Science and Mathematics Education Centre

The History of Computer Use in Senior School Mathematics Teaching in the Government School System of New South Wales: 1971 – 1992.

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: ....Peter J. Follows....

Date: THURSDAY 12TH SEPTEMBER 2013

Abstract

The History of Computer Use in Senior School Mathematics Teaching in the Government School System of NSW: 1971 – 1992.

Despite the volume of literature available describing the advent of computers into all aspects of business, industry, society and education in Australia, there is a paucity of information regarding the introduction of computers into *school* education, especially *school mathematics education*. This is surprising considering that Mathematics was the forerunner of all school subjects to take advantage of the vast number of opportunities made available through the use of the computer. Schools in the State of New South Wales (NSW), were among the foremost in initiating this innovation. The earliest use can be placed shortly after 1970, when a number of NSW ex-university students, who had studied mathematics and computing units at tertiary level, took up mathematics teaching positions in schools and introduced this knowledge into their classroom teaching. Computers were initially used in mathematics education in NSW in 1971, and that is why this study commences at that point. Communications technology was influential in society, education and in government policy by 1992, and that was therefore seen to be an appropriate point to end the study. This research project will document and provide an insight into a significant phase that Australian mathematics education has experienced, and will trace and describe how mathematics education became the foundation stone for the current widespread use of computers in other subjects taught in NSW schools.

A historical method of research was involved in undertaking this study, and both quantitative and qualitative variables, combined with a grounded theory methodology, were used in the collection of the historical information. This combined approach entailed the gathering of Primary data, including first-hand accounts of information, eyewitness accounts of events, State Government and school records, State Government and school policy statements and oral histories. Secondary sources of information included accounts prepared by persons other than those who participated in, or observed the events described. These involved teachers and NSW Education Department (now called the Department of Education and Communities) officials. Also examined was the extensive literature on the introduction of computers into Australian society. The Secondary resources enabled this researcher to understand the subject, and they provided extensive bibliographic information for delving deeply into the research topic. The process involved a rigorous collection and organization of evidence, and the verification of the authenticity and veracity of information and its sources. Eight informants who had worked in the mathematics and computer fields throughout the period under study were interviewed directly and also answered a survey. These interviewees were recruited, mainly through the Mathematical Association of New South Wales, and others nominated by the initial interviewees. All were knowledgeable about the period under scrutiny, having direct experience in the mathematics education at that time. Following this, the focus of the study became one of the selection, organization, and analysis of the most pertinent collected evidence under seven main themes and associated phases related to the study period. Finally, the research methodology involved the drawing and recording of conclusions in a meaningful narrative.

Outcomes of the study revealed the strong relationship between mathematics and computing in NSW schooling, mainly due to their related power in mathematical problem solving. Computers were introduced into schools generally through programming. Because programming was initially used in the subject of mathematics, the teachers of this subject were the earliest users of computing. The unit Computer Studies was introduced (later). With it came the introduction of school computer laboratories staffed by computer specialists. As a result, the leadership role of the mathematics teacher in school computing had diminished by the early 1990's. It would not be until many years later, with the advent of powerful hand-held graphics calculators, that mathematics teachers would again have the creative freedom to employ computing in their teaching in a way they had enjoyed in earlier times.

Dedication and Acknowledgements

I dedicate this book to my parents: Petronella (Elly) and Horst Sollorz. They are and have been with me all of my life, supporting me in my growth and education, and they have been an irreplaceable part of that life. I would also like to take this chance to thank them for their ongoing help, friendship and influence.

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Glossary of Acronyms and Terms

Acronyms

ACS: Australian Computer Society

CAI: Computer Aided Instruction

CAS: Computer Algebra System

CDC: Curriculum Development Centre

CEGV: Computer Education Group of Victoria

CEU: Computer Education Unit

CICG: Computer Implementation Coordination Group

CLIC: Curriculum and Learning Innovation Centre

CPT: Curriculum Project Team

CSC: Commonwealth Schools Commission

DET: Department of Education and Training

ICT: Information and Communications Technology

IT: Information Technology

MANSW: Mathematical Association of New South Wales.

META: mathematically enabled technologies and applications

NACCS: National Advisory Committee on Computers in Schools

NSCU: National Software Co-ordination Unit

NSW DSE: New South Wales Department of School Education

NSW Dept. Ed.: New South Wales Department of Education

NSWCEG: New South Wales Computer Education Group

NSWGSCECC: New South Wales Government Schools Computer Education Co-ordinating Committee

OECD: Organisation for Economic Co-operation and Development

P and C: Parents and Citizens Organisations

SCAG: Software Co-ordinators Advisory Group

SCOR: Schools Computing Online Resource

URL: Universal Resource Locators

VCEG or CEGV: Computer Education Group of Victoria

Terms and Definitions

Algebra

a system for computation using letters or other symbols to represent numbers, with rules for manipulating these symbols

Algorithm

a precise step-by-step plan for a computational procedure that begins with an input value and yields an output value in a finite number of steps

BASIC

a popular programming language that is relatively easy to learn

Calculus

the branch of mathematics that is concerned with limits and with the differentiation and integration of functions

Communications technology

the activity of designing and constructing and maintaining communication systems

Computation

the procedure of calculating; determining something by mathematical or logical methods

Computer

a machine for performing calculations automatically

Computer laboratories

a special room in which many secondary schools would house a collection of computers

Computer literacy

the ability to operate a personal computer and its associated software and hardware, and to understand most of the underlying concepts (but not necessarily the electronics, or a programming language)

Curriculum

the set of courses, coursework, and their content, offered at a school or university

Debugging (of software)

debugging is a methodical process of finding and reducing the number of bugs, or defects, in a computer program or a piece of electronic hardware, thus making it behave as expected

Database

a set of data organized on a computer

Determinant

a square matrix used to solve simultaneous equations

Digital artefact

any type of item produced and stored as digital/electronic version.

Drill and practice

a type of computer software meant to supplement the introduction of new material by a classroom teacher. After the introduction of new concepts and ideas, this computer software provides regular review and practice by students of basic concepts and skills

Finite

bounded or limited in magnitude or spatial or temporal extent

FORTRAN

a high-level programing language for mathematical and scientific purposes; stands for formula translation

Freeware

software that is provided free of charge

Graphic calculator

a graphing calculator typically refers to a class of handheld scientific calculators that are capable of plotting graphs, solving simultaneous equations, and performing numerous other tasks with variables

Grounded theory

grounded theory method is a systematic methodology in the social sciences involving the discovery of theory through the analysis of data. It is mainly used in qualitative research, but is also applicable to quantitative data

Higher School Certificate

an exam that year 12 students take to gain University entrance

Historical methodology

past-oriented research which seeks to illuminate a question of current interest by an intensive study of material that already exists

HyperCard

HyperCard was an application program and programming tool for Apple Macintosh and Apple IIGS computers, which was among the first successful hypermedia systems before the World Wide Web

Information Processing

the sciences concerned with gathering, manipulating, storing, retrieving, and classifying recorded information

In-service

to train or educate someone while they are working, to give "on-the-job" training

In-vivo coding

a relevant concept here is “In-vivo coding,” which is where the analyst builds “concepts” using the words of the data as well as of the interviewees instead of the researcher using his/her own words

LOGO

a high-level programming language used to teach children how to use computers

Mainframe

a large computer

Mathematics

an abstract representational system used in the study of numbers, shapes, structure and change and the relationships between these concepts

Mathematics education

in contemporary education, mathematics education is the practice of teaching and learning mathematics, also consisting of the examination and grading of the student involved.

Matrices

plural form of matrix

Matrix

a rectangular array of quantities or expressions set out by rows and columns; treated as a single element and manipulated according to rules.

MS-DOS

an operating system for personal computers. It was the most commonly used member of the DOS family of operating systems.

Numeracy

skill with numbers and mathematics

Operating System

software that controls the allocation and usage of hardware resources such as memory, CPU time, disk space, and input and output devices.

PASCAL

a programing language designed to teach programming through a top-down modular approach

Probability

the study of chance processes or the relative frequency characterising a chance process

Problem solving

the thought processes involved in solving a problem

Pre-service courses

courses undertaken during university training

Professional development

professional training that teachers undergo to increase their capabilities as teachers

Programming

creating a sequence of instructions to enable the computer to do something

Prolonged engagement

spending sufficient time in the field to learn or understand the culture, social setting, or phenomenon of interest

Public domain software

software that has property rights that are held by the public at large

Qualitative research

a set of research techniques in which data is obtained from a relatively small group of respondents and not analysed with statistical techniques

Quantitative research

the systematic scientific investigation of quantitative properties and phenomena and their relationships, using statistical methods

Qualitative coding

having each main idea under a conceptual heading helped in organising my thoughts and was the means to acquire the best from the data through refining it, categorising it, and enhancing my perception to grasp developing relationships with other groups of data

Self-service

a term used to describe the situation where teachers used their own resourcefulness to obtain the necessary knowledge on computing; with part time studies being a principal means to do this

Shareware

software that is available free of charge; may be distributed for evaluation with a fee requested for additional features or a manual etc.

Simulation

the act of imitating the behavior of some situation or some process by means of something suitably analogous (especially for the purpose of study or personnel training)

Simulation, computer simulation

the technique of representing the real world by a computer program

Software

written programs or procedures or rules and associated documentation pertaining to the operation of a computer system and that are stored in read/write memory

Spreadsheet

a screen-oriented interactive program enabling a user to lay out financial data on the screen

Statistics

a mathematical science concerned with data collection, presentation, analysis, and interpretation.

Tertiary level

at the University level

Word Processor

an application that provides the user with tools needed to write and edit and format text and to send it to a printer

CHAPTER 1

Introduction

1.1 Introduction

Tillett (1970, p. 9) claimed that, for the Twentieth Century, the most prominent and important development technologically was the computer, with its effects being felt more and more in a variety of disciplines and in every part of life. This author stated that some familiarity with the basic components of computing should play a role in education as a whole. Messing (1991, p. 385) also maintained that, with the computer, the world was at the start of a significant revolution in schooling. Brownell (1972, p. 13) predicted that the computer would become as common as the car. McCrae (1979, p. 83) was confident that the keyboard and monitor were destined to be the pencil and paper of the future. Bloom (1986, p. 135) foresaw that the introduction of the computer carried with it the possibility of better classroom education. It was Bloom's experience (1986, p. 140), whilst using "suitable" software, that the computer improved the working experience of the classroom and helped develop within students a more optimistic confidence towards mathematics. This provides a sample of views from a number of authors, concerning the implementation of the computer, into education. All foreshadow a positive outlook of its role in education that was held by many knowledgeable people at the time.

Education has always been in a state of flux, and significant changes have come about recently through the comprehensive use of Information Technology (IT). The development of these changes is an interesting and important topic of study. As will be shown, this link was especially relevant to the history of mathematics education because of an early relationship between computers and mathematics. This thesis focuses on the history of computers in education in mathematics in New South Wales (NSW), Australia, over the time period 1971 to 1992. The report commences by describing the introduction of the use of technology in the teaching and learning of mathematics as a subject. It then reports on the various changes in the role of technology in the discipline until the early 1990s. The major changes in the curriculum and policies regarding education will be analysed, as well as the experiences of some of the key players in these developments, in order to identify the major factors influencing the introduction of the technology and to consider the response of teachers, other educators and the general community to these factors. There were 3 main sectors found in schooling within NSW in the studied period, and these are the Primary years (Kindergarten to Year 6), the Secondary years (Years 7 to 10), and the Senior Secondary years (Years 11 and 12). The Senior Secondary years participate in the High School Certificate (HSC), which is an examination taken in year 12 in particular for entrance into universities. The study focusses on the Senior Secondary years in the government school system, and not that of the private system.

1.2 Background and Rationale

1.2.1 Why NSW?

Tatnall and Davey (2004, pp. 83, 84), stated that Australia, in comparison to the rest of the world, "moved into educational computing … very early." These authors commented that Australia was, "well known for early adoption of new technologies" and for their quick implementation of them into education (2012, p. 243). Because of this, Australia's place as a pioneer for computers in education was established. The State of New South Wales (NSW) was chosen as the focus for the thesis for a number of reasons. Studies have been carried out on the States of Victoria (Tatnall & Davey, 2004; 2012), and Queensland (Lloyd, 2003). However, NSW deserved a study in its own right because surprisingly, such a study has never been carried out despite it. (Another reason was that NSW is my home state.)

1.2.2 Why the Particular Period?

The period 1971 to 1992 was selected for particular reasons. Before 1970, the majority of the policymakers would have found the concept of placing computers into schools and of teaching students how to use them difficult to conceptualise (Tatnall & Davey, 2012, p. 245). These authors indicate that the idea was not even considered for school education. Hence, 1971 was used as a starting point for the study because at that time the introduction of computing into mathematics education began, being trialled and examined in one of the less rigorous mathematics school subjects, namely Level III (which shall be discussed in the relevant section).

The early 1990s was selected as the end point of the study because communications technology was being taken up by society in a widespread manner. By October 1991, in Australia, around 620 000 computers were connected to the Internet (Ryan, 2010, p. 94). Over one million computers were connected by October 1992 and, by October 1993, there was over two million computers connected. The issuing of Universal Resource Locators (URLs) for websites began in 1992 through a company known as Network Solutions, from January 1993 – September 1998. Because of this development in the Internet, it seemed reasonable to conclude the study of this thesis at 1992. Eventually education could be seen to soon be affected in a large fashion as the Internet increasingly became larger and more heavily utilised.

An increasingly urgent development could also be seen in the production of two important policy documents being dated in 1992. *Priorities 1992* (NSW Department of School Education (NSW DSE), 1992(b)), and *Education 2000* (NSW DSE, 1992(a)). These two policies projected a need for the rapid implementation of computers into education. Both policies made mention of communications technology which was nominated as Priority 9 in *Priorities 1992* (NSW DSE, 1992(b), pp. 24 – 25). *Education 2000* makes a mention of Communications Technology within it in Outcome 9.03 and Outcome 9.04 (NSW DSE), 1992(a), p. 11). Hence, the increasing prominence of communications technology in society, which indicated the start of a new era in technology, marked the ending of the study as 1992.

1.2.3 Historical Research

1.2.3.1 Definition of Historical Research

Historical research has been defined as “past-oriented research which seeks to illuminate a question of current interest by an intensive study of material that already exists” (Anderson & Arsenault, 1998, p. 101). These authors argue that in historical research, the literature review is not placed in an individual, separated section on its own, and it is not separate…done away from the research; instead it is put together augmented into the data collection, analysis and write-up (1998, p. 105). Johnson and Christensen (2004, p. 294) and Anderson and Arsenault (1998, p. 103) both provided sufficient points as guidelines to doing historical research and these are combined as a guide to this study and are outlined in Section 2.3.1

1.2.3.2 The Relevance of History

One of the reasons for studying history is that it is interesting for its own sake. However, something being interesting is not a good enough reason alone to complete a thesis study on it. Studying history is important for a number of reasons. History is the study of the past, and it helps us to understand what is happening now in the present. It can also teach and prepare us for decisions to make in the future. History provides us with a sound understanding about what is happening in the present, as the past has influenced the present state in which we live (Zinn, 1970, p. 275). To study history may help one to avoid maintaining and repeating previous mistakes and difficulties. Borg and Gall (1979, p. 372) stated, studying history allows us to learn from past discoveries and mistakes. George Santayana remarked "Those who cannot remember the past are condemned to repeat it" (Gilderhus, 1987, p. 7; Kent, 1985, p. 308; Stephens, 1985, p. 323; Vaughn, 1985, p. 11).

History has played and still plays a significant role in education. Trevelyan (1985, p. 190) wrote that the true significance of history is instructive. By giving people the benefit of hindsight, history can teach people. History as a subject at school is definitely of high significance. The fact that history is studied in schools and universities shows that it is a worthwhile and important subject to learn. Rowse (1946, pp. 11, 156) mentioned: "It is evident that history is a subject of superb [and of high] educational value." Thomson (1969, pp. 5, 11) added that history gives "an opportunity of a unique intellectual experience, a rigorous form of mental training …, and a stimulus of imagination and understanding which can enrich a man's life by deeper insights into human behaviour. It is perhaps the greatest human medium of our time, educational and cultural." Vaughn (1985, p. 5) considered that it can expand ideals and self-understanding as well as a sense of who one is. Vaughn also suggests that historical information is beneficial to "mental growth and the development of perspective" (1985, p. 39).

The present and future both have their roots in history. "Everyday language is replete with references to history," maintained Chesneaux (1978, p. 10). Daniels (1972, p. 6) stated that if we neglect history we have no knowledge about ourselves or how we got to where we are. If we never look at our history, we may do so at our own detriment (Tosh, 2010, p. 36), because it is an important and relevant method to understand the present and provides us with lessons to make decisions about the future. It may help explain why things are the way that they are. History can show us the way we got to where we are, providing a means to show how we arrived to our various localities in life (Tosh, 2010, p. 29). Something that shows the importance that history plays, lies in the fact that a considerable amount has been done by countries to discover their own history. One can build up a sound sense of how our society operates through the study of the past. History helps us to examine the means of change in areas of interest to us.

Gilderhus (1987, p. 7) also perceived history as something practical. It can aid us in working out the estimated and predicted results of what one does. However this argument is refu.ted by Tosh (2010, p. 39) who believes that even within a hundred years, history will not replicate itself. Tosh also argued that this truth confines the historian's self-assurance to estimate, although confining does not mean excluding, and this estimating still can be done as long as the historian is not looking for an exact match. Prediction is not the only positive aspect to be gained through the study of history. As Perkin (1985, p. 76) claimed, history gives us self-knowledge, which could be valuable for the development of principles and ideals. Also, Zinn (1970, p. 35) stated that historical composition and writing usually has an impact on people, and Thomson (1969, p. 7) regarded history as important because it is "one of the most widespread and popular activities of educated people". History is also an important component of a culture's makeup. Tosh (2010, p. 33) noted that:

> our sense of the heights to which human beings can attain, and the depths to which they may sink, the resourcefulness they may show in a crisis, the sensitivity they can show in responding to each other's needs – all these are nourished by knowing what has been thought and done in the very different contexts of the past.

A nation that does not promote history can be negatively affected. As Tosh (2010, p. 36) claimed: "a nation that cannot face up to its past will be gravely handicapped in the future". Although this statement may seem a bit over dramatic, however, a nation that listens to its history will avoid any such predicament. History makes up one of our top significant cultural resources, because it is "a memory bank of what is unfamiliar or alien" (Tosh, 2010 p. 33). Therefore, it teaches us, and explains, the unknown past to us. As Tosh (2010) stated: "Our present is the results of the effects of history" (p. 12), and to learn more about the present, a good understanding of the past would not go awry. History tells us how we have reached where we are at the present moment.

Finally, the facts, events and the ways of thinking studied comprise history and therein, contribute value to thinking in the future. Seen in this way, viewing and considering history can be thought to be a valuable and significant subject to study. If history plays an important role in education, then it must also play a positive role in the study of computers, and the study of mathematics. Both computers and mathematics play a very important role in society and are intertwined – and they were even more so in the early 1970s. Because, as will be seen, computers can and have had a role in mathematics education not hitherto reported for the State of NSW, this history of computers in mathematics education is a worthwhile subject to document and on which to report.

1.2.4 The Relevance of Computers to Society, to Education, and to Mathematics (then and now)

James (1974, p. 85) mentioned that it is not easy to think of a field of human knowledge or activity where the capability of the computer is not perceived as useful.

Kissane (1990, p. 61) observed that the computer was capable of bringing about economic and social revolutions, having results likened to the industrial revolution of the 1900s. Mason, reflecting on computer literature, commented that originally the computer itself was not designed for the education market (Mason, 1992, p. 91). Tillett perceptively suggested (1970, p. 10) that computing was not a fad; that there would be a developing need for trained computer users and workers, and to achieve such a development one needed to educate students before they attempted tertiary studies. As can be seen, computers were relevant, and they would be seen to be more relevant to computer enthusiasts today because they have become much more common and prevalent in society today.

Patahuddin and Dole (2006, p. 400) stated that "schools must be responsive to the new demands of technology, to match the needs of learners, and to look at learning in new ways;" believing the importance of schools is due to the fact that they ".... are one of the institutions that have primary responsibility for preparing students to succeed in this increasingly complex world." This makes educating students in the use of the computer a relevant task for schools.

Computers are also relevant and important for mathematics education, for software packages are helpful in promoting mathematical understanding. Teaching with technology can be seen as one way to develop skills which are "mandatory in current mathematics curricular documents for thinking, working and reasoning mathematically" (Williams, 2006, p. 559). Mathematics and computers have a symbiotic relationship. Wilcox (1983, p. 8) maintained that for many areas of computing, mathematics is necessary and significant, being able to make various computing jobs simpler. Kelman et al. (1983, p. 1) considered computers as being most suitable for completing, understanding, and educating in mathematics, mainly because computers were made to complete mathematical jobs and are basically mathematical machines. "Sophisticated software packages such as Computer Algebra System (CAS) are playing a growing part in the professional practice of mathematicians and also for statisticians, engineers and scientists" (Coupland & Crawford, 2006, p. 155).

Using a software package such as CAS can provide teachers with a number of suitable examples which, when given careful consideration to the correct results, can “allow students to recognise patterns and develop algebraic insight” (Pierce, Herbert, & Giri, 2004, p. 463). Mathematical tasks that were demanding and time consuming were found to be completed by students efficiently through the use of CAS, and in this use teachers’ found CAS to be a supportive colleague and an autonomous mediator (Pierce, Herbert, & Giri, 2004, p. 463).

Wilcox (1983, p. 9) mentioned that mathematics and computing can support each other and, if the two are not combined, this would lead to the loss of the mathematical education of the student involved. Zevenbergen and Lerman (2006, p. 591) suggested that within the setting of mathematical education there is a broad development of recognition as to the strength of technology to back up numeracy education. Programming, is a topic used in computing (more definitely in the early 1970s to the early 1980s), can be seen as an intrinsic and basic mathematical task (Kelman et al., 1983, p. 27). One reason being that programming consists mostly of problem solving, and problem solving is a fundamental task of mathematics. For example, FORTRAN (one of the first programming languages used) is a language that is very well related to problems of a mathematical nature (Tillett, 1970, p. 13). Another language was BASIC, and to use BASIC, Wilcox has said (1983, p. 7), one must know at least some mathematical concepts, because using this language enables one to reinforce those concepts. Hence programming was, in the first stages of computing, mathematical.

Geiger (2006, p. 246) mentions other authors (Asp, Dowsey, & Stacey, 1993; Templer, Klug & Gould, 1998) who have argued that META (mathematically enabled technologies and applications) allow students the freedom to explore new ideas and concepts. Wesley (1988, p. 120) maintained that highly motivating problems and questions can be created by the computer in an endless supply because of the capability of the computer to generate and operate random numbers, which permit the production of an infinite number of examples. In mathematics education, for all year levels, there has been “many ways in which technologies have been documented so as to show their potential in enhancing learning” (Zevenbergen & Lerman, 2006, p. 592).

Wharton (1989, p. 107) concluded that from the late 70s, the computer had been observed to naturally support the mathematics curriculum. Spreadsheets, a mathematical tool, allow for the study and examination of “relationships without tedious calculations, and present opportunities for the development of self-directed learning and the acquisition of higher order skills such as analysing, interpreting, critical thinking, and question posing” (Williams, 2006, p. 559). Williams also found that whilst using spreadsheets, educators discovered that the activities motivated students to pick up concepts quickly, finding these activities pleasant and relaxing (2006, p. 562). For mathematical learning, in particular numeracy, it has been found that there was a comprehensive acceptance of the ability of technology to support its teaching (Zevenbergen & Lerman, 2006, p. 591).

In those early days there was great anticipation among educational researchers when debating the ability of computer technology to enhance mathematical teaching and learning (Norton & Cooper, 2001, p. 386). “Curriculum policy writers and mathematics education researchers,” backed the potential of the computer in helping students to learn mathematics (Vale, 2001, p. 491). Using computers in mathematical learning helps to create better attitudes towards mathematics, according to Vale, and the views of many teachers were that, “digital technology could facilitate routine processes and accentuate features of mathematics, enabling students to receive dynamic feedback, study real life applications and make links between numeric, graphic and algebraic representations” (Vale, 2006, p. 512). Finally, the Internet is a fairly recent invention, and its use can affect the student’s education in a definite way (Patahuddin & Dole, 2006, p. 405). As seen above, computers hold an important place in the field of mathematics education, from their initial use in mathematics education until today. How education has fared throughout the history of this aspect of mathematics education is of relevance to this thesis.

This study will explain how computers became embedded in mathematics education in NSW during the first twenty or so years of their 'marriage'. The study is significant in understanding more about the role of computers in mathematics education in the past. It will allow those interested to view the goals, achievements, problems and outlooks on this subject. Readers will be able to learn how the NSW Government became involved, and if it was effective or not in its involvement, particularly with its effectiveness with regards to mathematics education.

1.3 Research Questions

The key questions guiding this study are:

1: What were the major stages of development in the use of computers in mathematics in New South Wales in the period from 1971 to 1992?

2: What were the major themes in the developments regarding computers in that period?

1.4 Significance of the Study

This study examines computers in NSW mathematics education over a 20 year period. This is a relevant aspect of the history of mathematics education (although mainly for secondary schools) for that timeframe. It shows the relevance that mathematics has had with computers, and discusses the beginnings of the computer in Primary schools. It is important to see where computers had their beginnings. This study looks at the computers' initial input into education, and how its mathematical aspects changed from the 1970s to the 1990s. Those who need to understand the history of computing will find this study useful. The seven themes studied overall show several aspects relevant to the history of computing. The fact that there are several themes shows that this history is rather complex and not as simple as one might assume. They were discovered when carrying out this research, and were not the production of any author or interviewee.

Another factor related to the significance of a research topic concerns its originality. Arguments for originality can be sustained even if another researcher uses the same set of data. This view is supported by the belief that more than one historian examining the same set of data rarely think the same about the same topic (Storey, 2009, p. 3). This view is also suggested by the way that individuals think and act differently, also through the process of interpreting data and thinking through the data because it is more than likely that the various interpreters, will have new and various ways of representing the data, even if some of the conclusions they arrive at are similar. As Corbin and Strauss (2007, p. 50) state, Different researchers will concentrate on various portions of the data; and data speaks to each researcher through various means.

As mentioned earlier, no study has been carried out on the history of computers in mathematics education in NSW. Tatnall and Davey studied Victoria's implementation of computers into schools and completed several studies of computers in Victoria. Tatnall and Jenner (1986) examined States policies in Australia. This information was of help to this thesis. Lloyd (2003) also studied the history of computers in Queensland, but that thesis had a very different methodology, and consisted of a different time frame (1983 to 1997). Although a section of the considered time frame is of relevance, the information was considered as very specific to Queensland. Lloyd, Tatnall and Davey are all professors at leading universities and still study aspects of computers in education. Their studies contain much information of relevance to their respective States, with some information also of relevance to NSW. However a study focussing and concentrating solely on NSW has not yet been carried out. Hence it is believed that this study is original, and is necessary. In the process of completing this study, a considerable amount of information was found, both through the literature and through the interviews.

1.5 Ethical Considerations

Participation was voluntary and participants were able to withdraw at any time. The participants included professors, teachers, and other relevant people who were interviewed. In these interviews, it was emphasised that there is no right or wrong answer; true opinions were sought. Rights are an important issue in any study, so the rights of the particular interviewees were deliberated on consistently and sufficiently. Initially, privacy was the main topic of conversation – apart from their respective relevance to the study at hand. The privacy of all of the participants was maintained. Individual‘s names were changed and pseudonyms used.

1.6 Summary of Chapter 1

Chapter 1 has introduced the reader to the thesis topic. It has explained a number of issues that are examined in the thesis – all of which revolved around computers in mathematics education in NSW schools. It has explained why NSW in particular was studied, as well as why the particular time period (early 1970s to early 1990s) was chosen. History was seen to be an important part of learning about one’s own culture. It was seen to be unique to society, to one’s own background and time period, not being repeatable. It was perceived to be an important part in education as well. Computers were also observed to be of great relevance to society, in the past and more so today. Because of this relevance, they were eventually seen to be relevant to education – to succeed in the modern world students would need to be proficient at using computers. Computers were also argued to be relevant to mathematics education, having been adopted by mathematics educators soon after their first appearance on the business schene. Undoubtedly they were useful in a number of mathematical tasks and in problem solving. A range of computer uses have been summarised and examined in this chapter. This was done in order to establish the relevance and role of computers in NSW mathematics education.

1.7 Structure of the Thesis

This thesis consists of four chapters. The second chapter consists of the Research Methodology comprising of information about the historical method and the grounded theory paradigm used in constructing the research approach and, in particular, details about the information found and gathered in the third chapter. Hence the sources of data, the procedures and methods used (historical research and grounded theory) which identified three phases and several themes in answer to the research questions, are discussed there. The three phases and several themes found are described in chapter 3, the Analysis chapter. This chapter, describes the data analysis derived from examining both the literature reviewed and the interviewee information collected throughout the course of the study. These two sets of information mutually contributed, each being carried out intermittently and supportively. Finally, Chapter Four concludes the thesis by answering the research questions; describing the limitations of the study and making several suggestions for further research.

Chapter 2

Research Methodology

2.1 Introduction

The methodology adopted in this study was informed by two traditions of research in education. The first can be classified as an historical research approach, as described by Johnson and Christensen (2004). The second as a qualitative approach using grounded theory methods described by both Charmaz (2006) and Corbin and Strauss (2007). The historical traditions will be considered first, and then the grounded theory tradition.

2.1.1 Historical Research

Historians are interested in knowing what happened in the past. But also in knowing "why" those happenings were significant, and why there is a sustained interest in discussing them (Marius & Page, 2010, p. 2). Historical writing involves more than simply collecting details and information about what happened. Historians make conclusions through interpreting facts (Storey, 2009, p. 54). The historian chooses the best and most dependable and edifying pieces of data (the facts), and develops and applies these bits of information in order to create explanations (p. 54). Tosh (2010, p. 89) claims that for most historians, library archives are the locations where the investigations take place, and that archives are probably the most vital sources for a study of the past (p. 90). As this study also included the examination of opinions through the conducting of interviews, the data did not rely entirely on historical facts. The integrity of the interviewees was assumed.

