods of collecting and interpreting data and imply significantly different understandings to those of the more quantitative models, in education of

factors such as: classroom behaviour; and the role of the teacher (Jacob, 1987). Therefore, the nature and basis of interpretive methods is described in this section, along with a rationale for their use in research concerning computer literacy.

### Interpretive Research Models

Interpretive research models are distinguished from more positivistic, quantitative models in the type of research questions asked and their underlying assumptions concerning humanity and society. Such interpretive models are variously labelled as: ethnographic; qualitative; naturalistic; and symbolic interactionist (Erickson, 1986). The distinction is made between these forms of research, which appear more suited to viewing human society, and the more standard quantitative approaches which appear more suited to the physical and biological world (Erickson, 1986; Jacob, 1987). While this distinction is made, Jacob (1987) refers to traditions in ethnographic research which may vary considerably between themselves and between their applications by researchers. However, Kuhn (1970) identifies several themes of these traditions: assumptions about human nature and society; foci of the study; and methodology. In general, interpretive methods are used when a study is concerned with the psychological concepts of meaning associated with phenomena or occurrences, behaviour, learning and thought processes (Erickson, 1986; Jacob, 1987).

The assumptions, peculiar to interpretive research, have important ramifications for the research methods used in a study. While there is little agreement over the correct methods to use, there are some distinct underlying themes (Erickson, 1986). The methods used in ethnographic

research focus on long term participation, careful recording, and analytic reflection and interpretation (Erickson, 1986). One such major data collecting method used in interpretive research is termed participant observational fieldwork. Erickson (1986) lists the reasons why participant observational fieldwork may be used and the types of questions likely to be answered. This study applied these interpretive research methods to questions concerning the communication between person and computer as Evans (1975) suggests. Jacob (1987) suggests the adaptation of ethnographic traditions should be employed to address new issues. Issues concerning computer literacy are relatively new and the use of such research traditions will begin the development of new theories.

Jacob (1987) discusses five qualitative traditions in terms of Kuhn's (1970) underlying themes. Two of her five traditions are particularly pertinent to this study: holistic ethnography and ethnography of communication. To a lesser extent, the traditions of symbolic interactionism and ecological psychology also are relevant to the study. Adaptation of the methods used by these traditions were employed in this study. The rationale for the application of the relevant traditions to this study is discussed in this section.

Holistic ethnography. Holistic ethnographic traditions adapt well to research into computer literacy due to the concern of the traditions with culture. Holistic ethnography is concerned with describing and analyzing all or part of a culture or community, "an exploration into the unknown" (LeVine, 1973, p. 183). In essence, computer technology has become part of the culture in which our society is embedded. This computer aspect of our culture is a new phenomenon about which little is known. Jacob (1987) uses the definition of culture: "the sum total of the

knowledge, attitudes and habitual behaviour patterns shared and transmitted by the members of a particular society" (p. 11). This study was concerned with the knowledge, attitudes, and behaviour patterns of students in the context of a computer environment. As with the traditions of holistic ethnography (Jacob, 1987) this study involved the identification and description of patterns and themes and an attempt to understand and explain these patterns and themes. Hence, the adoption of some of the bases and methods of holistic ethnography would seem to be appropriate when researching computer literacy.

Holistic ethnography employs a variety of methods. However, in general, the methods involve interaction between analysis and observation. Jacob (1987) lists four basic tenets which rely on fieldwork, including researcher observation and various types of interviews. In this tradition, interviews tend to be informal and include open-ended types of questions. The interviewer listens more than talks in order to develop an understanding of the culture being investigated. The use of such interviews, although a little more structured than Jacob infers, were a central part of the data gathering for this study for all samples used.

Ethnography of communication. The traditions of ethnography of communication are applicable to research into person-to-computer interaction. Sometimes referred to as microethnography, this tradition developed from an interest in face-to-face interaction focussed on a particular facet of culture (Jacob, 1987). While this tradition has in mind person-to-person interactions in a person based culture, it would seem appropriate to apply this tradition to person-to-computer interactions in a computer rich cultural environment. Computer scientists, such as Evans (1975) and Maass (1975), clearly see computer technology principally as

a communication medium which needed to be investigated and understood to overcome problems associated with the use of the technology. This study was concerned with the student-computer interaction and the effects of this interaction on the students in terms of student outcomes.

The research designs in this tradition vary from "exploration of the unknown" to the systematic examination of specific hypotheses. Whatever the case they all tend to start with methods of general participant observation and gradually focus by collecting more detailed data (Jacob, 1987). The naturally occurring sequence of actions is recorded and often tapes are used to preserve the data, which helps in the process of continually going back to the data to test and retest assertions (Erickson, 1986). While not abiding strictly to this design, due to practical limitations, this study used general participant observation to generate assertions on which more detailed data were focussed. This study did employ the use of tapes in interviews. Also, via participant observation, the sequence of actions of students was recorded whenever possible.

Other ethnographic research traditions. While the relevance of the traditions of symbolic interactionism and ecological psychology to interpretive studies of computer literacy is recognized, this study did not extend into these traditions to any great extent. Symbolic interactionism stresses the interpretations or meaning people give to their experiences and is concerned with the participants' points of view (Jacob, 1987). This study assumed that students interpret their experiences with computers and learning about computers. This study sought to discover students' points of view by questioning them. However, while this study looked for

themes in interpreting data (Jacob, 1987), rarely did this concern the interpretations and attached meanings of students. Ecological psychology is concerned with human behaviour and the environment with the goal of, "objective descriptions of naturally occurring behaviour that are amenable to quantitative analysis." (Jacob, 1987, p. 3). This study intended to provide research questions for further quantitative analysis. Further, this study was concerned with questions relating to student behaviour and environment and used one of the main data collection techniques used in ecological psychology, specimen records gained from observation of behaviour. However, this study did not make detailed descriptions of behaviour settings in the classroom and did not probe substantially the types of question typical of this tradition (Jacob, 1987, p. 5).

### Conclusion

This study draws on the traditions of interpretive research but also seeks to employ, in places, the quantitative methods of more traditional research. While observation and interview are the major data collection techniques used in interpretive research, in essence interpretive research involves problem-solving where all possible data practicable must be collected and applied to the problem (Erickson, 1986). These research traditions rely on the skilful interpretation of the analysed data where, in more positivistic traditions, this interpretative phase is more obvious and prescribed.

The use of ethnographic techniques has implications for all phases of a study. It attaches importance to the cultural background and beliefs of the researcher involved in fieldwork (Erickson, 1986) and the manner in

which data are collected, organised and interpreted. The role of the researcher in this study is outlined later in this chapter and the beliefs of the researcher with reference to computer literacy curriculum are outlined in Chapter 4.

This study employed ethnographic data collecting techniques but did not strictly abide by the ideal for data organisation and interpretation. Ideally, in ethnographic research, the data are gathered relating to a wide variety of levels of the social environment and then are successively focused on particular features of the environment as themes become evident (Erickson,1986). In a number of ways, this study was not true to the ideals of ethnographic research due to limitations of time and personnel. The study was conducted by a single researcher so that, while a wide variety of data were gathered, it did not relate to a variety of levels of the social environment. Also, most of the interpretation of the data occurred on completion of the data collection phase, not allowing for successive focussing of the data. Further, ethnographic studies are prone to under use or misuse of data which have implications for data collection and interpretation (Erickson, 1986). In the development of empirical assertions and more generalised assertions, this study was concerned with minimizing these inadequacies and, where necessary, recognized them in the discussion of results. In particular, the search for, and use of, discrepant instances (Erickson,1986) was attended to in this study.

Finally, the use of ethnographic techniques has implications for the way in which results are reported. Erickson (1986) lists nine main elements of a report of fieldwork research. Results should be reported in such a way as to allow readers to co-analyse the data and cases reported with the researcher. This was intended in this study and all nine elements



were attended to in this thesis.

### Ethnographic Research in Computer Education

Very little qualitative research has been done in the area of computer education, even less in the specific area of computer literacy (Carey & Gall, 1986). An exception is the work of Oliver (1985) in which he observed computer literacy classes similar to the one in this study and proposed factors in student learning concerned with the role of the teacher. Carey and Gall (1986) refer to other small ethnographic studies conducted by Ely (1984) and Giacquita, Ely, and Smith-Burke (1984) which investigated two different environments for computer literacy learning. Bergin and Ford (1986) used ethnographic methods in studying the behaviour of kindergarten students using computers.

### Background to the Study

This section provides a background to the study. The Year 8 computer literacy class, which was a focus of the study, and the course conducted are described. Also, a description of the management of the class is provided.

There were 14 Year 8 computer literacy classes at the school, each comprising between 17 and 23 students. These Year 8 classes were not streamed and therefore represented pseudo random groups. The classes were studying a compulsory unit of computer literacy for the duration of the school year. Each class met once a week for 50 minutes, throughout the year, to complete the content as outlined in Appendix B. Alternate weeks were spent in the computer room using the computers and in a

classroom for teaching sessions. The course curriculum and rationale are outlined in Chapter 4.

This study focussed primarily on the practical 'hands-on' sessions conducted in the computing room every second week. During these sessions, students worked in pairs on Microbee and Apple microcomputers using various pieces of software as instructed by the teacher. The programme for the hands-on sessions is shown in Table 2, with the software packages listed in the order they were used.

Table 2  
Programme for Hands-on Sessions of Computer Literacy Course

| Week Nos. | General Application | Specific Software Used       |
|-----------|---------------------|------------------------------|
| 1-2       | Introduction        | various games packages       |
| 3-7       | Wordprocessing      | Wordstar wordprocessor       |
| 8-11      | Programming         | BASIC programming language   |
| 12-13     | Data Processing     | Introductory Data Processing |
| 14-15     | Other Applications  | Word Puzzles & Beeartistic   |

In the hands-on sessions, the teacher typically invited the students into the class at the beginning of the session and issued instructions on what to do and how to use a specific software package. Then the teacher allowed them to use the rest of the time to complete the assigned activities in pairs. The activities, set by the teacher either with verbal instructions or on a worksheet, typically required students to practice a skill using a software package or required students to solve a problem using the package. For example, one of the tasks set using the wordprocessor was to type out a personal profile. The teacher and researcher spent time

during the session helping students who were in difficulty and overcoming hardware and software problems as they arose.

All students were permitted to run software on the Apple microcomputers. The software used was a series of public domain, Computer Assisted Learning (CAL) programs. During the first term, students were rostered onto these microcomputers in small groups. For the rest of the year, the use of these microcomputers was determined by either reward for early completion of the assigned tasks or by an ad-hoc roster system for a session, necessitated by the unavailability of an adequate number of Microbee microcomputers for that session. Students were permitted to use the Microbee microcomputers at lunchtimes as were all students at the school who were members of a computing class.

The teaching sessions (i.e. those sessions which did not involve hands-on experience with computers) followed a course of study set down by the student textbook "Let's Go With Computers" (Oliver & Newhouse, 1986). Five content areas were developed in the course : historical background to the development of technology; computer systems; applications of computer systems; programming computers in a BASIC language; and the implications to society of computer technology.

#### Role of Researcher/Observer

This section describes the role of the researcher in the school and classroom and contends that, even though the researcher was a participant in the study at a number of levels, this had minimal effect on the validity of the results of the study. Further, this section contends that this participation helped the researcher to be accepted by students as a

member of the class which thereby improved the quality of observation.

The researcher had a special role in the school and in the classroom. The researcher was the course coordinator for all the computing courses in the school. Although the principal of the school had the official responsibility for computing in the school he had delegated the task to the researcher. The classroom teacher in this study was a more senior teacher than the researcher and would not have felt intimidated by the presence of the computing coordinator. The students were aware of the researcher's position in the school but appeared to be unconcerned and treated both teachers with equal respect but still looked to the classroom teacher for instructions. This was not only indicated by the students' overt actions in class but also the responses the students gave in the final interviews. To the question "Who do you ask for help?", 47% nominated the class teacher while none nominated the researcher. In answering questions such as, "What did you learn about computers?", and "Did you like the course this year?", students typically showed appreciation for the help provided in the hands-on sessions by both the teacher and the researcher.

While the researcher observed students in the class he often was required to overcome hardware and software problems. This was not unusual, as he often was called in to other computing classes for the same reason. Students frequently asked for the researcher's help in running software and overcoming individual problems with operating the computers. In these situations the researcher attempted to help the students after questioning them about the problem and their response to the problem. This provided the researcher with clearer insights into what students were doing and thinking of as they used the computers.

## Method

The study consisted of three components which were designed to answer questions of the type described in Chapter 1 (p 6-7). Each component made use of a well defined sample of students. This section describes: the research design; the three samples; the data sources; the procedures used; and data analysis techniques used in the study.

### Design of Study

The students who participated in this study were from a large, secondary senior high school situated in a middle to upper class suburb of Perth, Western Australia . At the time of the study the school had a population of approximately 1400 students. The students tended to be above-average achievers in most academic areas of study.

The three samples used in this study were: the major sample of a Year 8 computer literacy class comprising 20 students; a group of four students selected from the first sample to work on a "state-of-the-art" microcomputer; and a sample of 16 Year 12 students selected at random from the school. The four students selected to work on the "state-of-the-art" microcomputer were also included as part of the major sample in the study.

### Computer Literacy Class

The major sample for the study consisted of 9 boys and 10 girls. One boy and one girl who joined the class in second semester were not included in the sample data. Also, one boy who started the course left

after three weeks. His data were included in results from early data collection. The class was selected to participate in the study because it was scheduled for the computer literacy course when the researcher was available and its teacher had taught the course the previous year. This made the teacher more experienced than colleagues teaching the same course. Therefore, it was felt by the researcher that this teacher was more likely to implement the course in the way that was intended by the course coordinator. Many of the other teachers, who had no experience in teaching computer courses, had difficulty managing their classes in order to implement the intended course.

The main Year 8 sample was involved in an interpretive study of the computer literacy of secondary students. The following six data sources were used for this Year 8 component of the study : Background Questions Sheet; Attitudes Questionnaire; Initial Interview; Final Interview; Class Observations; and School Grades. A chronological list of these data sources is given in Table 3. The observations of the class completing the computer literacy course only occurred every second week when the class was involved in hands-on activities. Copies of all the questionnaires and interview questions are included in Appendix C and Appendix D.

#### The MacIntosh Intervention

The second sample used in the study, consisting of 2 boys and 2 girls, utilized a MacIntosh microcomputer. These students were selected by the researcher with no overt criterion for selection. Each pair of students had worked together consistently over the course and were required to complete a joint wordprocessed assignment.

Table 3  
Chronological List of Data Sources Used

| Term   | - | Month(s)   | Key Name of Data Source    |
|--------|---|------------|----------------------------|
| Term 1 |   | Feb-Mar*   | Class observations         |
|        |   | Feb        | Background Questions Sheet |
|        |   | Feb        | Attitudes Questionnaire    |
|        |   | March      | Initial Interviews         |
| Term 2 |   | Apr-July   | Class observations         |
|        |   | Apr-July** | MacIntosh Interviews       |
| Term 3 |   | July-Sept  | Class observations         |
|        |   | July-Aug   | MacIntosh Interviews       |
|        |   | Aug-Sept   | Year 12 Interviews         |
| Term 4 |   | Sept-Dec   | Class observations         |
|        |   | Nov-Dec    | Final Interviews           |
|        |   | Dec        | Class grades               |

\*Class observations occurred throughout the year.

\*\*Interviews with students in the Year 8 samples which used the MacIntosh computers occurred when each pair concluded their use of the computer.

This sample was used to test particular assertions concerning the effect of hardware and software types on computer literacy which emerged during the study. The four students were observed as they learnt to use the MacIntosh microcomputer in a variety of applications. The students used the computer each week, for four to six weeks, in their computer literacy class time. The students were interviewed at the end of this period.

These students were given minimal supervision and about five minutes of demonstrative instruction by the researcher. Each pair went through two instruction tapes with associated disks in order to learn how to use the microcomputer. They then completed the assignment using the

Macwrite wordprocessor which the other students in the class were completing on the Microbee microcomputer. These four students were given permission, not afforded other students in the school, to use the MacIntosh microcomputer at lunchtimes once they had used the training tapes. However, other students in the class were given unlimited access to the Microbee microcomputers at lunchtimes and often after school. This ensured that access to the computers was not be a factor in any differences in computer use observed between students using the two different types of microcomputers.

### Year 12 Students

The third sample used in the study consisted of 16 students randomly selected from the Year 12 student population of approximately 250 students. This sample was used to test particular assertions about concept development, attitudes, and learning environments which emerged during the study. The only data source for this group of students was an interview conducted towards the end of the year. Responses were compared with the responses, to a similar set of interview questions, given by the Year 8 students.

### Data Sources

In the following discussion of each data source, reference is made to the data analysis, and procedures associated with that source. These data sources are referred to throughout the remainder of the thesis using the key names listed in Table 3.



### Background Questions Sheet

This section consists of descriptions of the nature and the analysis of the Background Questions Sheet. These include discussion of the questions, the data collection procedures used and the purpose of the data source.

The nature of the Background Questions Sheet. The Background Questions Sheet (Appendix C) was designed to collect data on the students' previous experience with computers and their job aspirations. This provided an indication of the utilization of computers by students entering the Year 8 computer literacy course. Also, in conjunction with other data sources, the responses were used to determine the effect of that utilization on the students' attitudes towards the use of computers.

The Background Questions Sheet contained seven questions relating to the student's use of computers at home, primary school and in the community. The first question asked whether the student had a home computer, two further questions determined the amount and type of use made of the home computer. Students were then asked to indicate how much time they spent learning about computers the previous year. Finally, students were asked for an indication of future vocation and an indication of the use made of Automatic Teller Machines (ATMs) to do banking.

The Background Questions Sheet was administered within the first two weeks of school commencing in term one. This was administered in the computer literacy class time during a teaching session. Students were told that the questions would be a part of an evaluation of the

computer literacy course and that the data collected would be confidential and anonymous.

Analysis of Background Questions Sheet. The responses to the questions were grouped by the researcher into categories of response to allow frequency counts to be made.

### Attitudes Questionnaire

This section consists of descriptions of the nature and the analysis of the Attitudes Questionnaire. This includes a description of the items, the scales constructed from these items, the data collection procedures used, and uses made of the data source.

The nature of the Attitudes Questionnaire. The questionnaire consisted of 48 items selected from an instrument (Appendix D) designed by the Minnesota Education Computing Consortium (Klassen, Anderson, Hansen, & Johnson, 1980). The validity and reliabilities associated with this instrument, stated by the designers were not available to this study. The items were designed to measure categories of student attitudes towards computers and the use of computers using 10 scales (Table 4). These measures were used to determine the probable influence of student attitudes towards computer technology on their present and perceived future use of computers.

The first 30 items on the questionnaire made use of a standard Likert five choice scale. The next 10 items were not used in the thesis. The final eight items each provided a different set of four response options

based on the strength of feeling towards eight adjectives used to describe computers (Appendix D). For example, one set of response options given to describe computers was: not frustrating; frustrating; very frustrating; and undecided. There were 9 reversed items throughout the questionnaire.

Table 4

Aggregated Scales From the Attitudes Questionnaire

| Scale Name                      | Items           | Scale | Scale |
|---------------------------------|-----------------|-------|-------|
|                                 |                 | Max   | Min   |
| Computer Enjoyment <sup>+</sup> | 1,5,6,7,10      | 5     | -5    |
| Computer Anxiety                | 2,3,4,8,9       | 5     | -5    |
| Computer Self-Efficacy          | 11,12*,13,14,15 | 5     | -5    |
| Computer Sex-Typing             | 16,17,18,19,20  | 5     | -5    |
| Policy Concern                  | 21,22,23,24,25* | 5     | -5    |
| Educational Computer Support    | 26,27,28,29,30* | 5     | -5    |
| Personal/Impersonal             | 41,47           | 6     | 0     |
| Challenge/Frustrate             | 42,45           | 6     | 0     |
| Good/Bad                        | 43,46           | 6     | 0     |
| Human/Dehuman                   | 44,48           | 6     | 0     |

\*These items were removed to improve the reliability of the scale.

+The first six scales use the titles given by Klassen(1980).

The Attitudes Questionnaire was administered at the same time and in the same manner as the Background Questions Sheet. The researcher personally administered the questionnaire, and conducted the briefing session used to explain to the students the purpose of the research. Students were again reassured that the results would not be used in any way in their achievement assessment for the course.

Analysis of the Attitudes Questionnaire. The scales, which comprised of related items, were scored in two different ways. For the first six scales

the five choice scores were collapsed to give a three point score. Numerical values of 1 for agreement, -1 for disagreement and 0 for undecided were used to aggregate a score for each scale. The collapsing of the responses for these items was felt necessary because the small sample size led to a situation where most categories of response had less than five responses. For the final four scales a score of 3, 2, 1 or 0 was recorded for each item.

Aggregated scores were calculated for each student on each scale by summing the scores of all the items for that scale. Possible scores on the first six scales ranged from -5 to 5 and on the last four scales ranged from 6 to 0. To improve the reliability of three of the first six scales, three items were removed (Table 4). Aggregated scores calculated for these four item scales were adjusted by multiplying by a factor of 1.25 to give the same possible range of values as the five-item scales.

Of the 10 scales identified on the questionnaire, the measures obtained from five of the scales were not reliable (Table 5) and were not used in the study. The scales not used were: Computer Sex-Typing; Personal/Impersonal; Challenge/Frustrate; Good/Bad; and Human/Dehuman. However on the Good/Bad scale 19 of the 20 students answered item 46 by the 'computers are good' choice which explains the low reliability (i.e., lack of variability on item 46). Scores from the five remaining scales were included in students' personal profiles as one indication of their attitude towards computer technology.

Analyses of Variance were used with the scales from the Attitudes Questionnaire as dependent variables and specific responses from the Background Questions Sheet as independent variables. Students were

grouped according to ownership of a home computer, amount of time spent learning about computers at school the previous year, gender, and use of Automatic Teller Machines for banking. These analyses were conducted to investigate the effects of these groupings on student attitudes by testing for differences in the mean scores for each of these groups on each of the five scale scores from the Attitudes Questionnaire used in the study.

Table 5  
Reliabilities on Scales from Attitudes Questionnaire

| Scale                        | # Items | Alpha |
|------------------------------|---------|-------|
| Computer Enjoyment           | 5       | 0.72* |
| Computer Anxiety             | 5       | 0.63* |
| Computer Self-Efficacy       | 4       | 0.73* |
| Computer Sex-Typing          | 5       | 0.40  |
| Policy Concern               | 4       | 0.70* |
| Educational Computer Support | 4       | 0.79* |
| -----                        |         |       |
| Personal/Impersonal          | 2       | 0.51  |
| Challenge/Frustrate          | 2       | 0.00  |
| Good/Bad                     | 2       | 0.28  |
| Human/Dehuman                | 2       | 0.61  |

\* These scales were accepted as reliable measures.

Analyses of Variance was considered an appropriate statistical test to use with these data because it could be argued that the group was likely to be equivalent to a randomly chosen group. It was not able to be ascertained how close the measures were to normality in the population nor the degree of homogeneity of variances. However, there was no reason to believe that there should be any major discrepancies in normality and variance homogeneity concerning these measures taken

from an internationally extensively used instrument . Further, it is clear that the Analyses of Variance test is very 'robust' in the face of departures from normality and homogeneity of variances (Popham & Sirotnik, 1967; p183).

### Interviews

This section consists of descriptions of the nature and the analysis of the interviews. The descriptions include the two interviews conducted with the main Year 8 sample, the interview conducted with the Year 12 sample, and the interviews conducted with the four students who used the MacIntosh. These three interviews were conducted and analysed in a similar manner and are therefore discussed together.

The nature of the interviews. The Interviews of the main Year 8 sample were conducted at the beginning and end of the year. The Initial Interview consisted of 14 pre-set questions designed to gather data on the computer-related background of students, future aspirations, perceptions on the use of computer technology, concepts in the area of computer technology, and student attitudes towards the use of computers. The Final Interview consisted of 16 pre-set questions designed to gather data on the perceived learning of students in the course, their future aspirations, perceptions on the use of computer technology, concepts in the area of computer technology and student attitudes towards the use of computers. Eleven of the questions in the Final Interview were identical to those of the Initial Interview (Table 6). The repetition of these questions was designed to investigate perceived changes in student responses to these questions throughout the course.

**Table 6**  
Interview Questions From Initial Interview Common to the Final Interview and Year 12 Interview.

| Initial Interview Question  | Interview Question No. |         |
|---|------------------------|---------|
|   | Final                  | Year 12 |
| 1. What do you think a computer is?   | 3                      | 2       |
| 2. Have you used a computer before? Where and when?                             | -                      | 1       |
| 4. Do you like using computers?   | 4                      | -       |
| 5. Do you think you could use a computer now to help you?                       | 5                      | 5       |
| 6. How do computers work?   | 6                      | 6       |
| 7. Can computers think?   | 7                      | 7       |
| 8. What does your family think about computers? Do you talk about them at home? | 8                      | 8       |
| 9. Would you like to use computers in your job after you leave school?          | 9                      | 9       |
| 10. Do you think computers are good or bad for the world?                       | 10                     | 10      |
| 11. What do you think is the best thing computers have been used to do?         | 11                     | 11      |
| 12. Do you think there is anything computers will never be able to do?          | 12                     | 12      |
| 13. How do you feel when you use a computer?                                    | 13                     | 13      |
| 14. When you use a computer do you know how to control it?                      | 14                     | -       |

The initial interviews were conducted by the researcher during the first five teaching sessions. Students were called out of class one at a time to be interviewed for about 10 to 15 minutes. All interviews were recorded on a small cassette recorder. Students were permitted to elaborate on answers and often the researcher added questions prompted by students' answers. All students responded to all the set questions even if the response was that they did not know how to answer the question. In order to minimize interruption to student progress in the lessons from which they were withdrawn, they were asked to complete the lesson's work at home.

Not all of the final interviews occurred in computer literacy class time, some were organised to be conducted in other session times to speed up the data gathering process. However, in all other respects the final interviews were conducted in the same manner as the initial interviews.

The Year 12 interviews each took about 10 minutes with most being conducted in free-time before school and some being completed in general class time. Eleven of the 14 questions were identical to those answered by the Year 8 students at the beginning of the year (Table 6). Three questions were included to assess the students' previous experience with computers. The identical questions used in the interviews of the Year 12 and Year 8 students allowed a comparison of the responses of the two groups. In particular, inferences were made about the similarities and differences between the two groups with reference to their attitudes towards computer technology and their use, both present and perceived future, of the technology.

The data source used for the four students using the MacIntosh microcomputer was an interview after each student had completed all allocated sessions on the computer. These interviews did not use pre-set questions. The researcher asked each student between 8 and 15 questions related to the student's experiences on the MacIntosh computer and resulting attitudes towards the utilization of computers.

Analysis of interview data. Student responses were taken at face value and only listened to by the researcher. Each student's interview tape was transcribed onto data sheets, question by question for each interview. Often literal transcription was done, however, where a student's answer was protracted or confusing it was summarized. When each tape had been transcribed, summary data were prepared on the



class's responses to the questions. To do this similar responses were grouped. This presented an overall picture of the responses for each question for the entire sample.

### Class Observations

This section consists of descriptions of the nature and the analysis of the class observations. The data collection techniques and the type of data collected are included as part of the nature of the observations.

The nature of the class observations. The researcher attended twelve of the fortnightly 'hands-on' sessions in the computing room in order to make class observations. It was not possible to observe all students in detail in each session because there were too many students in the class. In addition, some of the researcher's time was used to help the class teacher and students overcome technical problems with the hardware and software.

Class observations of the main Year 8 sample were made by recording brief notes onto specially prepared observation sheets. The observation sheets, ruled into horizontal strips (Appendix E), contained the name of each student in the class. Reference was made on these sheets to the activity in the class, the general progress of the class and any significant events occurring for individual students. Significant events for a student included any major questions asked or comments made, whether to the whole class or to the teacher or researcher. Also notes were recorded on students' personal progress throughout the tasks. General information on the class's progress or the running of the lesson

was written on the top or back of the sheet.

Data analysis for the classroom observations. The observation sheets were collated and comments pertaining to individual students were transferred onto a single sheet for each student. This gave every student a list of recorded comments for the year. Comments about the lesson or class also were collected into a summary. These summaries described the overall progress of the class throughout the computer literacy course.

### School Grades

School Grades were collected at the end of the year on the group of Year 8 students used in the study. These grades consisted of a single letter, either A, B, C, D, or F where the first four denoted pass grades. The first semester and end of year computer literacy grades for each student were obtained. The Computer Literacy grades were collected to give a measure of the achievement of each student in the computer literacy course. Each student's grade for mathematics at the end of the year also was obtained. The mathematics grades were collected as a measure of the students' overall ability and achievement at school. Mathematics was used because of the often cited connection between ability to use computers and ability at mathematics (Papert, 1980; Haines, 1987).

### Student Profiles

The data on each student were collated and from this a data profile on each student was written, making use of as much of the data as possible. A number of students were targetted for further investigation. These were the four MacIntosh students, two girls who had negative attitudes to using

computers in the Final Interview, and two students who seemed to have improved attitudes to using computers in the Final Interview.

## Data Interpretation

The data were used to generate assertions which related to the general research questions outlined in Chapter 1. This study was concerned with the utilization of computer technology by secondary students and factors affecting the utilization of the technology. Therefore, data from all sources were assembled to describe the previous, present, and perceived future use of computer technology by students and to support or refute assertions on factors expected to affect the students' use of computer technology.

The development of the final nine assertions involved a process of gradual synthesis and focussing. First, a large number of assertions specific to each data source were made. With the interviews the data count summaries were used to generate assertions for each set of questions. Where questions were the same in each interview (beginning and end of year) assertions were based on the summaries for that question making note of any perceived changes throughout the year. Where a question only appeared in one questionnaire, assertions were made using the summary for that question.

Some of the initial, data-specific assertions were combined to remove obvious repetitiveness. This resulted in eight assertions which were then grouped twice to fit two different logical structures: Knowledge, Skills, and Attitudes; and Students, Learning Environments, Activities, and Hardware/Software. The second of these two structures was preferred

and then refined through a consideration of associated literature to :  
Students; Computers; Learning Environments; and Concept  
Development. Finally the assertions were further refined to remove  
conflict and repetitiveness resulting in the nine assertions presented in  
Chapter 5.

The final set of assertions was supported using data from a  
combination of the sources provided in this study. The data sources used  
to support each assertion are presented in Table 7. Where possible, data  
from more than one source were used in the discussion of each assertion.  
The use of data, from a wide variety of sources, to support each assertion  
improves the validity of the findings of this study.

Table 7  
Data Sources Used in Formulating Assertions

| Assertion | Data Sources |    |    |    |    |    |     |
|-----------|--------------|----|----|----|----|----|-----|
|           | BQS          | AQ | II | FI | CO | MI | Y12 |
| 1         |              | *  | *  | *  | *  |    |     |
| 2         |              |    |    | *  | *  |    |     |
| 3         |              |    |    |    | *  | *  |     |
| 4         |              |    |    | *  | *  | *  |     |
| 5         | *            |    | *  | *  |    |    | *   |
| 6         | *            | *  | *  |    |    |    |     |
| 7         |              |    | *  | *  |    |    | *   |
| 8         |              |    |    |    | *  |    |     |
| 9         |              | *  | *  | *  | *  |    | *   |

BQS Background Questions Sheet; AQ Attitudes Questionnaire; II Initial Interviews;  
FI Final Interviews; CO Classroom Observations; MI MacIntosh Interviews; Y12 Year  
12 Interviews

## Summary

This chapter described the research methods, samples, data sources, and methods used to obtain data on the utilization of computer technology by secondary school students. The methods were designed to provide case study data and some general data focussing on the ethnographic investigation of students' experiences. This chapter also described the context in which the study was carried out, including information on the course content and methods of teaching. Finally, this chapter described the data sources, data analysis, and interpretation used to address the questions raised by the present and future utilization of computer technology by secondary school students.

## **CHAPTER FOUR**

### **DISCUSSION OF THE INTENDED CURRICULUM**

This chapter presents and discusses the intended curriculum for the computer literacy class observed in the study. The intended curriculum is presented in terms of the aims of the course, the intended student outcomes, the content of the course, the classroom environments used, and the teacher's role in running the course. A comparison between the intended and implemented curriculum is provided in the assertions developed in Chapter 5.

#### **The Intended Curriculum**

In Chapter 2 the curriculum for computer literacy/awareness in secondary schools was discussed in terms of the objectives and student learning. Further discussion of student outcomes, teacher behaviours and classroom environments used in the curriculum would be of little value as there is little agreement between educators on these. Due to the researcher's role as computer coordinator in the school involved in the study, it is more useful to present the intended curriculum in detail rather than dwell on other aspects of the curriculum as seen by educators. The overt computer literacy/awareness curriculum in the school was determined by the researcher. Thus the intended curriculum was the researcher's curriculum modified by the constraints of the school setting and the educational environment.

### Aims of the Course

The computer literacy course was designed to give students an appreciation for the uses of computer technology, the implications of that use for living in our society. In addition, it intended to encourage them to make full use of the technology without disadvantaging themselves or others. The course aimed to provide students with the knowledge, skills, experiences, understandings, and attitudes necessary for them to: make use of computer technology to complete tasks and solve problems in their present lives; make use of computer technology to complete tasks and solve problems in their future lives; and be responsible citizens in our society to ensure technology is used to benefit and not disadvantage people.

These broad aims encompass the aims of most computer literacy and awareness courses conducted throughout the world (see for example: Cupertino Union School District, 1983; Johnson, 1980). This study was particularly interested in the aims of developing attitudes, rudimentary skills and the desire and knowledge to use computers now and in the future. However, the aims of the course are interrelated and affect each other.

### Student Outcomes

The aims of the course give rise to a set of commensurate intended student outcomes. A detailed list of intended student outcomes for the course is presented in Appendix A. In general these intended student outcomes may be condensed to eight specific outcomes.

- . Students will be aware of the place of computer technology in history and in the development of technology.
- . Students will recognize a variety of computer systems.
- . Students will develop a generalizable concept of a computer system.
- . Students will recognize the widespread uses of computer technology.
- . Students will be aware of the social implications of the use of computer technology in our society.
- . Students will be aware of how they could use computers to help them complete tasks and solve problems now and perceive ways they could use computer technology to help them complete tasks and solve problems in the future.
- . Students will be motivated to use computers now and in the future to help them complete tasks and solve problems.
- . Students will use computers with confidence and display rudimentary skills in using the technology.

### Content of the Course

The content of the course consisted of two components, a computer knowledge and concepts component, and a hands-on practical experience component. The specific content of the course is found in the course's four-term programme which is presented in detail in Appendix B. For the purposes of this study it is only necessary to note the general areas of content and the rationale behind their inclusion.