Storey (2009, p. 63) believes that in historical research, "the arguments of primary sources and secondary works" should be reflected upon, "then (the researcher should) engage them constructively and responsibly". In this thesis however, although published literature and policy documents will be one source of data, interviews with key players in the introduction and use of computers in mathematics education in New South Wales (NSW) will also be included as an important source. The reason for this is that one of the aspects of historical research involves the scholar discussing the reasons for the current state of affairs, or for current problems and difficulties, with people directly involved in those affairs. Marius and Page (2010, p. 4) considers that the historical researcher will therefore use evidence gathered from the recollections of the people that were present at the time.

Interviews are important because it is a characteristic of historical research that one is not able to place a past situation or event into a laboratory setting, so enabling it to be repeated over and over as one would perform, for example, an experiment in chemistry in order to accurately view causality associations and connections (Marius & Page, 2010, p. 4). Part of the role of the historical researcher is to engage an interviewee's thought processes – as one who has experienced an event – in order to ponder events in a similar manner (p. 6). These authors describe the study of history as an endless investigative report, where the researcher attempts to explain problems regarding the facts and data and convey a most likely account of what actually happened. Such investigative accounts occur when the historian develops "connections, assigns causes, traces defects, makes comparisons, uncovers patterns, locates dead ends, and finds influences that continue through the generations until the present" (p. 7). Johnson and Christensen quote Berg (1988) regarding the recording of an historical account:

> Historical research is interpretative. Its presentation is much more than the mere retelling of past facts. Instead it is a flowing, fluid, dynamic account of past events that attempts to capture the complex nuances, individual personalities, and ideas that influenced the events being investigated (2004, p. 392).

This does not mean that the historical researcher does not use incidents, facts, dates, and figures. Rather, the historical researcher uses this type of information but also attempts to reconstruct and present the facts and figures in a way that communicates an understanding of the events from the multiple points of view of those who participated in them. Interviews were used to get the opinions of relevant knowledgeable participants in education in the time period studied. Hence, since opinion gathered through interviews was used as data in this study, the data did not rely entirely on facts, but also of opinions.

2.1.2 Grounded Theory

This thesis uses a qualitative approach using grounded theory methods, as discussed in Charmaz (2006) and Corbin and Strauss (2007). The main reason for grounded theory was because of the positive results that it can achieve: namely, it:

- can be an aid to the researcher in making the study increasingly discerning and perceptive;
- enable researchers to guide, oversee, and make their data gathering more efficient; and,
- allow the researcher to create an innovative study of the collected data. (Charmaz, 2006, pp. xii, 2).

Like Charmaz (2006, p. xii), it is also maintained that, to be a grounded theorist, one must begin by using the “data” (Charmaz, 2006, p. 3). Charmaz believes that all the lessons obtained from “the research setting(s),” or concerning a studied subject, can be used “as data” (p. 16). The data is built from the various items that the researcher collects about the subject at hand, and can include interpretations, relationships, opinions as well as facts. For the grounded theorist, the data is fundamental to all that one does. One of the benefits of using this approach is that researchers can add to their data bank as they collect, and this can occur at any time during the study, allowing for mobility to follow leads as they emerge. It has been suggested that this “analytic process, like any thinking process, should be relaxed, flexible, and driven by insight gained through interaction with data” (Corbin & Straus, 2007, p. 12).The aim of this thesis was to learn without really entertaining any previous assumptions on the matter at hand; initial assumptions were to be malleable and added or removed as differing evidence was collected. As Charmaz (2006, p. 15) believes, a researcher improves the data, moulding and remoulding the assembled data through implementing the procedures of grounded theory.

2.2 Procedures

The two main sources of data in this study, therefore, documents published in the period under examination, and interviews with a number of key personnel. This section includes discussions of the procedures used in conducting the literature search. It also describes the processes involved in identifying the interviewee sample. The literature examined consisted of published works and policy documents published in the relevant time period. The resources at several libraries were most helpful: For example, the library at the Board of Studies in Sydney and the Fisher Library in Sydney University. At the former, I examined relevant documents such as the "Additions to Syllabus for Higher School Certificate Mathematics, Level III" and the "Memorandum to High School Principals" by the Board of Senior School Studies (1970 (a) and (b), p. 1). Additionally, I studied past examination papers for Level III[1] examinations to determine assessment procedures over a number of years. These past papers were from 1972, indicating that programming was used exclusively in the Level III mathematics subject at that time. I also studied relevant mathematics education conference proceedings held during that period. Highly productive sources were documents from the *NSW Computer Education Group.*

The materials and the information that were used in this study – materials gained from the literature; interview transcripts; policy documents and archival materials – were all considered to constitute data. The majority of data was put together into the information presented in the Analysis chapter. The data gathering consisted of collecting relevant information in a meaningful manner. This process provided enough information for further data to be collected by more acutely perceptive means (Corbin & Strauss, 2007, p. 57) in the hope that saturation would eventually be achieved. These authors (p. 58) also claim that in order to prevent the collection of excessive data from overwhelming the researcher, they have to go back and forth from data collecting to analysis. This process allows the researcher to anticipate what to look for next early on in the research. Some of the benefits of starting and

[1] Level III was the lowest level of mathematics that was studied at that time. It was the first level of mathematics to implement programming into its syllabus.

continuing the analysis during the data collection have been given by Corbin and Strauss (2007, p. 58):

- it facilitates a feel of "direction";
- it encourages increasing understanding of the data; and
- it provides the analyst with the ability to reroute and modify interview questions or observations as he/she continues with the data collection and analysis.

I interviewed six people face to face and two others by email. The first interviewees were recruited through contact with the Board of Studies and the NSW Department of Education (NSW Dept. Ed.)[2]. This resulted in the recruitment of further interviewees through the suggestion of others who might be suitable and prepared to respond to a questionnaire. All persons selected were involved with computers in NSW mathematics education during the relevant years. The majority of these interviewees had been mathematics teachers at some stage during the prescribed time, while two were members of the NSW Department of Education's Computer Education Unit (CEU) in the early 1980s and had some involvement in related policy matters.

2.3 Methods

This section addresses three topics: first, my approach involving the records or documents examined; second, details of the interviewees and my audit of the interview material collected and finally, my process of applying data analysis to developing theory.

2.3.1 Examination of Records/Documents

According to Handlin (1979, p. 408), every one of the functions of history are ultimately reliant on the veracity of the literature. This was foremost as I conducted the review prior to, and throughout the study. The importance of document analysis was emphasized by Atkinson and Coffey (2004) who have suggested that studies that do not include an examination of written documents and other documented works,

[2] Now known as the Department of Education and Communities.

would not "always do justice to the settings they purport to describe, and it is necessary to redress the balance if only for the sake of completeness and fidelity to the settings of social research" (p. 56). They also suggest that the use of documents in a study has the potential to be the foremost enterprise of "qualitative research in its own right" (p. 58), and that the literature ought to be looked upon as "data in their own right" (p. 59). Thus document analysis was one of the major data gathering devices used in this study.

Both primary and secondary document sources were perused. McCulloch and Richardson (2000, p. 117) assert that the emphasis of historical research has been on "policy, administration and institutions". The primary sources used consisted of relevant policy reports available at public and university libraries. Such documents are extensively used for most historical studies (McCulloch & Richardson, 2000, p. 88). The same authors propose that the foremost sources of data on education policy and administration are the public records offices (p. 102). Government documents created by political parties supply a regular report on policies and politics (Seldon, 1988, p. 48). The information derived from these sources constituted an important part of this study as they highlighted key moments in the history of technology that caused computer education to be developed in NSW.

Howell and Prevenier (2001, p. 34) and Tosh (2010, p. 89) consider that the library archive is the historian's prime provider of data; historians shift from one archival record to another to obtain the facts for their research (pp. 81 – 82). Johnson and Christensen (2004, p. 394) concur with this approach to deal with data. This particular method of conducting historical research involves going to and fro from perusing the literature and then composing the materials – that is, writing up the information they unearth (Carr, p. 394). After perusing a number of primary sources, the researcher goes back (while still composing) to the sources, and obtains further material to add. The note-taking guides the examination due to the fact that the more one records, the greater the amount of knowledge the author gains on what he/she is seeking "and what needs to be read" (Carr, pp. 392 – 394). There is a difference between this approach and the one adopted for use in this thesis in that I have also included interviews, so there was a movement to and fro between document analysis, interviewing and composing, as the data guided the exploration.

Johnson and Christensen (2004, p. 294) and Anderson and Arsenault (1998, p. 103) have indicated that generally, the following guidelines are observed by the historical researcher, namely:

- Preliminary determination that there is enough data available.
- Description of the total data needed to address the problem or research questions sufficiently.
- Identification of the research topic and formulation of the research problem or question(s).
- Data collection or literature review, through:

(a) consideration of known data;

(b) seeking known data from primary and secondary sources;

(c) seeking new and previously unknown data.

- Evaluation of materials.
- Data synthesis.
- Report preparation or preparation of the narrative exposition
- Interaction of writing and additional data search and examination.
- Accomplishment of deductive and interpretative stage.

The relationship between historical research and writing/recording has been described by Marius and Page (2010, p. 5) as united and indivisible. In this thesis, I attempted to construct the writing "along analytical lines," making use of "short narratives" (and depending on the situation and the need, sometimes long narratives were used) to show various "points of analysis" (Storey, 2009, p. 89). The composition of the thesis was carried out in a narrative style, defined by Denzin and Lincoln (2005, p. 652) to be something that is either:

> Oral or written and may be elicited or heard during fieldwork; an interview, or a naturally occurring conversation. In any of these situations, a narrative

> may be (i) a short topical story about a particular event and particular characters such as an encounter with a friend, boss, or doctor; (ii) an extended story about a significant aspect of one's life such as schooling, work, marriage, divorce, childbirth, an illness, a trauma, or participation in a war or social movement; or (iii) a narrative of one's entire life, from birth to the present.

Storey (2009, p. 54, 62) mentions that interpretations should be made from the data gathered as this is one of the ways that the historian finds to create an innovative statement, thus gaining originality, even with "old" issues. Storey (2009, p. 63) explains that minute explanations and understandings have to be developed into bigger opinions which then have to be developed convincingly (p. 63). The conclusions will be based on what is found in the data while the analysis is being carried out. Data was obtained from interviews, hence opinions were obtained and used as useful information, making the data not rely totally on historical facts.

2.3.2 The Interviews

Interviews used a semi-structured proforma to guide the process (Appendix B, p. 163). Patton (2002, pp. 342 – 343), states that such an aid catalogues the respective enquiries or topics that are to be addressed throughout the progression of the interview. The guide serves as a map for the researcher, so ensuring that all of the significant points to raise and subjects to discuss with the interviewees are dealt with. I followed this self-written guide, however there were allowances for extra pursuits, for example, a topic was raised that came unexpectedly (yet was relevant), then I was free to follow-up that topic and gain any related information. Questions were focused on finding out information directly related to the topic of the thesis, and a professional relationship was maintained with all interviewees. I attempted to maintain a sense of informality in order to ensure that the respondent was at ease while at the same time I maintained a professional approach to the interview.

The interviews were "intensive and semi-structured" (Charmaz, 2006, pp. 25 – 34). Such a data-gathering approach is considered by Charmaz to involve "directed conversations" (p. 25), and an intensive interview is considered to be a good means for a detailed and in-depth investigation of the material of interest. I undertook such in-depth interview explorations with several interviewees in order to fill in gaps in my data that had been collected through document analysis. Opinions were gathered through this interview process, and as such, the study contains opinions and not just historical facts. As the interviewer, I made a positive attempt to be willing to hear, to watch with consideration, be responsive, and to support the interviewee to reply and answer, which had the effect of making the interviewee the predominant speaker (pp. 25, 26).

Data collection involved an initial examination of the literature. This guided the development of the first set of interview questions in order to confirm findings and gain extra information where the data appeared to be lacking, vague or confusing (Corbin and Strauss, 2007, p. 38). After the interviews were completed, the interview voice files were then transcribed into text. This comprised the data. The literature provided the information which guided the formation of the initial questions for the interviews. These questions allowed for new material and new questions to be gathered and used to help in the pursuit of new searches of the literature and for use with the interviewees. When a discrepancy occurred between the literature and an interviewee's responses, the problem was studied to explain the difference and seek the truth, possibly with follow-up questions with the interviewee. Discoveries in the data were used to improve the analysis.

Charmaz (2006, p. 27) believes that there are a number of details that an interviewer should share with an interviewee in order to ensure a successful session. I concentrated on encouraging the respondents to:

- Tell their stories just as they recalled them, to produce a coherent frame
- Contemplate on past occurrences in their lifetimes
- Decide what to disclose and in what way to disclose it
- Share significant experiences and assist me in interpreting them
- Express thoughts and feelings disallowed in other relationships and settings.

In the interviews, a digital note taker was used, and there were paper and pen on hand to take down notes when necessary. However, finding that taking notes was too distracting, I wrote down any relevant questions that came to mind to ask later. Freed from note taking, and knowing that the interview was being recorded and could be transcribed later, I was able to follow relevant leads (Charmaz, 2006, p. 32). I commenced the interview with a number of general, open-ended questions and attempted to examine details in depth through more focused questions later.

The approach began with a loose exploration of the topic then concluded with semi-structured focused questions. As my gathered knowledge increased, the questions became more specific in order to obtain responses that would answer gaps in the data; moving from the literature to interviews to data, to further interviews, literature and data. According to Charmaz (2006, p. 32), intensive interviewing is a method whereby concepts and subjects develop whilst undertaking the interview; however these ideas and leads can be immediately followed up through the use of this type of interviewing (p. 29). This is what occurred in the present study. As soon as I discovered what knowledge the interviewee possessed, I compared it to what was needed to be known. I adjusted my questions, creating new ones on the spot to cater for the gaps in knowledge that needed to be filled. This helped to achieve a deeper level of understanding: The questions would move from the "general" to the more "specific" as further specific information was sought and obtained.

2.3.3 The Interviewees

The first interviewees were nominated by the NSW Department of Education and Training (now called the Department of Education and Communities), where the Curriculum and Learning Innovation Centre (CLIC) provided the initial contacts. I also contacted the Mathematical Association of New South Wales from where I obtained further nominations. These initial contacts provided me with names and addresses for additional interviewees, and information about each person appears below. All interviewees had mathematics education backgrounds and had direct experience with the use of computers in the period under examination:

Interviewee 1 commenced teaching in 1979 and taught an ‘Other Approved Studies’ option for Year 11 in Computing, with the content of the course consisting mostly of programming. The interviewee was teaching or involved in the support of teachers’ use of ICT (Information and Communications Technology) during that time.

Interviewee 2 began teaching in 1978 and in 1980 was working as a Head of Mathematics at a boys High School. In 1983 the interviewee became Principal at a new school, and in 1984 set up the school’s first computer room.

Interviewee 3 taught a programming unit in 1971. The interviewee became a member of the NSW Computer Education Unit (CEU) when it first started in 1983. The CEU was a governing body that implemented policy on matters of computers in education.

Interviewee 4 commenced teaching in 1980. The interviewee first used Apple Mac computers in the mid-1980s at a senior High School. The interviewee taught the subject *Maths in Society* when it first became available.

Interviewee 5 attended one of the earliest in-service courses on FORTRAN programming in 1971, and the interviewee taught FORTRAN programming as soon as it became available in the NSW Level III High School Mathematics syllabus. The interviewee also taught programming in the 2 Unit A subject. The interviewee developed and conducted around 43 in-service courses (as a lecturer) in BASIC programming from 1979 to 1988.

Interviewee 6 had conducted considerable professional development work in schools (as a tutor), mainly linked to the use of computers and calculators. The interviewee was one of the pioneers of using technology in the teaching and learning of mathematics, especially secondary calculus.

Interviewee 7 taught mathematics in high schools from 1976 to 1987 and was also experienced in programming. This interviewee was the President of the Mathematical Association of New South Wales (MANSW).

Interviewee 8 first used a computational device in schools in 1971 teaching programming to more able students. This interviewee became NSW's first State computer education consultant (as a member of the Education Department). The interviewee was also a member of the Computer Education Unit (CEU) when it was first formed.

2.3.4 Instrumentation

Regarding the interview Guide, I discussed a number of key issues in the several interviews that I conducted. First, I requested some biographical details of the interviewees, and then details such as their experience with computers. I also sought details about the policies of the era and about any problems or issues that they may have encountered. Other questions I asked related to:

- the benefits of using computers,
- how computer usage developed in NSW schools,
- how changes to computer policy were introduced,
- features of the advent of programming in NSW, when it was introduced, how it was used and the major programming languages taught.

The earliest types of computers were discussed, and issues such as professional development provisions and the role of related government bodies were addressed. Finally, the interviewees views on the relation that mathematics had with computers was sought along with their recollections of the change in focus of mathematics and computers from the early 70s towards the early 80s, and then from the 80s to the early 90s. Specific questions were addressed to appropriate interviewees about the Computer Education Unit and the Computer Education Group, along with their recollections concerning the *Mathematics Level III, 2 Unit A* and *Mathematics in Society* courses.

2.3.5 Data Analysis Procedures

This section reflects first on the meaning of analysis and also considers the steps in conducting sound data analysis. Following this, the meaning of 'qualitative analysis' will be described, explaining what the concept means for the research conducted in this study.

This research attempted to relate a description of events that happened and also to theorise about those events. This was because historical research tends to state what occurred, state current trends, and then attempt to explain relationships between the two. Corbin and Strauss (2007, p. 55) are of the view that creating theory is an action that can be intricate. Theory represents a group of established categories (themes or concepts) (p. 55). In this thesis theory is demonstrated through organisation of major concepts (themes), and in explaining and discussing them. Corbin and Strauss (2007) claim that these concepts (themes) are "systematically interrelated through statements of relationship" (p. 55) in order to explain some situations and examples through the development of a theoretical framework. Charmaz's description is apt: A category explains concepts, incidents, or developments within the collection of data (2006, p. 91). Corbin and Strauss (2007, p. 55), maintain that theory development continues to be pertinent for research and should be accepted and believed as such. Developing theory consists of more than just summarizing raw data into categories, it also consists of developing these categories (themes, concepts) and putting them into a rational, organized illuminating outline (p. 55). Charmaz explains how to develop theories 'grounded' in the data themselves. The tools of grounded theory are made up of organized yet malleable procedures for accumulating and examining qualitative data (p. 2). And, as noted earlier, the data plays a central role in the researcher's analysis. What one gathers from the data stimulates our concepts and is the basis of analysis. A sensible way to express it is as follows: the collected data makes up the basis of our idea and beliefs, and the perceptions we make are formed from our investigations (p. 2).

Analysis is important in the processing of data. Knowing that methods alone do not necessarily create good historical research, special attention was paid to create sound analysis. Charmaz (2006, p. 17) states that through scrutinising the collected information (the "data") and inspecting our thinking through study at sequential stages, we create precise, detailed insights. Two factors involved in analysis specifically described by Corbin and Strauss (2007, p. 64) involve:

- breaking the data up; and

- developing concepts from the data.

These factors were guidelines to the overall analysis followed.

As suggested earlier, analysis of qualitative data attempts to identify concepts. Concepts (themes) are described by Corbin and Strauss as developing the foundations of “analysis” (p. 51). The initial stage of analysis is to develop concepts via the initial findings of the research (p. 57). The initial piece of data is important in that it provides a basis for developing concepts and also provides a clue as to what further questions to ask. Analysis is defined as a way of studying an object with the aim to discover “what it is and how it works” (p. 46). Analysis is also defined by Corbin and Strauss (2007, p. 57) as a development that grows through time and through the build-up of information; to be a means of producing, creating, and proving concepts. Analysis is then explained by these authors to be the undertaking of supplying a “meaning to data” (p. 64). Every process of collecting data allows for concepts to be contrasted so that new elements may be added to the already collected concepts or by the addition of innovative ideas to the already growing record (p. 57). Analysis is explained by these authors through the use of the term of “coding” (p. 66), an explanation of which follows.

Qualitative coding can be defined as sorting portions of information (“data”) under a title that concurrently abridges and provides explanations for all of these bits of information (Charmaz, 2006, p. 43). Coding takes raw data and develops it to a conceptual point. It is the act of obtaining and evoking ideas from this data (Corbin & Strauss, 2007, pp. 65 – 66). They also state that “coding” is the doing word, the “verb,” and that “codes” are the titles, the “names” which are assigned to the ideas obtained via this action, via this coding. Concepts are described to be worked out from the data, and the use of these concepts then gives a means of classifying and sorting the data (p. 51).

As I collected my data, I examined it and started to divide, organize, and combine it through qualitative coding (Charmaz, 2006, p. 3). Having each main idea under a conceptual heading helped in organising my thoughts and was the means to acquire the best from the data through refining it, categorising it, and enhancing my perception to grasp developing relationships with other groups of data. Charmaz (2006, p. 45) states that in order to start an analytic accounting of these relationships, what we code is displayed in the ways we choose, divide and arrange data. Charmaz (2006, p. 3) also explains that through the creation of, as well as the coding of, many differing components of the data, our methodical understanding of the information collected starts to develop. A relevant concept here is "In-vivo coding," which is where the analyst builds "concepts" using the words of the data as well as of the interviewees instead of the researcher using his/her own words (Corbin & Strauss, 2007, pp. 65, 82). In-vivo codes were used several times in this phase of the current study, such as with the conceptual heading of 'programming,' which came from the literature itself. Corbin and Strauss state that the concepts (themes) that are used are obtained from the data (2007, p. 51). The data plays an important role here, as it indicates to the researcher what is fact or fiction, and what is important and what is not. The concepts/themes that are collected illustrate the researcher's "impressionistic" perceptions of what is being portrayed by the interviewees (p. 51). It allows for a categorising and arranging of the information (2007, p. 51). It allows for a level of organisation and understanding that would not be possible without it. In this study, coding began while interviews were in progress.

Themes were found through the analysis of the continuing gathering of the data. Initial data collecting was obtained through talking to interviewees, and through looking up the concepts of the computer in education for as early as possible. It soon became clear as to what themes were important and what were not. For example, programming was shown to be implemented in certain school subjects at first. So the concept of programming, and the concept of school subjects became apparent as one of the important themes in this thesis. This continued until all of the themes were discovered, as they were limited in detail and in scope.

2.4 Quality of Data

The concept of validity is important to historical and qualitative research. There are several issues involved in establishing the validity of a study, the first of which is bias.

Bias can be due to either known or unknown prejudice or unfair attitudes. Gilderhus (1987, p. 90) suggests that a person undertaking a study should come to an evaluation in consequence to seeking for indications of bias. There is also the case when material can be purposely and intentionally omitted from the evidence produced, thus influencing what may or may not be important. The second issue is what the historian brings to the study as an individual. An historian has knowledge which is not based on the sources, which is the broad common understanding of the topic under discussion that they have prior to undertaking the research (Topolski, 1976, p. 219). This "non-source based knowledge" can be the cause behind a historian's own prejudices or biases.

The different "levels of sources" refer to how reliable an evidential source is, from those ranging from Primary to Secondary sources. A Primary non-human source is one which is recorded straight after the event and hence is more reliable than the Secondary source, which is recorded sometime after the event. The interviews conducted are considered to be Secondary sources since they were conducted over 20 years after the considered events. Although reliable, they are not as reliable as they would have been had they been conducted immediately during the period 1971 to 1992. The interviews are still reliable, however, as they present the views of experts in the field. "Scope of sources" refers to the types of sources available, such as persons, books, journals, internet websites and magazine articles. Depending on the "credibility of the authors", scope of sources can reveal relevant and reliable, or not so reliable, information.

The materials used, such as books and journals, were written by authors knowledgeable of the field, meaning that in the majority of cases, the credibility of the authors was intact. They were usually written for the advancement of knowledge in the use of computers, and hence have reliable intentions. Bias is always possible, and sometimes came across when authors were either too critical or too praising of the computer, but most of the time the consistency in reliability was there. Some of the journals contained advertisements of computers or software, but that didn't seem to change the content of the articles within them. Sometimes the authors wrote as presenters of facts or of opinions, but it always appeared clear as to which was being presented.

Finally there is the "credibility of publishers" that needs to be examined when reading information. For example, books published by Universities are usually more reliable than books published by commercial presses, as they usually are "reviewed by experts before publication" (Glenn & Gray, 2013, p. 202); whereas books published by commercial presses do not partake of the same level of examination. Likewise, journals that are comprised of scholarly articles are considered more reliable than magazines comprised of articles catered to a general audience. This is what this study consisted of. Apart from the interviews, there was a study of mostly books and journals printed by educational facilities with a scholarly audience in mind.

The potential for bias was something that I was conscious of and was not overlooked. It is necessary for a historical researcher to admit to bias or prejudice. As Topolski stated, the task of discussing the past will be coloured by one's current standards (1976, p. 129): "interpretation" is everything, "facts are nothing" (p. 148). Personally, I had no previous experience in teaching computers during that studied time period, therefore my interest in this subject has been, and continues to be, totally academic, as I held as malleable any preconceived ideas on the subject. This appears to be the best way at acquiring the information through research because it is a serviceable contrast to forcing one's own ideas on the evidence.

"Objectivity in qualitative research is a myth" (Corbin & Strauss, 2007, p. 32). We take into our analysis some form of bias. It is my belief that the negative effects of bias can be controlled and overcome. The main method used in an attempt to avoid bias was receptive to the ideas presented by the data, and to avoid letting present or pre-existing ideas dictate what was accepted as knowledge. One reason, according to these authors, is that, "background, knowledge, and experience" all support us to increase in consideration and responsiveness to ideas in the data (p. 34). That is because a researcher's previous experience is important in order to distinguish relationships between these ideas. It is placed upon oneself (as the researcher), to not let any errors in analysis to occur in their work (p. 34). As described later in Section 2.4.5 in this chapter, colleagues played a major role in assisting me avoid this problem.

Further to the discussion of bias, Charmaz (2006, p. 10) states that the researcher cannot present a precise replica of the researched area, but only a theoretical portrayal that gives an interpretative representation; our beliefs, and attitudes all affect the final narrative of the research. It is normal for researchers, in their studies, to extract from their own, individual gathered information (Corbin & Strauss, 2007, pp. 32 – 33). This is definitely not the same as imposing one's own conceptions and thoughts onto the data, rather it is the understanding that our own individualities (one's prior circumstances and previous knowledge and familiarity) provide us with the rational ability to react to and accept that which is found in the data while at the same time perceiving that what we find is an outcome of the data and what the scholar should take to the research (p. 32). Here, one's individual understandings can enhance what we find in the data. Ignoring one's own influence on the findings can actually worsen the effect: The further we are mindful of our influence – of our own personal interpretation – the more possible we can perceive our own effects on the analysis (p. 33). Charmaz (2006, p. 16) explains that the researcher's, "background assumptions and disciplinary perspectives" give them signals as to what to search for in the data. "Background, knowledge, and experience" assist the researcher to be increasingly perceptive to ideas in the data (p. 34). This background, knowledge, and experience, provides the ability to perceive associations among ideas (p. 34). The researcher influences the research, but if he/she keeps this in mind, mistakes of bias will hopefully be avoided. Seldon (1988, p. 46) suggests that the historian use his/her own decisions when deciding the amount of credence to give to a usable text. I adopted this approach in this study.

2.4.1 Qualitative criteria

The aim of this thesis is not only to record historical facts and opinions, but also to follow the advice of Tosh (2010, p. 2) and to produce a correct narrative. Efforts at studying history are to acquire the events behind the studied era; to tell it as truthfully as possible; to procure the facts and to relay them in an appropriate manner. With interviews, the information obtained was some of the most important gathered, since it was hard to find the relevant materials in books alone. Guba and Lincoln (1989) describe the following four quality criteria required for qualitative research to be valid and effective. All four were addressed in this study and explained below.

2.4.2 Progressive subjectivity

As a researcher I needed to monitor interviewees' performances, attitudes and responses to the questions I asked along with my own knowledge, beliefs and constructions as the research unfolded. These constructions were discussed with my cooperative colleagues in debriefing sessions. Debriefing was important in challenging observations and interpretations and to stay focused, objective and impartial in my response to events.

2.4.3 Member Checks

If any inconsistency arose among my interpretations, or questions were raised following the interviews, an email or phone call was made to the respective interviewees to confirm their response or to clarify the information they had provided.

Several of the participants who were interviewed in this study were able to discuss further, elaborate on and verify a number of the issues that I introduced via email. These people considered the questions that I asked and answered them seriously during the data collection, during the analysis stage and also the member check stage. Group discussions were not used, as group discussions were not feasible due to the widely different locations of the interviewees.

2.4.4 Prolonged Engagement

Prolonged engagement can be defined as the spending of sufficient time in the field to sufficiently learn the topic of concern, and in this case refers to spending sufficient time in the literature (or interviewing) so as to gain a competent understanding of the topic at hand. The review of the literature commenced in 2007. Initially I focused my studies at the Fisher Library at the University of Sydney, first looking at the importance of studying history and the importance of computers in mathematics education, and then combining the above two topics. Also, documents pertaining to this historical subject at hand were studied there. The two main references used on Grounded Theory were studied during 2010, as were volumes on historical research methodology. Contact was made with the NSW Board of Studies at the end of July 2010. Originally I made contact with the Department of Education and Communities in mid July 2009 and obtained the names of several persons to interview. I finished interviewing in late 2010 and continued my literature search over the following two years whilst writing up the thesis.

2.4.5 Cooperative Colleague and Peer Debriefing

My two supervisors maintained the role of cooperative colleagues, continually questioning my interpretation and conclusions regarding my findings and examining my evidence, and they also met the peer debriefing category – keeping check on each step I took throughout the study – as well. Regular contact was made with my supervisors. The ability to give them my beliefs and ideas and get their feedback and discuss outcomes, including situations where their views were in contrast to my own, was most fruitful. I regard the attention paid to these two criteria as perhaps the most important in achieving the credibility and dependability – that is, the trustworthiness of the study.

2.5 Summary of Chapter 2

This section summarised the research methodologies undertaken in completing this thesis, the methods of gathering the historical data, and the way the principal and secondary data were put together into a meaningful narrative. There were two main methodological traditions maintained throughout this thesis. The first was a historical research approach, and the second was a qualitative approach using grounded theory as a major guide. The main agenda to the development of this thesis consisted of: first, the choosing of the research topic second, the creation of the research questions, and third, the collection of the data through interviews; then a literature study; the analysis of the data and the production of this report. The historical study consisted of both primary and secondary information which was both important to this data gathering. Then, because this was not a complete basis for information, interviews were also used. Eight people were interviewed; the interviewees coming from a variety of backgrounds, each relevant to mathematics education in the time period studied. The grounded theory approach commenced with gathering the data, and then this data was used to generate further data in an ongoing manner, It consisted of developing concepts with the grouping of ideas into common themes and headings. Finally it involved converting the concepts into the narrative.

2.6 Guide to Chapter 3

The following chapter first and foremost contains the Literature Review of the period mentioned. The literature used was mostly from the period studied; that is, from 1970 to 1992. The chapter also describes the analysis of the useable data that was found in all documents and interviews conducted. It covers approximately 20 years and can be defined by the three phases: the Pioneer phase, the Policy phase, and the Proliferation phase. These three Phases were the result of the research undertaken and explained above, they were not the creation of another author. The Pioneer phase covers the early 70s to the early 80s, and deals with the first direct push for the implementation of the computer into the curriculum, seeing programming being part of a low level mathematics subject at that time. The Policy phase sees the first policies being put into play, with new important and relevant policy producing bodies being created; this covered the time period of the early to late 80s. Finally the Proliferation phase saw an increase in the powerfulness and flexibility of the educational software. Policies included Primary Schools at this time. These phases consisted of several recurring themes, namely: Relationship between Computers and Mathematics; Programming; Software; Hardware; School Subjects; Professional Development; and Arising Challenges.

Chapter 3

Data Analysis

This is a study of the history of the usage of computers in senior school mathematics teaching in the State of New South Wales (NSW), Australia, during the period from 1971 to 1992. The data was obtained from an examination of the relevant documents, including published academic literature and governmental policy statements and interviews with 8 key people who were highly active in the introduction and development of computer use. This chapter consists of the literature review and the data analysis, because these areas are closely interrelated to each other. Because this is a historical study, and because the relevant literature goes back a considerable length of time, some of the historical references are necessarily dated. This chapter presents a discussion of the major themes obtained from such an analysis. But first, there will be a recap of the research questions:

Research Questions

The key questions guiding this study are:

1: What were the major stages of development in the use of computers in mathematics in New South Wales in the period from 1971 to 1992?

2: What were the major themes in the developments regarding computers in that period?

Grounded theory analysis of the data gave rise to two major dimensions in which the findings can be discussed. First, the *Historic Dimension* provided three main Phases in the period under consideration, each with its own distinctive features. The Phases were derived as a result of this study. Second, the *Themes Dimension* identified seven main themes from the data. These were used to describe the developments in the use of computers in mathematics during the focus period. A discussion of each of these dimensions follows. The phases and themes were derived as a result of the research, and were not the product of any one author or interviewee. For example, one theme is programming, and that was put forward as a theme because of the large amount of information available on programming, unlike the Internet, which was non-existent in the time period studied.

The Historic Dimension:

Educational change can happen rapidly. Even though the focus of this thesis spans a mere twenty years, changes in the use of computers in mathematics education happened very quickly. Because educational change happens continuously and over time, it seemed easiest and most advantageous to divide the discussion of these developments into three Phases which necessarily overlap, with some contributing factors recessive in one Phase and then becoming dominant or highlighted later. This phenomenon is explained as follows:

1) *The Pioneer Phase*: This Phase, starting in the early 1970s and continuing on until the early 1980s, was marked by the activities of a group of independent mathematics teachers in a number of secondary schools, who made an effort to introduce computers into their classrooms, using limited applications for drill and practice and some basic programming in mathematics. Such uses of computers found its way into the official curriculum during this Phase and later into government policy in the following Phase.
2) *The Policy Phase*: This Phase extended from the early to the late 1980s, and is marked with the publication by educational authorities of a number of computer use policies and the establishment of special programs to promote and guide the use of computers in schools. Organisational structures within the NSW Education Department were developed to provide advice to the government and schools in order to manage the use of computers. The pattern of computer use in schools, mainly in mathematics subjects referred to in the *Pioneer Phase*, was slowly changing with the focus of computer use shifting to other subjects. During the latter part of this phase, computer use filtered into the primary school system.
3. *The Proliferation Phase*: By the 1990s, significant changes had occurred in the use of computers in education in general and in mathematics education

specifically. This occurred with the increase in production of useful, flexible and powerful general purpose software.

The Themes dimension:

Grounded theory yielded seven themes that represent aspects of computer use in NSW mathematics education. Not all themes are necessarily related to each historical period identified above; and, once again, these themes are not necessarily disjoint in their development – changes in one front usually were associated with, or implied changes in, other themes. Hence, there are some unavoidable overlaps in the following discussion.

The seven themes are:

1. Relationships between computers and mathematics;
2. Programming;
3. Software;
4. Hardware;
5. School subjects;
6. Professional Development.
7. Arising Challenges.

The discussion below is structured according to the Historic Dimension then, within the Themes Dimension, the relevant theme. The information is presented according to its relevance to the particular Phase under discussion (regardless of the date published), and therefore shall not necessarily be presented in a Phase consistent with the date in which it was published.

3.1 The Pioneer Phase (Early 1970s to the Early 1980s)

3.1.1 Relationship between Computers and Mathematics Education

Wharton (1989, p. 107) maintains that from the late 70s, the computer had been observed to naturally support the mathematics curriculum in some way. Computers appeared on the market in the early 1970s and schools were soon making use of their availability. One of the reasons the computer was recognised as useful was because of its speed of calculation in scientific and business problems (Kelman et al., 1983, p. 3). In line with this potential, schools hoped that students would be able to use this technology to solve problems in better and more efficient ways. Problem solving and mathematics are linked together. Kelman et al., asserted that “problem solving is at the heart of mathematics” (1983, p. 28). Hence, some mathematics teachers hoped that with a computer, students would have a “new-found freedom to explore, to test strategies, and to play, all of which are at the heart of problem solving” (Kelman, 1983 p. 3). Powerful problem solving capabilities of the computer provided students with the chance to labour with increasingly stimulating and difficult problems than was previously possible (p. 3). Seen as a problem solving device, the computer had the capability to modify the ways in which mathematics teachers could develop their teaching and their students’ ability at problem solving.

Computers were believed to promote problem solving through a reduction in the occurrence of students becoming bored and distracted by repetitive and lengthy calculations. Taylor (1980, p. 3) saw the usefulness of computers in replacing the energy otherwise depleted by the individuals using them, by performing the “tedious, mechanical” work for them. Interviewee 6 believed that computers were good for “getting rid of all the routine, jumping through hoops, following a recipe,” and to get into meaningful mathematics (Interviewee 6; Appendix H; p. 317)[3]. Computers were used “because it seemed the best way of helping people explore mathematics and investigate” problems, and to remove the “computational detail,” to “get to the key ideas; … to focus on the principle, on the big ideas” (6; H; 318, 324 – 325). Interviewee 6 adds, it “allows you to focus on the key ideas, the key properties of something without having to do so much computation and without so many errors. It removes the margins for error in unimportant things and lets you focus on the important things” (6; H; 316). The computer enables the student not to “just look at the one thing, but to look at how it is related to something else” (6; H; 325). Relations

[3] Appendices are denoted by: Interviewee Number, Appendix number, and page number. So, for example: “Interviewee 7, Appendix I, page number 337 of this thesis,” will be denoted by: (7; I; 337).

between concepts were able to be explored, and students were able to understand "how things change." Some examples given by Interviewee 6 were:

- In drawing graphs, without the computer, you "have to plot points ... you can calculate the coordinates wrongly, you can plot the points wrongly, you can miss things whereas the computer takes all that away" (6; G; 316). As a teaching tool, computers can display graphical representations of mathematical concepts more quickly and effectively than drawing on the blackboard.
- Another example is statistics. In statistics, with normal calculations "you've got to find sums of coordinates and sums of squares and you're spending ages adding and squaring and calculating and so on and you lose track of what it was all about. The focus becomes a formula and calculating a number rather than what the number means. But with computers, all those technicalities disappear as one focuses more on the results and the concepts themselves. The programs help with getting at what the data means" (6; G; 317).

Illustrating the importance and acceptance of the relationship between computers and mathematics, Wharton states that in the early seventies, it was claimed by some that the NSW Primary mathematics curriculum was out of date because it did not include computers (1989, p. 107) – and, as it will be seen, primary schools were left behind for quite some time.

Cater (1974, p. 5) advised that students who did computing should be capable of doing Algebra, or should have completed a course in Algebra, suggesting that a good Year for students to engage with computing would be about Year 9. Wilcox (1983, p. 8) mentioned that mathematics was useful and indeed necessary for many aspects of computing, being important in simplifying certain computing undertakings. Even though mathematics did 'hold the reins' with computing for some time, the fact that there is a link between computing and mathematics highlights the need for a teacher to be wary of a students' mathematical ability when undertaking a computing course (Wilcox, 1983, p. 9).

Early computers were mathematically based. For a number of years, mathematics was the only NSW school subject to use computers and would remain so for nearly a decade. From the very first, “computers were designed to do mathematics and are fundamentally mathematics machines” (Kelman et al., 1983, p. 1). This may have led Kelman et al. (1983) to state that “computers are ideally suited for doing, learning, and teaching mathematics” (p. 309). Computers were regarded as being logical (5; G; 302). Wilcox (1983, p. 9) suggested that mathematics and computing can reinforce one another, and that if there is a complete separation between the two, this would be to the detriment of students’ mathematical education.

There were also work-related factors that led to establishing this special relationship between computers and mathematics. When computers were first introduced into education, mathematics teachers doubled as the computer teachers in many schools. With the lack of availability of commercial software, it was the mathematics teachers who had to develop their own software applications in order to use the computer effectively. “It is not surprising that the majority of these early programs were mainly mathematical” (7; I; 356). The early instructors were mathematics teachers because, “that was the entry point into computing in those days” (3; E; 204). There was “no reference to computer use anywhere else in the curriculum”: there was no Computing curriculum; some had “Other Approved Studies and they had to be approved … and there were few of those.” “Most of the computers would have been bought initially for mathematics as part of the mathematics budget in the schools” (3; E; 204). These trends started to change “in the 80s with the introduction of the Apple computer and the IBM PC and PC Junior”[4] (3; E; 204 – 205).

Interviewee 2, used computers “because they enabled my teaching of mathematics in ways that were not possible without the assistance of technology, in all sorts of visual and dynamic learning experiences” (2; D; 179). They also “served as a catalyst for a more student centred pedagogy.” This was “far superior to the teacher centred

[4] IBM ran a program “which put PC Juniors into labs in classrooms,” running “quite a large program” (3; E; 205).

approach that was the norm" (2; D; 179). It was noted that, "the 80s were a time of great experimentation, willingness to try new things, and this was probably related to the increasing access to technologies which made new opportunities possible" (2; D; 181). There was the, "freedom of the school based curriculum movement of the seventies." This had been, "replaced by much more hard-headed policy-level pragmatism at the system levels (syllabus and curriculum documents were heavily prescribed and schools were required to implement these according to strict guidelines). Nonetheless, there was freedom within this implementation. The documents prescribed [a] general use of technology, so it was not hard to justify." Also, "in the early to mid-80s, computers were directly owned by the mathematics department, and there was a natural tendency for maths teachers to explore ways to use them" (2; D; 182).

3.1.2 Programming

Teaching programming was perhaps one of the major ways in which computers were used in mathematics education. Programming was introduced in a minor way into the NSW High School Certificate (HSC) school mathematics curriculum in the early 1970s. It is not difficult to see why this happened. Firstly, the people using programming in their university training were mathematics teachers (4; F; 229, 230). Tatnall and Davey (2004, p. 86) opined that the use of computers in schools in Australia started because of the, "exposure of particular teachers to computing during their university studies." When those teachers had introduced the computer into their classrooms, it was not surprising to see that they would focus on programing. Secondly, computers were introduced into schools, and in particular into mathematics, before any high quality and powerful software became available. Computers were basically still calculation machines. Before icons and multitasking interfaces were in common use, computing was linear with each task having to follow the previous one sequentially. Hence, operating the computer, like mathematics itself, was a structured activity. Programming illustrated this linear algorithmic thinking. As Interviewee 4 recalled: "In the early stages of computing, there was a feeling that there was a strong and natural link between computing and programming" (4; F; 247).

Programming was found to be, “easy to justify, suited the largely mathematics teacher-base of enthusiasts at the time and could be implemented without the school needing to own a computer” (Tatnall & Davey, 2012, p. 246). One of the benefits of programming is that learners obtained new ideas about their own metacognition. Using the computer in this way, as a tutee, could change the concentration and attention of the learner from end product (that is from gathering data, facts), to process, then to manipulating and understanding facts (Taylor, 1980, p. 4). When programming, students would write down their programs using pen and paper, and then “used the computer to test their solutions” (1; C; 171). This made computers practical.

In the early 1980s, the “most common use” of the computer “was teaching programming, and teaching computer studies” (8; K; 432).[5] It is interesting to point out in this context that the use of programming in mathematics classes was not only to develop knowledge and skill in mathematics itself. Programming was seen as a vocational skill (Kelman et al., 1983, p. 27). Since computing was seen as the vocation for the future, for a number of students programming was a worthwhile preparation for work (p. 27). Programming could also be seen as a very significant part of computer literacy. It was argued that elements of programming were fundamental to society. For example, “programming a microwave oven, a programmable hand calculator, a telephone, or a television” (p. 28). Hence being efficient at programming and learning to be confident in its use, would make these students more prepared for the real world; especially work. However this understates the complexity of the programming done in schools. Much more difficult than programming a microwave.[6] Being taught by teachers within mathematics, most programing activities were simple mathematical algorithms and calculations. For example, some of the early programming was to do trivial things such as printing out words. Also, they would input a birth date and calculate the exact day of the week they were born (4; F; 231,

[5] Appendix K is sorted by Dates, and is arranged under the following headings: Day/Month/Year, Interviewee X. It is referenced in the text in the following way: (Interviewee No. or name of person in question, Appendix K, and Page No. of thesis).
[6] Although it can be argued that programming is relevant to the real world, in particular with regards to problem solving, the above given argument exaggerates the relation somewhat.

232; and 7; I; 339). At times these programs were directly related to the content covered by the curriculum. For example, there were programs to demonstrate mathematical concepts such as Pythagoras theorem and for working out the volume of a box (8; J; 370, 371); they would have or write a program to square or cube a number, develop a program to solve a quadratic equation, or to simulate the throwing of a dice 500 times (4; F; 232; and 7; I; 342).

As Interviewee 4 asserted, although all of these applications are mathematical and some are related directly to the mathematics curriculum, there was nothing special about the computer. All this could then be done on the calculator (4; F; 231). Most programs written by students involved a single input (for example, they would input the length of side of a square), and would get an output (for example, they would obtain the area of the square). Later programs were somewhat more sophisticated and required more than one input. This allowed for experimentation and for generating patterns. One of the early applications of the *Apple IIe* was a simulation program of a rocket landing. The rocket would move up or slow down according to the ignition sequence given (8; J; 378 – 379). Another game they would play was a moon lander type where they would input the data, for example the value of the acceleration, to see the results – such as how long and how fast it was going, as well as how far above the ground it was. A printout would show these results to the student. When later versions of the computers became available with some graphic capabilities, they ran a real simulation on the screen (8; J; 378 – 379).

Programming, “can also be regarded as a fundamental mathematical activity” (Kelman et al, 1983, p. 27). Kelman’s thinking was that “programming is problem solving and problem solving is at the heart of mathematics” (p. 28). Perhaps the most important reason behind focusing on programming itself is its relation to problem solving and mathematics. Programming involves more than just learning the beginnings of a computer language and applying it to basic jobs such as generating the squares of the integers from one to one hundred, or printing ‘Hi’ on the computer; it is a creative activity. This includes the study and exploration of a range and variety of mathematical problems. To do programming, the student has to "explore the problem situation, define the problem, and work on various solutions until they have the simplest one". Kelman et al. (1983, p. 28) stated that "all programming languages are [a] fundamental means of expressing problems." One can view "teaching programming … [as] teaching problem solving" (p. 28). Programming can be viewed as a problem solving activity, where teachers can encourage their pupils to create their own programs and, "arrive at their own solutions to programming problems" (p. 29). There are no exact means to programming or problem solving, "there are only programming tools and procedures that make problem solving easier, faster, and more elegant."

While initial programming activities were linear and procedural (characteristics of programming languages such as BASIC and FORTRAN), later focus shifted to systematics analysis of problems based on Step Wise Refinement or Top Down Programming (as encouraged by LOGO and PASCAL)[7] (8; J; 407). Step Wise Refinement was where, "you look at a problem, then you break it down into its components, and then you solve the components and that gives you the answer to the whole" (8; J; 407). However, this connection between problem solving and programming was not without some controversy. Not all believed there was a link. One interviewee (6; H; 319) stated that, the focus of programming was on getting a program that worked and not on understanding mathematics. This is a reference to the fact that students could follow trial and error ways for debugging programs, or developing program code that produces the desired results even though they may not have reflected upon the standard mathematical algorithms to solve the problem.

Consideration now turns to some of the available programming languages used during that Phase. FORTRAN was considered to be the first high-level computer language (Kelman et al., 1983, p. 1). FORTRAN "stood for 'Formula Translation;'" being "invented for scientists and mathematicians" (7; K; 424). In the early 70s, FORTRAN was the standard mathematical programming language, before personal

[7] The respective programming languages that relate to "linear and procedural" and "Step Wise Refinement or Top Down Programming" were taken from: (8; personal correspondence; 2010).

computers became widely available (7; I; 333 – 334). FORTRAN was used mainly on mainframe computers, and users would punch cards to work with FORTRAN (3; E; 188; 7; I; 333 – 334; and 7; I; 424). There would be mainframes provided to various regions (regions shall be explained later in this chapter), which were “used for schools, for programming purposes” (3; E; 189 – 190). Users would program with punch cards, where one would punch a hole into the card (3; E; 188; and 7; K; 424). The punch card was the only way students were allowed access to the mainframes (7; K; 424). Using punch cards would take time and one needed to be very accurate in this activity because any mistakes, meant that the program would not run (4; F; 229). At first, users would have their cards sent out to get processed, and during the week of waiting for the return of their punch cards, they could work on new programs. When the punch cards were returned, they could fix any errors in them, and send them back along with a new collection of programs (Cater, 1974, p. 58).

FORTRAN was the first use of a programming language in education, generally used in Universities by their teacher trainees, as early as 1972. However in one school, it was used as early as 1971, and the results (the print out) from the mainframe were sent back from the university in a few days (3; E; 185). FORTRAN is a programming language that is very well related to problems of a mathematical nature (Tillett, 1970, p. 13). In the mid-70s, sixty NSW high schools were using the facility provided by Sydney University to process their cards (McDougall, 1975, p. 205). Cater (1974, p. 57) noted that punch cards were cheap, the method was cheap, and they could be filled out (that is, programmed) almost anywhere.

In 1976, BASIC was considered by Huggett (1976, p. 16) to be the third most popular computing language. The most popular being FORTRAN, then COBOL. BASIC was used in the NSW mathematics syllabus in 1976 for the newly added 2 Unit A course (5; K; 436); and “as a teacher educator,” Interviewee 5 “had to learn it.” BASIC was chosen because it, “was simple” and, “was available on all home computers.” BASIC was designed for educational purposes (Huggett, 1976, p. 16), and Zahra (1977, p. 83) claimed that BASIC is possibly the easiest programming language to learn, also being the most common language (p. 86). Kelman et al. (1983, p. 28) asserted that BASIC is a language that is easy to manipulate, and therefore is an “easy language with which to try out problem solutions”. BASIC “was a big hit,” and one of the reasons for that is that it was an “interpretive computer language, it gave immediate feedback on syntax whereas many of the other languages were compiled” (7; K; 435). BASIC was used by both the Apple and IBM machines (3; E; 189, 192).

Not all opinions regarding BASIC were positive. Some associates of Christensen (1982, p. 132) considered BASIC to be a disaster, and believed that it was only successful because it was the single programming language useable at that time on computers that were available in education. This author stated that BASIC was an unsuitable language with which to teach programming (Christensen, 1982, p. 134), and considered that BASIC was the cause of much faulty programming taking place in high schools. To create a useable language, due to his dissatisfaction with BASIC, Christensen developed a programming language named COMAL in February 1975 (pp. 132, 134); and claimed that it could be used on small and cheap computers, which was one of the main reasons BASIC was used extensively in schools. It was made as an expansion of BASIC, to make the teaching of structured programming to the amateur programmer much easier (p. 134). Another reason given for using BASIC was that many programs had already been programmed in BASIC (p. 134). Christensen argued that this amount is small when compared to the large potential of programs that could be coded in the future. Christensen reasoned that although many people used BASIC, this was small when compared to those that would program in the future. This author gave the example of Denmark where people had disregarded BASIC for COMAL, which they considered as far better.

During the early 1980s, BASIC became the standard language (2; D; 183), and was the only language that came with the Apple II. Hence, it became the predominant language used in NSW schools. Mattei (1974, p. 121) noted that BASIC had been indicated through research to be more easily understood than FORTRAN. This positive aspect of using BASIC is possibly one of the reasons why it eventually replaced FORTRAN in schools. To use BASIC, Wilcox (1983, p. 7) claimed that one must know at least some mathematical concepts when using this language, because using it enables one to reinforce those concepts.

A non-standard version of BASIC came out on a popular computer of that time, known as the Microbee (which will be discussed further later) (5; G; 292 – 393). The problem of the non-standard version of BASIC being introduced created problems for examiners and markers in State-wide exams, because it opened the doors to all types of differences in programmes to occur, and the examiner had to accept anything that appeared reasonable (5; G; 397). By the early eighties, LOGO, Pascal and BASIC were the languages to be implemented in the Computer Education Program policy document (National Advisory Committee on Computers in Schools (NACCS), 1983, p. 54) – a policy document that will be discussed in the Policies section. LOGO was only adopted at significant levels in the following Phase, and will be discussed in that section later.

Programming was taught in new forms of informal education that had arisen to cater for the needs of interested students. This was evidenced by some schools in NSW having established a computer club, which would meet once a week after school allowing opportunities for students to learn programming. This computer club tended to be maths based, as "there wasn't much you could write in BASIC programming other than things like maths" (7; I; 340). There were direct benefits for students from such informal opportunities of using the computer. Perhaps initially they provided students with a sense of "excitement of being there right at the beginning [of a new skill]", or of "doing something interesting and different". However, the benefits became more obvious when "workplaces started to use computers a lot" (7; I; 342). There was the perceived benefit of learning something that would be useful later in real life.

Other benefits included, "much higher levels of student engagement, substantial improvements in attitudes towards mathematics," going from being "passive spectators to being active participants and even creators of mathematics" (2; D; 180). There were, "improved results," although this is hard to verify with the many variables involved in determining results. These results were similar to those found in "research worldwide," and supported the belief that, "the effective use of technologies for learning translates directly into improvements in attitude, results and engagement on the part of students" (2; D; 180).

3.1.3 Software

Between the late 1970s and early 1980s, before the advent of software (Samootin, 1993, p. 132), computers in education was a wilderness of undiscovered prospects. Programming was the prime means of using a computer in mathematics education. The majority of software available at that time was teacher developed. In 1977, the Apple, however, was known to come with a "plethora of software," with which it was "possible to show other teachers just how useful (or otherwise) a computer could be" (Tatnall & Davey, 2012, p. 247). This plethora of software was used, just for demonstration, and the computer was just implemented with programming in mind, until there were more computers in the schools. What made this situation difficult for teachers and students was that disk drives were not available (8; J; 380). The capacity of the computer to deal with large applications was very limited. Cassette tapes were the first program and data storage facilities that the teachers were able to use (7; I; 338; and 8; J; 380 – 381). These were slow and awkward. If a program on the cassette tape took over two minutes to load, then the program usually would not work, "it fell over" (8; J; 380 – 381). With the advent of the Apple computer, the situation eased with the use of the floppy disc which, however, was still open to data erasure and data loss (7; I; 339). The limited availability of data and program storage was an important limitation for the availability of software. Software that was available consisted of small, single task programs developed by a number of keen mathematics teachers working in other schools around the state, usually written in BASIC or FORTRAN and designed to produce things like games or puzzles (7; I; 336).

The term that became common programs was *Computer Aided Instruction* (CAI), which pointed to using computers as a teaching aid (Juliff, 1984, p. 343). Much of that early software was used for drill and practice purposes (p. 343). One interviewee described it this way: "'Here's the question, give me an answer,' and if the answer was wrong it would repeat itself saying: ‘here’s the question, give me an answer’ again and again, sometimes with a little hint” (8; J; 381). Looking back at such uses of the computer, this Interviewee added “This was horrible”. This drill and practice approach to learning through the computer was critiqued for under-estimating the teacher, and the computer’s potential, as well as a pupil’s ability (Wills, 1984, p. 90). Sandry (1982, p. 52) claimed that the majority of the CAI software that was available at that time was not of good quality, tying up the teacher and the student, disregarding most of it as electronic page turning. Also, Kelman et al. argued that drill and practice type of software was based on three assumptions.

1. basic skills are taught like physical skills, through repetitive practice
2. ideas and skills can be learnt by being put into their respective sub-ideas and sub-skills
3. students will repeat taught behaviours when these correct responses are reinforced with a pleasant experience. (1983, p. 45).

Kelman et al. added that, “while [a] drill and practice computer program does not pretend to teach, it gives a well-organised, self-correcting drill on skills that have previously been learnt” (1983, p. 47). Furthermore, critics of such uses tended to state that it is monotonous and boring. On the other hand, such uses, do create self-paced exercise problems and may allow for more motivation when there is “creative graphics, animation, and sound being effectively employed” (p. 47). One problem noted about the use of graphics by educators was by Bork (1980b, p. 71). Teachers would be discouraged if they had to learn about the graphical capabilities of the computer and study the codes that make these graphics on top of learning a computer language. Students would need to do more than just working on software packages, however, as Bork (1980b, p. 77) mentioned, getting students to only use the software was unfortunate, just as it was also unfortunate to have students become only programmers. In the early 80s, one of the highest rated present and future needs of teachers in software (as found in a survey conducted by the Mathematics Syllabus Committee of the Secondary Schools Board – with additional material by the Curriculum Consultant) was “teaching computer studies and computer as a teaching aid" (8; K; 432). One of the highest regarded support needs was nominated as being software.

Bork (1980b, p. 68) mentioned how extremely important visual information was for young learners. His view supports the practical relevance of graphics in education, as this practical utility of graphics was good for those students who did not learn well with verbal descriptions, but could do better with other available modes of communication.

During the latter part of this Phase, a variety of commercially available software had started to become available to schools. The "introduction of more powerful, general purpose applications such as word-processing, spreadsheets, databases and educational software" had several implications for the use of computers in schools and in mathematics education (3; K; 427).

The increasing availability of this software implied that teachers in other subjects had started to see the good potential of the use of computers in their areas. For example, the availability of word processing packages attracted the attention of English teachers; History and Geography teachers saw benefits in using computers for learning games, HyperCards, databases, and statistics (3; E; 192 – 193, 202 – 203; and 7; I; 356). Art and Music teachers saw great potential in some software with graphical and sound capabilities (3; E; 199, 202). As other software improved, subjects such as "social science, music and languages began to take over" (2; D; 182). The availability of such software demonstrated that one did not need to know anything about programming in order to use the computer. This happened as other software improved, and mathematics software, "remained little different to the early multiple choice tutorial type of software and this could not compete with" other software that had a competitive edge (2; D; 182). However, the application of such software (with the exception of the spreadsheet), was not seen as particularly and directly relevant to mathematics teaching. This was a limited blessing for mathematics teachers as, on the one hand, the increase of interest in computers in schools implied that it was easier for the school to attract money (mainly from its internal sources and sometimes from parents) to increase the availability of the computer in their school, while on the other hand, such wider uses of computers in schools implied a greater competition to mathematics teachers for the (still) limited resources available. There were, “problems for multiple teachers accessing and sharing relatively few resources” (2; D; 179). This led, within some schools, to debates among other things about who should have priority for the use of the computer and whether they should be in labs (3; E; 204 – 205).

3.1.4 Hardware

Early computers did not arrive with significant amounts of powerful software. They lacked the icons and environments taken for granted today. Initially, computers “were clunky to use” (8; J; 376). The earliest hardware used by some schools involved large mainframe computers available at universities and businesses that were not interactive (5; G; 250, 269). Obtaining results from running a program was a slow process, with teachers and students having to wait for results to be returned (3; E; 191). The introduction of the Canon Canola, which had a keyboard that allowed the typing of numerals and special symbols, made using the computer more interactive. The Canon Canola was the first programmable device used in schools in the early 1970s (8; J; 368). The funding that mathematics teachers obtained for buying computers for their schools usually came from Parents and Citizen Organisations (3; K; 427 – 428).

The Canon Canola was more of a calculator than a computer, but this distinction was rather unfair, as it was the very first programmable device (8; J; 368). One interviewee remembers them in one school as early as 1971 (3; E; 185). The “early computers did not offer much without the software” (7; K; 435). The language of the Canola was specific to the Canola; the name of the language was unknown to the Interviewee (3; E; 187 – 188). The punch cards used on the Canola were different to the ones used on the mainframes (7; K; 429). You would, “punch a hole through them with a bobby pin or something to push through the holes” (3; E; 188). It was a flexible teaching tool that could be used either for programming with more advanced students or for the programs used by the less advanced students. For example, one could get the more advanced students to write a program that would calculate compound interest for a number of years; and the less able student would input the values to get an output (8; J; 378). The Canola's were, "rudimentary machines" (like the "Canola 167P and 1614P"), however the positive role that they played was that, "they brought the concept of computer programming to the masses" (8; K; 435).