Computer knowledge and concepts. The computer knowledge and concepts part of the content was designed to help students place computer technology in the contexts of history and technological development. This also was designed to present students with a general model of a computer which would allow them to recognize a variety of computer systems. Finally, this part was designed to outline the major uses and associated implications of computer technology in our society.



The approach used to teach the content in this section was not technical in nature and was designed to give an introduction to computer technology. This content was covered by Chapters 1, 3 and 4 of the computer awareness student textbook, "Let's Go With Computers" (Oliver & Newhouse, 1986). A student workbook and a teacher's guide published to complement the textbook were also used with the class. Each student completed activities from their own workbook, and the teacher used the teacher's guide as a source of teaching ideas, questions, and answers for each topic covered in the course.

The course started by discussing the historical development of technology with the emphasis being on the reasons for, and the mechanism of development. The development of computer technology was then highlighted using specific information on people and events involved in the development of computer technology, but with the emphasis still on the reasons why the technology was developed, applications for society, and changes which occurred in society as the technology developed.

The historical development concluded with the development of the microprocessor. This developed into a brief discussion of the composition of computer systems in terms of hardware, software and personnel. The hardware/software of a computer system was described as involving input, processing, storage, output, and communication. Because most students only picture a computer as a microcomputer, they were given this general description of a computer system and then shown how a variety of systems from mainframes and microcomputers to microwave ovens and calculators fitted this description. The importance of software was stressed and the variety of uses of the microprocessor was highlighted.

The course then dealt with a variety of uses of computers centring around their place of use. Students were given some general categories of use such as information processing, simulation, design, control, and then shown how these applied to the specific uses. For example, the use of computers in offices, banks, government, and industry was presented. The intention was to increase student awareness of how they may use computers now and in the future by increasing their awareness of the current uses of computers.

Finally, out of these uses of computer technology the course presented some of the social implications of computer technology. In particular, the problems of unemployment, security of information, and control of information were discussed. The aim was to raise the students' awareness of these social implications. In addition the issues involved in buying a home computer were discussed because of the number of students who want to buy their own microcomputer.

Hands-on experience. The hands-on part of the course was not designed to be closely related to what was taught in the knowledge and concepts part. Some may perceive this dichotomy to be a discrepancy from an ideal curriculum. The dichotomy was seen to be necessary to cover the content of the course in the time provided and because some of the computer knowledge and concepts could not be related readily to practical experiences which students could be presented with at school.

The practical part of the course was primarily designed to introduce students to a number of pieces of software and thereby demonstrate some uses of the microcomputer. It was intended that students would pick up a few skills in the use of computers such as keyboarding, booting up,

running software, following instructions, using menu systems and elementary maintenance. It also was intended that students would develop confidence in using a computer, see the benefits and limitations, and develop a desire to complete tasks and solve problems using computers.

This part of the course started by spending two or three sessions using some easy to use, educational games-type packages designed to introduce students to the microcomputers used in the school. This experience also was designed to allow students to become familiar with a computer keyboard and to respond to requests from the computer.

The students then spent about six sessions learning how to use the Wordstar wordprocessor, the aim being to wordprocess an essay which was part of the assessment of the course. The intention was that students would learn general wordprocessing skills from their use of Wordstar, which would then allow students to make use of any wordprocessor. This part of the content was designed to contribute to the development of skills and confidence, and to increase the awareness and desire of students to use computers to help them.

Students were then introduced to computer programming through the BASIC language by using Chapter 5 of the textbook, "Let's Go With Computers" (Oliver & Newhouse, 1986). The intention was not to get students to write their own programs, although some may, but rather to create an awareness for the need to instruct the computer in a logical and precise manner. Students were introduced to a simple structure to parallel their introduction to computer systems: input, processing and output. This part of the course was designed to contribute to the

development of concepts and confidence in using computers as helpful, instructable machines.

Finally, students were given three packages to use: Introductory Data Processing (IDP), Word Puzzles, and BeeArtistic. The IDP package collected personal data and analyzed the data for them. The Word Puzzles package allowed them to enter word lists with clues to generate crosswords or word sleuths. The graphics package, BeeArtistic, allowed them to construct simple graphic displays in both soft and hard forms. All three activities were familiar ones to the students from their classes in Social Studies (IDP), Science (Word Puzzles) and Creative Arts (BeeArtistic). It was intended that students would recognize personal benefits using these packages and would therefore look for other uses and benefits in the future. This part of the content was designed to contribute to the development of skills and confidence, and to increase the awareness and desire of students to use computers to help them.

### Classroom Environments

The course was presented in two concurrent sections, conducted in different physical settings to match the two parts of the content. Teaching sessions, conducted in a standard classroom, were used to present the knowledge and concepts part of the content. Laboratory sessions, conducted in the classroom which contained all the microcomputers purchased for student use, were used for the hands-on part. Some may argue that the course should not have been split between these two environments. This was done in this course for two reasons. Firstly, to ensure that time was allocated to cover all the content of the course. In previous courses, teachers and students tended to neglect the computer

knowledge and concepts component. Secondly, to allow the school to make maximum use of the relatively few microcomputers available to students. While the classes used the standard classroom setting, other classes could make use of the microcomputers.

In the standard classroom students, sat at individual desks with a textbook and workbook. Class discussion and individual seatwork occurred in this setting with students being required to complete the activities presented in the workbook using the textbook as a resource. In the computer laboratory, students sat either at clustered tables to complete bookwork or listen to the teacher or they sat at microcomputers placed around the perimeter of the room. Typically, students sat in pairs at the microcomputers.

### Teacher's Role

The teacher's role in the course outlined in this study was to administer a prescriptive programme (see Appendix B) to the class. The course was prescriptive because most of the teachers in the course had little experience with computers. The teacher's role in the standard classroom environment was to : present the material from the relevant section of the book emphasizing the points related to the intended student outcomes of that part of the content; ensure students completed the questions from the text and the activities from the related section of the activities book; answer any questions asked by students; and administer two tests.

The teacher's role in the computer laboratory environment was to : manage the use of the computers by the students; ensure students had

the correct disks and manuals for the session; set tasks for the students to use the software; give students introductory instructions on the use of the software; give help to individual students; attend to problems with the hardware and software; and assess the students on their use of the hardware and software.

The teacher in this study was conscientious about keeping to the programme outlined in Appendix B and made use of the student text and workbooks. In almost all of the teaching sessions he used a whole class discussion to present the major teaching points of the topic and followed this by requesting that students use the textbook to answer questions and complete activities from their workbook. Where indicated in the programme, he showed the class videos which related to the content of these sessions. The teacher ensured that the class used all of the software prescribed in the course programme and set tasks for the students to complete using the software.

## Overview

This chapter presented the intended curriculum of the computer literacy course which was studied by the students in the main Year 8 sample of the study. In Chapter 5, assertions are formulated on the basis of the data that were collected in the study. Some of these assertions concern various aspects of this curriculum, as it was implemented. In particular, congruencies and discrepancies between the aims and outcomes of the implemented curriculum and intended curriculum are discussed.

## CHAPTER FIVE

### RESULTS AND INTERPRETATION

#### Introduction

In this chapter assertions pertaining to the research questions of the study are presented. However, preceding the presentation of the assertions is a description of the main Year 8 sample based on responses to questions on the Background Questions Sheet. These results are presented as an indication of the prior knowledge and nature of the learners, which are important considerations in applications of constructivism. Following this background section, the assertions are presented in terms of student learning discussed in Chapter 2. The findings presented in each assertion are interpreted within the contexts of this theoretical model and the findings of other relevant research. In this way the implemented curriculum is compared with the intended curriculum, particularly with reference to those outcomes directly concerned with the 'hands-on' sessions of the course. Therefore, the student outcomes relate to the students' utilization of computer technology and factors characterizing their present and perceived future use of computers. The assertions are supported through an analysis of all the data sources.

#### Background Information

The Background Questions Sheet was designed to gather information on the main Year 8 sample in four areas: the use of home computers, career aspirations of students, time spent learning about computers in the

previous year, and current use of Automatic Teller Machines for banking. An analysis of the responses to these background questions is presented in Table 8. The results in this table will be referred to in a number of the assertions that follow.

Table 8  
Frequency Counts on Responses to Background Questions Sheet

| #   | Question  | Answers                   | Cases | %   |
|-----|---|---------------------------|-------|-----|
| 1.  | Do you have a home computer?  | Yes                       | 8     | 40  |
|     |   | No                        | 12    | 60  |
| 2.* | How often do you use this computer?   | Often                     | 7     | 88  |
|     |   | Sometimes                 | 1     | 12  |
|     |   | Almost never              | 0     | 0   |
| 3.* | What do you use this computer for?  | Games                     | 8     | 100 |
|     |   | School work**             | 3     | 36  |
| 4.  | What type of job would you like when you leave school?                            | Don't Know                | 6     | 29  |
|     |   | Professional <sup>+</sup> | 12    | 57  |
|     |   | Non-professional          | 6     | 29  |
| 5.  | How much time(average) per week did you spend learning about computers last year? | Less than 5 mins          | 7     | 33  |
|     |   | up to 30 mins             | 6     | 29  |
|     |   | up to 1 hour              | 5     | 24  |
|     |   | over 1 hour               | 2     | 10  |
| 6.  | Do you use an Automatic Teller to do your banking?                                | Always                    | 1     | 5   |
|     |   | Sometimes                 | 4     | 19  |
|     |   | Never                     | 15    | 71  |

\* % based on number of students who had a home computer

\*\* Other categories not listed because frequencies were not more than 3

<sup>+</sup> four of these were vets.



## Findings

The focus of the study concerned students' present and perceived future use of computers and the influence of the computer literacy course on the students' present and perceived future use of computers. The findings are presented as nine assertions using the structure : the nature of students; the nature of computers; student learning and conceptual development; and the learning environment. Although factors relating to the nature of students and the nature of computers are interdependent, they are presented separately.

### The Students

One assertion related to the nature of the student group at the beginning of the computer literacy course. This assertion concerned student attitudes towards the use of computers.

Assertion 1 : Students entering secondary school: enjoy using computers; generally have low anxiety towards using computers; are confident about their own ability to use computers; highly value the use of computers; and want to learn about computers.

The attitudes that students have on entering secondary school, tend to be positive regarding the use of, and learning about, computers. The categories of attitudes towards computers used in this study are: enjoyment; anxiety; confidence; and value. These four categories were measured by responses to the attitudes questionnaire, and responses to specific questions in the interviews. Student attitudes towards learning about computers were determined by responses to interview questions.

The results for each of these attitudes is reported separately in this section. They show that students in the two major samples of this study tended to possess the attitudes required to maximise the use of computers.

Enjoyment. Student enjoyment of using computers was determined from: responses to two interview questions; the attitude questionnaire; and class observations. The question, "Do you like using computers?", was asked in the initial and final interviews. The responses to this question and the score on the Computer Enjoyment scale were used as the primary indicators of student enjoyment of using computers. However, observations on the behaviour and attitude of the students in class while using computers also was considered along with comments made in response to the final interview question, "Did you enjoy the course this year?".

Most of the students (17 out of 19) in the initial interview said that they enjoyed using computers and, apart from two girls, students did not change their response in the final interview. Also, most of the students (14 out of 19) indicated in the final interview that they enjoyed the course. Many of these students stated that the part of the course they enjoyed most was using the computers, citing the use of certain packages. Further, it was observed that throughout most of the course, the students enjoyed using the computers in the hands-on sessions and were engaged in on-task behaviours for most of the time in these sessions.

The level of enjoyment for using computers is best illustrated with the results from the attitude scale, Computer Enjoyment. The mean for the group of students in the main sample for this scale was 3.6, with a

standard deviation of 1.6. On the basis of this measure, only one student (Table 9) was found to dislike using computers, the rest of the students scored positive values indicating enjoyment for using computers. Further, seven students (i.e., 35%) scored the maximum value of 5, indicating maximum enjoyment.

Table 9  
Frequencies for Aggregated Score : Computer Enjoyment

| Score   | Frequency | %  |
|---------|-----------|----|
| -5 to 0 | 1         | 5  |
| 1 to 2  | 2         | 10 |
| 3       | 4         | 20 |
| 4       | 6         | 30 |
| 5       | 7         | 35 |

Note: Negative scores indicated a dislike for using computers and positive scores indicated liking to use computers.

All of these findings clearly indicate that students tend to enjoy using computers. For most of the students in the main Year 8 sample this positive attitude was maintained for the duration of the course.

Anxiety. The terms anxiety and confidence often appear to refer to feelings emanating from the same source. However, in this assertion, anxiety was defined in terms of 'computerphobia' as outlined by Jay (1981). The degree of anxiety felt by students was measured using the Computer Anxiety scale on the attitudes questionnaire (Appendix D).

The scores on the computer anxiety scale indicated strongly that students did not fear using computers. The scores had a mean of -3.2

with a standard deviation of 1.7. The mean represented a relatively low level of anxiety for the main sample. Only one student in the sample recorded a positive score with 15 students (i.e., 75%) scoring in the range -3 to -5 (Table 10). It is clear that this measure indicates low levels of anxiety in the main sample.

Table 10  
Frequencies for Aggregated Score : Computer Anxiety

| Score | Frequency | %  |
|-------|-----------|----|
| -5    | 5         | 25 |
| -4    | 5         | 25 |
| -3    | 5         | 25 |
| -2    | 1         | 5  |
| -1    | 3         | 15 |
| 1     | 1         | 5  |

Confidence. While the Year 8 students started with little anxiety and were confident using the computers, some students did feel a lack of confidence when using computers in certain situations. Student confidence in using computers was determined from: scores from the Computer Self-Efficacy scale on the attitudes questionnaire; two questions from the interviews; and class observation data. The questions from the initial and final interviews, "How do you feel when you use a computer?" and, "Can you get a computer to do what you want?", also were used to determine student confidence in using computers. In addition, observations on the behaviour and attitude of the students in class while using computers were considered.

All measures of confidence showed that a significant number of

students lacked confidence in some situations. On the Computer Self-Efficacy scale, almost half of the students' scores were negative, which indicated some lack of confidence in using computers (Table 11). The mean score was 0.4 with a standard deviation of 2.7. This small positive value combined with a high proportion of negative scores demonstrated that there was a significant number of students who felt they could not cope with using computers (Table 11).

Table 11  
Frequencies for Aggregated Score : Computer Self-Efficacy

| Score | Frequency | %  |
|-------|-----------|----|
| -3.75 | 1         | 5  |
| -2.5  | 4         | 20 |
| -1.25 | 5         | 25 |
| 1.25  | 3         | 15 |
| 2.5   | 3         | 15 |
| 3.75  | 3         | 15 |
| 5     | 1         | 5  |

While in both interviews the largest proportion of Year 8 students responded that they felt confident when using computers, a significant degree of concern and lack of confidence was evident. When asked in the initial interview how they felt when using computers (Table 12), five students (i.e., 26%) responded that they felt worried when using a computer. In the final interview, six students (i.e., 32%) gave this response. Most students responded to this question with more than one feeling so that it was not clear whether worry was an overriding feeling or even the most prominent feeling. Even so, it is clear that a certain proportion of the students had some measure of worry about the use of

computers. Further, a number of students (9 out of 19) responded, in both interviews, that they felt that they could only sometimes get a computer to do what they wanted.

Table 12

Comparison of Responses Between Initial and Final Interviews

Question : How do you feel when you use a computer?

| Response                   | Initial Interview |    | Final Interview |    |
|----------------------------|-------------------|----|-----------------|----|
|                            | Count             | %  | Count           | %  |
| Confident,enjoy,no worries | 9                 | 47 | 11              | 58 |
| Worried                    | 5                 | 26 | 6               | 32 |
| Normal                     | 3                 | 16 | 3               | 16 |
| Excited                    | 3                 | 16 | 0               | 0  |
| Angry if doesn't work      | 2                 | 11 | 0               | 0  |
| Scared                     | 1                 | 5  | 1               | 5  |
| Sometimes frustrated       | 1                 | 5  | 1               | 5  |
| In charge                  | 0                 | 0  | 1               | 5  |
| Don't care                 | 0                 | 0  | 1               | 5  |

All the data sources used in this section show a significant number of students did not feel confident about using computers. While the questionnaire responses indicated little anxiety among students, the responses indicated some lack of confidence, which was supported by findings from responses in the initial and final interviews. Student confidence seemed to depend on various teacher and instructional variables concerning the activities and student applications of computers. The reason given in the interviews by most of the students who stated some concern was that they were worried that they would do something wrong and in some way damage the computer. They felt confident when they were given clear instructions of what to do. Even Alan, a competent

computer user for at least five years, said that how he felt depended on what he was doing on the computer. At the end of the year he said he did not feel as confident using the school's computers as he did using his home computer. It was observed and mentioned by many students that they were confident when using the packages presented in the course and following the instructions provided by the teacher. These and a number of other factors may be reasons for student anxiety concerning the uses of computers. Some of these reasons became evident in later assertions.

Value. A measure of the value that students placed on the use of computers in society and personal use was constructed from the responses to two questions in the interviews. One question in both the initial and final interviews was, "Do you think computers are good or bad for the world?". The second question used from both interviews was, "Would you like to use computers in your job after you leave school?".

Responses to the two questions showed that the majority of students valued the use of computers. At the beginning of the course 14 students (i.e., 74%) felt that computers were good and only one student thought they were bad (Table 13). Also, 12 students (i.e., 63%) felt that they would like to use a computer in their job when they left school. By the end of the year the responses of most students to both questions were unchanged. However, of interest was the rationale given for these responses. At the beginning of the year many students felt computers were good but they were not sure why. By the end of the year their reasons were more factually based and often concerned the storage of information. Student opinion did not appear to have been changed, but their reasoning was often better based.