You "could code, test and debug on the spot and there was no single right way of doing that" (8; K; 435). There was an "inbuilt card reader," the cards could have holes punched into them "with a paper clip." Further, you could use a "card puncher machine," where you would "type in instruction on the keyboard and the card would get punched," and then you would get the next card and start with that one (3; E; 190). Sometimes it would "take three hours to process." The cards would then be, "sent to Macquarie University and it would take two to three days or a week to get the cards back." One interviewee (2; D; 176) in a teacher education program at University described how they would send their punch cards to Macquarie University and have them returned the next day. One was able to print out the code if there was a printer available, then one could send the printout away for checking (8; K; 435). The results would be printed out on special paper, and if one made a mistake, they would have to redo it and wait more time to receive the results again (3; E; 191).

The Canola started to be phased out around 1977 or 1978, with the establishment of the Apple computer (3; E; 188 – 189). In the late 70s, and especially in the early 80s, the Apple became "pretty well established;" they were popular (3; E; 189). Also popular was the Commodore 64 (5; G; 265). However, it was believed by one Interviewee that, "the Apple never led the market, but they always certainly had a very strong presence in schools" (2; K; 426). Then, "other machines became available, and word processing and databases also became available, and other school subjects started to become interested in computer use" (3; E; 192). The introduction of the immediate interactivity of the computer was a significant development that allowed for important changes in the way that it could be used in education. For example, the programmable mainframe computers did not allow for interaction with the user while the program was executing. It was "unusual to have more than one or two computers in a classroom" in the late 1970s, and early 1980s (1; C; 171); however these conditions "led to innovative ways of teaching with them."

The second major development in hardware came with the introduction of the BMS Map that used the same punch cards as the Canola (5; G; 289 – 290). It had a 60 centimetre (24 inch) screen, with the letters on the screen being 2 centimetres high, however it failed to develop further (5; G; 291) even though it possibly showed the possible practicalities of using another method of teaching with the computer; using it in "demonstration mode" (1; C; 171). This is where the students would be, "gathered around the computer," and either the teacher or the student would use a keyboard. Then a large monitor would be used to allow the students a better view of what was displayed. At about that time a string of computers were introduced into different schools. These included the Commodore (64), the Tandy Radio Shack TRS 80, the Atari, and the Microbee (3; E; 186; 5; G; 265; and 7; I; 337). In the early 80s, limited speed and large costs for hardware were still a concern for teachers (Bork, 1980b, p. 77). Bork expected this would still be a problem for the 1980s.

Different computers varied in price and graphics capabilities. The Apple II's arrival in 1977 "saw the end of this period and the beginning of real advances in the use of computers in schools" (Tatnall & Davey, 2004, p. 86). In 1980, there were approximately 223 computers in NSW schools. For at least 90% of schools being tallied, most were Apple (Webster, 1981b, p. 2; Wiktorowicz, 1981, p. 26). Webster claimed that there was a considerable grassroots activity in NSW for several years (1981a, p. 1). In 1982, there was a growing resource imbalance within NSW schools, mainly because some of the schools did and others did not have access to community provided funds (Webster, 1981b p. 3). In 1980 in a survey conducted by the Mathematics Syllabus Committee of the Secondary Schools Board and with additional material by the Curriculum Consultant, found that, "65% of high schools had at least one computer" (8; K; 432). Most schools that were lacking in computers, "said it was due to a lack of funds." In 1982, 77% "had at least one computer;" and 88% of those respondents said that they "had at least one Apple II computer." One of the highest regarded support needs was "provision of computer hardware."

In the classroom, the computer could be used as a teaching tool or in demonstration mode – like with Excel (7; I; 351). The earliest computers in schools faced some limitations in their second usage for demonstrations. There were problems of having only one computer in a room where 30 or so children had to sit around one small screen (7; I; 353). Later generations of computer monitors were a little larger; however, sometimes at the sacrifice of resolution. A further problem with the use of computers in a demonstration mode was the malfunctioning of the hardware at inappropriate moments (Kelman et al., 1983, p. 43).

3.1.5 School Subjects

In NSW, the High School Certificate (HSC) was first adopted in 1967 (Board of Studies, 2007a; and 5; K; 426). For mathematics, there were four main types of course available at the senior years[8]: Level 1 (the highest level), Level 2F (2 Full – the second highest level), 2S (2 Short), and then Level III (the lowest level) (5; G; 253, 256). Programming was used only in Level III. The justification given for this by the Board of Senior School Studies (1970b, p. 1) was indicative of the rationale for including programming in the mathematics curriculum, as well as its status. There were two major reasons given by the Board. Part of the rationale for including programming in the school curriculum was vocational: the Board saw that in order to avoid any possible disadvantages for Level III students when they left school and went into the workforce, they needed to be computer literate. Secondly, the respective mathematical content usually covered in the Level III syllabus (that was replaced by this new material), was seen to be easily replaced by the new content of programming. Hence, at this stage in computer development within mathematics education, even though mathematics and computing were seen to be highly related, the content of mathematics in higher level courses was seen as not dependent on use of computers and too important to be replaced by programming skills. Due to their focus of use on school mathematics, computers had, “very little overall impact on other aspects of education (Tatnall & Davey, 2012, p. 245).

[8] The senior years are the HSC level; that is Years 11 and 12.

Programming was used in Level III from 1971 (most likely for Year 11, but was officially examined for the HSC in 1972) through to 1975 (5; K; 434; and 7; K; 423). Programming was optional on the last two sections of the HSC examinations. Students could attempt either one on "latitude or longitude" or one on "programming" (5; G; 256). However there were not many teachers who could assess programing questions during those years. Level III was replaced by 2 Unit A in 1976,[9] a process which continued until 1981 (7; K; 423). This had BASIC programming in its syllabus (5; K, 437). In 1982, this subject was replaced by Mathematics in Society[10] (7; K; 423). Mathematics in Society had programming in BASIC as part of its syllabus (4; F; 218; and 5; K; 433). It was said by one of the Interviewees (3) that in the early 1980s, the mathematics syllabus contained BASIC, but it lacked reflection on the relationship between computers and mathematics; "it was a little bit after that that a rethink happened," (3; E; 194).

Interviewee 3 stated more about the situation in the early 80s, stating that there was a rethink of mathematics "and what we should be teaching in schools" and how to use spreadsheets and calculators in schools (3; E; 201 – 202). There were debates about calculators, more so than computers. Also "graphing tools and simulations and modelling" had a place in the syllabus as well (3; E; 201 – 202). This rethink included doing,

> "simulations, trying to implement algorithms, trying to get the understanding of what's behind finite methods in continuous process because mathematics deals with both continuous and discrete processes, and the question was: how do you actually manage to address continuous processes using finite type machines?" (3; E; 194).

[9] The other levels that replaced Level 1, 2F, and 2S were 4 Unit, 3 Unit and 2 Unit respectively (5; K; 433).

[10] The other subjects (4 Unit, 3 Unit and 2 Unit) stayed the same. Mathematics in Practice was a totally different subject that was introduced in 1989, whilst the other subjects remained the same (Board of Studies, 2001; and 5; K; 433).

It also included:

> As computers are computation devices, so mathematics should look at what the role of computation is and how computations can be viewed from a computing point of view as well as a mathematics point of view. But also using spreadsheets for simulations and the like, doing 'what if?' type things (3; E; 194).

This entailed "making teaching more experimental and experimenting [for example] with changing the parameters of an equation; changing one of the parameters when you graph two lines" (3; E; 194). There were programs that allowed for this type of experimentation. This was changing the way one thought about mathematics, "but it was not a comfortable time for mathematics," due to mathematics not being accepted as an experimental science, and there being experimental methods currently available (3; E; 195). There were spreadsheets, databases, and graphic packages allowing for personal interest to be developed in "how that can be relevant to teaching" (3; E; 196). This came out of interest in programming. However, it seems that "the mathematics curriculum … has abandoned this area" (3; K; 428).

McCrae (1979, p. 78) has noted that by analysing the way things were progressing in the USA and England, up until the late 1970s, the mathematics curriculum was not significantly impacted by the computer in Australia. Years 9 and 10 were suggested by Robinson (1973, p. 39) and by others (a group called the "Steering Committee") to be relevant year levels to work on the early, basic and introductory facts on computers, with topics such as the algorithmic methods and problem solving being fitted into a possible core subject. "Elective classes in computing were always popular as parents perceived this as a way of gaining employable skills," which could be seen as an "advantage over others who hadn't had these skills" (1; C; 174).

In addition to the officially examinable subject in the HSC, schools could set up their own courses as optional topics (called Other Approved Studies) as long as they met a certain level of rigor (8; J; 372). Other Approved Studies were courses that were endorsed by the Board of Studies. They were created by schools for the specific needs of their students (8; J; 372). Most of these courses were designed for Year 11, and they did not count for university entry. As early as 1979 there were about 40 of these different computer-related courses submitted for approval (8; J; 372 – 374). Schools would submit their own courses of study on computing to be examined as part of the HSC requirements. The exams for these courses were marked locally. In the late 70s, schools also could have programming as an optional topic in the Year 9 and 10 School Certificate, conducted in schools that could handle it (8; J; 372). The NACCS (National Advisory Committee on Computers in Schools) (1983, p. 6) explained their process in the early 80s as follows:

> The Secondary Schools Board (years 7 – 10) and the Board of Senior School Studies (years 11 – 12) have approved many computer related courses developed by schools. In late 1982, the Secondary Schools Board established an Advisory Group on Computer Education which recommended that Computer Awareness should be part of the core curriculum in the compulsory years of schooling, and that optional courses in Computing Studies should be included in the School Certificate. A syllabus committee has been established by the Board to produce both kinds of syllabus. A Curriculum Project Team representing a range of interest groups has also been established by the Department to develop a statement of principles for Computer Education K – 12 and to coordinate curriculum development for the use of computers in primary schools.

The Ministers for Technology and Education accepted computer literacy to be significant and of importance, as a part of looking into and analysing technology's influence on society (Wiktorowicz, 1981, p. 26). In 1980, a survey of high schools was conducted by the Mathematics Syllabus Committee of the Secondary Schools Board with extra information given by the Curriculum Consultant. Of the schools surveyed, 41% had some form of computer education in Year 10 (8; K; 431). The same percentage existed for the survey conducted in 1981. In 1980, 38% had some form of computer education in Year 9 (8; K; 432). A "high number of teachers was willing to teach computer courses."

From 1971 to 1982 "there was a grassroots movement" developing "showing interest in using computers across other areas of the curriculum" (3; K; 427). "Other subjects started to become [more] interested" in the late 70s when the Apple came out, and word processors and databases became available (3; E; 192). History as a subject became interested in technology in the late 70s because of the databases available. English teachers and geographers started becoming interested also, due to, for example, the possibility of, "database of facts about geographical locations". (3; E; 193). Programming began therefore, to, "take a back seat in the early 1980s". For interviewee 3, "computing is what I do and maths is an interest and hobby, and it used to be the other way around" (3; E; 202).

By 1981, the, "Department of Education considered computer education of a high priority and important for the whole curriculum" (8; K; 431). The "introduction of computers into all levels of education in Australia occurred very early in a global sense" (Tatnall & Davey, 2004, p. 89). Although primary schools took a back seat in this Phase, in 1982/1983, the Department of Education, "had developed a workshop…to investigate the use of computers in primary schools."

3.1.6 Professional development

An important way to understand the introduction of computers into mathematics in this Pioneer Phase is to examine University pre-service training of those teachers implementing technology into their teaching. During this Phase an increasing number of teacher training institutions provided prospective high school mathematics teachers with some training on computers as part of their courses. However, not many teachers were encouraged to do computer science at University level when it was first established as a separate course, due to the possibility of them choosing it as a career path instead of teaching (5; G; 250). In fact, "anyone on a teachers college scholarship was forbidden to do computing science."

Soon after, it steadily became common for teacher training courses to require some computing experience as a compulsory part of their mathematics education degrees (1; C; 171). Some teacher training programs in NSW required the completion of a mathematics degree, which typically contained some subjects in computer studies mainly consisting of programming (4; F; 230 – 231). But there were some teachers who had undertaken a complete computer science degree yet remained in education (1; C; 171). It is important to point out that during this Phase most of the experiences in computing at University level consisted of programming in a variety of languages. Further, it was more likely for mathematics and science trainees to take computing subjects than others (4; F; 230 – 231).

Most teachers would not "use computers in the classroom because they were worried" about the negative possibilities (1; C; 173). Taylor (1980, p. 1) suggested that even experts could scarcely keep up with technology. Nevertheless, Sandry (1982, p. 43) claimed that many high school teachers were, "personally interested in computers – how computers work, programming them, finding applications for them." In 1980, a survey was carried out by the Secondary Schools Board to which 272 schools responded. It was discovered that among these respondents "33% have staff with no computer experience; 40% have more than one teacher with experience; 86% have staff willing to teach computer education; and, 76% have more than one teacher willing to teach the subject" (Webster, 1981b, p. 15). Concerning computer education (Webster, 1981b, p. 16):

- 61% of respondents gave it a high priority
- 9% more would give it high priority if they had a computer
- 34% said it should be compulsory
- 25% would have liked it as an elective
- 24% said it should be part of the Mathematics course
- 42% said the course should involve both computer appreciation and programming
- 21% said there should be two different courses.

The 1980 survey (by the Mathematics Syllabus Committee of the Secondary Schools Board with additional material by the Curriculum Consultant), also found that, "a high number of teachers are willing to teach computer courses" (8; K; 432). Teachers considered more in-service being provided should be regarded as one of the highest priorities. One trainer/Interviewee (1; C; 173) demonstrated to other teachers, "how productivity could increase with the use of certain software tools." However, there was no requirement that teachers participate in such opportunities. In particular, there were in-service courses related to the use of the computer aimed at introducing the possibilities in terms of software as well as the use of computers in terms of teaching (2; D; 177 – 178). In-service training could be seen as necessary because as Sherwood stated (1988 - cited in Samootin, 1993, p. 136), teachers must be in-serviced about the teaching applications of computers for particular contexts (though specific reasons for this were not given). In-service courses on using programming started being developed as early as 1971, focussing on FORTRAN programming (5; K; 433). Other in-service courses focused on drill and practice programs, and games and simulations (Sinclair, Holmes & Nylander, 1984, p. 358).

A further source of professional development experience on the use of computers came from a variety of professional conferences conducted during that time. During the Pioneer Phase, there were a variety of regional professional associations where members met to study various aspects of mathematics teaching. In the 1970s, there were 12 regions, cut back to 10 by the mid-1980s. (8; J; 379). Some funding for in-service courses was regionally based (others were State based) (8; J; 368). Regions dictated regional based funding (8; J; 369). "People would make submissions and have a conference each year;" for example "the Liverpool Maths Teachers Association (Liverpool Region), was very active in this area and they organised a mathematics conference every year. There would be, "various regional conferences" (8; J; 369). In time, these regional conferences included discussions on the use of computers in mathematics education. Attendees of the mathematics conferences would exchange software with each other (8; J; 381). Most presenters were teachers within the respective region who were happy to share their experiences with other mathematics teachers. Each region had, "at least one Computer Education consultant and, in most cases, a mathematics consultant who would work together in many cases" (8; K; 435). The groundwork was described by this Interviewee as "fantastic." Regions were "largish," and they were later discontinued and were split into separate districts (3; K; 430).

In addition to regional conferences, a State wide conference in NSW and a national conference of the *Australian Association of Mathematics Teachers* (AAMT) held regular presentations about the use of computers in mathematics education (7; I; 343). These conferences had become a venue for exchanging software between teachers (8; J; 381). The introduction of the computer into mathematics education was gradual, and would come about through the contribution of individual teachers who were ahead of their time and who would develop educational software (7; I; 342 – 343). These pioneering teachers were more often than not always ready to share their ideas and products with more novice teachers. It is worth noting that there was very little input from education authorities at this stage towards dealing with this innovation in education for the development of teachers.

Another conference held in this Phase, the VCEG Computer Education Conference (1981) was attended by many people from all over Australia (Webster, 1981b, p. 16). There were few people coming from NSW, and this negatively influenced the view held by the other States towards NSW (p. 16). There was also the ACS-9[11] Computer Conference that was organised every four years. A number of NSW students were sponsored to attend these events (p. 16).

Brownell (1972, p. 14) stated that teachers were, at that time, "inadequately prepared" to educate students in the subject of Computer Studies. Brownell also believed that to rectify this, teachers' training had to be of main significance to

[11] Tatnall (K; 437) noted that he was "sure that VCEG should be CEGV". CEGV is known as the Computer Education Group of Victoria. Tatnall, an expert in the field, noted that he had "not heard of any other organization with that name." And about the ACS conference, Tatnall and Davey stated that the ACS (the Australian Computer Society) was an "organisation representing computer professionals in Australia and maintains an active interest in the use of computers in education" (2012, p. 266).

anyone hoping and wanting to introduce the subject into their school. However, Robinson (1973, p. 38) indicated that there were many teachers who had, due to experimental courses in Canberra, obtained experience in the use of the computer as well as in teaching computing in the early 1970s.

3.1.7 Arising Challenges

Dwyer (1980, p. 114) argued that,

> "even though one can see the computer as giving millions of students access to what 'Alexander the Great' had access to, namely a tutor as knowledgeable and responsive as Aristotle, the computer still does not closely resemble the individual charisma of an Aristotle because it does not implement nor does it represent the one-on-one aspect of individualised teaching."

One of the strongest impediments of the implementation of into mathematics education was the "lack of computer access" (Webster, 1981b, p. 16). The hindrance for teachers of subjects other than mathematics (for example Science or History teachers), in teaching and learning computer studies was the perception that computers were linked only with mathematics (McDougall, 1975, p. 205), hence not everyone was in favour of mathematics taking the sole reins with regards to computing. An example of this is a review from the Centre for Educational Research and Innovation of the OECD in 1968 which stated that if mathematics held such a rein: "many of the most valuable rewards of computer education are lost" (McDougall, 1975, p. 195).

There were "issues of access and affordability" (2; D; 179). The unavailability of hardware and suitable authorised software were two major hindrances to the use of the computer in the classroom in the Pioneering Phase (Dailhou, 1991, p. 61). The computer was expected by Sandry (1982, p. 52) to be used by only a small number of enthusiastic students and staff. Once the first interests of getting a computer diminished the user realised how much effort would have to be made to effectively implement computing. In addition to the development of short computer programs to be used in teaching, there was also, “preparation of grant proposals, installation of the hardware, in-servicing of other teachers, development of school policies and teaching with them in mathematics classrooms” (1; C; 171). Looking back over their previous ten years, (that is from the early-1970s to the early-1980s), the Commonwealth Schools Commission (CSC) acknowledged that the first momentum for the use of the computer into schools came from the enthusiastic work of individual teachers and parents (NACCS, 1983, p. 1).

“Schools were crying out for curriculum materials (and) software” (8; J; 370). Often, teachers had developed software with limited resources, expertise and a vision for the potential of computer use in mathematics education. Not surprisingly, bugs in these early programs would arise and cause the running of these programs to falter, whereas other programs just would not demonstrate adequately (Kelman et al., 1983, p. 43). Developing “powerful demonstration programs,” required “elaborate and time-consuming programming”. Similarly, the debugging of the software and creating documentation added to the demands on the inexperienced teachers. The problem of keeping a collection of reliable, catalogued and well written programs and software that could be put together by schools was regarded by Sandry (1982, p. 53) as a large one. Developing a program that runs as a tutor requires several hours to create one hour of quality teaching; taking longer than is required to develop a lesson to be delivered by a human teacher to teach their students the same materials – depending upon the spontaneous improvisation and performance of the teacher (Taylor, 1980, p. 3).

Human taught lessons were also simpler to cater to because individual differences are not accommodated by them, whereas in computerised lessons, the individual could be catered for, thus taking more time to develop (Taylor, 1980, p. 3). One complaint about the software of that time concerned the strategy of using the computer to have students read textbooks from the screen. The complaint was that using a computer in this way was not the best way to use its capabilities to full advantage, leaving the student doing something which may be completed more simply through perusing the textbook by itself (Watson, 1982, p. 2).

Further, these programs that were developed by teachers generally consisted of simple drill and practice and required low level recall of facts, as well as the use of simple mathematical computational skills. This home-grown variety of software remained, “little different to the early multiple choice tutorial type,” and was unable to compete with the more interesting and more graphical and fun programs of other subjects such as, “Where in the world is Carmen Sandiego?” (2; D; 182). Commercially available software was either not directly relevant to mathematics, or too expensive to obtain for many schools. For example, the software program called ‘*Maths Circus’*, cost approximately $200 (8; J; 415). This amount was quite a commitment for many mathematics departments, particularly when its educational quality was not determined (8; J; 415). Webber (1992, p. 214) identified the cost of purchasing new software (as well as hardware) to be a major consideration for many schools.

The quality of software was not given much consideration by schools (and parents who mainly funded the computers), as they seemed more concerned with the quantity of computers in schools rather than with the quality of their usage (Fraser, 1992, p. 61). Webster (1981b, p. 3) also mentioned that a school's general use of the computer was a significant concern accompanied by little information, and was wrought with a large amount of speculation. One view was that discussing computers for learning largely became challenging due to the teachers being eager to utilise the resource whilst lacking in appropriate knowledge (concerning their view towards general education), or due to teachers being “liberals,” uneducated in technology and largely unsympathetic towards it (Webster, 1981c, p. 19). Taylor (1980, p. 1) suggested that only the expert could just barely keep up with technology because the innovations in it had arisen so quickly.

Nunan (1982, pp. 11 – 12) realised that the work of the specialist who was designing the lessons for the teachers through software was often discredited by those teachers because the nature of teaching is too spontaneous to be designed for: The media hardware and its associated materials was rather to be considered as audio-visual aids, aids which were to be used by the teachers in their teaching, and not to control them. Other challenges came because University courses based most of their training on programming and mathematical lines, and there had not been the production of textbooks with computers in mind, hence teachers had little experience or confidence in training in other areas than these (McDougall, 1975, p. 205).

However, there were more challenges to the use of computers in mathematics education than arguments about the competition for resources. The early 1980s was a period when questions were raised about the long term implications of computers within mathematics education. One question raised was whether the introduction of programming within the High School Certificate (HSC) Level III subject at the senior secondary school level was sufficient for computer use in education. Also, it was questioned whether computers had wider implications for what was important in mathematics education. Seen as computational machines, it was not too difficult to imagine how they could be used to develop the computational skills of students. However, less clear was the question of the role computers were to play in mathematics education in the age of wide availability of computers. Did computers have a role in shifting the focus from algorithmic thinking to problem solving? It was an uncomfortable time for many teachers involved. (3; E; 194 – 195). On the one hand, there was a realisation that the focus in mathematics education should be moving away from working with, "well known algorithms and students learning of techniques, … solving equations, doing algebraic things, and learning number facts," towards more open, "play … [and] experiment with numbers"; that is, developing higher order thinking skills (3; E; 195). On the other hand, such software was not yet available.

McDougall (1975, p. 205) noted that computer applications to mathematical problems, though relevant, was just a part of a considerably greater set of uses available. Cooper (1972, p. 38) identified the problem of a mathematics dominated computer curriculum was that this use could not provide students with an in-depth study of many of the significant components of computer education. Cooper suggested that a separate subject, *Computer Studies,* should be added to the curriculum. However, Tillett (1974, p. 136) commented that although computers were relevant to other subjects, such as Literary Studies, the Arts and the Humanities, to push for their inclusion in these subjects at High School level was to over emphasise their significance. The reason for this was not given by the author, but it seems that it is argued in this way possibly because computers were not yet developed enough to be fully adaptable to these subjects.

3.2 Policy Phase (Early 1980s to Late 1980s)

3.2.1 Relationship between Computers and Mathematics Education

Along with governmental policy development there was a reinforcement of the shift of focus from computer use in mathematics to all subjects in the curriculum in the mid to late 80s**.** Government policy saw computers as, "not just about mathematics education" (3; E; 209). There was an outlook for a more general approach to how computers could be used in the classroom. Some policies would, "talk more generally about the [overall] role of computers in education; the need for students to be aware of technology and how it can influence their lives; how technology can enable students to learn better and so forth" (3; E; 208). In fact, mathematics itself was not "a real spark for any policy development or direction" at that time (nor, as will be seen later, was it an inspiration for policy direction at any time). This change of perspective may have been encouraged by the change in the potential of computers at that time. Hence, by the mid-1980s, the stronghold that mathematics held concerning computers in education was almost totally broken.

3.2.2 Increasing Governmental Involvement

Before government funding, mathematics teachers had, "been primarily responsible for acquiring … resources through P and C (Parents and Citizens) organisations" (3; K; 427 – 428). The National Advisory Committee on Computers in Schools (NACCS), was created in 1973 by the Commonwealth Schools Commission, "to report on how it might help to provide funding for school computer education" (Tatnall & Davey, 2012, p. 246). However, prior to 1983, the "Commonwealth support for curriculum development and software production for schools has been very limited" (NACCS, 1983, p. 6); with the majority of this occurring "at the state or school level". Also, in its initial document, the NACCS mentioned that the majority of investment into schools for computing had been through the, "individual schools funds or from state government sources" (p. 5). This lack of Commonwealth involvement was due to the fact that in education, the Commonwealth Government was, "limited to co-ordination, leadership and the funding of specific projects," whereas, "education was the role of the individual State" (Tatnall & Davey, 2004, p. 83). It was the State Government Education Ministries that governed a school's curriculum, and supported and delivered it (Tatnall & Davey, 2012, p. 244). The Commonwealth determined policy and "supplied funding for specific education projects" (p. 244). A very limited number of Commonwealth programs had been made available for the assistance of schools to obtain computers (NACCS, 1983, p. 5). The Commonwealth Schools Commission (CSC) provided some funding through programs such as those for Disadvantaged Schools and Special Projects, while the Department of Education and Youth Affairs offered funds through arrangements such as the Transition Education Program. Demands from teachers, schools, educators and the general public about the need to increase the use of computers into schools provided pressure on the government to increase its development of policies on computer use as well as on funding in schools (New South Wales Government Schools Computer Education Co-ordinating Committee (NSWGSCECC), 1985).

The NSW Department of Education nominated several computers (these computers were then considered to be "on contract"), for schools to use in their overall implementation. Recommendations from the Department of Education nominated which computer systems would be supported in terms of technical advice availability, professional development programs, and the development and evaluation of software and other curriculum resources (Tatnall & Jenner, 1986, p. 624). More than one computer system was recommended for schools in NSW to permit schools to pick from the, "full range of applications possible with small computers" (p. 623). Schools were required to have more than just one type of computer. The Department of Education did not charge schools for the servicing of schools' hardware; rather, only schools using the school equipment that was on contract was subject to such benefits. The majority of schools chose computers from the contract list (p. 625).

In 1973 The Commonwealth Schools Commission was first established within the Federal Government Department of Education. It was, "responsible for researching and advising on school funding" (3; K; 429). The CSC initialised national planning and reported to the Australian Government on the need for a National Computer Education Program. This was carried out from 1984 to 1986. A report from the National Advisory Committee on Computers in Schools (NACCS) was released by the CSC entitled: Teaching, Learning and Computers: 1984 Information Kit. The report recommended a number of priorities useful for the Computer Education Program (NSWGSCECC, 1985, p. 3) in secondary schools, namely for the: Professional development of teachers; Curriculum development; Software/courseware development; Support services; Hardware development; and Program evaluation.

In 1984, the Computer Education Program had commenced making available $18.7 million for schools all over Australia. The Program took a whole curriculum approach and recommended that any computer educational programs were to be put in the context of the total curriculum (Commonwealth Schools Commission (CSC, 1984, p. 2). Likewise, the Program recognised the importance for a sufficient time period needed by teachers for their understanding of the computer technology itself, as well as for the gaining of the ability to work through the issues brought up when trying to implement computers into the whole curriculum (p. 3). Further, the Program recognised the importance of the whole school community, including parents, teachers and students all becoming involved in the decision-making process of the hardware to be bought and used in their respective schools (p. 3). The compulsory high school years were to be considered a first priority in curriculum planning (CSC, 1984, p. 6), followed by changes in the primary and senior secondary schools curriculum as a second priority (p. 6). The creation of an optional Computer Studies course to permit specialisation in computer science was to be of a third priority (p. 7). Such priorities might explain the slow exposure of the use of computers to the primary schools. Limited amounts of funds were made available for that purpose (New South Wales Government Schools Computer Education Co-ordinating Committee (NSWGSCECC), 1985, p. 3).

Students from disadvantaged backgrounds were also given consideration (CSC, 1984, p. 7). Further, the Program stipulated group instead of individualised competitive learning, with the creation of curriculum materials and processes to be supportive of that type of learning. Professional development activities were given high priority for the provision of funds for schools through the "Computer in Schools Program and from the Commonwealth's Professional Development Program" (p. 8). When mathematics was mentioned, special attention was to be paid to the, "full participation of women teachers, non-mathematics and non–science teachers and disadvantaged groups amongst teachers", that is those, "working in conditions or areas which make the provision of services related to computers difficult;" in other words, mathematics education was not given any priorities in the Program. Support centres were to be given some of the funding from States (p. 11). Funding was also to be given to tertiary institutions which were able to increase the number of teachers able to exhibit experience in computing topics.

Women were to be given special measures for gaining employment, in turn necessitated development of employment, training, and policies to encourage a growth in their numbers (p. 12). The supply of small grants was to be "made available for the support of innovative practice in schools" (p. 13). Also, it was suggested that for the relevant recommended hardware, that general purpose software be made available from Program funds (p. 14). It was considered a matter of urgency that the CSC develops mechanisms to:

- provide for the acquisition, adaptation or development of general purpose and subject specific software and courseware
- allow for appropriate marketing procedures
- assess the continuing software and courseware needs of schools.

The government accepted these conditions, "subject to funds being available from existing sources and advice from the CDC [Curriculum Development Centre]" (p. 14).

Software and courseware made and intended for widespread use was to be developed with a team approach consisting of "teachers, programmers and other qualified personnel" (CSC, 1984, p. 15). The programming languages that were chosen to be supported were LOGO, Pascal and BASIC (pp. 15 – 16). The Program was determined to "support software and courseware that meets educational needs and is free" from any form of sexism, racism, or social bias (p. 16). The NACCS recommended certain computers to be supported for purchase; however, the CSC and the government did not endorse that, suggesting that the more powerful and versatile computers should be purchased instead of the less advanced hardware (pp. 18 – 19). Reviews were to be regularly completed, to update the list of microcomputers to be used due to the improvements in technology (p. 19).

The Computer Education Program was administered in NSW through the framework of the "3 Year Plan 1984 – 1986" (NSWGSCECC, 1985, p. 3). The NSW 3-Year Plan had eight important elements: Professional Development; Curriculum development; Software/Courseware (Evaluation, Development, Provision); Support Services (Consultancy Support, Information Services); Hardware (Evaluation, Development, Provision); Special Initiatives; Evaluation (Program, Projects); and Administration.

3.2.2.1 Computers in Schools: A General Policy Statement

The NSW Department of Education saw the massive potential that the computer meant for education (in spite of its inability to predict the future in this regard), and in 1983 issued a policy document called "Computers in Schools: A General Policy Statement" on this topic (NSW Department of Education, 1983, p. 2). The policy provided guidelines on "the use of computers as a learning tool, as a focus for learning and as a tool for administration purposes" (1; C; 173). The policy which was intended to be phased in over three years consisted of categories for attention:

- learning about computers and computing
- using computers for learning
- using computers for management.

(NSWGSCECC, 1983, p. 12; NSW Dept. Ed., 1983, p. 4).

Also, it identified several minimal goals including:

- Each pupil should be knowledgeable of what the computer indicates for the individual and society.
- Each learner should feel and be capable of examining the implementation of a computer as a means for investigation and discovery.
- Each pupil should develop a perception of the large diversity of areas to which a computer can be implemented.
- Each learner should be given practical experience in implementing suitable "computer programs in simple, well-structured, problem-solving situations."
- Each learner should be conscious of the make-up of a computer program, without the added condition of having the ability to design one.

(NSW Dept. Ed., 1983, p. 8).

The Policy stated that the main aim of using the computer in education should not be job focussed (p. 8).[12] Rather, it pointed to the fact that the computer can cater for the individual needs and learning styles of students. Further, the Policy document argued for the importance of computers at all year levels, from Kindergarten to Year 12 (pp. 4, 6). It also mentioned that "learning about computers occurs not only through formal courses but also through the use of computers in a variety of ways, including their use as a learning aid across the curriculum" (p. 5). It anticipated the provision of "specialised courses in computing as an elective component of the curriculum; where teacher development in these specialised areas will be needed" (p. 6). Such provision may have prepared the grounds for the Computer Studies course to be introduced in 1988 into the Year 10 NSW School Certificate. The Policy statement stipulated that each school implemented this Policy in their own way (8; J; 382 – 383).

In summary, this overall Policy was "really little more than a set of rules governing the use of the computers in the school" (1; C; 173). The Policy considered concerns

[12] This may have disappointed some parents, who may have had employment opportunities in mind for their children with regards to them learning the computer in schools.

fairness and access by assuring that the “scarce resources were available to as many students as possible” (2; D; 181). However, more importantly, the contribution of this Policy was to highlight the belief that “learning benefits would accrue from use of the technology” (2; D; 181).

3.2.2..2 Primary Schools Finally Recognised

The first National Advisory Committee on Computers in Schools (NACCS) addressed the need for establishing “computer awareness and computer literacy experiences” for compulsory High School pupils as a first stage before implementing computers into the curriculum at the primary and senior secondary school levels (NACCS, 1985, p. iii). So, the government suggested that the Computer Education Program should be focused on compulsory level high schools, and then later to consider its use in primary schools; however, the Committee agreed, but suggested the necessity of the introduction of computers into primary schools to happen forthwith, even if it has to be as a “second stage” (NACCS, 1983, pp. iii & 23). The compulsory secondary years were considered the necessary option in 1983 by the NACCS, with the Primary and Senior Secondary years considered to be at a “second stage” (NACCS, 1985, p. iii). This was a recommendation that was “endorsed by the Schools Commission” as well as being “accepted in principle by the government.” With regards to using computers from Kindergarten to Year 12, there was a lingering “strong support [from] within the community” for a national program for all those years. The NACCS wrote in 1985 a document entitled “Teaching, Learning and Computers in Primary Schools”, where it considered the implications of a national program for primary schools and made a list of recommendations for the government to consider and endorse in order to extend the computers into the much neglected area of primary schooling. As of 1985, there were approximately 98 000 primary school teachers, and the ability to obtain the professional development of most of these teachers within what could then be considered a reasonable time-frame would be not be easy, mainly because of geographical factors (NACCS, 1985, p. 3).

It was understood by the NACCS (1985, p. 3) that for primary schools:

- computer equipment was a necessary component to be added to schools, in order to use the more powerful software that could provide the productive use of the computer and its associated technology in schooling;
- the support in the creation and design of higher value software" was recognized as important, as there was much material available at the time that was of inconsistent value
- there was little curriculum development available for the current existing software.

The use of programming languages such as BASIC and PASCAL were not advocated for primary schools (NACCS, 1985, p. 20). LOGO also was not to be seen as an end in itself; however, it was "seen primarily as a tool for presenting children with open-ended problem-solving environments" (NACCS, 1985, p. 20).

A problem that faced schools was providing the balance between obtaining as many computers as they could; providing students with the necessary access, and the problem of obtaining "powerful, versatile machines" that had the potential to deal with powerful software (NACCS, 1985, p. 22). This led to the other problem of whether to obtain the equipment at that time or to wait until better equipment came out, seeing that it appeared that the longer one waited, the better the deal that eventuated. The NACCS (1985, p. 34) acknowledged four main areas for technological advancement in primary schools; which were: "Research, Software/Courseware Development, Curriculum Development, and Professional Development." It was encouraged in that report that the respective primary schools should work with their community and that this relationship between the two should be acknowledged, developed and supported in a national primary program (NACCS, 1985, p. 28). And although this document did not in itself constitute policy, it was a definite first step for the government in that it provided outlines and recommendations for schools to implement.

3.2.2.3 Establishment of Government Bodies

Government involvement in activities aiming to enhance the use of computers in education occurred not only in the area of policy: Initiatives of funding to schools were gradual and varied. By the mid-1980s, 70 per cent of overall funding came from the state and federal government, with the rest of it coming from parent associations (Fitzgerald, Hattie & Hughes, 1986, p. 21). It was stated that the level of funding had not altered much through the preceding five years (p. 21).

Further, several special official bodies were established to provide support for the development of policies and for providing advice to the government. In 1983, the Computer Education Unit (CEU) was created (and officially formed in 1984) under the leadership of an advisor to the Minister of Education; after the Unit was formed the head of the Unit was classified as a Chief Education Officer (3; E; 197, 200). The CEU was set up as a NSW State Computer Education Centre (A. Tatnall; K; 437). State Computer Education Centres were setup across Australia, with the aim to provide both support and professional development to teachers involved in computer education (Tatnall & Davey, 2012, p. 246). Initially the Unit consisted of four people. "Computers in Schools: A General Policy Statement" document (as discussed above called) was funded by the federal government (3; E; 197 – 198). Two of the members of the CEU had a mathematics background; one had a mathematical as well as a computer science background, and one had a social science background (3; E; 200). The CEU was described by the NACCS (1983, p. 7) as a unit to bring "together work on curriculum development, the evaluation, development and distribution of software and other resource materials; consultancy, support and in-service education of teachers; and advice on the selection of computer equipment for schools." As mentioned by Tatnall and Davey (2012, p. 255), all Australian states, in the 1980s, had the "policy to recommend specific computer hardware for use in schools and so to comply with Government tender, offset and preferred supplier requirements. Government offset policy was designed to encourage local manufacture of computing equipment by requiring that foreign companies re-invest, in the state, 30% of the profits they made as the result of being nominated as a preferred supplier." This was a job that could not be completed centrally, nor could it be regionalised or given to individual schools due to economic reasons. It was a job that was completed by every State Computer Education Centre.

One major accomplishment of this group was the production of the Policy statement referred to above. Very quickly, and with the influx of government money from the Commonwealth, the Computer Education Unit grew from four members to thirty (3; E; 198). The CEU was involved in curriculum development. It worked with syllabus committees to develop new syllabuses or work with various committees on the integration of computers into adopted syllabi (3; E; 199). In addition to its Curriculum Development team, it established teams for Professional Development; Software and Hardware; Information Systems; and, Special Education. This was indicative of the wide range of responsibilities it was entrusted with (3; E; 198 – 199).

The CEU eventually took part in the actual implementation of the Policy statement discussed above by being participants of the Computer Implementation Coordinating Group (CICG) (3; E; 211 – 212). This body consisted mainly of members of the CEU, the NSWCEG, representatives from parent organisations and from the Premier's Department. The CICG was the body responsible for approving and monitoring all government expenditure on computers and education (3; E; 212 – 213). The CEU "started to fade in the early 90s" (3; E; 203), and this was due to a number of factors. First, "there was a lot more interest" shown by others so that the "job of the Unit in spreading the word and developing resources" ended up "being taken over more and more by regions and teachers," who "were starting to become more and more familiar with it" (3; E; 203). Secondly, the "policies were in place, the syllabuses had been developed, so the Unit no longer had a role there." Thirdly, there were also some political factors behind such a decision. The CEU was considered by some to be a "one stop shop," and "was considered to have maybe too much power and influence [be]-cause [it was] approached for policy decisions about various aspects of computers in schools" (3; E; 203).

The NSW government established bodies to consider the curriculum implications of the use of computers in schools. Prior to the early 1980s schools were "crying out for curriculum materials" and "software" (8; J; 370). The "Curriculum Project Team

(CPT)[13] in Computer Education" was formed by the Education Department for this reason. The CPT was formed in "about 1983" (8; K; 431). It was "responsible for curriculum planning," and the planning was to be implemented at all levels of education, from Kindergarten to Year 12 (8; J; 382). This Curriculum Project Team had three agendas which were: "learning about computers and computing, using computers for learning, and using the computers for management." These are the same as the three categories needing attention from the 1983 "Computers in Schools: A General Policy Statement" (see above in section 3.2). The "terms of reference" for the Curriculum Project Team as summarised by (8; K; 432) were to:

- "make a Curriculum Statement, for K – 12 on Computer Education,
- work out the need for and to produce support materials,
- evaluate existing learning materials,
- create new learning materials,
- create appropriate in-service,
- suggest a plan for implementation, and
- create a program for evaluation of curriculum implementation."

3.2.3 Programming

Increasingly in this Phase educators were questioning whether the link between mathematics and programming was a productive one. One negative opinion was that those who perceived programming as the only thing that mathematics teachers needed a computer for, "were thinking so unintelligently" (Messing, 1985, p. 102). Programming did not come without its problems. Wilcox (1986, p. 7) maintained that, suggested by "a growing body of research," the most common problems with programming faced by beginning teachers was the mathematical concept of a variable, which demonstrated that there were concepts that "did not work well with programming". With the widening applications of computers in schools and the availability of a variety of software applications, programming in schools had tended

[13]The difference between the CPT and the CEU was that the CPT set the policy and the CEU implemented the policy.

to decline (Fitzgerald, Hattie & Hughes, 1986, pp. 23 - 24). There was a reported increase of the use of LOGO in high schools at the same time (p. 19).

The study by Fitzgerald, Hattie and Hughes (1986, pp. 11, 19) considered the different uses of computers that became available in the mid-1980s. This study, along with Tatnall and Jenner (1986, p. 620), who found that "computers are currently used in many different ways in all parts of the school curriculum," saw that the implementations most used in computer studies included Word processing; Problem solving; Drill and practice; Information handling; Tutoring; Simulations and gaming and modelling; Spreadsheets; Graphics; Programming; and LOGO; Computer awareness courses; Tutorial; Electronic blackboards and Mathematics and Science. By the 1980s, computers had increased in their availability and flexibility in terms of hardware and software. These developments and the relevant issues associated with them will be discussed in other sections following.

Although computers had started to be used in school libraries and for computerising school records, the applications that were the least developed in this Phase were:

- database applications,
- specialist courses in computer studies, and
- computer-managed learning.

(Fitzgerald, Hattie & Hughes, 1986, p. 19).

The situation was not very different in the primary years. Fitzgerald, Hattie and Hughes (1986, p. 23) noted that drill and practice application were the most common usage of computers in the primary mathematics classes. While topics of data handling were playing an important role in the mathematics curriculum with regards to statistics, the use of spreadsheets was noted as very limited (Fitzgerald, Hattie & Hughes, 1986, p. 23). However, simulation and gaming applications were reasonably high. Simulation can be defined as "a representation of a real-world situation" where different "factors can change;" and "as they do, they produce other changes throughout the simulated world" (Kelman et al., 1983, p. 49). Because many of the relationships are complex, with the products being much of the time unpredictable, simulations created “a problem-solving situation in which decisions are made in light of past experiences and projected into the future” (p. 49).

Also, computer simulation games have been described by Newell and Pike (1982, p. 8) to be one avenue of providing students with practical methods in mathematics; being able to recreate real-life situations where a pupil can create a succession of choices and decisions concerning such situations, and providing the student with practical experience in decision making. The educational game is a “drill and practice activity in an arcade format” (Kelman et al., 1983, p. 54). They are quick “tests of cognitive and motor skills.” Further, educational games can utilise the graphical capability of the computer to increase their attraction for students with a potential of huge educational benefits. Many of the very “first educational computer games” were in fact mathematical games (Kelman et al., 1983, p. 1). One opinion was that games were good for supplying interesting and appealing situations for problem solving as well as giving motivation for drill and practice (Mocciola, 1977, p. 230).

Games such as *Green Globs* were seen as good at “cleverly disguising the learning experience and engaged students” (2; D; 177). *Green Globs* was a program that would plot “points around a coordinate axis” on the screen, and the pupils would have to work out what were the “equations of functions to pass through as many of the globs as possible” (2; K; 425 – 426). The range of activities was enough to test the students, with equations ranging from straight line graphs to parabolas, cubics and more. However, one problem with arcade type educational games was that although they were “intrinsically motivating, they were not intrinsically mathematical” (Kelman et al., 1983, p. 55). The abilities that these games developed could easily be gained from other subjects, such as “spelling words or social studies facts”. However, many of these educational games remained as “drill and practice activities in an arcade format” (p. 54).

While the previous programming languages discussed above were basically numerical, LOGO was a spatially based language. Seymour Papert was “one of the international gurus” behind the movement concerning LOGO (7; I; 348). LOGO had its beginnings in 1967 (Papert, 1980, p. 210). Papert “wanted it to have the power of professional programming languages,” yet also “wanted it to have easy entry routes for nonmathematical beginners.” The first version of LOGO was created in 1967 (Papert, 1980, p. 8; Sara Barnett, 2001; Wikipedia, 2012a). Papert popularised it with a book called “Mindstorms” in 1980 (5; G; 283 – 284). In the book, Papert makes the claim that “two major themes: that children can learn to use computers in a masterful way, and that learning to use computers can change the way they learn everything else – had shaped” (his) research (Papert, 1980, p. 8). Kelman (et al., 1983, p. 28) stated that LOGO “is an easy language with which to construct mathematical ideas.” LOGO became really popular, and *Turtle Maths* took off in a big way (7; I; 350). *Turtle Maths* involved the user working with either a robotic object called a Turtle, which was controlled by the computer and moved along the ground, or alternatively controlling something on the screen, such as a triangle (7; I; 350; and 5; G; 270 – 272). LOGO was seen by Interviewee 2 (2; D; 177) to be full of “possibilities” for “teaching mathematics through a problem solving and physical engagement approach.”

The robotic turtle would follow given instructions from the student (or teacher) to the computer. The turtle could have a pencil placed within it so that it could draw on a large piece of paper placed below it as it moved (5; G; 272). Only the schools that could afford the turtle could obtain one, and in that case there was only a few in existence (7; I; 350). When LOGO first became available the software “was very expensive for schools and schools were not super convinced of its use” (8; J; 361). Then there was free software that the Department of Education had developed that was given to schools to implement LOGO with Apple II computers (5; G; 286 – 287). It was noted that “in the poorer regions the schools were using drill and practice software because that was their focus and that's all they could afford, but the better-off schools were using software such as LOGO to promote higher order thinking skills” (8; K; 435). However, LOGO was not seen as part of the curriculum and hence did not appear in state examinations. Perhaps, this was the major cause for it not replacing BASIC as a main programming language in schools.

LOGO provided “a tool for experiment[ing] with mathematics, not for anything else” (4; F; 284). LOGO was seen as “a good environment for teaching mathematics through a problem solving and physical engagement approach” (2; D; 177). The claim was that LOGO helped students to become motivated and achieve good results (Betts, 1992, p. 8). LOGO was considered by some to be the highest suitable programming language for teaching and learning mathematics (Horton, 1987, p. 15). Quoting Noss (1983), Horton suggested that LOGO is a “natural, extensible and procedural” language, being usable by a large collection of age groups and capabilities via the turtle geometry. Taylor (1980, p. 9) noted that using the computer as a tutee with LOGO, where the child programs the computer as to what to do, the child would learn more deeply than by learning through software programmed by others.

During the 1980s, LOGO’s role in education had grown significantly – a pattern that would continue into the following Phase. Some of the complex topics that could be taught with LOGO were “drawing graphs using [the] concept[s] of the tangent, the angle of the tangent, and the drawing of parabolas” (5; G; 287). However, master[y] of one computer language is not necessary in this situation, but an overall understand[ing] of programming is, because it prepares “students to make creative and effective use of tools, ranging from word processors to numerical analysis programs, from graphics packages and drawing programs to full-fledged programming languages like BASIC and LOGO” (Kelman et al, 1983, p. 28). Bork (1980b, p. 77) recommended that students learn a number of programming languages, more than one, so that they develop a more reliable and precise idea of what the computer means for them, as well as for coaching the student for future implementations; suggesting that using only one language is too restrictive for students and would be unfortunate. Although programming was used in schools, “by the mid to late 80s, programming had all but died out. It was no longer required to be taught as the mathematics teachers handed over their special relationship with computers to the other subject areas” (2; D; 183).

3.2.4 Software

One observation about the use of computers in mathematics classroom practice in the early 1980s was that it did not utilise the full power of the computer, instead it maintained the traditional learning styles that had already been set in place (Wills, 1984, p. 90). During this Phase, the increasing availability of software opened new possibilities for the use of computers in mathematics. In particular, applications such as spreadsheet and word processing applications became widely available to schools (7; I; 336). The very first spreadsheet was called *VisiCalc*, which was released in 1983 (8; J; 370). The first word processing programs that came out around the same time were called *Sandys* and *Zardax* (8; J; 379 – 380; and 8; K; 431). There was a "big argument [about] which word processor was the best" (8; J; 370)). Perhaps the application of word processing software was limited in mathematics. However, the potential for the use of spreadsheets was well recognised. For example, they were seen to be a good tool to use in order to teach concepts of variables (4; F; 228), complete simple graphing of data, and demonstrate numerical differentiation (7; I; 351). However, their actual implantation into schools was slow, leading one Interviewee to raise the question whether "we [have] missed the boat because spreadsheets are used in industry, commerce, and many, many jobs," but not so in schools (7; I; 351; and 7; K; 434).

Similarly, software packages generally called Computer Algebra Software, in particular *muMath* (which in turn became known as *Derive*) attracted the attention of some teachers (2; K; 425). These packages were able to carry out all the algebra that teachers would "spend the high school years unsuccessfully trying to teach our students" (2; D; 177). Budgets for programs such as this "were tight, since I could not justify that it would be used by anyone other than me" (2; D; 177). Further, the advancement in the graphical capability of computers resulted in new applications – in particular those that allowed for the effective graphical representation of mathematical concepts. Graph plotters such as *ANUGraph* had become available on the Mac, and *CapGraph* was used generally on the MSDos computers (2; D; 177). The graph plotters were becoming very popular in schools, with one teacher finding that all of the group that were taught loved graph plotters. The reason why this appeal existed was “the immediacy, visual appeal,” and the “congruence with their existing experience” (2; D; 179). As explained by Kelman et al. (1983, p. 41), “computer’s graphics and animation capabilities” greatly “enhances classroom demonstrations”. The computer is capable of developing “colourful, clear, and precise displays” speedily and simply (p. 41). When numbers become visual, they “take on new meaning,” and they “reveal new relationships.” Functions, for example, can be represented through graphing programs which allow different functions to be drawn on the same axes very effectively.

The use of software such as Computer Algebra Software (CAS) was not without its critics or its share of problems. Some teachers saw that such methods for solving equations and even graphing were a type of “cheating … like they were looking up the answer in the back of the book” (2; D; 179). Students’ reaction to the use of such software was mixed. In every class, there would always be some students who would start off with a negative attitude towards the technology (6; H; 317, 319 – 320). On the other hand, some of the senior students, in the early days of computing, became more knowledgeable about its uses than the adults.

One can make an interesting observation here by comparing the wide acceptance of graphical software and the rather limited implementation of the spreadsheet application. One can argue that the graphical software fitted in more with what teachers usually teach in mathematics, and that they merely supplemented the type of activities teachers do. On the other hand, the use of spreadsheets implied new methods of teaching and also some changes in the content of the mathematics curriculum. Perhaps this partly explains their limited use within mathematics classes in this Phase. Similarly, new software allowed Geometry to be taught more effectively by computers than, for example “Algebra, Trigonometry, and Number Theory” (Fitzgerald, Hattie & Hughes, 1986, p. 5).

3.2.5 Hardware

The purchasing of computer equipment was made easier with Government funding, which was distributed as schools followed the directions given as a result of the evaluations by the State Education Authorities (Tatnall & Jenner, 1986, p. 619). "Once PCs[14] became popular[15] they took over because of affordability and familiarity; Apple computers remained popular amongst the few, and remain popular in a relatively small proportion of high schools (more popular in primary schools) (2; D; 183). Generally, PCs were chosen over the Apple because that is what the "teachers and students were more likely to have" in their homes, basing it on "the argument that 'that is what they will use in the real world'" (2; D; 183). Tatnall and Davey mentioned how the use of the Apple II, BBC, MIcrobee, IBM or Macintosh computers, made a "big difference to a school's computer education curriculum" regarding which type of computer was used, and the software compatibility of the computer (2004, p. 87). Tatnall & Jenner (1986, pp. 621 – 622) identified a limited range of computers were used in schools, and there were several reasons for adopting this plan. These included:

- aspects of software use were cheaper and easier
- the delivery of teacher in-service courses "was easier, cheaper and more effective"
- the costs of computer maintenance were cheaper
- the advice given by support centres was of higher value
- "the interchange of ideas, information, materials and support between schools was much easier" (Tatnall & Jenner, 1986, pp. 621 – 622).

It was estimated that computers were housed in separate laboratories in about 44% of schools, while 43% were housed in individual school classrooms. About one third of the schools had computers that were mobile between classrooms (Fitzgerald, Hattie & Hughes, 1986, p. 24). Variations existed between different types of school, with 82% of independent schools being computer equipped compared to the 67% of public schools and Catholic schools (Fitzgerald, Hattie & Hughes, 1986, p. 18). In the same vein, metropolitan schools had twice as many computers as the country schools (p. 18), however, it was noted that country schools were often quite small. The given

[14] PC here stands for IBM and IBM compatible computers: that is "personal computer; non-Apple computer (2; K; 426).
[15] The Interviewee mentioned could not give a date for this (2; personal correspondence; May 14, 2013).

tatistic was “one computer for every 123 students in city schools, and one computer per eighty-two students in country schools”, showing that the country schools may not have been so disadvantaged in terms of computer availability (p. 18). Socioeconomic background of the school was not seen as a factor in computer distribution, with 69% of upper socioeconomic schools, 67% of middle socioeconomic, and 69% of lower socioeconomic school having access to computers (p. 19).

Obviously, the cost of the computer was a crucial prohibitive factor in limiting its wide use in schools. The average cost of a computer had remained the same from early 1980 to the mid-80s. A typical price for a computer being $1 600, which was a significant amount of money at that time (Fitzgerald, Hattie & Hughes, 1986, p. 21). However, with costs remaining the same there was a huge increase in power (James, 1984, p. 244), and computers were seen as becoming more affordable. The purchasing of computer equipment was made easier with Government funding, which was given as schools followed the directions given as a result of the evaluations of the State Education Authorities (Tatnall & Jenner, 1986, p. 619).

There were also variations in the type of computers available in schools. In general, Apples were the most common personal computer used in schools in this Phase, with the Microbee coming a close second. However, there was a steady increase in the use of the MS-DOS (initially called IBM compatible and later Windows based) computer. By the mid-1980s, Apple eventually became the most popular computer product used in schools, due to the large increase of educational software available for it (5; G; 294). Table 3.1 (below) shows the percentage distribution of computers within NSW (Fitzgerald, Hattie & Hughes (1986). In the 1984 – 1986 Computer Education Program discussed earlier, a call was made for “more powerful and more versatile machines and not lower end hardware” to be supported and encouraged (CSC, 1984, p. 18). In 1985 more specific choices were made as the education department entered into a contract with the MicroBee, the Apple IIC, and an IBM machine (8; J; 407, 415). The NSW Education Department in fact “endorsed the MicroBee” (5; K; 437).

Table 3.1: *Type of Computer Use in NSW in 1985*

Name of Computer	Percentage Usage in NSW
Apple	37
Macintosh	2
Microbee	32
BBC	2
Atari	5
IBM	1
Tandy	3
Ohio	0
Commodore	8
Others	1

(Source: Fitzgerald, Hattie & Hughes, 1986, p. 21).

This variation in the type of computer adopted was also a function of the type of school using them. Public schools mainly used Apple computers since the Department of Education had a contract with Apple. However, "private schools … did their own thing," and usually ended up with the IBM at a higher cost (7; I; 337 – 338) or with the other competitors at the lower price range. In the mid-1980s, school computers were chosen by the State Education Authorities not because they were low in price or power, but because of the expectation that "they (would) be powerful, but also reasonably priced in order to be affordable in large quantities by schools" (Tatnall & Jenner, 1986, p. 621). They had to be "easy to use by students and teachers not familiar with computers." They also had to be "robust, reliable, portable, safe, and have adequate ergonomic features" due to the expectation that they were going to be used in different environments. Colour graphics was also seen to be important. It was stated that sophisticated computers were needed because "it is the unsophisticated users that need the most sophisticated computers." There was a need for a regulating body because if there was not one available "schools would be totally at the mercy of salespeople" (1986, p. 621).

When the Macintosh computer first came out, they were seen as a revolution due to the fact “that they were easy to use” (4; F; 237). However, they were more expensive for many schools. The IBM also came onto the scene, but they “weren’t in schools in very big numbers” until later (3; E; 186). The Apple did “certainly have a very strong presence in schools,” yet this “gradually diminished as Windows computers have become increasingly more affordable” (2; K; 426), particularly with the rise of IBM compatible computers. Arguably, another factor leading to the increase adoptability of the IBM (and its compatible) machines was that many of the members of the Parents and Citizens (P&C) organisations who provided funds for computers had business connections and thought that the IBM computer was more important because it was used more in “business” (5; G; 298 – 299). This was problematic because “there was no (educational) software available” for the IBM.

Not all computers had good graphics capabilities, especially the earlier models. The Apple had much potential “mainly because of the graphics” (8; J; 371). It had “colour, graphics and sound.” It seemed that graphics and use of icons had won over the business computers users at that time. However, this did create some tension between many schools who had based their purchasing decisions on educational considerations (including graphics and educational software capability) and other schools who were making decisions on future employment considerations.

3.2.6 School Subjects

By the mid-1980s, the majority of schools provided courses, at both the upper primary and lower secondary levels, which taught students the basics about “computers, how they are used, and the social effects of this use” (Tatnall & Davey, 1986, p. 620). The upper secondary levels had Computer Science/Studies and Information Processing courses which “were more specialised and academic, and in some cases give greater emphasis to the ways computers are used in business.”

In 1983 and until 1992, Year 10 classes in NSW were offered three-level courses in mathematics: Standard, Intermediate, and Advanced (5; G; 296; and 4; F; 222 – 223). For each course, there were core and optional topics (5; G; 296). Computer electives were regarded as optional in these courses and consisted of "*Data Processing*", *LOGO*, *Flowcharts*, or *BASIC programing* (5; G; 294 – 295; and 5; K; 426 – 427). None of these different courses had a core component related to computer use. These computer elective courses were extremely popular because they were perceived as a means of gaining employable skills thus providing students with an advantage over others (1; C; 174).

At the senior level, the subject *Mathematics in Society* also included computing as an optional topic (4; F; 218). Prior to the Internet, the applications of computers in this subject were considered to be very low. Students felt that they would be merely playing games with them (4; F; 232). Activities consisted of tasks such as: "write a code in '10 or 15 lines … to list … [the] numbers from 1 to 100, their square roots, cubes etc. No wonder students were rapidly underwhelmed (4; F; 231 – 232). The Maths in Society subject "went right up until 2000" (4; F; 221); but the computing element "discontinued from 1994, presumably because of the introduction of the HSC (2 Unit) course Computing Studies (5; K; 427).