Table 13

Comparison of Responses Between Initial and Final Interviews

Question: Do you think computers are good or bad for the world?

| Response  | Initial Interview |    | Final Interview |    |
|-----------|-------------------|----|-----------------|----|
|           | Count             | %  | Count           | %  |
| Good      | 14*               | 74 | 13              | 68 |
| Bad       | 1                 | 5  | 4               | 21 |
| Undecided | 4                 | 21 | 2               | 11 |

\* many had no reasons

Students want to learn about computers. Data were collected from both the main Year 8 sample and the Year 12 sample to determine student interest in learning about computers. Students in the Year 8 sample were asked in the initial interview, "What are you hoping to learn in the course this year?". In the final interview these students were asked whether they wanted to do a computing course in the following year. Students in the Year 12 sample were asked whether they hoped to learn more about computers in the future.

Both groups of students were found to be enthusiastic about learning about computers. Only two of the Year 8 students coming into the course did not want to learn about computers. Eleven of the students mentioned that they wanted to learn how to use computers and understand them because they had a notion, usually vague, that it may be useful for their future, and they were also naturally curious. Only one student nominated a career as a reason for learning about computers. At the end of the course only five students (i.e., 26%) did not choose to join a computing class for the following year, and two of these students wanted to do so but were prevented by their parents. Ten of the Year 12 students (i.e., 67%)



stated that they hoped to learn more about computers in the future. All of these students gave the reason for learning as the increased career opportunities open to those with some knowledge of computers.

It is clear that the majority of both the Year 8 students and Year 12 students were interested in learning about computers. Both groups of students were most interested in learning to use computers but for slightly different reasons. The Year 12 students were motivated by career prospects where the Year 8 students were motivated by interest and a notion of the value of computers.

Interpretation of findings. The findings of this study concerning the attitudes of secondary students towards the use of computers showed that students tend to have positive attitudes towards using and learning about computers. This finding supports the findings of many studies, such as those by Chen (1986), O'Loughlin (1987), and Loyd, Loyd and Gressard (1986). O'Loughlin (1987), found that secondary students tend to have low levels of anxiety towards the use of computers and that students are confident in using computers. While the present study concurred with the finding of low levels of anxiety it found that some students lacked confidence to use computers in some situations.

The lack of confidence felt by some students did not constitute anxiety or computerphobia. This can be seen in the types of questions comprising the Computer Anxiety, and Computer Self-Efficacy scales on the attitudes questionnaire (Appendix D). Most student responses to questions such as: "I feel helpless around a computer."; and "Walking through a room filled with computers would make me feel uneasy.", demonstrated little anxiety. However, on questions from the Computer

Self-Efficacy scale such as: "I feel confident about my ability to use computers."; and "On the whole, I can cope with computers in my daily living.", some students demonstrated a lack of confidence. From the difference in the types of questions used on the two scales it is clear that the students did not fear computers but did lack some confidence in using them.

Apart from the lack of confidence exhibited by some students, the prevailing attitudes of students determined by this study would be interpreted by most computer educators as the attitudes characterizing a computer literate person. The desire to learn about computers expressed by students is an important prerequisite to the continued development of their computer literacy. This desire, coupled with motivating attitudes towards the use of computers, provides schools and teachers with a fruitful context for student learning in computer literacy and other subject discipline classes.

### The Computers

Three assertions are presented in this section concerning factors affecting computer literacy attributable to the nature of computers. These assertions discuss: the reliability of computer hardware and software; the use of "state-of-the-art" software; and the use of "state-of-the-art" hardware. The features of what is defined here as "state-of-the-art" hardware and software are described in the assertions. The main Year 8 sample in the study used Microbee and Apple II microcomputers with a variety of software. Four students were chosen to use the MacIntosh microcomputer with its standard wordprocessing and graphics software.

Assertion 2 : The use of unreliable hardware diminishes the value of computers as perceived by students, and may cause anxiety in students when using computers.

Data gathered from class observation and the final interviews indicated that the reliability of the computer hardware was a significant factor in the student perceptions and attitudes towards the use of computers. A number of students indicated the development of a degree of anxiety due to the unreliability of the computers they used in the computer literacy class. The questions used from the interview were: "Did you like the course this year? How could it be improved?"; and "How do you feel when using a computer?".

From the beginning of the course, the use of the Microbee microcomputers in the hands-on sessions was associated with numerous hardware problems. Often disks were corrupt, data disks were lost or scrubbed and usually at least one computer was not working. For example, in the first session, three computers out of nine were not working. Most of the problems were not attributable to error on the part of the students. The effect of the unreliability was noticed in all the activities the students were given, but was most noticeable in the wordprocessing activities.

The use of the Microbee microcomputers for wordprocessing highlighted the effect of unreliable hardware because the activities relied extensively on a time consuming task for the students, that of keyboard input. As a result, any hardware malfunction usually meant the loss of student work representing a substantial investment of effort and time.

The teacher had impressed on the students the importance of the use of computers for wordprocessing and therefore the students persevered with the wordprocessing activities they had been given despite frequently having to repeat activities due to malfunctions. By the end of the series of sessions using the wordprocessor, most students seemed to prefer to handwrite assignments rather than use the wordprocessor and risk having a disk corrupted. This was evident in responses to the question asking them whether they had liked the course. Some students commented that they had difficulty completing their assignments because the computers kept malfunctioning and disks were corrupted or lost.

While the effect of computer malfunction was most pronounced on wordprocessing tasks, it was still a factor in all activities which used the Microbee microcomputers. This probably explained the lack of confidence expressed by some students in the final interview. For example, Alan explained that the school's computers were different and "may mess up". Brian felt that "computers do their own thing" and explained that he became confused when they flashed up messages and didn't do what they were supposed to. Many other students expressed similar concerns in using the computers where they had experienced difficulty due to malfunction.

Interpretation of findings. The malfunction of hardware appeared to prompt the students to lose confidence in the use of computers, particularly for the applications in which the malfunctions caused them the greatest difficulties. From responses in the final interview it was clear that many students had lost confidence in the use of school's computers for wordprocessing and therefore did not value computers for this application. While assertion one found that students have positive

attitudes towards the use of computers, a degree of lack of confidence was noted. Some of this lack of confidence is likely to be due to experiences of malfunction of computers.

Assertion 3 : Students entering secondary school have poor keyboard skills, which is an obstacle to their use of computers. Therefore, use of "state-of-the-art" hardware devices which overcome such obstacles facilitates increased use of computers by students and the development of positive attitudes towards the use of computers.

There are a few rudimentary skills required to make good use of a computer. One of the most important of these is skill in using the keyboard effectively because the most often used form of input is still the keyboard. Typically, students entering secondary school have not developed keyboarding expertise through a typing course or the like. The lack of keyboard skills is an obstacle to efficient use of computers and may even deter students from using computers. Therefore, the use of hardware devices which reduce the need for keyboard skills helps to overcome this potential obstacle for students.

Data gathered from class observation were used to support the assertion that students lacked keyboarding skills and that this was an obstacle to their use of computers. Data from the MacIntosh interviews were used to investigate the effect of using hardware devices that reduce the use of the keyboard. The "state-of-the-art" device used to investigate this effect was a mouse which is an input device operated by one hand to move a pointer displayed on the screen.

The lack of keyboarding skills by students in the main Year 8 sample was evident early in the course when they were required to use a wordprocessor. Few students had typed before or used a wordprocessor and, therefore, they completed very little of the set tasks in the first few sessions. For some students it became an achievement to complete two lines of typing in a 25 minute time period. Motivation was not a problem because the teacher presented the students with interesting exercises such as typing up a personal profile. The students lacked the keyboarding skills required and, as a result of their slow progress, many students became disillusioned. This is best summarized by Mark's exasperated comment towards the end of a session, "I wish I could type."

In the more "state-of-the-art" computers, such as the MacIntosh, much of the use of the keyboard is replaced by the use of input devices such as the mouse or touch sensitive screen. From the interviews it was clear that all four students who used the MacIntosh microcomputer enjoyed using this computer, commented on the ease of use, and considered it more favourable than the standard computers used by the class. Three of the four students who used the MacIntosh microcomputer commented specifically that the mouse made the computer easier to use. Although one of these students did point out that lack of keyboarding expertise was still a problem when wordprocessing, there were significant gains in using the mouse with the menus and cursor controls. This was supported by the fact that all four students completed their essays on the computer in the set time and before most of the rest of the class who were using the standard computers.

Interpretation of findings. The computer-interface students confront consists of hardware and software components. Many educators, such as

Eason et al. (1975), have stressed the importance of easy to use interface components. The hardware components involved include input devices. One such input device which has been designed to make computers easier to use is the mouse. The use of a mouse replaces a substantial amount of keyboard use. This study found that the use of the mouse, helped students overcome a lack of keyboard skills which was an obstacle to their use of computers. This finding supports the arguments of Eason et al. (1975), and Chen (1986), who advocated the use of up-to-date systems in education.

Assertion 4 : Students entering secondary school find difficulty in using command driven software, which is an obstacle to their use of computers. The use of software which incorporates concrete design concepts facilitates better use of computers and the development of positive attitudes towards the use of computers.

The study identified differences in command structures, command inputs, and types of display as factors in the design of software which effect student use of computers. The command structures were categorized as: command driven software; and menu driven software. Command driven software requires users to type in specific alphanumeric codes to instruct the computer. Menu driven software allows users to choose from a selection of single keystroke instructions. The command input categories used were: standard choice menus; and pull-down and icon menus. Standard choice menus require users to choose from one menu displayed on the screen, pull-down and icon menus provide access to more than one menu displayed on the screen. For a pull-down menu, the instruction choices are 'hidden' on a bar displayed at the top of the

screen where an icon menu presents instruction choices using pictorial symbols which represent the instruction to be given. Because the wordprocessing application was highlighted, the display types were categorized in terms of whether what is seen on the screen is what appears on a hardcopy and the degree to which concrete concepts such as pictorial representations of entities are used in the displays. The study found that students prefer menu driven software incorporating pull-down and icon menus and concrete concepts in displays and commands. These results are indicated in the data collected from the sources: Class Observation; Final Interview; and MacIntosh Interview.

The use of wordprocessing software demonstrated the effects of the differences in software design. Most of the students found the Wordstar wordprocessor confusing and difficult to use. They found the control commands difficult to understand and remember. They also found the abstract ideas contained in printer commands difficult to understand. After a few weeks almost all of the students felt that it was easier to write out their work than to wordprocess it. Although there were a number of explanations for this a major reason cited in the final interview was that the commands they had to use with Wordstar were too difficult to understand. For example, Alan had no trouble reading the Wordstar menus but typed a ^ symbol instead of pressing the down the control key. He interpreted the menu in a concrete rather than an abstract way even though the class had been instructed a number of times about the control commands.

The use of pull down and icon menus, and the non-abstract displays encountered by the students using the MacIntosh resulted in increased student satisfaction, work output, quality of work, and perceptions of the



value of computers. From the interviews of the students who used the MacIntosh, it was clear that they all enjoyed using this computer. All four students commented that the use of the type of menus and graphic display made the computer easy to use. All four students were able to use more features of the wordprocessor and graphics software on the "state-of-the-art" computer than the rest of the class did on the equivalent software for the standard computer. For example, these four students all used a variety of printer effects (eg. underline, boldface, italics) in each document and used the editing facilities such as cut and paste. In comparison the rest of the students rarely used more than one printer effect in a document and never used editing commands other than simple deletion. Three of the students using the MacIntosh said they would like to continue to use the microcomputer to complete work for English and Social Studies assignments. These students did continue to use the microcomputer at lunchtimes and occasionally after school, with Brian using the MacIntosh extensively.

Interpretation of findings. The interaction between computer and student depends on a dialogue involving command names, and argument structures associated with them (Jorgensen, Barnard, Hammond, & Clark, 1983). These names and structures are determined by computer system designers who possess specialist computer knowledge. Jorgensen et al. (1983) argue that this leads to a mismatch with the use and understanding of users who may not possess that specialist knowledge. They suggest that the use of more "user-oriented" or "natural" command names and structures will improve user performance. Some of the software, particularly the wordprocessor used by the students in the computer literacy class, tended to be more "system-oriented". In contrast, the software used by the students on the 'state-of-the-art' computer was

more user-oriented in its commands. The findings of this study indicate that this difference in software design accounted for some of the improved student performance on the "state-of-the-art" computer when compared with the classroom computers.

The important characteristic of the user-oriented software seemed to be the concrete concepts employed in its design. Examples of such concrete concepts are: the use of pictures on the screen to represent entities such as files; and names involving concepts commonly associated with tasks in the way that 'cut' and 'paste' are associated with graphic and text layout. The use of such concrete concepts appears to facilitate better student use of computers. Students find the use of more abstract command names and structures an obstacle to the use of computers. This may be an example of Hedberg, and Mumford's (1975) proposed ideals for the design of user-oriented computer systems. It may be that more concrete concepts suit students better in, what Hedberg and Mumford (1975) refer to as, their task environments and the "model of man" they are familiar with. The concrete models of computers that Mayer (1982) argues for would require the use such concrete concepts in computer software design. Further, the use of concrete design concepts generally provides displays which are easier to read and analyse, which Eason et al. (1975) propose to be an important factor in high performance use of computers. All of these arguments support the value of employing concrete concepts in software designed for use by secondary students.

The difference between use of concrete and abstract concepts in software design probably accounts for the often quoted correlation between mathematical ability and computer literacy. Brian was a low achiever in mathematics but was keen to use computers at school. He had relatively

little success using Wordstar and had difficulty with the programming activities. For example, in one session he was experimenting with programming and was completely baffled when E+16 appeared. Concepts such as this were too abstract for Brian to understand. However, he made good use of the MacIntosh and the software packages used later in the course. In fact, he was motivated to test the potential of the MacIntosh as far as possible, as indicated by his statement, "I want to sort of know how to get more use of MacWrite". He worked well in cooperative situations with other students. His lack of mathematical ability did not appear to be an obstacle in his use of computers where non-abstract software design was employed.

### The Learning Environment

Three assertions are presented in this section concerning factors affecting computer literacy in relation to learning environments. The first compares the importance of the school, home, and community as learning environments. The second assertion concerns the effect of previous use and learning about computers at home and at school on attitudes about using computers. The third assertion concerns the activities involving computers presented to the students in class. Each of the assertions draws on a variety of data sources.

Assertion 5 : The majority of the students' use of computers and learning about computers is at school or at home, not in the community.

This assertion concerns the nature of the previous use of computers and previous learning about computers. The previous use of computers and previous learning about computers by the main group of Year 8

students was determined from responses to items on the Background Questions Sheet and the Initial Interview. In the Initial Interview students were asked whether they had used a computer before and if so where and when. The Background Questions Sheet asked students whether they had a home computer, how often they used it, and what they used it for. Also, students were asked to estimate the time per week they had spent the previous year at school learning about computers. The influence of learning environments and the previous use of computers for Year 12 students was determined from the interview questions asking them what had most influenced their opinions about the use of computers and where they had used computers before. The information obtained from these sources on both groups of students was categorized by environment: use at home; use at school; and use in the community.

From responses to the question, "Have you used a computer before? Where and when?", in the Initial Interview (Table 14) it was clear that those students who had used computers had done so at school or at home, not in the community. This was supported by the small number of students who indicated in the data source, Background Questions Sheet (Table 8), that they had used an Automatic Teller Machine (ATM). In addition, a few students mentioned in the final interview that they used friends' computers or that their parents brought computers home from work.

Those students who had a home computer used it often but mainly for games (Table 8). Therefore, it is unlikely that these students spent time learning about computers in a wider sense when using their home computer. Sixty-five percent of the group (Table 8) spent a minimal amount of time (less than 30 minutes a week) learning about computers in

the previous year at primary school. The quality of this learning and the amount of time spent using a computer at school is difficult to assess and was not estimated in this study.

Table 14

Initial Interview : "Have you used a computer before?"

| Response | Where used | Count | %   |
|----------|------------|-------|-----|
| No       |            | 6     | 32  |
| Yes      |            | 13    | 68  |
|          | Home       | 7     | 54* |
|          | School     | 10    | 77* |
|          | Friend     | 1     | 8*  |

\*% of students who responded Yes

The Year 12 students were diverse in what they felt had influenced their attitudes. However, the influence of the school environment was particularly evident with 60% nominating school use of computers as an influence, 40% nominating school friends, and 27% listing their own thinking (Table 15). This compares with 40% who listed parents, and 40% who listed the media as being the major influences. Further, the students had almost all had some contact with computers either at school (57%) or at home (43%). Although these responses show a definite influence of the home environment this is small compared with the influence of the school environment on attitudes about computers, and the use of computers by students.

Interpretation of findings. This study found that the only significant use of computers occurred at school, making school the major learning environment for computer literacy. Even so, a significant number of Year

8 students had spent a minimal amount of time previously learning about computers at school. Students who had home computers generally made little use of them other than to play games, and all students seemed to make little use of computers in the community. However, both the Year 8 and Year 12 students seemed to have relied largely on the school environment to learn about computers because it was here that they were most likely to use computers. This finding supports the arguments of Carey, and Gall (1986), and McGarvey, Okamoto, and McDevitt (1986) who highlighted the important role of the school environment for student computer literacy.