Perhaps relevant in this context is the fact that computer use in this timeframe was escalating not only at school but at home as well. Fitzgerald, Hattie and Hughes (1986, p. 25) regarded the regular users of the computer to be those that "used computers at home, school or work at least once a week."[16] The study pointed out that the most likely teachers to be regular users of the computer were the new teachers – those who went through teacher training in the seventies and the eighties rather than those trained in the 50s and 60s (4; F; 229, 230 – 231). A study found that the regular users (as they defined it) "included 68 per cent of the students, 32 per cent of the parents, and 50 per cent of the teachers" (Fitzgerald, Hattie & Hughes, 1986, p. 25). The mid-1980s were the starting point for the use of computers as part of many students' lifestyles, with only 5 per cent stating that "they had never used computers". Twenty per cent claimed to have first used computers within the past six months; 26% within

[16] This definition is somewhat different to how a regular user would be defined today, where probably today a regular user would be defined as a much more consistent and persistent user.

the past year; 9% within the past two years, and 19% three or more years ago" (Fitzgerald, Hattie & Hughes, 1986, p. 33). It is interesting to point out that more students than teachers were judged to be regular users.

By the second half of this Phase, computer use had spread to most subjects in the curriculum. Some subjects that then used computer labs were "Geography; Commerce; Music; Home Science; Science; Careers; English; Remedial Studies; History, and General Studies" (Kazlauskas & Sheehy, 1987, p. 110). However, Messing (1987, p. 140) considered the development of the computer, where it was used for all subjects, to be a backwards step if computing was to be regarded as a definitive and distinct topic.

3.2.7 Professional development

Professional development courses for computer use in mathematics education had continued into the 1990s. Professional conferences played an important role for the peer exchange of experiences and resources. In addition to regular conferences including sessions on computer use, the Mathematics Association of New South Wales (MANSW) ran special in-service courses on the mathematical use of computers (7; I; 359). However, new opportunities arose. First, the main employer groups such as the Department of Education and Training (DET), responsible for public schools and the Catholic education system took some responsibility in providing in-service opportunities for teachers under its own jurisdiction. For example, the Catholic Education Office ran many courses for teachers in its schools (7; I; 366). However, for the Catholic system, there was some concern that these attempts to teach teachers how to implement this technology into their classrooms were, to a large extent, piecemeal (2; D; 184). The DET ran them for teachers of Government schools and the "Association of Independent Schools (AIS) ran in-service courses for teachers at independent schools" (7; I; 359).

Second, some of the computer companies themselves realised the need, and benefit, for the professional development of teachers in the use of their computers and software. For example, IBM, in conjunction with the University of Sydney, ran "quite a large program training teachers," in 1985, getting the teachers to go "out of schools for weeks on end," while "putting labs full of PC Juniors into classrooms" (3; E; 205)."[17] Five schools were chosen to be included in the Project, with "the major focus … around major applications software". A total of sixteen IBM Personal Computers were donated to each school, with the University of Sydney also receiving a donation of computers (3; K; 428 – 429). Similarly, the Apple company started to become involved and conducted several in-service courses and conferences (7; I; 359). These courses were mainly held at the regional level (1; C; 175; and 8; J; 410), where the different regions would determine their priorities.

Third, this Phase witnessed the rise of the NSW Computer Education Group (NSWCEG) as "a professional association representing educators from Pre-School to Tertiary using computing technology to enhance their teaching and student learning" (NSWCEG, 2011). The group was formed in 1984 (G. Preston; K; 434). When the NSWCEG started, it was arranging conferences and meetings regularly (7; I; 343; and 7; K; 424) as well as conducting in-service courses for teachers (3; E; 206). The NACCS (1983, p. 7) acknowledged that the NSWCEG was making a valuable contribution to the professional development of teachers. The group also would supply members to "work on committees or to go into consultation … [and give policy] advice" to "syllabus committees and in policy groups" (3; E; 206, 210). Sometimes "people in the Computer Education Group would also work in the Computer Education Unit" (as discussed above), to write [curriculum] materials (3; E; 207).

In the 1980s, one deputy principal ran in-service courses in his school on a variety of topics for teachers using *Microsoft Works*, which was a "combined word processor, spreadsheet, and database program" (4; F; 218). During this Phase, the issue of the professional development of teachers had become a subject for direct research investigation. In 1986, most teachers were found to possess no training in computer courses in their pre-service teacher education (Fitzgerald, Hattie & Hughes, 1986, p. 25). This is an important fact, because the same authors had found that the teachers

[17] The PC Junior was an IBM personal computer model available at that time.

that had as little as “a few hours to less than a week of in-service courses” were maintaining regular use, in contrast to the non-users who did not receive any training. Regular users had substantial pre-service or in-service training; however, most of the teachers at that time did not attend computer courses in their initial training (p. 25).

3.2.8 Arising Challenges

As in the previous Phase, the literature and the interviews identified several hindrances facing mathematics teachers in introducing computers into their classrooms. First, there was the problem of competition with other school subjects for access to the limited available computers in the school. This situation commenced with mathematics educators making the most use of computers, due to their early “inclusion of a computing topic in some senior syllabuses” (1; C; 172). As discussed earlier, with the advancement of software and new directions in Government policy, these events challenged the dominance of mathematics with regards to computer use in education. Slowly, other school subjects began to incorporate computers into their teaching starting in the early 1980s (3; E; 192 – 193). For example, the *Fourth World Conference on Computers in Education* was held in 1985 and it included several sessions on the educational use of computers, the majority of which were not concerned with mathematics at all (3; E; 193).

Schools started to house computers in computer laboratories. Funding for these laboratories came from the schools themselves, which were backed up by government funding to assist its set up (2; K; 425). Competition for the use of these laboratories started to grow – for example, one interviewee pointed out that the Social Sciences teacher numbers were growing in their use of these laboratories, “overtaking the use by the mathematics department” (2; D; 177). This was most likely because the number of available computers in the school was not sufficient to meet the increasing demands for them.

Not everyone believed that the computer was useable and able to replace the teacher. Blundell (1986, p. 148) stated that although the computer can compete with the teacher with its speed of working out calculations and in its ability to deal with many students one at a time (if adequate numbers of computers are present), it cannot however relate as simply and cleverly as the teacher alone. The conclusion reached by Blundell was that a mixture of both computer and teacher should be used. Also, computers were not entirely fool proof; if they failed, the "teachers had to be flexible in their planning" (1; C; 172).

According to Fitzgerald, Hattie & Hughes and Interviewee 1, some of the most significant problems with introducing computers in the mid-1980s were:

- insufficient computers for the respective classes
- not enough funds to buy hardware
- not enough teachers with specialist training to act as resource teachers
- teacher education institutions failing to provide adequate preparation in the educational use of computers
- insufficient appropriate in-service courses
- an unsuitable range of software – where the computer industry was not oriented towards education concerns – which changed rapidly with the realisation that there was a huge market waiting for decent software
- too little … [was] known about how children learn when using computers.

(Fitzgerald, Hattie & Hughes, 1986, p. 23; and 1; C; 172).

Many parents and teachers were seriously considering the part that computing played in education and what they could and should do to influence it (Taylor, 1980, p. 1). Although Taylor (1980, p. 1) noticed that the application of computing to education was less than 25 years old, it was poorly handled with regards to the public, in spite of the large amount of materials that had, up to that time, been collected. Unfortunately, the media had generally focussed and overrated a small collection of improvements while neglecting to mention other developments (Taylor, 1980, p. 1). One area that Sandry (1982, p. 53) regarded as requiring urgent attention was the creation and production of effective teaching methods using the computer. Blundell (1986, p. 151) quoted Alderman (1978) as stating that software which permits the pupils to learn at their own speed runs the danger of losing those students who cannot achieve or accomplish their own education and knowledge gathering.

Problem solving was (as noted earlier), initially the main use of the computer. One problem with addressing the problem solving aspects of the computers was to focus primarily on its problem solving capabilities and in doing so just perceiving "half of its mathematical potential," whereas the often other ignored potential to look at is to deal with the "mathematical ideas embedded within the programming activity itself" (Wilcox (1986, p. 7) quoting Noss (1983)).

3.3 Proliferation Phase (Late 1980s to Early 1990s)

3.3.1 Relationship between Computers and Mathematics Education

As discussed earlier, in the first Phase, mathematics had a stronghold with computers. This stronghold began to diminish in the early 1980s, had almost disappeared by the late 1980s. This was in line with the Governmental policies and programs, and with the advancement in multipurpose and powerful software. Computers had become much more user friendly, not only for students but more importantly for teachers. One Interviewee noted that the leadership that mathematics had possessed concerning computers mostly ended with the "drop down menu and icon driven programs;" stating that "if it wasn't gone completely [in the 80s] it certainly disappeared in the 90s" (4; F; 247, 248). This also, coincided with the rise of Computer Studies as a distinct school subject in the curriculum. It is worth pointing out though, that many of the Computer Studies teachers came from a mathematics background. However, with the establishment of computer studies qualifications at teacher training institutions, and computer teaching in schools was seen less and less as a part of mathematics. One of the Interviewees for this research made the observation with some concern, that when "teachers in other subjects seized on using computers", mathematics teachers were a little less enthusiastic about developing the use of computers in their own classes (6; H; 329).

Nevertheless, by the late 1980s and early 1990s, there was a great sense of optimism in educational literature about the potential use of computers in mathematics education. Combining the power of the computer with that of mathematics was believed by Mathias (1988, p. 2) to give the student access to "two of the most powerful analytical tools available to man," and by using them on real world information, the students would cultivate "skills and knowledge of direct relevance in everyday life". At a time when the computer applications to mathematics had increased to a level that raised the question as to the very nature of mathematics and its role in education, there have been questions whether the curriculum itself had significantly changed to meet this challenge.

During this Phase, there was a significant increase in computer applications within mathematics taught in schools. Kissane (1990, p. 57) has indicated that software was available for "expanding and factorising expressions, solving equations, systems of equations and inequalities, evaluating limits, differentiating, integrating (both definite and indefinite integrals) and summing series". Similarly, packages such as spreadsheets lent themselves to empower the student with greater understandings and skills in mathematics (Meade, 1989, p. 71).

Donelay (1991, p. 75) pointed out that the mathematics curriculum had, traditionally, avoided focussing on things that were relevant to people's real world outside of the school and had "little or no experiential learning activities to help students relate topics to their everyday lives". With the wide availability of the computer, a potential for change had dramatically increased. Donelay claimed that technology had created a necessity for a reconsideration of the aims of mathematics teaching to meet the demands of an advancing technological society that required an increase in the comprehension of mathematics – yet perhaps a different type of mathematics that was based on simple calculations and procedures. Hence, at a time when computers provided the greatest opportunity to reform mathematics education, it failed to do so. The situation in Primary years was not so different to that in Secondary Schools. Computer use did not play a major role in the NSW late 1980s K – 6 mathematics syllabus (NSW DSE, 1989b); in fact Lewis (1993, p. 219) stated that: "the issue of how the curriculum may be influenced (or ultimately transformed) by computers is unfortunately only briefly addressed in the support statements provided, even though they acknowledge that computers may provide a means of linking physical, pictorial or symbolic representations."

One can question why this might have happened. For one Interviewee at least, this situation followed the pattern of the traditional conservatism and lack of flexibility often claimed against the profession (2; D; 177). The Interviewee went on to say that the prevailing culture of mathematics teaching at that time placed emphasis on and gave value to teacher-centred learning, with chalk and talk being favoured over students' independent work (2; D; 177; and 2; D; 179). "Mathematics teachers stayed consistent in being "unconvinced that they really needed to change their practices: chalk and talk worked well for them, it was how they were taught, and it was quick and efficient;" this being "more so than explorations and investigations, which were very time-consuming" (2; D; 182). For mathematics teachers, it was easier to 'show them'. "This culture of teaching and learning made the technology an optional extra in the mathematics classrooms – something to fill in a Friday afternoon or if you finished the program early" (2; D; 182).

Another obstacle that kept teachers in need of computer laboratories was the "means of display" (2; D; 177). Dailhou (1991, p. 67), based on observations by Wiske (1988), described how many teachers aspired to remain the centre of attention of the students and that the computer actually acted as a source of rivalry in the classroom. However, Fitzgerald, Hattie and Hughes (1986, pp. 23, 30) studied attitudes and found that the fear of a reduction of the teacher's role in the classroom due to the computer was a problem of least concern.

Interviewee 2 concluded that there was an "unwillingness to change behaviour on the part of teachers" (2; D; 179). Innovations that did not produce definite exam improvements were not deemed to be warranted. This conservatism was not a problem of individual teachers. It was a manifestation of the "prevailing culture of mathematics learning, especially in NSW" (2; D; 179). This prevailing culture in NSW was one "which valued individual unassisted completion of set tasks." This Interviewee contrasted NSW mathematics teaching with other States such as Victoria, and maintained that the other States exhibited a much less resistant attitude because they "explicitly valued problem solving and collaborative learning" (2; D; 179). This Interviewee, who has "carried out Professional Development (PD) in hundreds of schools across Australia and overseas," found that the "vast majority of NSW teachers remain highly conservative and critical of technology" with only "10-20% of teachers embracing the technology; for the rest, it was all too hard, for all sorts of reasons" (2; D; 181). Even those who initially were quick to experiment with the use of computers in mathematics education (some had some "early flirting with technology"), remained stuck " in the 50s as far as curriculum and pedagogy were concerned," all the while complaining bitterly that their students were not learning and were disinterested and disruptive (2; D; 182 – 183). Not "all that much has changed in NSW schools" (2; D; 181). Acknowledging that there could "be a grudging acceptance that some of it is okay," there were just "too many obstacles to teachers actually using it in their classrooms" (2; D; 181). There was a "natural conservatism on the part of maths teachers, and a lack of understanding on their part that the ways in which they were taught did *not* work for the majority of students, only for the few" (2; D; 182). Therefore the "changes, in effect, were more about teachers *not* changing." The computer laboratory also was "always booked for computer studies or [for] social science" (2; D; 181).

However, the lack of willingness by teachers to adopt the technology goes beyond their own personal preference to a teaching style. Mathematics teachers are always aware of the heavy demands that the curriculum places on them (Porter, 1988). Approximately in (and possibly before) 1993, some changes were being made in the syllabi of various subjects, however the changes were made mostly in adding extra material inside, by this time, an "already full curriculum" (Samootin, 1993, p. 132). In other words, while one can argue that a reconceptualization of the curriculum in the computer age was necessary, the computer was merely drafted onto the traditional curriculum. Arguably, mathematics teachers were more subject to curriculum pressure due to the hierarchal nature of the discipline and its perceived importance for further studies and real life. This problem of putting computers into mathematics was seen as an addition to the curriculum rather than a replacement of some traditional skills, procedures and materials (Felton, 1992, p. 128). Similarly, performance on mathematics tests was often judged as the ultimate indication of the success of both the teaching and learning of mathematics. There was considerable teaching, too much for students to learn, and if students were found to fail in exam improvement, their use, therefore, "could not be justified" (2; D; 179).

It was claimed by Newton (1987, p. 22) that computers were likely to alter the very look and face of mathematics itself, and that this had already happened in the workplace where mathematics was implemented as a tool (that is, it was used to complete work-related tasks). This author gave the case of spreadsheets being used by the practising mathematician, actuary or statistician, which provides an example showing that software used for mathematics can be used in the workforce. Porter (1988) noted that the early computers were basically good at dealing with numbers because the data input into the computers was numerical (p. 12). Sometimes the computer was only used as an electronic blackboard (that is, like a blackboard but the information was delivered through the computer; probably through a projector); and using the computer this way was considered by Kissane (1990, p. 48) to be a powerful idea (possibly because the teacher can present the ideas logically and can implement changes to the text to display corresponding ideas easily and as soon as they are needed).

In Kissane's (1990, p. 61) opinion, the implementation of educational computing into school mathematics had taken an unproductive and hazardous approach; mostly because of the belief that students learnt about the computer, but did not particularly learn how to use them as tools: "there's not much point in learning how to use a tool that isn't in your toolbox." Also, according to Mason (1992, p. 91), the computer was introduced into education because after some time it was seen to be an excellent tool for improving the educational experiences of pupils of all ages.

As mentioned earlier, mathematics and problem solving are closely related. And as stated previously, authors promoted the relationship between computers and mathematics and were in favour of the implementation of the computer into mathematics education. This can be seen by the argument that computers, if used correctly in schools, can be a means of promoting problem-solving skills (Porter, 1988, p. 28). Problem solving and all of the positive benefits provided by it, can occur with the responsible implementation of the computer (Wesley, 1988, p. 120). All levels of the Computer Studies syllabus stress, as a major objective, problem solving skills (Chopping, 1988, p. 223). These skills are practical for all components of the curriculum. One of the most fundamental reasons for educating with and about computers is to implement this tool to solve problems (p. 223), hence the shift in problem solving tools for computers transferring from mathematics to computer studies. In fact, with the rise of the Computer Studies subject, the subject started to "monopolise access to the computers, restricting that access for all except those students and teachers involved" (1; C; 174).

3.3.2 Programming

During the late 1980s and early 1990s, the function of programming in schools had undergone major changes. For example, the teaching of programming languages remained in the HSC curriculum in this Phase, with the NSW Board of Studies continuing to provide a choice between BASIC, Pascal, Pseudocode or LOGO in schools (Samootin, 1992, p. 275). Messing (1988, p. 249) suggested that learning to program properly, enabled and aided pupils to grow into thinkers. Seeing that most schools did not have near enough hardware for their students, Messing (1988, p. 255) noted that programming could be still done mostly without hardware, and stated that such a deprived situation might be beneficial; this is because it could allow students to use their time more effectively programming on paper than via the computer. One interesting insight about a relationship between programming and mathematical problem solving came from Downes (1988, p. 235), who claimed that for an initial course in programming, it was challenging and difficult to discover a usable selection of relevant, non-mathematical problems for pupils to learn from and work through, showing that at this time, obtaining suitable mathematical problems for the computer was not too challenging.

Students and the general teacher have difficulties with programming, and this restricted the total amount of potential users of the computers, particularly when programming skills were, at that time, an essential requirement for its use (Bella & Gow, 1987, p. 2). Messing (1988, p. 249) believed that, in the late 80s, even with software, the students did not feel in control due to the fact that what they did was dictated by the specific software that they were using. However, with programming, students and teachers considered that this is where they could be in control of the operations of the computer. Having this control may allow for better performance, as Horton (1987, p. 15) argued that the general view at that time was that programming was not the only means to aid student's towards better performance in mathematics, however it was thought to be one of the more successful ways of achieving that.

The community perception in the 1980s was that it was not actually considered to be computing unless one was engaged in some programming (Sheerin, 1989, p. 197). However, the role of programming in general diminished significantly during this Phase. The emergence of powerful and multipurpose software implied that the singular connection between programming and problem solving in mathematics had been questioned, and it opened the door to develop problem solving through other computer applications. Similarly, the argument that programming allowed students to develop computer literacy had weakened: for example, McCluskie (1988, p. 242), who although stating that there were many people who in practice related or confused computer literacy with the skill to program, maintained that programming was a skill not needed for surviving in the information society. With the rise of computer studies subjects, programming moved out of the mathematics curriculum and into the arena of specialised subjects preparing students for further studies in computing. However, students participating in these courses still represented only a few hundred out of the total 67 000 students in the HSC (4; F; 237).

Seymour Papert had launched a team in order to create the LOGO programming language (Frost, 1989, p. 41). LOGO was created to help students "communicate with a computer in a natural way – without being taught" by a teacher on using the computer. Papert claimed (1980, p. 54) that "the mathematics of space and movement and repetitive patterns of action – is what comes most naturally to children. It is into this mathematics that we sink the tap-root of Turtle geometry." This was all based on a theory by Piaget which states that people learn through doing.

LOGO had risen over the years in popularity. It was seen as good for students in that it provided an opportunity for them to feel in-charge of the computer. LOGO serves as an excellent way to have students start on the computer and grow in their "problem solving, inquiry and social skills" (Porter, 1988, p. 92). It remained a language of choice in some schools with its improvements in its user friendly interface, such as LOGOWriter, and the addition of robotic, graphical and musical capabilities (Samootin, 1992, p. 276; Placing, 1992, p. 164).

However, these developments implied that what was initially considered a mathematical environment was increasingly used by teachers for: geography (for graphing capabilities); science and related engineering subjects (for exploring the control of machines); computer studies (who "see the logic system advantages and programming advantages"); and English and language teachers (who liked the "absolute need for correctness in spelling and grammar") (Fraser, 1991, p. 246). Further, Ross (1989, p. 165) believed that LOGO gave the pupils an opportunity for discovery learning, to grow in problem solving skills as well as their logical thinking, and for them to search and investigate their innovative gifts and skills while simultaneously becoming used and accustomed to a number of the potentials and restrictions of the computer.

Rice and Crouch (1990, p. 468) claimed that a positive aspect of LOGO was that it could enable students to discover strong and powerful mathematical concepts in a spontaneous, natural manner; however, they noted that the connections made from what happens mathematically in the classroom and what occurs in the computer laboratory are not always there – meaning that the pupils will not always gain the positive potential mathematical profits from programming with LOGO. Oakley (1987, p. 174) believed that students are taught two sorts of knowledge categories, namely the mathematical and also one concerning learning ("mathetic" knowledge). Looking at his popular book "Mindstorms," Papert suggests (1980, p. 52) that mathetics "is the set of guiding principles that govern learning." And Papert mentions that what was taught in the classroom possibly related mostly to the technology available at the time, which before computers was pencil and paper; and with computers "the range of easily produced mathematical constructs will be vastly expanded," thus changing the range of topics possibly to be discussed. LOGO helps the student to learn through personal experience (Frost, 1989, p. 41). It turns the computer into a tool which students use to reinforce their thinking. It can be used in a way where students learn at their own pace, in any order. It provides the student with a positive way to interact with the computer.

It was found, in the late 80s, that students found LOGO activities, though challenging, to be motivational and an interesting method to back up their comprehension of the mathematics covered in the classroom (Horton, 1988, p. 50). However, this does seem to contradict the point, mentioned earlier by Rice and Crouch (1990, p. 468), that students were unable to make a connection between what they learnt in the classroom and what they learnt with LOGO in the computer laboratory. LOGO is more than an isolated subject about computers, it is a language for discovering materials, "developing skill areas, solving problems, building intellectual structures, exploring language and communication, with students obtaining levels of success regardless of their skill levels" (Frost, 1989, pp. 44 – 45). Using the computer in this way allows and inspires students to be risk takers, to investigate and research, as well as to make choices and draw conclusions (Ross, 1989, p. 166).

Other literature points out several benefits from the use of LOGO in education both for, and in addition to, developing problem solving: Au (1992, p. 27); Porter (1988, p. 92) and Gibbons, (1989, p. 53). Wesley (1988, p. 121) considered LOGO to be ideal for problem solving as did Fraser (1991, p. 246) who claimed that LOGO was considered to be one of the best for problem solving environments. LOGO was also helpful for logical thinking according to Betts (1992, p. 8). LOGO has been considered to be the nonprofessional computing language (Samootin, 1992, p. 275), ideal for the students' independent learning. It is a computer language that can be used at a very basic level, to be used with lower level students (e.g. to teach directions and drawing simple geometric figures), and yet can be developed at complex levels of high school (for teaching algebra and problem solving, for example) (Samootin, 1992, p. 275).

3.3.3 Software

Earlier software that became available during the previous two Phases raised several concerns. Kissane (1990, p. 48) mentioned that in the 1980s, much of the available software was developed on the assumption that there was only a single microcomputer in the mathematics classroom, and software was therefore developed for demonstration purposes only (this could possibly be because this was the way mathematics was perceived to be taught). In some instances such software was designed to replace a textbook based on elaboration of concepts with pre-designed worked examples. Kissane (1990, p. 48) regarded the use of the computer to display textbooks or to give a drill approach to pupils as a "silly" way of utilise the power of the computer. Wharton (1989, p. 109) suggested that it was possible for the computer to provide the necessary examples that are important for concept formation. From a different viewpoint, Bella and Gow (1987, p. 2) noted that although most software packages sold commercially were of the drill and practice type, there was, in the late 1980s the development of open ended software where the user had the investigative control, using the computer as a means to solving problems.

By the early 1990s, several trends have been noted in the availability and use of software in many schools. During this Phase, there had been an increase in schools of commercially available software developed for the "business market". Such general applications software included word processing packages, spreadsheets, and databases. One possible reason for this development was that the writers of the software "got better at the user interface, so that kids could use it more easily" (6; H; 325). Similarly, such software was increasing in its power and flexibility. In January 1985 *Microsoft Office* was released (Wikipedia, 2013a) and in September 1987 *Microsoft Works* was released (Wikipedia, 2013b). However, "before Office was affordable people just had Works" (7; I; 341). In 1992, MS Works had become available for all computer environments; it had developed into an unofficial standard to be used in education (Samootin, 1992, p. 274).

One argument for the use of business software was that it offered the experience which could aid the student to “develop the type of abilities that thinking business people are asking for” (Dyson & McShane, 1989, pp. 157 – 158). However, there was a danger in using such software in mathematics classes: Kissane (1990) argued that spreadsheets were mainly used due to the fact that they were available and accessible, and not because it was the most effective and useful instrument teaching mathematics. Kissane made the distinction between teaching students how to *use* the spreadsheets and teaching students how to do *mathematics through* the spreadsheets.

It is worthwhile here to focus on three developments in software that were significant for education. First, developments were made allowing word-processor programs to include the ability for the user to type in mathematical symbols with what became known as an equation editor, and to create mathematical diagrams and tables through applications such as “Formulator, (MacAuthor,1986); TeX and TechWriter; Word 4 and 5” (Lander, 1993, p. 79, 82; Sheerin, 1993, p. 85). TechWriter, developed in the early nineties, had the capabilities to deal with determinants and matrices (Lander, 1993, p. 82). This was an interesting turn, which would make the computer more relevant to the student of mathematics than ever before. Second, in 1984 *HyperCards* software came in before Hyper Text Markup Language (HTML) and the Internet, from the early days of the Macintosh (3; E; 202; 7; I; 365; Wikipedia, 2012b; Computer History Museum, 2006). HyperCard was added to every Macintosh sold, and for current owners, it came at a cost of $70 (Messing, 1988, p. 171). The concept consisted of developing a document (called a ‘stack’), which comprised of many pages (called ‘cards’)” (7; K; 429 – 430). Inside each document you could place what was called hypertext links. The user could click on the links and go to another page or card in the stack. Such software was “a great tool for teachers” (3; E; 202). The teachers could “then develop a sort of database with interactive type application” (3; E; 202) to provide features such as virtual tours of certain locations or interactive games. Special mathematical HyperCards, for example, on algebra, were developed. Such software allowed for the combination of several tools such as "text, graphics, sound, animation and video" through the medium of the computer (Luke, 1991, p. 381; Messing, 1991, p. 386).

Third, Geometer's Sketchpad was also a useful program at the start of the 90s. It was implemented by some early adopters, namely the "teachers who came on board early and got proficient at it;" they were definitely more confident at its use in their classes (4; F; 242). Geometry programs (such as Cabri Geometry and Geometer's Sketchpad) allow the students to "get to an understanding of what a shape is" (6; H; 318). These programs "allow for creativity and the use of the imagination." Also, in some schools Calculus was learnt through "*A Graphics Approach to Calculus*," produced by David Tall; which dealt with many aspects of the Calculus curriculum via the computer (6; H; 314, 331 – 332).

Doig, Carss and Galbraith (1992, p. 159) cited that they had identified over 20 examples of computer use (for all year levels) from the literature, from primary to tertiary; with the usage ranging from using "spreadsheets, computer graphing packages, computer assisted instruction and a variety of specific software packages." Mathias (1988, pp. 4, 5) maintained that there were several obvious applications for the use of computers in mathematics, including: "spreadsheets, databases, using LOGO for logic development, using LOGO for limits and approximation work in calculus, Lego robotics controlled by computer, probability software, statistical analysis, graphical presentation, and report writing." Mathias (pp. 3, 4) also classified software into the following ten types: "Information Retrieval (or Database), Data Analysis, Drill and Practice, Games, Modelling, Simulation, Tutorial, Programming Languages, Applications Packages, and Teaching Support." One problem, in the late 1980s, was suggested by Mathias (p. 4) to be that most of the mathematics software packages were only suitable for use with the primary and/or lower secondary levels, and the higher secondary had just a few packages. The software packages that were available for upper Secondary in the late 1980s were mostly of a utility type and gave a means for data storage, data analysis, graphing or presentation purposes (Mathias, 1988, p. 4).

NSW Parents and Citizens (P&Cs) associations spent over six times as much as the government on school computers, according to the P&Cs annual report, and Messing considered the government's contribution to be paltry (Messing, 1987, p. 145). Also, software budgets for schools were described to be usually quite small, if there was a budget at all. One problem mentioned by Messing was that schools would make as many backup copies as needed by the school, but the actual licence did not allow for that. This problem would only get larger as time went on as schools purchased more and more computers. To get improved deals on software, Messing (1987, p. 145) found that schools by themselves would not have the authority or influence to negotiate on these matters. Looking for a solution, Messing noted that the Department of Education would have had the necessary power to obtain a better deal; suggesting that they should do so for schools with every software package, or they could also create all of the school's required software. Kissane (1990, p. 63) recommended consistency in the type of software used throughout the grades – and noted that the importance of this could be seen in the consistency of the calculators usage throughout the school.

A related problem with software availability for use in mathematics education was its cost (Mason, 1992, p. 92). When software with educational applications first became available, the schools' budget was fairly restrictive and therefore would not allow for the purchase of a wide variety in software. Many schools had hardly sufficient funds to invest in such a resource. Hence, software had to be selected with care. Arguably, powerful software is expensive to develop. There was also a perception that educational software was overvalued – just for being labelled educational (p. 91). In some instances, this may have led to illegal copying of the software (Mason, 1992, p. 92). However, thanks to the generosity of dedicated programmers, a new phenomenon arose in the availability of what has become to be known as Shareware, Freeware, or public domain software which although may not have been as good as the expensive, commercially available software, did provide a cheap alternative (Preston, 1992, p. 97). Shareware and Freeware first became available around 1981 (p. 93). At times, this shareware did lack somewhat in the quality, reliability and attractiveness of the commercially available software. However, in many cases it provided for the genuine need when alternatives were limited. Messing (1987, p. 145) complained that another problem with software was the need of schools to buy large volumes of this resource, which was required to be supplemented further and upgraded more often than the hardware needed to be. Software costs remained a problem for many schools.

In 1987, the National Software Co-ordination Unit (NSCU) was formed (Krystyn, 1987, p. 124). Its agenda concerned educational software and computer related learning materials, and the provision of information concerning this nationwide as well as the coordination and provision of information concerning the development of this educational software (p. 124). Krystyn (1987, p. 124) claimed that the NSCU was well positioned to gather and assist consultations with regards to educational software between groups concerned and involved with it. The NSCU had two major goals:

- to provide information nationally about educational software and computer related learning materials, and
- to coordinate and provide information about the development of educational software (Krystyn, 1987, p. 124).

The Curriculum Development Council aimed to labour in close collaboration with education systems in the States and Territories, with the main concern being software (Krystyn, 1987, p. 124). The Curriculum Development Centre and Curriculum Development Council[18] both referred on a more informal basis with a broad variety of interest groups (p. 124). The Curriculum Development Council appointed a feasibility study to examine, in Australia and overseas, software review

[18] “The Curriculum Development Centre flew a representative from each State to meet together trying to form a common curriculum” (8; K; 436). “The Curriculum Development Council seeks to work in close cooperation with education systems in the States and Territories” (Krystyn, 1987, p. 124). “The Council meets regularly with Directors of Curriculum from education departments and liaises with non-government schools and systems. The Council and Centre also consult on a less formal basis with a wider range of interest groups in the education community.” The Curriculum Development Centre “has a small permanent staff who provide support for approved projects and who work to maintain and develop a cooperative climate for curriculum development on a national basis. The Curriculum Development Council aimed to labour in close collaboration with education systems in the States and Territories. The Curriculum Development Centre and Curriculum Development Council both refer on a more informal basis with a broad variety of interest groups.”

and evaluation (Krystyn, 1987, p. 125). This was due to the NACCS[19], in 1983, displaying the necessity of national efforts and of resources being coordinated. Also, the NACCS suggested the great necessity and potential of a group that collects and gives information on software giving help to educational systems and schools in developing the most useful implementation of software resources for education. As a part of the feasibility study, the *Schools Computing Online Resources* (SCOR) was developed; this was an electronic database that consisted of software reviews (p. 125). This feasibility study was finished in 1986. Upon the finalising of the study, the Curriculum Development Council put money towards a Working Brief for the NSCU, for the Working Brief's "comprehensive planning and development," with planning involving "extensive consultation with educational systems" and other skilled assemblies (Krystyn, 1987, p. 125). To create the Working Brief, a Working Party was developed to get submissions from a broad variety of groups, to look over and contemplate them (p. 125).

It was noticed that the software development teams in education systems did not provide much collaborative work, avoiding official and organised discussions and transfer of information between respective teams (Krystyn, 1987, p. 125). Meeting for the first time in April, the Software Co-ordinators' Advisory Group (SCAG) was established, meeting for once a year at a minimum, to converse about matters relating to activities of the NSCU (Krystyn, 1987, p. 126). An electronic database was to be distributed across the Australian Schools Catalogue Information Service (ASCIS) and was linked through the Australian Curriculum Information Network (ACIN) (Krystyn, 1987, p. 127).

The information contained in this section about software, has been summarised in the Timeline for Section 3.3.3 on page 107.

[19] As defined before, this is the abbreviation of the National Advisory Committee of Computers in Schools.

1981	• Shareware and Freeware became available
1983	• SCOR, a feasibility study was begun
1984	• HyperCards became available
Jan 1985	• Microsoft Office released
1986	• The SCOR feasibility study had finished
1987	• NSCU was formed • The SCAG was established
Sep 1987	• Microsoft Works released
1988	• A Graphics Approach to Calculus was released
Early 1990s	• Business market software became available (i.e. word processors, databases and spreadsheets)
	• Geometer's Sketchpad was marketted
1992	• MS Works became available for all computer environments
	• End of studied era

Timeline for Section 3.3.3: Software use over the Proliferation Period

3.3.4 Hardware

From 1983 to 1986 there was a significant increase in the number of computers in public primary schools (Woodcock & Dailhou, 1992, p. 175), with an average of 3.4 computers per school and considerable variation in the number of computers available in each school (p. 175). This raised serious equity issues for governments and educational departments. Research from over a thousand schools in 1986 found that 98% of Secondary Schools had computers, with "an average of fourteen computers per school;" whereas only 57% of primary schools had computers, with an average of three computers for each school (Fitzgerald, Hattie & Hughes, 1986, p. 18). The possibility of computer applications to the whole curriculum implied that schools started developing larger efforts to increase the access for their students to computer facilities. Later, computer numbers had continued to rise due to various government initiatives (Woodcock & Dailhou, 1992, p. 177). However, there was a pattern of change in the type of computers purchased by schools. As discussed earlier, the Apple had dominated the educational market since the early 1980s because of the variety of the "educational software" available for it (5; G; 294; Samootin, 1992, p. 264). Also, the Apple computer implemented graphics rather well; other computers successfully implementing graphics were the "Macintosh, Amiga, Atari and Archimedes," while the MS DOS computers were based in the business type of software (Chidgey, 1991, p. 227; Samootin, 1992, pp. 264 – 265). However, as discussed earlier, in many schools there was a shift from a special purpose curriculum based software to multipurpose commercial packages. Similarly, the rise of the computer studies subjects demanded computer programming languages and databases that were not always as well supported on Apple computers (Samootin, 1992, p. 264).

Lowery (1992, p. 313) stated that from 1988 to 1992 schools had been well provided with necessary hardware; however, these provisions did not always satisfy the needs of teachers inside the classroom due to the housing of the computers in a limited number of laboratories. Messing considered hardware as a problem even in the late 80s and predicted future shortages (Messing, 1987, p. 145). Noting that not many NSW schools had a one-to-one student to computer ratio, Messing complained that the usual working ratio of three students to one computer was not practical nor effective. This author called the solution of rotating groups through “hands on and hands off activities” a band aid solution, only working as a temporary measure. The lack of hardware was likened to completing Chemistry experiments with only one Bunsen burner for the whole class.[20]

Even with the wide establishment of computers in schools, the cost of hardware remained a major consideration. One school described by Messing (1987, p. 146) had received an entire computer laboratory development. It cost the school $100 000, with $70 000 being for the hardware and the rest was for the software as well as the appropriate licences. Noting that not many schools in NSW would have been able to afford a budget of $20 000 per annum, Messing found that, with the few avenues available to schools for funding, this would be impossible unless the government offered some assistance. Some of the other persistent costs that were not usually considered included office furniture such as computer desks, chairs and other products (p. 147). Even textbooks were noted to cost at over $40 per book – thus illustrating the sometimes unrealistic expectations which some schools and teachers were put under. For many schools, having to choose between buying books for the library or for the purchase of computers was a serious problem (Porter, 1988, p. 182).

However, as some authors have noted, too many computers in a school does come with its problems. One problem with having a computer on each and every desk would be that it would take up too much of the desk space; also it would be unnecessary due to the fact that in doing most of the mathematics of that time, computers would not usually be required (Kissane, 1990, p. 62).

Primary schools obtained a dramatic increase in hardware due to two inputs from the state government from two programs, entitled the “1988 – 1990 Computer Education Program” and “School Link”. These two policies are discussed in the “Later Policies” section following. There was still a significant difference between high schools and

[20] Although this does seem to exaggerate the problem, it does make an intelligent argument.

Primary schools' computer usage because in 1991, in K – 6 schools, there was approximately only one computer in each classroom; unlike the high schools where the computer laboratory was common and had been for several years prior to 1991 (Walters, 1991, p. 177).

3.3.5 School Subjects

Two main issues are worth pointing out in this context about the use of computers in school subjects. First the computer use in mathematics classes was limited by the lack of changes to the mainstream curriculum. Second, Computer Science had established itself as a separate discipline within the curriculum. Kissane (1990, p. 65) pointed out that many changes to the teaching and learning of mathematics in schools had arisen from the contribution of computer teachers in the schools. This author presented a challenge for mathematics teachers to start changing the mathematics curriculum instead of the computer teacher doing this to make a positive use of the real potential of the computer within the mathematics education classroom, and to make sure that these real possibilities become certain and authentic for their students. Considering the lack of progress in extending computers into mathematics classrooms, Kissane (1990, p. 64) suggested that a computer-sensitive curriculum be developed, and that schools be permitted to make the decision whether to use it or not, depending on their facilities. The schools that decide not to use it could continue with the curriculum already in use.

The computer was capable of being used in several powerful ways in primary mathematics (Wharton, 1989, p. 107). The idea that pupils could effectively be taught about computers through using the computers in education had started to be accepted by primary schools in the late 80s (Harrison, 1988, p. 37). Kissane (1990, p. 63) believed that the earlier years in schooling, such as in the primary grades, had weaker arguments in favour of students using computers because the computer was seen as less practical and beneficial for younger children. According to Harrison (1988, p. 38) primary school teachers enjoyed the flexibility of not being held to a strict schedule and agenda all of the time; they found that staying in their own rooms and not moving to a computer laboratory at a chosen time was more suitable.

Harrison (1988, p. 38) claimed that in primary schools, computers and their accompanying software were capable of being used in three ways to positively influence the teaching/learning process, namely as a tool, a learning stimulus, and as a context for learning.

In addition to the wider dissemination of computer usage into other subjects, the Proliferation Phase witnessed the integration of computers into the curriculum in another way. For the first time, students could choose a Computer Studies subject as part of the Higher School Certificate (HSC) along with other subjects such as Mathematics, Science, Language and Art. In other words, it had become a discipline in its own right (Samootin, 1992, p. 263). Tatnall and Davey suggested that the value of a subject in many school systems was "measured in its interaction with the final year of schooling (Year 12), as many ascribed special importance to those subjects that are seen as valid preparations for tertiary study" (2004, p. 87). This view demonstrates the relevance of the Higher School Certificate (HSC) examinable Computer Studies subject. There were several reasons for placing this course into the curriculum (McCluskie, 1988, p. 243): parental pressures, needs of employers, changes created in society by computers, and the needs of the students in the future to have the ability to handle change. McCluskie (1988, p. 241) claimed that computers had come to be perceived as the fourth R in education, and were a survival skill for all students. Fraser (1989, p. 173) suggested that the feeling was strong, among teachers and students, that Computing Studies would be a popular elective, leading some to believe that all students would want to do that course, even choosing their own schools on the basis of whether it was taught there as an elective.

In 1988 the NSW Computing Studies subject became examinable in the Year 10 School Certificate, with 739 students taking the subject (Board of Studies, 2007b). Similarly, Computer Studies was introduced in 1989, for Year 11, and examined in 1990 for Year 12 (CEU, 1988, p. 1; Tolhurst, 1989, p. 201) with 4767 participants in the 2 Unit Computer Studies HSC examinations in the first year (Board of Studies, 2007c). Fraser (1989, p. 171) envisioned that there were many problems and obstacles to putting a new course into the school, however this author suggested that in this case it was not as difficult as it initially appeared, due to the backing of the CEU, Regional consultants and other staff assistance. The Computing Studies course that was run was “so different to that which was run in a maths course,” it was more holistic and had more than just programming in mind (1; C; 175). It had the “social issues, graphics, robotics etc.,” and the “computing element … [within] the mathematics syllabuses was removed”. Fraser (1989, p. 177) stated that teaching a rounded approach, and not focussing on one agenda (like word processing, programming or computer mathematics) was the key (to success), as the aim of the Computer Studies course was one of enabling students to make educated choices concerning their life engaging with computers. Noting the need for more research, Kissane (1990, p. 63) reminded the reader not to be naïve in thinking that conducting more research would be sufficient to enable educational change to take place.

The development of the Computer Studies subject, in particular at the Senior School level (Years 11 and 12), had an unintended and negative effect on the use of computers in all subjects in the school, and in particular mathematics classes. As discussed above, it was the practice of many Secondary Schools to house its collection of computers in a special room known as the computer laboratory. The Computer Studies subject was given priorities regarding the use of those laboratories. This made access to them by mathematics teachers considerably more difficult (4; F; 236). With the onset of the Computer Studies course, computer rooms were monopolised, “restricting access for all [students]” apart from those attending the Computer Studies course (1; C; 174). On the other hand, other subjects experienced a rivalry between Computer Studies and themselves with the concept of “computers across the curriculum,” and it took some time before they were “convinced that a school was more likely to possess a large number of computers if it offered Computer Science” (Tatnall & Davey, 2012, p. 260). Tatnall and Davey maintained that “the most damaging criticism came from those teachers who claimed that the presence of a specialist subject detracted from the move to encourage the use of computers across the curriculum” (2004, p. 87). The prime argument for this was that the subject took away access to the laboratories for other subjects. The argument for Computer Studies dominance of the computer laboratory was that the main purpose of buying computers “at all was to support the teaching of Computer Science” (Tatnall & Davey, 2004, p. 87). Secondly, the inclusion of a specialist subject worried teachers who were concerned that other subjects would not consider computer use for their subjects at all.

In the 80s, the introduction of graphics calculators capable of producing graphs made the use of the computer in that area irrelevant (Tatnall & Davey, 2012, p. 256). Coupled with the difficulty for the mathematics teacher to reserve the computer room, the graphics calculator became popular through its ease of access, these items being able to be brought into the classroom in a whole set with a carry case (6; H; 331).

Another argument supplied by Tatnall and Davey (2012, p. 256) for the decline of computer use in mathematics education following the introduction of the Computer Science course was because of the important position held by mathematics as a prerequisite for university entrance into science courses. Teachers involved did not want to over burden their students with another topic in an already overloaded, difficult and time consuming mathematics curriculum.

3.3.6: Professional Development

While the focus on school and government policy in the Policy Phase was on making computers and software accessible to schools, the focus of the Proliferation Phase was on how the computers were used. Teachers, were considered by Dailhou (1992, p. 3) to be the main factor behind the effective adoption of this technology in teaching. Woodcock and Dailhou (1992, p. 183) explained that in one sample, about half of the teachers were not incorporating the computer into the classroom or were using them at a minimum level. However, Doig, Carss and Galbraith (1992, p. 155) suggested that judging by the number and variety of reports that they had access to, the computer seems to have been more readily accepted (than the calculator) as a component of the teachers’ tools to be used in mathematics education.

One study reported an interesting result that schools with a high pupil/computer ratio (less computers per student) reported more computer use than other schools with a considerably lower pupil/computer ratio (more computers per student). This study also noted that a higher level of teacher training was reported in those schools with higher use of the computer (Woodcock & Dailhou, 1992, p. 182). It seems that the schools with a high pupil/computer ratio had "teachers with more training (with an average of 36 hours)," and reported more computer usage; whereas the schools with a low pupil/computer ratio had "teachers whose average training was 20 hours," and reported less computer usage. Therefore, teacher training could be seen to be more influential for computer usage than simply heavy investment in hardware or software.

The in-service courses that had been found to achieve the most were those that were taken intentionally by the teachers (Dailhou, 1991, p. 62). During this Phase there was a change in the type of professional development provided for teachers with more on the job training. In one survey carried out in the early 1990s, 36% of educators had learnt their computer skills through on the job training and 40% perceived that future training would be comprised of on the job training (Woodcock & Dailnou, 1992, p. 180). In that study, 12% of teachers had been trained through in-service courses, and in-service was deemed by 20% to be their source of training in the foreseeable future (p. 180). Lastly, some research showed that the teachers who responded best to training were those with knowledge and experience in teaching (Dailhou, 1991, p. 63).

Within the NSW State school system, in-service courses were in the late 1980s most commonly run in schools rather than being regionally organised (Nanlohy, 1988, p. 327). Messing (1987, p. 142) noted that teachers mainly found three tiers of training: pre-service, in-service, and self-service. One problem with the pre-service training of computer specialists was that it did not ready them for teaching the skills that they learned, but only for the skills needed for the personal use of the computer (p. 142). Messing noted that these trainees would not have been content with the lower pay they would receive for using their skills teaching rather than what they would get for applying them in the workforce.

The in-service training of the late 80s was not considered suitable for training teachers (Messing, 1987, p. 143). In-service training was effective for the circulation of ideas and display and exhibition of techniques – which have been seen to be effective in certain cases. Messing observed that computers were added as a part of the teacher training courses so that pre-service teachers could see how they relate to their current subject areas (1987, p. 143). Also of concern were the two to six weeks in-service courses, which could be regarded as only for refreshment, and also there was the belief that they were not good for a complete education, as it would take several years to learn the material that was covered (p. 143). Bella and Gow (1987, p. 3) suggested that the late-80s funding cutbacks in Australia had a large effect on in-service courses, creating the need for innovative techniques in the support of teachers through in-service courses.

'Self-service' was a term used to describe the situation where teachers used their own resourcefulness to obtain the necessary knowledge on computing; with part time studies being a principal means to do this (Messing, 1987, p. 143). Self-service was considered to be something that was not used to its full potential by tertiary institutions, basically because these courses were popular and were always fully booked, with the number of teachers applying for them being more than the available number of places available. This meant that a considerable number of teachers would end up in courses that they were not intending to take, nor needed to take initially.

3.3.7: Arising Challenges

While the challenges in the first two Phases identified above were related to the availability of computers and the usefulness and availability of the respective software, the main challenges in the late 1980s and early 1990s related to the teacher's readiness to incorporate the computers into their classrooms. In fact, just a small number of teachers actually used the computers in their teaching up to the early 1990s (Dailhou, 1991, pp. 60 – 61). One major cause for this was that teachers were not comfortable in their use (p. 62). Murray (1987, p. 20) claimed that there was an entrenched attitude where the belief was that the subject of Mathematics could be better taught through the traditional route. One could argue that through the use of the computer, one might not need the teacher anymore. Commenting on the argument that computers would make education “teacher proof”, Dwyer (1980, p. 113) dismissed this by commenting that it was not only a wrong way of looking at it, but it was a thought process that could derail the full potential of the computer. Dwyer continued by arguing that the most important user was the student and teacher combination, and not the people behind the research and development of a computer’s use.

To understand teachers’ reluctance to integrate the computer into their teaching cannot be realised without examining the curriculum imposed on schools; the available professional development, and the time that it takes to make changes in the teaching and learning experiences. Ransley (1990, p. 7) claimed that there was some initial discontent and dissatisfaction with the “unimaginative drill and practice” type of software that was in use at that time. And despite that, in the late 80s, there was an increase in the appeal and attraction in the ability in using computers to assist teachers in working more successfully.

Also, in education, the focus should have been on teaching, on “instruction” instead of on the computer; unfortunately, the opposite was true (Messing, 1988, p. 171). Teachers were asking themselves if computers were good and suitable for their students. They were raising questions such as:

- What is it that the student is actually acquiring?
- When students learn on the computer for a considerable while, how will other parts of the curriculum be hurt and to what extent and effect will this be?
- Can computer learning be left for high school?

(Porter, 1988, p. 2).

Similarly, Samootin (1993, pp. 132 – 133) noted that there were differences in opinions between the respective teachers concerning the computer’s place in the classroom. Some remained sceptical about the benefit of using computers in the classroom. By the end of the Proliferation Phase such hesitance was gradually diminishing (Meade, 1991, p. 104).

Kissane (1990, p. 51) believed that one reason for the resistance towards computers in education emanating from many parents, employers and mass media came from the suggestion that the routines which had previously and already been developed were not as significant as they once were. However, another source of “great anger” was the lack of computation skill in the children (p. 51). McCluskie (1988, p. 244) suggested that it would be incorrect to give people, either parents or students, the expectation that taking part in a computer course would develop an advantage for the pupil in seeking work in any industry, even the computer industry. Another negative attitude was that of Dyson and McShane (1989, p. 154), who believed that because lower primary school students would not be leaving school for another ten or so years, there was not much point in teaching them basic concepts due to the possibility that they would no longer be relevant to the work place by then. They concluded that it was fine to use software, but not to dedicate large chunks of time teaching about this to primary schools. Differences between primary and secondary schools may have been due to the attitude that the computer was much more relevant to secondary school students than to primary school students (Kissane, 1990, p. 62).

Also lacking was a system that rewarded teachers for participation in professional development activities, and for the introduction of the computer into their classes. Dailhou (1991, p. 65) stated that incentives and rewards were significant for the teacher who was just beginning to use the computer in his or her school. Unfortunately, teachers from the 80s to 90s were not given any of these system-wide rewards or incentives in any way for taking their part in using the technology within their own classrooms (p. 65). However, the best personal rewards (the real rewards) for using the computer were found to be “peer esteem, self-confidence and improved classroom atmosphere” (p. 70). However, one interviewee with experience in professional development in schools found that a number of students would give up using the computer at the first signs of trouble (6; H; 317 – 318, 319 – 320).

In 1989, Wharton (p. 113) declared that there was room for improvement with computers in education, most importantly the need for: improved software and courseware; more integration of computers and mathematics in classes; better interfaces to cater for personal and individual development and the needs of the learner; more computers; more open-ended software tools, and ideas as well as activities for teachers on using the computer for student needs. Looking into the future, Doig, Carss and Galbraith (1992, p. 160) envisaged that changes needed to be made to assessment practices if computers were to become commonplace in the classroom. They also noted that another area that needed attention was the way in which research into computer use was conducted; encouraging the teacher to take on a major role in implementing action research. Harrison (1988, p. 38) claimed that through using applications software (such as drawing software), the students would soon learn that the computer is not always an appropriate option (possibly due to the impracticality and difficulty of its use). Also, there were reasons not to integrate technology, like that given by Wharton (1989, p. 107), who believed that drill and practice can be achieved better without and away from the computer (however this may not be the case if learning tools are integrated into the drill and practice type of software). Meade (1989, p. 70) suggested that the drill and practice approach of learning may best be implemented using conventional methods rather than using computers especially if resources are low. Bella and Gow, in 1987, (p. 2) argued that it was regarded as a challenge to apply the computer to the teaching of mathematics in the majority of schools in Australia. This was possibly because of an overemphasis on programming, a deficiency in suitable and relevant software, as well as the absence of suitable teacher education programs (p. 2).

3.3.8 Later Policies

Three government initiatives are worth noting in this Phase: (i) the primary school hardware grant (Woodcock & Dailhou, 1992), (ii) “School Link” (Woodcock and Dailhou, 1992) and (iii) the “1988 – 1990 Computer Education Program” (NSW DSE, 1989a). Also, two policy documents were published in 1992 – one called “Education 2000” (NSW DSE, 1992a) and the other “Priorities 1992” (NSW DSE, 1992b).

3.3.8.1 The Primary School Hardware Grant

In this Phase, Government funding was diverted into primary Schools. Funds for the purchasing of hardware was made available to primary schools in 1986 (Dailhou, 1991, p. 61). For primary schools in NSW, a hardware grant of $2.5 million was made in 1987, and was repeated in each of the following four years (Woodcock & Dailhou, 1992, p. 176). Primary schools had finally been significantly assisted in implementing computers into their curricula by the government after being previously ignored in comparison to high schools.

3.3.8.2 School Link

Then in 1988, the Federal government launched a program called “School Link” which planned to make available $64 million for schools (in all states of Australia collectively) over the ensuing four years (p. 177).[21] No grade was left out, and consideration was given for every subject (p. 177); hence, it included all levels of primary schools and was a considerable investment in this area. In 1988, the School Link Program was put into place, with the federal government[22] allocating $64 million for the following four years. This provided funds to schools for all subjects as well as every grade level, including primary schools, with extra funding supplied for the “computerisation of [the] schools’ administration” (CEU, 1988, p. 1). A Computer Education Coordinator was appointed to each school, and this coordinator was to lay a large part in all aspects of the school’s computer program. According to Woodcock and Dailhou (1992, p. 176), in the late 80s, the NSW Government allocated funds towards appointing one Computer Coordinator to every school to assist in the development and application of technology.

[21] The amount for NSW itself was not given.

[22] It is not stated in the reference whether the state or federal government was involved in the funding of this initiative, however it was assumed to be the federal government due to the inclusion of all states in its funding.

The Program was also to include professional development activities to assist and aid the teachers and schools "in all aspects of computer education" (CEU, 1988, p. 1). Funds were for the provision of "a series of direct grants to schools" so that appropriate hardware could be purchased; the hardware bought was to meet the guidelines given, as well as the government schools Computer Contract (p. 1, 2). A series of direct grants was also to be given to schools for the provision of appropriate software and resource materials to help in the overall implementation process (p. 2). Access to electronic mail (email) and remote databases was becoming available, and there were associated costs which were to be offset by the various funding given (CEU, 1988, p. 2). This was to provide links between schools, the education community, regional consultants and other Departmental Units. For primary schools, other parts of the School Link Program, enabled them to use a portion of their funding "to improve security and the learning environment in which computers are used" (CEU, 1988, p. 2). Additional to the money provided, the government advised that more funding would be available for an administrator for each school. As 1988 came to a close, this initiative was under trial and near completion. Mathematics Education was not given priority in the funding arrangements, rather computer education was the main beneficiary.

3.3.8.3 The 1988 – 1990 Computer Education Program

Murray (1987, p. 20) noted that there were expenditure cutbacks in the late 80s. Bella and Gow (1987, p. 3) suggested that the late-80s funding cutbacks in Australia had a large effect on in-service courses causing the need for innovative techniques in providing resources for teachers through these in-service courses. However, the 1988 – 1990 Computer Education Program awarded $53 million into schools for that given time period; the main focus of spending was to be on "purchasing staff development activities and materials, additional software, computer equipment and/or consumable items, improving security and/or computer room facilities" (NSW Department of School Education [NSW DSE], 1989a, p. 1). A base grant was provided to all schools (p. 3), which was to be used in order to ensure that each school purchased services and equipment to an amount which would be the most suitable for that school. The variance in a schools' sizes was taken into consideration through an extra per capita loading. A Computer Coordinator was to be provided to schools, yet if the school opted to not have a Coordinator then they were to receive a supplementary grant (NSW DSE, 1989a, pp. 4, 7).

The money did not come without conditions that schools had to fulfil. First, schools had to provide up to a four-year plan, which was to include professional development (NSW DSE, 1989a, p. 5). The provisions on spending for software were that they buy only educational software, software that could be run on computers that were or had been on contract, and software that did not breach copyright. Then hardware was to be bought only if it was on the "NSW School's Microcomputer Contract at the time of purchase" (NSW DSE, 1989a, p. 5). Finally, schools were required to report annually on the "results and achievement of the Program within the school."

In the 1988 – 1990 Computer Education Program, the contract agreement meant that buying equipment allowed for significant savings (NSW DSE., 1989a, p. 15). One means of saving money when schools purchased hardware was through the Bulk Purchase Scheme. This scheme gave substantial discounts to the schools which used it. The scheme maximised the grants to the respective schools by "discounting the normal contract price of a selected range of computer equipment." It was used on a trial basis, depending on the "degree of response and the level of savings achieved" (NSW DSE, 1989a, p. 15). Once again, Mathematics Education was not given a priority in any of the points of this policy.

3.3.8.4 Priorities 1992 and Education 2000

Two major policy documents were published in 1992: namely *Priorities 1992* (NSW DSE, 1992b) and *Education 2000* (NSW DSE, 1992a)[23]. Both provided guidelines for people involved in education in NSW. Lowery (1992, p. 313) suggested that *Priorities 1992* was a continuation of *Education 2000* (the 1991 all State version – not the NSW version), [24] expanding each of the objectives to display all of the new activities that

[23] Education 2000 provided objectives and outcomes from 1992 to the year 2000.
[24] There were two versions of Education 2000. The first one was written in 1991 for Australia in general; and the second one was written in 1992, for NSW. The NSW version is the one that will be discussed here.

were to be taken into 1992 (p. 314). *Priorities 1992* was a document that was designed to be a guide for the respective school's planning and programs (NSW DSE, 1992b, p. 3). On the other hand, *Education 2000* was a public statement of the Department's purposes and direction; giving "reference points by which … [one] could measure … [their] success" (NSW DSE, 1992a, p. 3). It was to be used in "planning the development and well-being of the students entrusted to their care." They are proof that the priorities of the government at that time (after changing focus from being hardware specific to curriculum oriented) were:

- knowledge and skill in the implementation of technology as a resource; and
- for the increase of the range of each students' learning experience with the use of communications technology.

(Lowery, 1992, p. 313).

3.3.8.4.1 Education 2000

Out of seven key issues mentioned in *Education 2000*, the most relevant issue here was issue number two concerning the "continuing rapid pace of technological change" (NSW DSE, 1992a, p. 11). Then, of the Outcomes mentioned in the document**,** Outcome 9, is the most relevant here. Outcome 9 of *Education 2000* stated:

- "Students, teachers, school executives and ancillary staff are competent and discriminating in using technology to enhance their productivity (9.01).
- Student learning is supported by technology in all syllabus areas and students with special learning needs are assisted by technology (9.02).
- The variety of student learning experiences is expanded by the use of communications technology (9.03)
- The planning, evaluation and operational needs of staff are supported by communications technology and information systems (9.04).
- New technology is adopted and applied with sensitivity to the privacy of individuals (9.05)."

The importance of staff competence with the computer was clearly emphasised here. If staff were competent, then it would help them to guide students. Also, the important area of communications technology appeared to be important here, being mentioned in Outcomes 9.03 and 9.04 – goals that are shown to be relevant more so today, as evidenced in the way that *Communications Technology* had taken over the computer industry. This emergence of *Communications Technology* in 1992 marks the end of this study. Students' involvement with computers in every subject area was emphasized by policy makers to ensure that the technology was relevant to all syllabi and not just one area. Particular subjects were not mentioned, and the special relationship mathematics had with the integration of computers seems to be long gone (they still share that relationship, but the 'special' relationship where they were the sole bearers of computer technology seems out of place now). An observation worth mentioning is that mathematics was not mentioned in any of these points.