Table 15

Year 12 Interview : "What or who has shaped your opinion?"

| Response               | Count | %  |
|------------------------|-------|----|
| School use             | 9     | 60 |
| School friends         | 6     | 40 |
| Parents*               | 6     | 40 |
| TV(media)              | 6     | 40 |
| Own thinking           | 4     | 27 |
| Friend with a computer | 2     | 13 |
| Home Computer          | 1     | 7  |
| Religion               | 1     | 7  |

\* usually father mentioned

Assertion 6 : Prior experience with computers and learning about computers was associated with feelings of confidence and enjoyment regarding the use of computers.

This assertion has two parts, the first suggests a relationship between previous use of a computer and confidence in using computers. The

second part suggests a relationship between previous learning about computers and a positive feeling of enjoyment in using computers. Each of these is treated separately. Students' previous use of computers and previous learning about computers was determined from responses to items on the data sources, Background Questions Sheet and Initial Interview.

The effect of previous experience on confidence in using computers.

The feeling of confidence students in the main sample had in using computers was analysed in terms of possible effects due to previous use and learning about computers. One of the possible areas of previous use of computers was determined to be the use of a home computer. The level of confidence was determined from the Computer Anxiety scale on the Attitudes Questionnaire. The level of learning was determined by the amount of time spent learning about computers at primary school as indicated by the Background Questions Sheet. Students having the use of a home computer were found to have higher levels of confidence. No significant effect was found for the level of previous learning on confidence.

Using Analysis of Variance, significant effects were found for having a home computer on the Computer Self-Efficacy scale (Table 16). There was no interaction effect and no effect found for previous learning on the Computer Self Efficacy scale. The mean measurement of confidence was large and positive for the 40% of the students who had a home computer where the mean for those who did not have a home computer was negative (Table 16), indicating lack of confidence. These results indicate that those students who owned a home computer were confident in using computers and had more confidence than those who did not own a home

computer.

Table 16

Analysis of Variance : Effect of having a Home Computer and Previous Learning on Feeling of Confidence in Using Computers

| Source            | df | F-value | R <sup>2</sup> | Pr>F   |
|-------------------|----|---------|----------------|--------|
| Home Computer     | 1  | 15.01   | 0.44           | 0.002* |
| Previous Learning | 2  | 0.2     | 0.02           | 0.9    |
| Interaction       | 3  | 1.99    | 0.18           | 0.2    |

\* Significant at the 0.01 level

Group Means

|                    | No. | %  | Mean Confidence |
|--------------------|-----|----|-----------------|
| Have Home Computer | 8   | 40 | 2.50            |
| No Home Computer   | 12  | 60 | -1.04           |

The effect of previous experience on enjoyment of using computers.

The initial stated student perception of enjoyment of using computers was analysed, using Analysis of Variance, in terms of possible effects due to the use of a home computer and previous learning about computers in school. The Enjoyment scale on the Attitudes Questionnaire was used as a measure of student perceptions of enjoyment in using computers. A statistically significant effect was found for previous learning but not for use of a home computer (Table 17). There was no interaction effect and no effect found for ownership of a home computer on the Computer Enjoyment scale. A Student-Newman-Keuls' Test indicated significant differences between the means of the group which had no previous learning and the groups which had some previous learning. The group of students with no previous learning had a mean enjoyment of 2.4, and the



groups with some previous learning had means of 4.0 and 4.6 respectively (Table 17). These results indicate that those students who spent some time learning about computers at school the previous year had more positive feelings of enjoyment towards using computers than those who had not spent any significant time the previous year.

Other findings related to the assertion. Each attitude measure from the Attitude Questionnaire was analysed in terms of possible effects due to previous learning and use of a home computer. No statistically significant effects were found for any of the attitude measures other than the two listed in this assertion. That the use of a home computer should increase confidence in using computers was not surprising. Perhaps of more interest was that previous learning at school did not reduce enjoyment but rather increased the enjoyment for using computers. However, that no effects were found for the anxiety measure was of particular interest because there was an expectation that anxiety would be reduced by increased use and knowledge.

Interpretation of findings. The constructivist learning theory assumes that previous learning and knowledge are important for future learning. This study found that previous experience and learning were likely to affect student attitudes towards the use of computers. This in turn should affect student learning. Although it is likely that previous experiences which students perceived to be unrewarding will facilitate negative attitudes in students and thereby present an obstacle to learning, this was not observed in this study. The Year 8 computer literacy students who indicated significant levels of previous experience and learning tended to have more positive attitudes towards computers than those who did not. This finding supports the findings of Moon, Tung, and Hui (1986), and

Chen (1986), who found that the use of computers at home and previous learning were likely to develop positive attitudes in students towards the use of computers.

Table 17

Analysis of Variance : Effect of having a Home Computer and Previous Learning on Perception of Enjoyment in using Computers

| Source            | df | F-value | R <sup>2</sup> | Pr>F  |
|-------------------|----|---------|----------------|-------|
| Home Computer     | 1  | 1.92    | 0.06           | 0.2   |
| Previous Learning | 2  | 3.78    | 0.38           | 0.04* |
| Interaction       | 2  | 1.48    | 0.15           | 0.3   |

\* Significant at the 0.05 level

Group Means

| Time per week<br>Enjoyment | No. | %  | Mean |
|----------------------------|-----|----|------|
| > 30 mins*                 | 7   | 35 | 4.57 |
| < 30 mins                  | 6   | 30 | 4.00 |
| < 5 mins                   | 7   | 35 | 2.43 |

\* students responding >30mins and > 1hour were grouped together

Assertion 7 : Parents tend to communicate positive attitudes about computers to their children and most of this communication reflects the parents' use of computers at work.

This assertion concerned the attitudes and knowledge which students gain from their parents in the home environment. Data were collected during interviews of students in both the Year 8 and Year 12 samples. Students were asked to recount conversations about computers at home.

Also, students were asked to state their perceptions of their parents' attitudes towards computers.

In all three interviews the response patterns to the question about parents' attitudes towards computers and conversations relating to computers at home was similar for the Year 8 sample and for the Year 12 sample (Table 17). About half the Year 8 students reported that they talked about computers at home, most of the conversation being about the parents' work use of computers and about buying a home computer. The number of students reporting conversation about parents' work use increased from the initial interview to the final interview. This may have been due to the students being more aware of the use of computers. In the Year 12 sample, 60% responded that they talked about computers at home. Once again, the parents' work use of computers being the main topic for conversation. For the Year 8 sample 12 students (i.e., 63%; Table 18) reported that their parents communicated positive attitudes towards the use of computers, however, five students (i.e., 26%) did not know their parents' attitudes. Similarly nine students (i.e., 60%) from the Year 12 sample perceived their parents had positive attitudes towards the use of computers.

While most of what parents communicate to their children with respect to computer use is positive, there are some exceptions. It is likely that some parents pass on the notion that a person has to be very intelligent to use computers. This was likely to be the case when they were students but it is not the case today. Brian, who was not an academic student, became very proficient at using the MacIntosh and was very keen to use computers whenever he could. Unfortunately, his mother would not let him enrol in a computing class for the following year because she felt that it was too difficult for him. His mother wanted him to be a garbage collector while he wanted to do a job which used computers. Parents may also tend to encourage sons rather than daughters to use computers. This may be the explanation for Rachel's deteriorating attitude throughout

the year. Although a little ambivalent to learning about computers at the beginning of the year, she was prepared to investigate possible uses of computers. By the end of the year she was not interested in using computers and did not want to learn about them. In fact, although she was an academically successful student, she claimed that she did not want to use computers because she "can't understand them". It was noticeable that neither of her parents used computers or talked about them, and that, although they had a home computer, Rachel rarely used it because it was monopolized by her brothers.

Table 18

Frequency of Responses to Year 8 and Year 12 Interview  
Question : Do you talk about computers at home? What does  
your family think of computers?

| Response              | Year 8            |    | Year 8          |    | Year 12 |    |
|-----------------------|-------------------|----|-----------------|----|---------|----|
|                       | Initial Interview |    | Final Interview |    |         |    |
|                       | Count             | %  | Count           | %  | Count   | %  |
| Yes                   | 10                | 53 | 8               | 42 | 9       | 60 |
| Not really            | 9                 | 47 | 11              | 58 | 6       | 40 |
| Jobs                  | 1                 | 5  | 1               | 5  | 1       | 7  |
| TV Programs           | 1                 | 5  | 0               | 0  | 0       | 0  |
| Parent's work         | 4                 | 21 | 9               | 47 | 9       | 60 |
| Getting a computer    | 3                 | 16 | 7               | 37 | 1       | 7  |
| Parent's think .....  |                   |    |                 |    |         |    |
| Computers are good    | 12                | 63 | 11              | 58 | 8       | 53 |
| Don't like computers  | 1                 | 5  | 2               | 11 | 4       | 27 |
| Don't Know what think | 5                 | 26 | 7               | 37 | 3       | 20 |

The data collected from three interviews of two different ages of secondary students presented a fairly clear pattern. In about half of the homes of students in this study a significant amount of conversation about computers occurred. Certainly enough to gain the attention of the

students. Most of this conversation appeared to have been positive with respect to the use of computers, with students perceiving positive attitudes in their parents. The majority of the conversation about computers at home centred on the parents' use of computers at work and, for the Year 8 students, the possibility of buying a home computer.

Interpretation of findings. The home has always been seen by educators to be an important learning environment for students. Previous findings of this study have demonstrated that the school is the main learning environment for students with respect to computer literacy and that students make very little use of computers at home. Therefore, for the home to be a significant computer literacy learning environment, the learning must involve interaction with other members of the family or the media present in the home, such as the television. This study has found that some student learning is facilitated by conversations with parents, primarily about the parent's work use of computers. The main effect on student learning is in their attitudes towards the use of computers.

Assertion 8 : The perception students have of the value of the activities they are given to complete on computers and the extent to which the computer facilitates completion of those activities are determinants of students' perceptions of the value of computer technology.

The Year 8 students in this study seemed to base their perceptions of the usefulness of computers upon their attitude towards the activity on which they were currently engaged in using the computer. This concerned the perceived value of the assigned activity, and the degree to which the computer facilitated the completion of the activity. Where either the activity was not valued, or the use of computers did not improve the

process or output of the activity, the students tended to devalue the use of computers. The converse was also true. This effect was seen in both the home and school environments. In the home, students' perceptions of their parent's typically positive attitudes towards computers largely reflected the parent's use of computers at work (refer to Assertion 7). At school this effect was observed in the attitude of students towards the activities they were set to do on computers.

An analysis of the data collected from observations of the students in the hands-on sessions showed how the software activities influenced students' perceptions of the value of computers. Student behaviours and comments noted during the activities and specific comments students made in the final interview were used in this analysis. In the analysis of these data the activities were grouped according to the software package being used. The use of the Introductory Data Processing package, Word Puzzles package, and Wordstar wordprocessor packages are presented. The first two represent examples of an enhancement of students' perceptions of the value of computers, the third represents an example of the reverse. Generally the activities which utilized these software packages were specifically designed to highlight the value of computers or to practise specific skills associated with a computer application.

Activities in which the use of computers was valued. The Introductory Data Processing (IDP) package and the Word Puzzles package, used later in the course, were examples of computer applications where the associated activities were perceived to be valuable and the computer helped to complete the activities more quickly and to a higher standard. As a result, the use of this package tended to enhance the students' perception of the usefulness of computers. In both applications, students

may have likened the activities to similar activities conducted in other subject classes. This similarity may have increased the perceived value of these computer applications. Through observation of the students using these packages and through comments made in the interviews it was clear that the students felt the computer facilitated their completion of the activities.

The value students placed on the use of computers to help them complete the activities associated with the IDP and Word Puzzles packages is indicated by the maintenance of enthusiasm and endeavour throughout the sessions involving these software packages, despite repeated setbacks caused by hardware and software malfunctions. There were problems with corrupt and misplaced disks and, in addition, some students did not follow the Word Puzzles instructions carefully and therefore had to repeat some activities a number of times. Despite these problems, the students were keen to complete the associated activities. Some students were prepared to retype word files and wait a long time for their crosswords to be printed out by the Word Puzzles package. With the IDP package students enjoyed collecting the personal data and then entering it into the computers.

The students probably saw the value of the computer in completing the data processing activities and the crosswords because of the similarity to activities conducted in other classes. Many students may have likened the data processing activities to those of a social sciences survey assignment which most students enjoy doing. However, they would have found completing the activities more satisfying than those in their social science classes because the computer helped them to organize the data and then, with a single number command, output graphs, percentages

and averages. They were using the computer to do familiar activities in a very quick, helpful way. Similarly, the Word Puzzles package concerned a familiar activity, making crosswords in English and Social Science classes, and made the difficult part, placing the words in the crossword, easy. The activity was perceived to be important and, because the computer helped to complete the activity more easily, the students' perception of the usefulness of computers was enhanced.

Activities which devalued the use of computers. The only section of the course in which most students displayed predominantly negative attitudes in activities were those involving the use of the Wordstar wordprocessor. These activities made them question the value of the computer and many became disillusioned and did not like being involved in the computing class. Some, particularly a group of four girls, developed negative feelings and attitudes towards computers and the computing class.

There are a number of possible explanations for what happened during this section of the course, many have already been highlighted in other assertions. However, the result was that most students took many weeks to do a task which normally would take one or two weeks. To these students the computer was a hinderance rather than a help. In fact a number of students asked to be allowed to handwrite their assignments because using the computer was taking too long. The students developed negative attitudes about using computers because, although they perceived the task they were doing to be important, they had reason to believe that they could complete the task more easily without a computer.



Interpretation of findings. In the use of the three software packages presented in this assertion the students regarded the activity as being important. As a result, they persevered with the activities despite repeated setbacks. The use of computers did not help them to do the activities associated with the wordprocessor, and therefore, only in this application did the students develop negative attitudes towards the use of computers. These findings support the arguments and findings of : Calfee (1985); Anderson, Klassen & Johnson(1981); Chen(1986); and Eason et al. (1975), who stress the importance of presenting relevant activities for students to complete and, where the use of computers can be seen to readily facilitate completion.

#### Student Learning and Concept Development

One assertion is presented in this section concerning student learning, and concept development as a factor in computer literacy. The study found further evidence for the importance of the school environment as an influence on student attitudes, knowledge and conceptual structure.

Assertion 9 : The school environment and experiences of secondary students influence the conceptual frameworks students develop to assimilate knowledge about computers. These frameworks develop before students learn a significant amount about how computers work or about computer systems.

This assertion concerns the nature of change in students' conceptual frameworks (Pines & West,1986) which may be attributable to the school

learning environment and computer related experiences occurring at school. The operation of these frameworks can be seen in their influence on student: attitudes; awareness of the benefits and problems associated with the use of computers; and awareness of the potential uses of computers both now and in the future. Learning and concept development are discussed in terms of the school learning environment because most of the data collected referred to this environment. Also, assertion 5 established the important role of the school environment in the use of, and learning about computers. This assertion proposes that students' school experiences changed their conceptual frameworks in relation to the use of computers both by design and spontaneously.

Data sources used to support this assertion were mainly those associated with the main Year 8 sample and the Year 12 sample. Data from the Year 12 students were used because the sample was primarily included to investigate the influence of general secondary experience on students' perceptions and attitudes towards the use of computers by a comparison of the responses from this sample with the responses from the main Year 8 sample. Student learning and conceptual framework development is discussed in terms of: the development of an awareness of the benefits and implications of the use of computers; the development of an awareness of the potential uses of computers; and learning about computer systems and how computers work.

Conceptual frameworks. Papert (1980) claimed that children develop their own conceptual frameworks to explain and make use of phenomena they encounter. This was evident with the main Year 8 sample as they encountered computers. The students appeared to have a variety of conceptual frameworks concerning computers and these seemed to

change throughout the course. However, all students were involved in completing the required activities on the computers, with a large measure of success. Therefore, none of the conceptions held by the students appeared to stop them from using any of the software provided.

A variety of concepts in early stages of development were demonstrated by the Year 8 students. All students at some stage exhibited an anthropomorphised concept of a computer which created some conflict with the 'machine' concept of a computer they often espoused. However, many students exhibited other concepts of computers at various times. Examples of such are : the thinking machine; the modified TV; the modified typewriter; and the calculator. The thinking machine concept was amply demonstrated by Andrew's explanation that a computer was "another brain". Many students, such as Michael, who claimed computers were for playing games, seemed to have a modified TV in mind. The modified typewriter was evident in Colin's claim that the computer was "something you type things in". This framework may explain why students such as Helen, who was a competent computer user, were surprised that text could be inserted between lines of text when she claimed that you "can't fit anymore in now". Taren saw the computer as a combination of TV and typewriter. Alan depicted the computer as a calculator and Gayle probably had this in mind when she described the computer as a "machine with memory". While such a variety of concepts was evident among the students, by the end of the course the most prevalent concept involved information processing.

The major concept the computer literacy course hoped to impart to the students was that of a computer as an information processor. It was felt that this concept would enhance student perceptions of present and future

use of computers. Throughout the year student conceptions about computers seemed to move towards this "information processing" concept. The concept of a computer held by a student was inferred from responses to the common questions from the interviews: "What do you think a computer is?"; "Can computers think?"; and "Is there anything computers will never be able to do?".

The development of student conceptions towards that of information processing as intended by the course is indicated in response to the question, "What do you think a computer is?". Ten students (ie. 43%, Table 19) gave an information processing description at the end of the course. This was not evident at the beginning of the course where the largest proportion, seven students (37%), included in their response something concerning a "machine that helps people".

Table 19

Frequency of Responses to Year 8 Interview Question : What do you think a computer is?

| Response type               | Initial |    | Final |    |
|-----------------------------|---------|----|-------|----|
|                             | Count   | %  | Count | %  |
| Stores Information          | 1       | 5  | 10    | 43 |
| Applications (helps people) | 3       | 16 | 6     | 26 |
| Memory (process)            | 1       | 5  | 4     | 17 |
| Physical Description*       | 4       | 21 | 3     | 16 |
| Games Machine               | 4       | 21 | 0     | 0  |
| Confused response           | 4       | 21 | 0     | 0  |
| Don't Know                  | 2       | 11 | 0     | 0  |

\*In the initial interview these 4 students also mentioned, 'helps people'.

The degree to which students saw computers as a human-like being was reflected in the questions about thinking and what computers would not be able to do. The majority (73%) of the Year 12 students felt computers were programmed and therefore could not think. On this question, as for many others, their responses were very definite. In both interviews about half of the Year 8 students were sure that computers could not think because they were programmed. However, the nature of their commitment to this concept seemed to change throughout the course as evidenced by their responses to the more general question, "Do you think there is anything computers will never be able to do?" (Table 20). At the beginning of the course, most students were either unsure or tended to respond that computers can not think for themselves. By the end of the course fewer students gave the cognitive, "think for themselves" response and preferred more affective responses to do with computers not being able to be like them or have feelings and emotions. Five students mentioned that computers could not be human (like us), two students also nominated "feelings" and "emotions". However only three students made the "think for themselves" response.

Table 20

Frequency of Responses to Year 8 Interview Question : Is there anything computers will never be able to do?

| Response             | Initial Interview |    | Final Interview |    |
|----------------------|-------------------|----|-----------------|----|
|                      | Count             | %  | Count           | %  |
| Think for Themselves | 6                 | 32 | 3               | 16 |
| Show Feelings        | 2                 | 11 | 2               | 11 |
| Be Like Us           | 0                 | 0  | 5               | 26 |
| Not Sure             | 6                 | 32 | 4               | 21 |

\* Other responses are not recorded here because they had frequencies of 1 or 2

The results from the two questions may indicate that, during the year, some of the students felt that the computer had challenged their personal status in terms of thinking beings. As a result, they seem to have reaffirmed themselves as being fundamentally different in the affective domain. It seems that students may attribute human thought characteristics to computers but not emotional characteristics.

The conflict in the anthropomorphized concept of a computer created by the programming activities appeared to motivate a number of students to greater use of computers. One such was Gayle who was very tentative in her use of computers at the beginning of the year. On the wordprocessor she was reluctant to type even a line of text, preferring to let her partner do all the computer control. She possibly had a typewriter conceptual framework for the computer, demonstrated by her desire to only type in a final draft of her essay. However, in the programming activities, she became competent at controlling the machine and was keen to try her own programs. For the rest of the course she was keenly involved and probably viewed the computer more as a thinking machine. In the final interview she explained that computers "sort of" think and used the example of the Word Puzzles package in saying, "when I made my puzzles, it thought of where to put the words." It appears that a change in conceptual framework had occurred for Gayle and this had facilitated better use of computers for her.

Awareness of benefits and implications of the use of computers. The study investigated the awareness and understanding Year 8 and Year 12 students had of the benefits and implications commonly associated with the use of computers. Student awareness and understanding was determined by the scores on the Policy Concern scale from the Attitudes

Questionnaire and two questions common to the interviews of both groups of students. The first question used, "Do you think computers are good or bad for the world?", was followed by a request for reasons. These reasons gave an impression of their awareness and understanding of the benefits and implications. The second question which followed this was, "What is the best thing computers are used for?", which gave an insight into the major benefits that students perceived. The results of the study seem to indicate that students are aware that computers are useful but do not really understand why or how. Further, students have little awareness of the problems associated with computer technology but can be introduced to such an awareness.

At the beginning of the course, 15 students (ie. 75%, Table 21) scored positive values on the Policy Concern scale. Approximately the same percentage (75%) of the Year 8 and Year 12 students thought that computers were good for the world. However, students were typically vague as to why they felt that way. A range of responses was given to the question referring to the best things computers were used for. Four or five students in each group gave no response to this question. Little change was evident throughout the year for the Year 8 students, except for a number of students who mentioned games. It seemed that the best thing computers were used for tended to become what the students enjoyed doing on them the most, games.

While the major response the Year 8 students gave to the question, "Do you think computers are good or bad for the world?", did not change throughout the year, the reasons given for that response did. In both interviews most students thought computers were good for the world. However, in the first interview, their reasoning indicated little

understanding of the implications of computer technology for our society. The responses given in the final interview indicated more understanding of these implications, particularly those of: unemployment; information processing; security of data; and productivity.

Table 21

Frequencies for Aggregated Score : Policy Concern

| Score     | Frequency | %  |
|-----------|-----------|----|
| -3 to -1  | 5         | 25 |
| 0         | 2         | 10 |
| 1 to 1.25 | 5         | 25 |
| 2 to 3    | 3         | 15 |
| 3.5 to 5  | 5         | 25 |

One explanation for the negative attitudes displayed by Colin towards using computers may be that he felt that computers were likely to make the jobs he would like to be employed in, redundant. He was not an academically strong student and did not like the teaching sessions, but demonstrated that he had learned some of the content from these sessions. While he showed some concern at the beginning of the year that computers were "taking over", this was more pronounced by the end of the year where he stated that computers were bad because, "They are taking jobs."

Awareness of Potential Use of Computers. While students are aware of the benefits of using computers, they have little prior knowledge and understanding for how they could use computers now and in the future. However, students can gain such knowledge and understanding through learning experiences provided at school which are designed to show how



computers can be used, and which allow students to use computers to complete tasks. This was demonstrated throughout the computer literacy course where the Year 8 student perceptions of possible present use and future use of computers was enhanced.

A major emphasis of the computer literacy course was to encourage students to see how they could make use of computer technology now and in the future. In the interviews, both Year 8 and Year 12 students were asked whether they could use a computer to help them now and whether they thought they would like to use computers in their chosen careers. These questions gave an impression of their present and perceived future use. However, it was not possible from this study to determine whether their stated intentions would be realized.

The Year 12 students were divided as to whether they could use a computer to help them now (53% Yes) but only two of them did not feel they would use computers in the future. The results in Table 22 indicate that 10 (ie. 53%) of the Year 8 students started the course saying that they could use computers to help them now in some way. This in no way means that they used computers in that way. Many students indicated reasons why they did not, or could not, use computers even though they knew that such use would be helpful. Once again only two students felt that they would not like to use computers in their job. In both groups of students only half the students felt they could use a computer now. Although very few of them actually made use of computers, most of them perceived that they would use computers in the future. However, they were not sure in what way they would use computers in the future.

Table 22

Frequency of Responses to Year 8 Interview Question : Do you think you could use a computer to help you?

| Response          | Initial Interview |    | Final Interview |    |
|-------------------|-------------------|----|-----------------|----|
|                   | Count             | %  | Count           | %  |
| Yes - informed    | 10                | 53 | 14*             | 74 |
| - not informed    | 1                 | 5  | 2               | 11 |
| Not sure          | 4                 | 21 | 1               | 5  |
| No - informed     | 1                 | 5  | 1               | 5  |
| No - not informed | 3                 | 16 | 1               | 5  |

\* some said they needed a better computer or more knowledge

Table 23

Frequency of Responses to Year 8 Interview Question : Would you like to use computers in your job after you leave school?

| Response  | Initial Interview |    | Final Interview |    |
|-----------|-------------------|----|-----------------|----|
|           | Count             | %  | Count           | %  |
| Yes       | 12                | 63 | 13              | 68 |
| No        | 2                 | 11 | 4               | 21 |
| Undecided | 5                 | 26 | 2               | 11 |

The responses of the Year 8 students at the end of the course seemed to indicate increased awareness and understanding for how they could use computers. By the end of the course a further four students (i.e.27%, Table 22) were convinced that computers were useful and could be used to help them complete necessary tasks. The quantitative response pattern for the question referring to use of computers in future employment was inconclusive (Table 23) with regard to change. However, it was

noticeable that for both questions (Tables 22 & 23) students demonstrated more specific knowledge of possible computer utilization in the final interview when compared with the initial interview. At the beginning of the course their responses to these questions tended to be vague. The students who felt that they could use computers to help them now tended to say they could be used to help with schoolwork but could not say exactly how this could be done. Students who wanted to use computers in the future had a vague notion that they would like to use computers but were not sure how they could. By the end of the course students who wanted to use computers in their careers or felt they could use computers to help them now tended to give details of exactly what sort of tasks they would be doing and what hardware, software and knowledge they needed.

For example, at the beginning of the course Rachel said she did not use a computer at the moment to help her but felt that she probably could in some subjects. However, she said she didn't think of using computers and wasn't sure how she could use a computer anyway. At the end of the course Rachel said she still didn't use a computer because she didn't have one at home. However, she said that if she knew a little more she could use a computer to help her in graphing, Maths and typing stories for English.

Similarly, Peter said he wanted to be a chef and saw no need to use a computer at the beginning of the course. By the end of the course he said that although chefs may not use computers directly to cook he would use one attached to a till ("that's a sort of computer") and to 'keep how much they have got in storage'.

The students in the main Year 8 sample perceived further possible uses and the requirements for these uses. This is supported by the number of students intending to get a computer or already using one at home (Table 9) and by the number of students who felt they needed a better computer or further knowledge (Table 22). The Year 8 student responses in the Final Interview also seem to indicate that this increased perception was due to what they had learned in the course about how computers are used and to their use of computers in the course.

The students were asked what they had learned in the course. There was an improvement in their knowledge concerning how computers could be used and where they could be used. Eleven students (ie. 58%, Table 24) stated they had learned more about how to use computers and seven students (ie. 37%) said they knew more about the uses of computers in society. It would appear that learning how computers are used increased student perception of how they may use computers.

Table 24

Frequency of Responses to Year 8 Interview Question : What did you learn about computers?

| Response* (Final Interview) | Count | %  |
|-----------------------------|-------|----|
| How to use computers        | 11    | 58 |
| Uses of computers           | 7     | 37 |
| Hardware/other theory       | 6     | 32 |
| Programming                 | 5     | 26 |
| Wordprocessing              | 4     | 21 |
| Storage of Information      | 3     | 16 |
| MacIntosh                   | 2     | 11 |

\* Other responses had a frequency of 2 or less and were not tabulated

### Learning about how computers work and computer systems.

Although students seem to have learnt about how computers are used they did not learn a significant amount about how computers work or about computer systems. The knowledge students had about computers was determined from three interview questions, common to both the initial and final interviews. The questions used were: "How do computers work?" ; "What have you learnt this year in the course?"; and "What is a computer?". The first and last of these questions was common to the Year 12 interviews and were used as a measure of their knowledge of computers. These measures were qualitative rather than quantitative measures of the students' knowledge.

Typically, at the beginning of the year the Year 8 students had very little knowledge about the workings of computers, with nine students (i.e. 47%, Table 25) having no idea. By the end of the year very little change was evident. However, six students felt they had learnt something about hardware and five students felt they had learnt something about programming. This perceived learning was not evident in their responses to other questions. Most of the Year 12 students did not have extensive knowledge about computers, only 20% gave a reasonable, technical description of how a computer works. These findings support O'Loughlin's finding (1987) that secondary students have limited computer knowledge.

Interpretation of findings. In investigating the development of conceptual frameworks, which Mayer (1982) refers to as intuitions, by students consideration must be given to: existing frameworks; intended frameworks imposed by the curriculum; the spontaneous development of frameworks; and the interaction between all these frameworks. Most Year

8 students did not seem to have well developed conceptual frameworks nor were they strongly committed to these frameworks. The computer literacy course: presented an information processing framework, or model (Mayer, 1982); gave students some technical information about how computer systems operate; and allowed hands-on interaction with microcomputers under minimum supervision. As a result, the students seemed to gradually acquire the information processing model but did not assimilate the technical information to any significant extent. In addition, students seemed to develop spontaneous frameworks from their interaction with the microcomputers. Finally, the interaction between the frameworks resulted in students experiencing conflict, particularly in the degree to which they anthropomorphized computers. A discussion of the existing, imposed, and spontaneously developed frameworks, and the interactions between them are presented in this section.

Table 25

Frequency of Responses to Year 8 Interview Question : How do computers work?

| Response type                          | Initial | Final | Count | %  |
|--|---------|-------|-------|----|
|  | Count   | %     |       |    |
| No idea                                | 9       | 47    | 7     | 37 |
| Some idea but not sure                 | 6       | 32    | 3     | 16 |
| Some idea - memory etc.                | 3       | 16    | 7     | 37 |
| Sound idea - used technical terms etc. | 1       | 5     | 2     | 11 |

Mayer (1982) argues that it is important to assess the expectations and intuitions that students have about how to interact with computers. These expectations and intuitions Mayer refers to as frameworks for

student use of computers. In the present study, few students seemed to have significant existing conceptual frameworks, which probably reflected their lack of experience with computers. They certainly did not appear to be committed strongly to existing frameworks and had difficulty articulating any conceptual notions relevant to computers and computer use. However, at times students exhibited intuitions about interaction with computers based on their previous experiences, such as with calculators and typewriters, in the way Mayer (1982) suggests. Almost all students exhibited a low level of understanding for the workings of computer systems. Therefore, it is likely that students' existing frameworks included working models of a computer which bore little resemblance to the technical nature of computers or the design of computers.

The computer literacy course attempted to reinforce the prevalent attitudes of students that computers are useful and fun while, at the same time, giving them skills and understandings to facilitate better use of the technology. The course presented students with some technical information about computers, while in places it developed an information processing model of computers. Acquisition of the imposed framework largely depended on use of the textbook in the teaching sessions and centred around: how a computer is structured; how it works; where it is used; how it can be used; and in particular the implications for society. By the end of the year only some of this was evident in student thinking. Many of the students' answers to questions indicated that they did develop a concept of the machine more in terms of an information storage system. This concept became a part of their conceptual framework. Also, the students seemed to have a wider understanding for what computers could be used to do. Many of them could see that they would be using computers in their chosen jobs. In addition, students

appeared to develop a little more understanding of the social implications of using computers. Implications such as unemployment, work, and automation worried students a little more, which led to some conflict over whether computers were good or bad. Previously, most students had been adamant that computers were good. The change in the feelings of some students is perhaps somewhat attributable to the imposed framework.

While the Year 8 students appeared to have acquired very little of the technical knowledge concerning the operation of computer systems, they did develop the knowledge and skills to allow them to use, at a rudimentary level, the application software which was used in the course. While it is unlikely they developed a sufficient knowledge and skill level to use computers adequately in the future, it is likely that they developed helpful attitudes for future use of computer technology. The Year 8 students were always aware of the potential usefulness of computers but only developed a rationale as they learnt to use application software. While many (Eason et al., 1975) would argue that to make full use of software packages and to recover from errors, difficulties and system malfunctions, users need correct understandings about how the machine functions, these students were not required to do either and therefore their lack of understanding was not a hinderance.

Although the computer literacy curriculum did attempt to impose an information processing framework on the students, the interaction with the computers was not structured to present a particular conceptual framework for operation. In most sessions the students were not told what they should learn, and were largely left to interact with the computers. Therefore, much of the students' conceptual development was likely to be



spontaneous through their interaction with the microcomputers. Students' spontaneous conceptual development generally concerned the degree to which students anthropomorphized the computer. In many instances it was evident that students were trying to make sense of what they were seeing and doing. They had to make sense of: how the software worked; how to overcome problems when they occurred; why problems arose; and generally just how computers worked and responded to them. This was particularly evident when they were programming in BASIC as, here, they felt they were really operating the computer. Many of them treated the machine as a person and tried to communicate with it. They tried to make sense of how this 'computerperson' operated in much the same way as Fernie (1986) describes. The spontaneously developed, anthropomorphised framework was evident in students at various stages in the course with the students demonstrating the need to differentiate the machine from themselves in the way that Olson (1985), and Fernie (1986) suggest.

The interaction between the imposed conceptual framework and the existing student frameworks was largely characterized by lack of conflict with some measure of spontaneous concept development and formally acquired conceptual learning. However, for one or two students there was some conflict. These were mainly students who had home computers or had used them extensively at primary school. The conflict was evident for some students in questions such as "Can a computer think?". Also, one student who used the MacIntosh had the concept of a computer as a machine like the Microbee that was difficult to use and required the use of complex command strings. He had difficulty referring to the MacIntosh as a computer and felt it was more like a TV game. For him, this provided a conflict situation.

In summary, it seems that students need to develop working models of computers which become part of their conceptual framework for interacting with computers. These models must be of necessity non-technical, and must relate to students prior knowledge. Mayer (1982) suggests the use of concrete models and encouraging learners to "put it in their own words" (p. 144). The students in this study used a variety of concrete models from their own experience some of which were not helpful. The combination of the information processing model and the perception of the computer as a machine which was programmed to use human thought logic provided a useful working model of the computer as part of their conceptual frameworks for many students. These models were both concrete and able to be articulated by most students in their own words, allowing students to apply their previous knowledge concerning activities they were completing using computers. An additional explanation for the success of the information processing model is what Mayer (1982) calls, "chunking" (p. 151). This model allowed the formation of meaningful chunks of schemas. The result of the adoption of these models was that many students developed conceptual frameworks for the use of computers which were able to provide a rationale for their attitudes and opinions about computer use.

## **CHAPTER SIX**

### **SUMMARY, IMPLICATIONS and CONCLUSIONS**

This chapter includes a summary of the study, states limitations and implications of the study, and draws conclusions from the findings. The first section contains a summary of the purpose of the study, the methods used, and the results obtained. In the next section limitations of the study are outlined and the implications of the findings for education policy, teaching practice, and research are presented. Finally, the findings are synthesized to present general conclusions drawn from this study.

#### **Summary of Study**

The purpose of the study was to investigate the factors which affect the computer literacy of secondary students. The problem which provided the focus for the study was the pressure being applied on the education system to provide students with the attitudes, knowledge, and skills required to use computer technology effectively in modern society. As a result it is important that the necessary attitudes, knowledge and skills be identified and that an appropriate curriculum is designed. Investigation of the characteristics of present and perceived future use of computers by secondary students will help identify the factors which mediate the attainment of these desired attitudes, knowledge and skills. Also, investigation of the conceptual frameworks relevant to student-computer interaction will help in this identification and the design of curriculum. By focussing on the factors affecting computer literacy the study intended to provide valuable information for the formulation of educational policy, the design of computer literacy curricula, and improving teaching practice.

The study involved the review of relevant literature in three fields. Literature related to computer literacy in society and education were reviewed in order to set the study in a theoretical context. Literature concerned with constructivism was reviewed to provide a theoretical context for discussion of student learning. Finally, literature concerned with ethnographic research models and techniques were reviewed to provide a context for the methods used in the study. A structure for the presentation of the findings of the study emerged from a review of the literature. This structure comprised: the nature of students and computers; the learning environments; and concept development.

Primarily, the methods used in this study were interpretive. However, some quantitative ex-post-facto methods also were used. The major focus of the study was on the student-computer interactions in a secondary class throughout a year long course in computer literacy. This class was observed using computers once a fortnight by the researcher. In addition, data were collected from this sample using an attitudes questionnaire, a background information sheet, samples of work, school grades, and each student was interviewed at the beginning and end of the course. The data were analysed using frequency counts, analysis of variance techniques, and student and class profiles.

Two other samples were used to address specific research questions in relation to the main sample. A random sample of Year 12 students was interviewed to provide a comparison with the Year 8 sample on questions concerning, learning environments, student use of computers, and student attitudes. A third sample of four students was drawn from the main Year 8 sample to use a 'state-of-the-art' computer to provide interview data relating to the effect of computer design factors on student

use of computers.

The results of the study were presented in terms of nine assertions which evolved from interpretation of the data. These assertions, presented in Table 30, were classified according to the structure developed in the literature review. All of the data sources were used to either support or refute the assertions.

### Synthesis of Findings

The findings of this study concern factors affecting the computer literacy of secondary students. They have been presented in terms of assertions concerned with: the students; the computers; the learning environment; and student learning and concept development. This section presents a synthesis of these findings in terms of students' computer literacy and educational theory associated with acquiring the knowledge, skills, and attitudes required by a computer literate person.

Traditional learning theory emphasizes the need for students to acquire relevant attitudes, knowledge and skills. Students tend to exhibit the desired attitudes but lack the knowledge and skills required to use computers effectively, as evidenced by the Year 8 students in this study. Therefore, it is important that students develop the knowledge and skills without losing the positive attitudes. It was found that student confidence in using computers was fragile and that the perceived value students attributed to computers was subject to factors relating to current activities in which they were engaged and the reliability of the computer systems they were using.

**Table 26**  
**Assertions Which Emerged In Study**

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No. Statement of Assertion

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**The Students**

1. Students entering secondary school: enjoy using computers; generally have low anxiety towards using computers; are confident about their own ability to use computers; highly value the use of computers; and want to learn about computers.

**The Computers**

2. The use of unreliable hardware diminishes the value of computers as perceived by students, and may cause anxiety in students when using computers.

3. Students entering secondary school have poor keyboard skills which is an obstacle to their use of computers. Therefore, use of 'state-of-the-art' hardware devices which overcome such obstacles facilitates increased use of computers by students, and the development of positive attitudes towards the use of computers.

4. Students entering secondary school find difficulty in using command driven software which is an obstacle to their use of computers. The use of software which incorporates concrete design concepts facilitates better use of computers, and the development of positive attitudes towards the use of computers.

**The Learning Environment**

5. The majority of the students' use of computers and learning about computers is at school or at home, not in the community.

6. Prior experience with computers and learning about computers was associated with feelings of confidence and enjoyment regarding the use of computers.

7. Parents tend to communicate positive attitudes about computers to their children and most of this communication reflects the parents use of computers at work.

8. The perception students have of the value of the activities they are given to complete on computers, and the extent to which the computer facilitates completion of those activities, are determinants of students' perceptions of the value of computer technology.

**Student Learning and Concept Development**

9. The school environment and experiences of secondary students influence the conceptual frameworks students develop to assimilate knowledge about computers. These frameworks develop before students learn a significant amount about how computers work or about computer systems.

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The lack of keyboard and abstract thinking skills presented obstacles to the present use of computers, while a lack of knowledge and helpful conceptual framework presented possible obstacles to future use of computers. The students using the state-of-the-art computer demonstrated that a lack of skills and understanding can be overcome to

some degree by using appropriate hardware devices and choosing software which incorporates concrete design concepts which fit students present task understanding. It was not so obvious how to overcome obstacles presented by a lack of knowledge.

The development of useful conceptual frameworks for using computers can not be accomplished by presenting students with factual information about how computer systems work. While this may be important for later development, in the early stages, such as the Year 8 students, much of this information is too complex and confusing. For students to develop useful frameworks for computer use, they need to be presented with experiences and information which highlight the information processing nature of computers. They also need to confront the similarities between human and computer functions, assert their control over computers, and perhaps use their understanding for human task functions to help them use computers to do similar tasks.

Students rely on school for their knowledge of computers and experiences with computers. However many students do attend to attitudes communicated to them by their parents. These attitudes are usually not in conflict with those encouraged at school. From all indications the Year 8 students used in the study were more computer literate at the end of the year than the beginning some of which was attributable to the computer literacy course in which they were engaged.

### Limitations of Study

In considering the limitations of this study it must be recognized that the generalizability of the findings of interpretive studies is limited

because small samples are usually involved, and data which is often difficult to quantify are usually collected. However, the main objective of this study was not generalizability, rather it was investigative. Many more similar studies need to be conducted which verify the findings of this study in order to further generalize these findings.

The major limitations of this study were due to the use of a single researcher instead of a team of researchers, and the limited amount of hardware and software available. Much of the data were collected by the researcher using interviews and observations. Both of these techniques involve high degrees of error due to researcher bias and the need for inference and interpretation. This reduces the validity of the findings dependent on these sources of data. If a research team had been employed such a bias would have been reduced. The school used in the study had available only a limited number of microcomputers and a small selection of software. In particular, there was only one state-of-the-art microcomputer to use to test the assertions involving, software design and the use of a mouse. A wider variety of types of microcomputer systems and software would have facilitated further investigation of student-computer factors in computer literacy.

### Implications of Study

The findings of this study have implications for the formulation of educational policy, the improvement of teaching practice, and further research relevant to computer literacy.



### Implications for Educational Policy

It is now widely recognized by those responsible for educational policy that school curricula need to address the computer literacy of students. The findings of this study have demonstrated the importance of the school learning environment for the development of the attitudes, knowledge, and skills necessary to ensure students are computer literate. In addition, this study found that the hardware and software used by students and the activities they are set to complete on computers are important factors in their computer literacy. These factors need to be considered by those responsible for the setting of educational policy at all levels of the education system.

It can be argued that schools' need to provide specialist computer literacy courses for students because the school is such an important learning environment with regard to computer literacy. This study found that students entering secondary school have very little developed conceptual framework relevant to computer use and that their computer related attitudes, knowledge, and skills are heavily influenced by learning at school. In particular, the assertions concerned with the learning environment highlighted the importance of the school environment for student use of computers. Therefore, to ensure students become computer literate and develop useful conceptual frameworks, such as the information processing framework, schools can not rely on ad-hoc use of computers in other subject classes. Specialist computer literacy classes are needed as an integral part of the curriculum of the school to provide well implemented learning strategies. If it is important for students to be computer literate then they need to learn within the computing subject discipline.

While the need for specialist classes has been argued from the findings of this study, schools also need to consider the use of computers throughout the curriculum. This study found that if students successfully use computers to facilitate completion of activities they consider to be important, then they are more likely to perceive future uses of computers in their lives. Therefore, school computer literacy policies need to consider the areas of students' lives most likely to generate activities relevant to computer use and the nature of these activities.

The school environment is most likely to provide relevant computer activities for students to complete. The environments students deal with are: home; school; and community. The home environment does not appear to generate many computer related activities despite the predictions of the literature. Most home computers are used for entertainment (playing games) or by parents for work related activities. Some students complete some homework on computers but this is in essence a school generated activity. In the community while students may use computers for such purposes as banking, a computer scoring system at ten-pin bowling and may use scanners and terminals in retail stores and libraries they tend not to do so. Overall, students make little use of computer technology in the community. As a result it is primarily the school environment which is likely to generate computer related activities which are vital to the development of computer literacy in students.

School presents students with a variety of activities to complete, many of which may be completed using computers. Many of these activities may be best tackled using computer technology. Examples of such tasks are: assignments which may be wordprocessed; maths calculations which

may be done on a spreadsheet or statistics package; dangerous science experiments which may be simulated on a computer; information retrieval in the Social Sciences and library which may use a database; surveys in English which may be collated on a database; graphics presentations in art which could use a graphics package; and the overall activities of learning which may be able to make use of CAL packages. There are many other types of activities set secondary students which may be able to make use of computer technology.

Schools need to provide students with well chosen activities to complete using computers. The generation of computer related activities seems most likely to come from the school environment. Therefore, to help students to become computer literate schools need to allow students to apply computer solutions to activities which occur in the school environment and place these activities in the teaching curriculum. Such applications will set up patterns of behaviour and facilitate the development of a useful conceptual framework for the future use of computers by secondary students. However, the activities chosen must fulfil the two criteria found in this study. Firstly, students must perceive the activities to be important, which does not necessarily imply that the activities need to be related to reality in the work or community environments. Secondly, when students use computers such use must be seen to facilitate completion of the activities.

A further implication of the findings of this study for educational policy concerns the purchase of hardware and software for students to use. This study found that students had difficulty using keyboard input and using software which was designed to employ abstract concepts. Therefore, once the computer related activities for students are identified, attention

needs to be given to the hardware devices required by these activities and the design features of the associated software. For example, it may serve the interests of students better to purchase a few more "state-of-the-art" computers rather than a large number of "poorer" quality computers. Also, software needs to be evaluated carefully to consider not only its educational merit but also its design features. The use of concrete concepts in software design will help students to use the software and to become computer literate more readily.

Policies concerned with computer literacy courses and across the curriculum computer use need to address the needs students have which will affect computer use now and in the future. These needs must form the basis for the objectives of any computer literacy/awareness curriculum. The identification of appropriate activities, hardware, and software, is a necessary start to the development of such policies.

#### Implications for Teaching Practice

All nine assertions of this study probably have implications for teaching practices in computer literacy and other subject areas. However, the assertions of most significance to teaching practice are those concerning student attitudes, the relation of software to activity, and student learning and concept development. Implications for teaching of assertions in each of these areas are considered below.

The students used in the study generally had positive attitudes towards the use of computers although some of them expressed lack of confidence and a feeling that they lacked the necessary knowledge and skills. For teachers involved in computer literacy programmes these

positive attitudes need to be used to motivate students to use computers to complete activities. It is important that these attitudes are not reversed by negative experiences such as teacher-centred lessons or unreliable equipment. Students have a desire to use computers and should be given as much opportunity as possible to do so, unhindered by interruptions, such as from teacher talk. However, students need to be given activities on computers which gradually develop their confidence by continual success and the development of knowledge and skills.

It is clear that teachers need to choose computer applications for their students which make use of appropriately designed software and hardware. The necessity for the choice of appropriate activities for students to be set to complete on computers has been raised and is important in the choice of computer applications software. It is not necessarily important that the software and activities chosen need to accurately reflect use of computers in the workplace or community. What is important is that students consider the activities to be necessary and that the computer facilitates the efficient completion of the activities.

Students beginning secondary school appear to have little knowledge and understanding of computer technology. It seems that students are prepared to readily accept the conceptual frameworks provided by teachers where these are supported by subsequent experiences using computers. In particular, students are amenable to the 'information processing' model of a computer system. Therefore, teachers should consistently develop such a framework and support it with the use of computer applications with which students experience success. This conceptual framework tends to develop in students a greater appreciation for the value of the computer and increases their perceptions of their own

future use of the technology.

### Recommendations for Further Research

The limitations of this study mean that it is important that the findings be replicated by similar studies in Australia and internationally. The assertions give rise to important research questions. Possibly the foremost concerns the conceptual frameworks students develop as they use computers. Little research has been conducted into the conceptual frameworks of person-computer interaction and yet this psychological factor is seen, by leading computer scientists, as a major area of concern. Also, more research is needed to identify the uses people make of computer technology in the community, home and work environments. Once these uses have been identified they need to be translated into relevant activities for students to complete at school.

### Conclusions

After more than 20 years of computer use in education little is known of the characteristics of the interaction between students and computers. Computer scientists now see the need for an understanding of the psychology involved in this interaction. There are characteristics of humans and of computer systems which affect this interaction. This study found that in general students have positive attitudes towards the use of computers but may feel that they lack confidence or the necessary knowledge and skills. They see the computer as a useful tool but complex and difficult to understand. Therefore, schools need to work to maintain these positive attitudes and provide students with experiences which develop their confidence in using computers.

The computer is by nature a processor of information and the characteristics it contributes to the interaction are largely determined by the models of interaction assumed by the designers of software and hardware. This study highlighted the need for the use of more concrete and manipulative input devices, display forms, and command structures. The other important computer characteristic which is a factor in student use of computers was the reliability of hardware. Students lose confidence in computer technology if their own computer use is characterized by unreliability.

School was determined to be the crucial learning environment for the development of computer literacy. The learning environments investigated in the study were the: school; home; and community. While student attitudes were affected by previous experiences at both school and home, the school was determined to be the most significant contributor to student learning for computer literacy. In addition, it was recognized that the activities students were given to complete on computers influenced their perceptions of the value of the technology and the potential uses for themselves. The implication of these findings was that it is the school's responsibility to provide students with experiences and activities which ensure they are computer literate.

Students are amenable to the conceptual frameworks presented to them in school. While students are not able to assimilate a lot of knowledge concerned with how computers work and other associated technical details, they can do so with knowledge concerned with the applications and social implications of computer use. This probably means that students develop a working concept of computers which bears little resemblance to the technical nature of computers or the designed

nature of computers. While this may not be acceptable for some future uses of computers, particularly those found in the computing industry workplace, it may be a necessary intermediate step towards developing such an understanding.

It is likely that all users anthropomorphize computers to a degree, no matter what their understanding of the technology is. This study found this to be the case for the group of Year 8 students observed. However, the nature of this anthropomorphization varied and possibly had a bearing on their use of computers. To operate computers to their full potential, the user needs to appreciate that computers use human logical thought and organisational structures to solve problems and process information. However, there is a degree of personal conflict of control for the naive user which must be addressed. It is important that the user perceives (s)he has control over the computer and not the other way around. It is likely that the user has to assert a difference between humanity and computer and then develop the positive concepts of human-computer similarity for interaction with the technology.

This study was concerned with the computer literacy of secondary students and identified a number of influencing factors. These factors had implications for educational policy and teaching practice. Further, the findings of this study identified a number of research questions for further research. The determination of student computer literacy, particularly the perceptions that students have of future use of computers, will be an important consideration in any such research. For it is imperative that every possible effort is made to help schools ensure students are computer literate and are thereby ready to live and work in our increasingly technologically based society.



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## **Appendix A**

### **Description Of Specific Student Objectives For Computer Literacy Course**

#### **Teaching Sessions**

##### **Historical Background**

- . Students will see computers as a part of the technological development of society.
- . Students will regard computers as a man made machine which was designed to help improve the quality of life by solving problems.

##### **Microcomputer technology**

- . Students will gain a broad perspective of a computer system as comprising various pieces of hardware, software and personnel.
- . Students will develop a picture of a computer system involving input, processing, storage, output and communication.

##### **Applications**

- . Students will realize that computers are used in many ways in our society to help us solve problems.
- . Students shall understand why computer systems are useful to our society.
- . Students will be encouraged to be involved with the computer technology of our society.

##### **Social Implications**

- . Students will realize that while computer systems are used to benefit our society they may also, in some instances, be harmful to some members of our society.
- . Students will understand that the use of computer technology has necessarily had an impact on the way we live in our society. Further they will begin to be aware of these changes.

## **Hands On**

### **Introductory software**

- . Students will become familiar with the hardware of a microcomputer and with supplying simple instructions to its software.

### **Wordprocessing**

- . Students will see the benefit of using a computer system for wordprocessing.
- . Students will become confident at using the microcomputer system.
- . Students will become confident at giving instructions to the computer and following instructions.
- . Students will use a microcomputer to complete a task which it is necessary for them to do and in so doing will be encouraged to use computer systems.

### **BASIC Programming**

- . Students will become aware that a computer system must be programmed and is a machine which follows instructions.
- . Students will become confident at using the microcomputer system.

### **Introductory Data Processing**

- . Students will see the value of processing data using a computer system.
- . Students will use a microcomputer to complete a necessary task and in so doing will be encouraged to use computer systems.
- . Students will experience a number of output forms which may be used.

### **Word Puzzles**

- . Students will use a microcomputer to complete a task which it is necessary for them to do and in so doing will be encouraged to use computer systems.
- . Students will become aware of the power of computer systems to complete tasks which are difficult or tedious for us to do.

### **Graphics**

- . Students will experience another possible output form.
- . Students will appreciate the multitude of uses which may be made of computer systems.

## APPENDIX B

### COMPUTER LITERACY COURSE PROGRAMME

| PROGRAMME |   |   | TERM 1 | 1986 |
|-----------|---|---|--------|------|
| Week      | Hands-On Sessions<br>(FORTNIGHTLY)  | Classroom Teaching Sessions<br>"Welcome to Computers"                   |        |      |
| 10/2      | Introduction to wordprocessing using WORDSTAR<br>- menus<br>- open document on Data disk<br>- save document | Hardware and Software (1.1)<br>Central Processing Unit (1.2)            |        |      |
| 17/2      | APPLE software for year 8   |   |        |      |
| 24/2      | Cursor movements<br>- delete ( just using delete key)<br>- insert   | Input/Output Devices (1.3)  |        |      |
| 3/3       | APPLE software for year 8   |   |        |      |
| 10/3      | Print out a document  | Memory (1.4)<br>Mass Storage Devices (1.6)<br>Communication Lines (1.7) |        |      |
| 7/3       | APPLE software for year 8   |   |        |      |

**NOTE :**

1. The APPLE software is not just 'keep them busy' game type material. The aim is to expose them to a variety of software which require different input responses and show a variety of processes and outputs. The software is in folders which include instructions on how to run the programs.
2. Students work best in pairs on the computers.
3. In the first session please stress the need to look after the disks etc.
4. There should be one wordprocessor disk to each Microbee along with a data disk. Students must only save their documents on the data disks.
5. During the time in the Computing room students should have the opportunity to use both the Microbee and Apple microcomputer systems.
6. Wordprocessor instructions sheets are available along with copies of the menus. It is hoped that students will largely be able to follow instructions by reading the menus off the screen. There are also manuals and an introductory guide book available.

## PROGRAMME

## TERM 2

1986

| Week             | Hands-On Sessions<br>(FORTNIGHTLY)   | Classroom Teaching Sessions<br>(Text : Let's Go With Computers)  |
|------------------|--|--|
| 7/4<br><br>14/4  | WORDSTAR : revise creating, editing and printing documents.<br><br>Introduce topics for essay assignment. Students should begin to collect information.<br><br>Continue using APPLE software.                                  | 1.1 Machines and Tools have Changed<br><br>HAND OUT student work books<br>ALLOCATE textbook numbers to students, they must use this numbered book every time. (coordinate with other classes set at the same time) |
| 21/4<br><br>28/4 | WORDSTAR : Introduce printer effects.<br>ESSAY : Begin typing in using Wordstar.<br>(Note: Students may need to work on computers in lunchtimes)<br><br>Students should be rostered between the Microbees and APPLE computers. | 1.2 The Industrial Revolution<br>1.3 Early Computing Devices<br><br>NOTE : Students may borrow texts from MY office overnight. Class set books may not be borrowed.  |
| 6/5<br><br>13/5  | Continue working on essay.   | 1.4 Information Based Technology<br><br>(VIDEO : VC 37 "The Computer Program - part 1")  |
| 20/5<br><br>27/5 | Continue working on essay.   | 1.5 Electronic Computers<br>1.6 Computer Systems   |
| 2/6<br><br>9/6   | Hand in ESSAY.   | TEST (First and second term theory and wordprocessing theory)  |
| 16/6             | Students may use computer games on Microbees and APPLES. Please see me for games disks.  | 1.7 Computer Software  |

|              |                   |     |
|--------------|-------------------|-----|
| ASSESSMENT : | TEST              | 40  |
|              | Essay             | 20  |
|              | Book work         | 20  |
|              | Use of Computers  | 10  |
|              | Other assessments | 10  |
|              | TOTAL             | 100 |

## Assessment of Essays :

|                 |    |
|-----------------|----|
| Content         | 10 |
| Use of wordstar | 10 |

(look for accuracy, layout and use of features of wordprocessor eg. printer effects)

## PROGRAMME

## TERM 3

1986

| Week         | Hands-On Sessions   | Classroom Teaching Sessions   |
|--------------|---|---|
| 7/7<br>14/7  | <p>Programming in BASIC<br/>(use Chapter 5 of text)</p> <p>Only use Microbee computers. (get your disks off me)</p> <p>5.1 Computer Programming<br/>Continue to use APPLE software</p>                      | <p>3.1 What Can Computers Do ?<br/>(VIDEO : VC 12 "The Silicon Factor 1")</p> |
| 21/7<br>28/7 | <p>5.2 A Simple BASIC program</p> <p>(Note: Students should be aware that the purpose behind this short programming course is to show them how a computer is instructed, not to make them programmers.)</p> | <p>3.2 Administration</p>   |
| 4/8<br>11/8  | <p>5.3 Organising Simple BASIC programs</p>   | <p>3.3 Banking</p>  |
| 18/8<br>25/8 | <p>5.4 Making Decisions</p>   | <p>3.4 The Retail Industry</p>  |
| 1/9<br>8/9   | <p>5.5 Repetitions</p>  | <p>3.5 Farms, Mines and Factories<br/>3.8 Entertainment</p>                   |
| 15/9         | <p>Programming TEST</p>   | <p>3.10 Computers at Home</p>   |

PROGRAMME

TERM 4

1986

| Week           | Hands-On Sessions  | Classroom Teaching Sessions   |
|----------------|--|---|
| 6/10<br>13/10  | Introductory Data Processing<br>(We have a special package for the Microbee which involves students collecting and analysing data)     | 4.1 Introduction to Computers in Society<br>4.2 Unemployment        |
| 20/10<br>27/10 | Introductory Data Processing<br><br>Ensure ALL students have seen and used ALL the APPLE software. You could subjectively assess this. | 4.3 Who Controls the Computers ?                                    |
| 3/11<br>10/11  | Introductory Data Processing   | 4.5 Misuse of computers<br>TEST (third and fourth term theory only) |
| 17/11<br>24/11 | Use WORD PUZZLES package on Microbee   | 4.6 Can Computers Be Trusted ?                                      |
| 31/11          | WORD PUZZLES or games  | 4.7 Buying a Personal Computer<br>4.8 Careers in Computing          |

|              |                              |     |
|--------------|------------------------------|-----|
| ASSESSMENT : | Programming Test             | 20  |
|              | Theory TEST                  | 20  |
|              | Introductory Data Processing | 20  |
|              | Word Puzzles                 | 5   |
|              | Book Work                    | 20  |
|              | Computer Awareness Test      | 10  |
|              | Teacher Assessment           | 5   |
|              | TOTAL                        | 100 |

## APPENDIX C

### INTERVIEW QUESTIONS

#### Year 8 Initial Interview Questions

1. Have you used a computer before ? Where and when?
2. What do you think a computer is?
3. What are you hoping to learn about computers this year?
4. Do you like using computers?
5. Do you think you could use a computer now to help you if you had one?
6. How do computers work?
7. Can computers think?
8. What does your family think about computers ? Do you talk about them at home?
9. Would you like to use computers in your job after you leave school?
10. Do you think computers are good or bad for the world?
11. What do you think is the best thing computers have been used to do?
12. Do you think there is anything computers will never be able to do?
13. How do you feel when you use a computer?
14. When you use a computer do you think you know what it is doing and how to get it to do what you want it to?

Year 8 Final Interview Questions

1. What did you learn about computers this year?
2. Did you like the course this year? How could it be improved?
3. What do you think a computer is?
4. Do you like using computers?
5. Do you think you could use a computer now to help you if you had one?
6. How do computers work?
7. Can computers think?
8. What does your family think about computers ? Do you talk about them at home?
9. Would you like to use computers in your job after you leave school?
10. Do you think computers are good or bad for the world?
11. What do you think is the best thing computers have been used to do?
12. Do you think there is anything computers will never be able to do?
13. How do you feel when you use a computer?
14. When you use a computer do you know how to control it?
15. If you didn't know something, who in the class would you ask?
16. Will you do computing next year?



Year 12 Interview Questions

1. Have you used a computer before ? Where and when?
2. What do you think a computer is?
3. Do you hope to learn more about computers in the future?
4. In what ways do you think you are most likely to use a computer?
5. Do you think you could use a computer now to help you if you had one?
6. How do computers work?
7. Can computers think?
8. What does your family think about computers ? Do you talk about them at home?
9. Would you like to use computers in your job after you leave school?
10. Do you think computers are good or bad for the world?
11. What do you think is the best thing computers have been used to do?
12. Do you think there is anything computers will never be able to do?
13. How do you feel when you use a computer?
14. What is your current attitude to the use of computers?
15. What (or who) has most shaped your opinion on the use of computers?
16. Have you done computing courses at school?

## **APPENDIX D**

### **ATTITUDES QUESTIONNAIRE**

(Taken from the Minnesota Educational Computing Consortium computer attitudes questionnaire.)

Your Name (please print) \_\_\_\_\_

Dear Student:

We would appreciate your help by having you answer the questions in this booklet. There are two parts: the first part asks for your opinions and attitudes and the second part is a test of your knowledge about computers. Keep in mind that in the first part (the attitude questions) there are no right answers or wrong answers; just select the answer that best expresses how you feel. In the second part (the computer knowledge test) there may be items you have not yet learned. Just answer as many as you can. Keep in mind that the right answer is the best choice for each question.

## PART 1

**DIRECTIONS:** Indicate how much you AGREE or DISAGREE with each of the following statements by circling the appropriate letter. Circle "a" if you STRONGLY DISAGREE with the statement. Circle "b" if you DISAGREE with the statement a little. Circle "c" if you are UNDECIDED about whether you agree or disagree with the statement. Circle "d" if you AGREE with the statement a little. Circle "e" if you STRONGLY AGREE with the statement.

As an example, if you AGREE a little that computers are noisy, then circle "d" as shown below:

Computers are noisy

a   b   c   **d**   e

Or, if you are UNDECIDED about whether computers are noisy, circle "c" as shown below:

Computers are noisy

a   b   **c**   d   e

If you have any questions, ask your teacher.

|  | STRONGLY DISAGREE | DISAGREE | UNDECIDED | AGREE | STRONGLY AGREE |
|--|-------------------|----------|-----------|-------|----------------|
|  | a                 | b        | c         | d     | e              |
| 1. I would like to learn more about computers..                                | a                 | b        | c         | d     | e              |
| 2. Working with a computer would probably make me feel uneasy or tense.....    | a                 | b        | c         | d     | e              |
| 3. I feel helpless around a computer.....                                      | a                 | b        | c         | d     | e              |
| 4. Computers sometimes scare me.....   | a                 | b        | c         | d     | e              |
| 5. I would very much like to have my own computer.....                         | a                 | b        | c         | d     | e              |
| 6. I would like the idea of taking computer courses.....                       | a                 | b        | c         | d     | e              |
| 7. I enjoy using computers in my classes.....                                  | a                 | b        | c         | d     | e              |
| 8. Walking through a room filled with computers would make me feel uneasy..... | a                 | b        | c         | d     | e              |

|   | STRONGLY DISAGREE | DISAGREE | UNDECIDED | AGREE | STRONGLY AGREE |
|---|-------------------|----------|-----------|-------|----------------|
|   | a                 | b        | c         | d     | e              |
| I feel uneasy when I am with people who are talking about computers.....  | a                 | b        | c         | d     | e              |
| I enjoy working with computers.....   | a                 | b        | c         | d     | e              |
| I feel confident about my ability to use computers.....   | a                 | b        | c         | d     | e              |
| It is my guess that I am <u>not</u> the kind of person who works well with computers.....   | a                 | b        | c         | d     | e              |
| On the whole, I can cope with computers in my daily living.....   | a                 | b        | c         | d     | e              |
| I am able to work with computers as well as most others my age.....   | a                 | b        | c         | d     | e              |
| Computers are gaining too much control over people's lives.....   | a                 | b        | c         | d     | e              |
| In general, females can do just as well as males in computer careers.....   | a                 | b        | c         | d     | e              |
| More females than males have the ability to become computer specialists.....  | a                 | b        | c         | d     | e              |
| Using computers is more for males than for females.....   | a                 | b        | c         | d     | e              |
| Studying about computers is just as important for females as for males.....   | a                 | b        | c         | d     | e              |
| Men make better scientists and engineers than women do.....   | a                 | b        | c         | d     | e              |
| Falsifying information in computers is a serious crime.....   | a                 | b        | c         | d     | e              |
| Access to personal information in computer files is a serious problem.....  | a                 | b        | c         | d     | e              |
| Organizations should <u>not</u> be allowed to create secret computer files containing detailed information regarding people's personal lives..... | a                 | b        | c         | d     | e              |
| Because of computerized information files, too many people have information about other people.....   | a                 | b        | c         | d     | e              |

|   | STRONGLY DISAGREE | DISAGREE | UNDECIDED | AGREE | STRONGLY AGREE |
|---|-------------------|----------|-----------|-------|----------------|
|   | a                 | b        | c         | d     | e              |
| 25. To protect people's privacy it is necessary to have laws regarding computer files that contain personal data..... | a                 | b        | c         | d     | e              |
| 26. Every secondary school student should have some minimal understanding of computers.....                           | a                 | b        | c         | d     | e              |
| 27. Every secondary school student should be able to write a simple program.....                                      | a                 | b        | c         | d     | e              |
| 28. Every secondary school student should learn about the role that computers play in our society.....                | a                 | b        | c         | d     | e              |
| 29. Computers can be a useful instructional aid in many subject areas other than mathematics.....                     | a                 | b        | c         | d     | e              |
| 30. Computers provide more disadvantages than advantages in education.....  | a                 | b        | c         | d     | e              |

**DIRECTIONS:** Indicate whether you think each of the following values is UNIMPORTANT, IMPORTANT, or EXTREMELY IMPORTANT by circling the appropriate letter. Circle "a" if you think the value is UNIMPORTANT. Circle "b" if you think the value is IMPORTANT. Circle "c" if you think it is EXTREMELY IMPORTANT.

As an example, if you think saving money is EXTREMELY IMPORTANT, circle "c" as shown below:

Saving money

a

b

c

|                          | UNIMPORTANT | IMPORTANT | EXTREMELY IMPORTANT |
|--------------------------|-------------|-----------|---------------------|
|                          | a           | b         | c                   |
| 31. Freedom .....        | a           | b         | c                   |
| 32. World Peace.....     | a           | b         | c                   |
| 33. Economic Growth..... | a           | b         | c                   |

|                                    | UNIMPORTANT | IMPORTANT | EXTREMELY IMPORTANT |
|------------------------------------|-------------|-----------|---------------------|
|                                    | a           | b         | c                   |
| 34. Scientific Knowledge.....      | a           | b         | c                   |
| 35. Privacy.....                   | a           | b         | c                   |
| 36. Technological Advancement..... | a           | b         | c                   |
| 37. Computerization.....           | a           | b         | c                   |
| 38. Efficiency.....                | a           | b         | c                   |
| 39. Love and Friendship.....       | a           | b         | c                   |
| 40. Self Respect.....              | a           | b         | c                   |

**DIRECTIONS:** Below are some adjectives that can be used to describe computers. For each adjective circle the alternative which best expresses how you feel about computers. If you aren't sure how you feel, circle "undecided." As an example, if you feel that computers are very big, then circle as shown here:

a. not big      b. big      c. very big      d. undecided

If you feel that computers are not big, then circle as shown here:

a. not big      b. big      c. very big      d. undecided

Circle one alternative for each of the eight adjectives.

COMPUTERS ARE:

- a. not personal      b. personal      c. very personal      d. undecided
- a. not frustrating      b. frustrating      c. very frustrating      d. undecided
- a. not good      b. good      c. very good      d. undecided
- a. not humanizing      b. humanizing      c. very humanizing      d. undecided
- a. not challenging      b. challenging      c. very challenging      d. undecided
- a. not bad      b. bad      c. very bad      d. undecided
- a. not impersonal      b. impersonal      c. very impersonal      d. undecided
- a. not dehumanizing      b. dehumanizing      c. very dehumanizing      d. undecided

## COMPUTER LITERACY RESEARCH BACKGROUND QUESTIONS

These questions are designed to help us see how useful the computer literacy course will be. Your name will not be used at any time and once we have used the information, these sheets will be discarded. It is important that you answer the questions truthfully and to the best of your ability. Your answers will in no way influence your success in the course.

NAME \_\_\_\_\_ T6 \_\_\_\_\_

SEX (M) or (F) (cross out one)

### GENERAL QUESTIONS

1. Does your family have a computer at home ? **YES/NO** (cross out one)

2. If your family has a computer, do you use it ? - tick one of the following,

(often) ☐ (sometimes) ☐ (almost never) ☐

3. If you have a computer, what do you use it for ? (tick box for each)

|                         | often                    | sometimes                | never                    |
|-------------------------|--------------------------|--------------------------|--------------------------|
| games .....             | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| wordprocessing .....    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| programming .....       | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| keeping accounts .....  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| doing school work ..... | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| other uses              |                          |                          |                          |
| _____                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| _____                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. What type of job would you like when you leave school ?

5. How much time per week (on average) did you spend learning about computers last year ? (tick one box)

less than five minutes ☐  
up to 30 minutes ☐  
up to 1 hour ☐  
over an hour ☐

6. Do you use an Automatic Teller to do your banking ? (tick one box)

always ☐  
sometimes ☐  
never ☐