3.3.8.4.2 Priorities 1992

Then there was *Priorities 1992*. Of the ten priorities stressed by *Priorities 1992* (NSW DSE, 1992b, pp. 24 – 25) Priority 9 is the most relevant for this topic. Priority 9 was dedicated to implementing technology to improve the "delivery, quality and effectiveness of teaching, learning and administration." Some of the points set for Priority 9 (Lowery, 1992, pp. 313 – 314; NSW DSE, 1992b, pp. 24 - 25) were:

- the Computer Education Program; which basically is to "support the use of computers in all curriculum areas;"
- Distance Education; to study and analyse technology to better develop access for students to a larger choice and amount of educational programs;
- Technology Education; and to encourage IT education in "schools and other departmental workplaces."
- Office and Communications Technology was to be considered, with the provision of improved technology including "department-wide FAX network, electronic mail and office systems."

Priorities 1992 was limited in its forecast, but with *Education 2000* the government was thinking about the next eight or nine years. *Communications Technology* was mentioned, and that is, as mentioned elsewhere, another reason for ending this study in 1992.

3.4 Summary of Chapter 3

This chapter consists of the Literature Review interlinked with the Data Analysis. This is because the data from both complements each other well. The chapter presented the data in three main phases: the Pioneer Phase, the Policy Phase, and, the Proliferation Phase. These phases were self-explanatory, with the full details of these 3 separate phases being given in the sections provided. The phases were further grouped into several themes: The Relationship between Computers and Mathematics; Programming; Software; Hardware; School Subjects; Professional development; and, Arising Challenges.

This chapter consisted of a large amount and a range of information, therefore the summary for this chapter shall not look separately at the phases themselves, but instead shall study the several themes within these phases. Then, a separate section shall look at policies and their relevance to mathematics education specifically.

3.4.1 The Relationship between Computers and Mathematics

From 1971, mathematics had all of the say with regards to computers. This strong and sole relationship lasted for some time. By the early 1980s this relationship was challenged by other subjects. For about a decade, mathematics was the only subject to use computers, through programming, unfortunately for reasons previously explained, it was only available in the lowest level HSC subject. The largest error of the initial implementation of the computer into mathematics education was not to make it part of the whole mathematics curriculum, as possibly other students would have benefited from such a move, especially the more advanced, since they would have been more capable.

The relationship that mathematics had with computers was believed to be partly because mathematics involved problem solving, and so does programming, which was the only way to use the computer at that time. Because they both were effective at promoting the learning of problem solving, and they both could be used together, then they were suitable together. The strong relationship that mathematics education held with regards to computing was weakened by the early 1980s, and had diminished by the mid-1980s, as government policies took the direction away from mathematics directed attention to other subjects and the computers' inclusion into the whole curriculum. Computers became relevant to other subjects due to the increasing ease of use and software capabilities. It was inevitable for mathematics to lose complete use and relevance of computers as these changes took place.

Any thought of such a strong and sole relationship had completely disappeared by the late 1980s, due to the creation of varieties of software, with different and useful applications made available. Policies did not directly give a consideration of mathematics at all. The Computer Studies course, which was implemented into the School Certificate and Higher School Certificate, was introduced into the curriculum. Mathematics still held a strong relationship to computers, in spite of its lack of attention in schools. The applications of software available increased in its relevance to mathematics education. With these changes in software availability, there was a possibility for change to the way that mathematics could be taught, but this change did not take place.

The curriculum developers maintained a resistance to computer use, for high schools as well as primary schools. Teachers also maintained resistance, due to keeping to safer and more known traditional pedagogy. And when the mathematics curriculum was changed to implement computers, it would be an addition to an already fully developed curriculum, without removing anything else. Teachers were more influenced by the practical side of things, looking for direct exam results rather than teaching their students in new ways. Finally, the link between mathematics and problem solving, and computers and problem solving, was taken over by Computer Studies which by then, had its own links to problem solving.

3.4.2 Programming

Programming was, initially, the only way to use a computer. Throughout the whole studied time period, the most used language was BASIC; and LOGO was the most popular. Programming ranged from the use of punch cards, to directly inputting instructions through a keyboard onto a computer. Teachers learnt how to program, as part of their preparation in University to become mathematics teachers in secondary school. Programming was seen as a skill useful for work, and it was seen as a means to do problem solving. Because of this it was seen as relevant to mathematics, although not everyone thought that way.

In the mid to late 1980s, LOGO had grown in importance, and had also increased in relevance to a wide variety of subjects, ranging from Geography to English. The biggest problem was that LOGO was a highly spatially oriented language, and very useful in that area, yet was not successfully implemented into an inclusive school curriculum for all year levels to get the best out of its potential. Programming began to decline by the end of the Pioneer Phase. By then, the drill and practice approach was the main way of using computing. Opinions towards programming were held very high, but some were turned off due to its links with mathematics and their personal difficulties with that subject. Even if programming did not have this link with mathematics, people still had trouble due to the rigour required in programming. Later, the connection between mathematics and problem solving was no longer of relevance to computing due to the increasing capabilities of software. Programming was no longer the only way to use computers. Programming is now only used specifically in an elective subject, and only chosen by a small number of students.

3.4.3 Software

Software was undeveloped in the early 1970s to the early 1980s. The only type of software that was available at that time was the programs that were developed by the teachers themselves. Most of the early programs invented by teachers was of the drill and practice type. Although, software applications for mathematics increased after the early 80s, teachers remained in the pre-computer mindset. Spreadsheet software was developed but remained largely unused in spite of their potential. The ability to use graphical software increased in the early to mid-80s and became popular. One reason suggested for the use of graphical software and the lack of use of the spreadsheet was that the graphical software is able to be implemented into an already set curriculum without much change to this material needing to be done; whereas with the spreadsheet applications, new materials would have to be made and created.

Authors of software became better at composing it, and hence improved software was on the market. Software packages such as MS Office and MS Works came out for all computer environments in the late 1980s to early 1990s. The business type of software became more available at that time, but not all views were in favour of its use in mathematics. This software included word processing, spreadsheets, and databases. Software increased in their applications towards mathematics, with software such as HyperCard (which was used sometimes with mathematics in mind), Geometer's Sketchpad, and 'A Graphics Approach to Calculus' all becoming available. It was found that most of the software used for mathematics was not adaptable to the senior secondary school levels. Budgets of schools restricted spending on hardware and software. Varieties of software arose such as Shareware, Freeware, and public domain software became available; but these lacked in quality, so cheapness came at a price.

The National Software Co-ordinating Unit (NSCU) was created in 1987, it was mainly focussed on educational software and computer type learning products, and this was to be distributed with information nationally. There was also the Curriculum Development Council and the Curriculum Development Centre, each working with different people and from differing perspective for a common curriculum. The Software Co-ordinators Advisory Group (SCAG) was formed, and it documented in an electronic database concerning the software that was available at that time.

3.4.4 Hardware

The icons and Windows environments that computer users are so aware of now were not available when computer use commenced. The mainframes initially used were those of Universities until the Canon Canola first became used in schools in 1973. Mainframes, and even the Canon Canola, did not provide immediate interaction. This did not occur until the personal computer came out in the early 1980s. A range of computers came out, but the Apple took prominence, and in 1980, most of the computers in schools were Apples.

In the mid-1980s, primary schools had increased the amount of hardware being bought. Costs affected the purchase of computers, but computers were seen as more affordable as their capacities increased without much increase in cost. The Apple and Microbee were the most popular computers in the mid-80s. Public schools usually bought what was on government contract, and private schools usually bought what they themselves were interested in. The Apple had potential because it had good graphics, and a large range of educational software. However, the IBMs (or IBM compatibles) were more associated with the businesses, and did not have such an extensive range of educational software.

Computer numbers had started to increase due to government resourcefulness. In the late 80s, there was a change in the type of computer being purchased, from the educationally software based computer (like the Apple) to the business software bases computer (like the IBM). The need for a certain type of programming language and databases for the Computer Studies subject also created a need for the IBM type of computers.

Placing the computers into laboratories limited their availability to mathematics teachers as there was competition in gaining access to them, and because priority was given to the Computer Studies subject. However, it was because of the Computer Studies subject that increasing amounts of computers were being bought by schools. Policies at that time increased the funding allowing for a growth in the number of computers in schools.

3.4.5 School Subjects

Programming was implemented into the lowest level mathematics subject, in the HSC, from 1971 to 1975. This was known as Level III. The subject changed names, and the following subject (2 Unit A) also contained programming until 1981. Then this lowest level mathematics subject transformed and became known as Mathematics in Society; it contained programming within it, but was quite a different course to the other two before it. At that time, schools would submit their studies, known as Other Approved Studies, with computer related topics being devised by the schools.

From 1983 to 1992 in NSW, Year 10 mathematics offered computing as an optional topic in its curriculum. These courses were popular in that they were seen to be practical for future employment, as computer skills seemed relevant for future society and hence future jobs. Then the Computer Studies subject had become reputable as an independent subject in its own right. This new subject was more complete than the computer element within mathematics courses: it did not focus solely on programming. This developing new course took over the computer rooms, and made it very difficult for mathematics teachers to gain access to these labs. Programming also was withdrawn from the mathematics syllabus at that time.

3.4.6 Professional Development

University students who were training to be mathematics teachers in the early 1970s would undergo some computing training. This training primarily consisted of learning programming. In-service courses for teachers started in 1971 and focused on FORTRAN programming. Later in-service courses would focus on drill and practice, as well as games and simulations. Then there were regionally organised professional conferences, where teachers would exchange ideas about mathematics teaching, computers and software. There were 12 regions (which was cut down to 10) in NSW that held regular conferences for mathematics teachers for each of their respective area, and computing had been a topic at those conference since the early 1970s.

These professional development courses and mathematical professional conferences (that contained ideas about computing and mathematics teaching) continued from the Pioneer Phase through to the Policy Phase. The Department of Education and the Catholic Education Office ran computing in-service courses for teachers in their schools and some companies, like IBM, seeing the potential of running in-service courses for their respective computers, ran courses in the schools that would have them. By the late 80s, in-service courses were conducted on software such as MS

Works. Also in the late 80s, in-service courses started to be run by the schools themselves, rather than being regionally organised.

3.4.7 Arising Challenges

Putting computers into mathematics education came with a number of challenges, throughout the whole studied period. An initial problem with implementing computers into mathematics education was the lack of availability of the computer. Another was that the lack of access to software caused problems for teachers and students. Teachers had to create the programs themselves, and bugs would arise in them, and the collection of these programs was a big issue. To make a program that would act as a tutor would take much longer than to prepare an actual lesson. Most programs were drill and practice, and these had trouble competing with the programs of other subjects. Software was expensive, with no guarantees as to its qualities. Knowledge was limited concerning the use of the computer in schools. By the end of the Pioneer Phase, more software became available on the market. Because of this, programming was no longer the only way to use the computer, and other subjects took an interest in using them. This new interest, countered the reigns that mathematics held with computers in education, and the other subjects started to use them.

Some of the major problems for the implementation of computers into education involved

- the insufficient amounts of hardware for the classes;
- not enough money from the government for purchasing hardware;
- not enough training and not enough in-service courses, and more.

The education of the public through various means, mostly through the media, was not carried out successfully. Traditional attitudes held sway for the mathematics teachers in the Proliferation Phase: they were not confident in the computer’s use, nor did they believe in its positive capabilities. Rewards were also insufficient, which did not encourage its use. Computer laboratories, where most of the school’s computers were held, were increasingly used by other subjects as the computer increasingly became relevant to them. This was a major criticism when Computer

Studies became a part of the school curriculum, yet the counterargument was that Computer Studies had increased the interest of schools in buying the computers themselves.

3.4.8 Policies

Policy formulation deserves a further brief mention at this point. The policies of the government over this study's time period consisted of a number of different initiatives. Policies concerning computers and education started to be implemented in 1984. One important note about all of the policies studied is that none of them took the issue of mathematics education, with its relevance or with its respective issues pertaining to computers, very practically, thus virtually ignoring mathematics education. The policy makers' largest error was to ignore the relevance of computers to mathematics education: as they made steps to include the whole curriculum they tended to ignore mathematics. However, this is understandable and acceptable on the basis that the computer did become more relevant to other subjects, as software development increased and as computers became easier to use. Computers were relevant to other subjects by the time policy was achieved for computers in schooling.

3.5 Guide to Chapter 4

The next chapter will conclude this study. First, it will do so by summarising the chapters respectively. Then it will examine the limitations of the study, by analysing the difficulties in compiling a respectable research methodology for it; then it will examine the problems in gathering the data. The chapter will provide a perspective on the present context of computers operating with mathematics teaching, showing hardware and software are still relevant for mathematics education. Finally the implications for future study are described along with a number of questions that could be asked and answered by other researchers.

CHAPTER 4

Conclusions, Limitations and Implications for Future Study

4.1 Introduction

This chapter consists of four sections. Answers to the Research Questions are presented in 4.2. Section 4.3 describes limitations of the study and several implications for future research. Section 4.4 concludes the study.

This thesis has described the development of computer use in NSW mathematics education from the early 1971 – 1972 by presenting:

- A historical study examining the relationship between computers and mathematics, programming and software derived from primary and secondary sources of information.
- An examination of those relationships through focusing on three distinct phases of development each embracing seven principal themes.

This arrangement facilitated the provision of answers to the two research questions.

4.2 Research Questions and their Answers

This research was guided by two research questions. The answers to the questions are provided below

Research Question 1

What were the major stages of development in the use of computers in mathematics in New South Wales in the period from 1971 to 1992?

Major stages were explained to fall within what were referred to as the Pioneer Phase, the Policy Phase, and the Proliferation Phase. The Pioneer Phase consisted of the period of the introduction of the computer into NSW education, and in this instance, it was mathematics education that played the leading role in this process. The Pioneer Phase came to a close in the early 1980s, just prior to the introduction of policies and directives from DE&T that began to influence schools regarding this initiative. The Policy Phase started in the early 1980s. As well as addressing computer start-up policy in schools, the Policy Phase involved a whole curriculum approach to the issue. This phase ended as the late 1980s approached. The Proliferation Phase covered the period of the late 1980s to the early 1990s, and witnessed an extraordinary increase in, software and hardware availability and capability of the computer. Events in this period had considerable impact on schools, their staff and their students. These Phases were examined in chapter 3.

Research Question 2

What were the major themes in the developments regarding computers in that period?

There were several themes discovered and suggested within the computers' development in schools over the period 1970 – 1992. They addressed (i) the relationship between computers and mathematics; (ii) Programming; (III) Software; (iV) Hardware; (v) School subjects; (vI) Professional development, and (viI) Arising challenges. Also, government policies were examined as a topic of interest within the Proliferation Phase. A summary of the respective themes follows.

(i) The Relationship between Computers and Mathematics

Mathematics is well known for its problem solving capabilities. Programming was implemented with problem solving in mind. Their united capabilities make them work well together. Programming was the only way to use computers in the initial phase of implementing them in education, and mathematics was the only subject to use computers (and hence programming) and did so for about a decade. Unfortunately programming was for the lowest level HSC subject. As computers became more able and delivered with better software, this sole relationship had diminished and other subjects became involved. Computer Studies finally completed the trend, becoming the focus of the teaching of computing in schools, accompanied by the comprehensive use of new computer laboratories.

(ii) Programming

Programming developed from punch cards to the input of instructions through the keyboard. At first, it was the single means of using the computer. A variety of languages were used throughout the studied period, ranging from FORTRAN, to BASIC and LOGO. Being used for problem solving, programming had relevance to mathematics as that subject too has an affinity with problem solving. As the computer hardware and software capabilities grew, programming began to decline, and this was observed by the end of the Pioneer Phase.

(iii) Software

When computers were introduced into education, software remained undeveloped. Teachers created the programs themselves. They were of the drill and practice type. After the early 1980s, software increased in capability. Drill and practice remained in use, and spreadsheet and graphical software became available and popular. In the late 1980s, business type software (word processors, spreadsheets, and databases) became available; and these were suitable for IBM type machines. Other software applicable to mathematics education became available. Various organisations were created, such as the NSCU, the Curriculum Development Council, the Curriculum Development Centre, and the SCAG, to deal with the issues evolving around software and education.

(iv) Hardware

Mainframes were the initial computers in use, when computers were first implemented into schooling. Programs on punch cards were sent to universities or organisations that kept them. In 1973, mainframe use was replaced by the Canon Canola. These computers were largely inadequate as they failed to provide immediate interaction. This soon changed with the introduction of a number of computers in the late 1970s giving immediate feedback, of which the most popular were the Apple and the Microbee. Primary schools also began to increase their amount of hardware.

Eventually it became a competition between Apple computers and IBM (and IBM compatibles). Apple had capacity for graphics, whilst the IBMs had capacities for business type software. Apple had a large range of education software, whereas IBM did not. Computer Studies created a necessity for IBM type machines due to their need for a particular programming language and for databases. Computers were also mostly placed into computer laboratories by then. Mathematics teachers found it hard to obtain access to them mainly because Computer Studies had privilege. There was a counter-argument stating that Computer Studies did increase the amounts of computers being brought into schools because they created a necessity for them.

(v) School Subjects

The lowest level HSC mathematics subject (Level III in 1971 to 1975, and 2 Unit A in 1976 to 1981) had an element of computing: Programming. After came the subject Mathematics in Society. In the late 70s, 'Other Approved Studies' became available and allowed for the introduction of more computer related courses to be introduced into schools. At that time, Primary schools had no developments in that area. Year 10 mathematics had electives in computing from 1983 to 1992. Within this time period, Computer Studies became a reputable option for the HSC, having more than just the mathematical elements included.

(vi) Professional Development

In the early 1970s, many university students training to be mathematics teachers in training would partake in some computing training. These courses mainly consisted of learning programming. Teacher in-service courses based on computing began in 1971, mainly looking at FORTRAN programming. Later, they would contain drill and practice, and games and simulations. There were conferences arranged by regions (regions were areas designated by locations in NSW, there were 12 regions at first, which were eventually cut down to 10). In these conferences teachers would exchange ideas and programs. This continued from the Pioneer Phase through to the Policy Phase. Different organisations ran computing in-service courses, such as the Department of Education and the Catholic Education Office. Companies (such as IBM) also began to run in-service courses; and there was in-service provided on particular software. Finally in-service courses were run by the schools themselves.

(vii) Arising Challenges

Using computers in education did not come without problems and challenges. Lack of hardware and suitable software were a major hindrance, through all phases. Teachers initially had to create the programs themselves, and a large amount of the programs were drill and practice. Software also was expensive, when it was developed. As software was introduced, starting largely in the Policy Phase, other subjects became involved with computing as programming was no longer the only way to use the computer. Apart from inadequate amounts of hardware, insufficient funds and lack of training and in-service courses all contributed to making computer implementation into schooling more difficult.

Mathematics teachers remained mostly in the traditional mindset, in the Proliferation Phase. They were not fully convinced of computers' abilities to help students learn mathematics, nor were they confident in their use. Computer Studies took over control of computer laboratories and were the cause of an increase in the purchasing of computers by schools.

(viii) Policies

The Policy Phase, and took an all-curriculum approach. Although mathematics has a direct relevance to computers, this was not mentioned in any of the policies of the times. This occurred because policy attempted to include the whole curriculum, and avoided emphasising any particular subject. Unfortunately, this meant that mathematics was left out despite its importance. On the other hand, computers did become increasingly relevant to learning in all subjects, as part of its development, as it became easier to use with a growth in hardware capabilities and a growth in accessible and easy to use software. Policy took this direction because computers grew in this particular way at the time of policy creation.

4.3 Limitations, Implications and Significance of the Study

4.3.1 Limitations of the Study

One limitation involved the data-gathering procedures. The literature was an initial source of data. It was found that a considerable amount of needed and relevant information was not present or made available. Another problem was that attitudes were different in the studied era to now: some authors either did not know how far computers would go in education or they were too optimistic, thinking that eventually computers would be used in everything, taking over all the tasks of the students. This second type of attitude was not found that often.

Despite extensive efforts to recruit knowledgeable interviewees, a total of only eight could be found. It would have been beneficial if there were more participants available to contribute their experiences of the period of the study. Another problem was location of interviewees and resources. A number of different cities and towns had to be visited, and they were sometimes in remote places. Likewise, the interviews were conducted at places which took effort to get to because of location, to make the interview as convenient to the interviewee as possible. After examining the literature, and through the interviews, some information was still lacking. For example, more information on the reasoning behind the implementation of computers into the mathematics curriculum at the early stage as 1971 would have been informative. Also, more information on the policies concerning computers in education, and the reasoning behind why mathematics education was so neglected within them, would have enhanced this thesis considerably.

One outcome found in the production of this thesis was that some of the information had to be found directly from the Internet. Although most, if not all of the websites were credible such as the Department of Education website, and the NSWCEG website, others consulted did not always appear to be authoritative.

4.3.2 Implications of the Study

4.3.2.1 Some More Recent Considerations

In today's educational environment, computers are still extremely relevant to mathematics education. The strong capability of technology to support numeracy (an important aspect of mathematics education) is seen to be found in its acknowledgement within school mathematics (Zevenbergen & Lerman, 2006, p. 591). As seen in Chapter 3 of this thesis, spreadsheets were not commonly used in the period of the study. However using spreadsheets tasks, teachers noticed that students "found" these tasks were "enjoyable, easy and motivating;" with the students learning the "new ideas quickly" (Williams, 2006, p. 562).

Also, students were, “found to choose to use CAS to perform difficult or time consuming mathematical operations, but commonly anthropomorphised CAS as a helpful friend and independent arbitrator” (Pierce, Herbert, & Giri, 2004, p. 463). This comment demonstrates that computers, even with spreadsheets and CAS, became more user friendly to the mathematics student as time passed. Education researchers, both nationally and internationally, have shown, “high expectations for the potential of computer technology to improve the teaching and learning of mathematics” (Norton & Cooper, 2001, p. 386). The implementation of the computer as an aid to students learning of mathematics has been supported by, “curriculum policy writers and mathematics education researchers” (Vale, 2001, p. 491). The relevance of the computer to mathematics education is therefore starting to reignite.

Finally, Communications Technology has made an impact on school learning. One teacher’s experience showed that the, “uses of the Internet [had] impact[ed] positively upon student’s learning” (Patahuddin & Dole, 2006, p. 405). Communications Technology is relevant for all subjects of the curriculum, not only mathematics.

4.3.2.2 Implications for Future Study

There are a number of implications to be made for future study from the findings of this thesis and from its limitations. Because of the relationship found between computers and mathematics, especially through programming, future research could be carried out, focussing particularly at the link between computers, mathematics and problem solving. The links today would have changed, with advances in both hardware and software, hence the relevance of computers to mathematics today would be of interest, as would an analysis of the different advances that have been made with today’s hardware and software in relation to mathematics education. With the dramatic increase in the computer’s power, it would be interesting to see what software of direct relevance to mathematics education exists, and how it could be incorporated into mathematics teaching and learning. Also, an interesting question to investigate would be, “To what extent are computers more relevant to mathematics education than the 1970’S”?

With the revelation of the NSW government's lack of attention towards mathematics education (as seen in 3.2.2 and 3.3.8) and the computer's implementation within the subject, the policy directions of the government in the time period after 1992 would be worth studying. Has NSW's policy direction changed? Does it include mathematics now?

It was mentioned in chapter 1 that a history of computers in education has been completed for the States of Victoria and Queensland. This current study will give reader's knowledge that was previously not gathered in one place for mathematics[25] education for NSW. Other States' use of computers within their education systems would be an interesting subject for analysis. Of particular interest would be the policies of those states, as compared to those of NSW.

Although programming is perhaps not as valued as much as it was in earlier times, there still remains an interest in it because there still exists a course on programming in the NSW HSC syllabus. Programming languages may have changed somewhat since the time period studied, so a study on the relevance of the newly available programming languages and their relevance to mathematics, when compared to BASIC or LOGO, would be an interesting analysis. How have they changed, and are there any computer languages now that are more mathematical and easier to master than the older languages?

One question related to this study – the relevance and usefulness of the Internet with regards to mathematics education – was not considered due to its non-existence in the time period analysed. The Internet marked the end point of this study. It has many uses and it has many features not covered by this current study. Researchers could examine many aspects of Internet use that have been implemented to influence the way that mathematics students' are taught and learn mathematics.

[25] As seen in this study, mathematics was the foundation discipline for all school computer use in NSW.

Finally, a comparative study which examines the modern uses of technology in mathematics education and its relation to the past would also be of value.

4.4 Conclusion

Mathematics initially had a very strong relationship with computers, primarily through programming. This was because software was not available, nor were personal computers. Both of which are familiar today. Icon use and Windows environments were not available, making computers a much more abstract tool. This relationship between computers and mathematics education had grown with the development of a range of application software able to assist students in their learning of mathematics. Mathematics 'held the reins' with computers for about a decade until other subject teachers became interested and became involved. This was due to the changes in computers taking place at that time – they became more user-friendly, easier to use, and, also more practical a tool for learning.

Schools initially emphasised mathematics education, as this was the only subject linked to computers at that time. Computers were only implemented in the lowest level mathematics courses available at that time, and this was possibly an error in judgement by the authorities. This decision may have been a mistake as the students ignored by that decision would probably have been able to utilise the computer more effectively in their own learning, and probably would have performed better than the students in this selected lowest level subject. Also, its initial exclusion from other year levels (such as Year 10) was perhaps unwise, as it would have prepared students more so for the rigour of computer use in their own learning later when they chose to study the subject in their later years.

Policies developed by both the Ministry and within schools gradually indicated that change was taking place. Moves were being made from a mathematics-focussed computer curriculum to a situation where other subjects were becoming involved. Shortly afterwards, definitely by the mid-1980s, the type of professional development that was taking place were also seen to move from a mathematical focus to other subjects. There was a lack of focus on mathematics education in policy direction and this was, however, an overall major shortcoming with regards to this discipline. Policy neglected mathematics education almost completely. Overall, mathematics stood as the initiator of computers into the school curriculum, into schools as a whole, and as computers became more capable of being used, and became easier and more user friendly, other subjects became involved. Computers are now relevant to all areas of education, and it is important to see how the revolution began, how they evolved in education, and where mathematics and computers shared a common ground.

References

Alderman, D. L. (1978). Evaluation of the TICCIT Computer Assisted Instructional System in the Community College. *Final Report E.T.S.* Princeton New Jersey.

Anderson, G & Arsenault, N. (1998). *Fundamentals of Educational Research*. G. Anderson: London, UK and Philadephia, USA, The Falmer Press.

Asp, G., Dowsey, J., & Stacey, K. (1993). Linear and quadratics graphs with the aid of technology. In B. Atweh, C. Kanes, & M. Carss (Eds.), *Contexts in Mathematics Education* (Proceedings of the 16th annual conference of the Mathematics Researchers Group of Australasia, Gold Coast, (pp.51-56). Brisbane: MERGA.

Atkinson, P., & Coffey, A. (2004). Analysing Documentary Realities. In D. Silverman (Ed.), *Qualitative Research: Theory, Method and Practice, 2nd Edition* (pp. 56 – 75). London: SAGE Publications.

Au, W. K. (1992). Using Computers to Develop Problem Solving Skills. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 27 – 37). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Barnett, S. (2001). Instructional Technology Timeline. Retrieved May 7, 2011 from http://www.isrl.illinois.edu/~chip/projects/ timeline/1967barnett.html

Bella, J., & Gow, L. (1987). Microcomputers and Teaching School Mathematics: An answer to the challenge. *The Australian Mathematics Teacher*, 43(1), 2 – 4.

Betts, J. (1992). A Child's Progression of Developing Information Handling Techniques in Logo for Databases. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 7 – 20). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Bloom, L. M. (1986). The Microcomputer as an Aid in the Calculus Classroom. In Ed K. V. Swinson (Ed.), *Australian Association of Mathematics Teachers, Eleventh Biennial Conference* (pp. 135 – 140). Queensland: The Queensland Association of Mathematics Teachers.

Blundell, RLG. (1986). Using the Computer to Study and Assist the Learning of Mathematics. In K. V. Swinson (Ed.), *Australian Association of Mathematics Teachers, Eleventh Biennial Conference* (pp. 146 – 155). Queensland: The Queensland Association of Mathematics Teachers.

Board of Senior School Studies. (1970a). *Memorandum to School Principals*. (Circular 3, 1970: Higher School Certificate). Sydney, Pitt St: Board of Senior School Studies.

Board of Senior School Studies. (1970b). *Additions to Syllabus for Higher School Certificate Mathematics, Level III*. Sydney, Pitt St: Board of Senior School Studies.

Board of Studies, New South Wales. (2001). *An Introduction to General Mathematics Stage 6 in the New HSC*. Retrieved on March 21, 2012 from http://www.boardofstudies.nsw.edu.au/archives/syllabus_hsc/pdf_doc/maths_general_sup.pdf

Board of Studies, New South Wales. (2007a). *Statistics – Higher School Certificate 1967 – 1990*. Retrieved July 15, 2011 from http://www.boardofstudies.nsw.edu.au/bos_stats/hsc67_70stats.html

Board of Studies, New South Wales. (2007b). *School Certificate 1979 – 1988*. Retrieved August 10, 2011 from http://www.boardofstudies.nsw.edu.au/bos_stats/sc79_88stats.html

Board of Studies, New South Wales. (2007c). *Statistics – Higher School Certificate 1990*. Retrieved August 8, 2011 from http://www.boardofstudies.nsw.edu.au/bos_stats/hsc90stats.html

Borg W. R. & Gall, M. D. (1979). *Educational Research: An Introduction*. New York: Longman Inc.

Bork, A. (1980). Learning through Graphics. In Taylor, R. P. (Ed.) *The Computer in the School: Tool, Tutor, Tutee* (pp. 67 – 82). New York: Teacher's College Press.

Brownell, S. (1972). Computer Studies at Higher School Certificate Level. *The Australian Mathematics Teacher*, 28(1), 13 – 14.

Carr, E. H. (1963). *What Is History?* Knopf: New York.

Cater, R. S. (1974). Some Experiences with Computers in a High School. *The Australian Mathematics Teacher*, 30(2), 57 – 59.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. London: SAGE Publications.

Chesneaux, J. (1978). *Pasts and Futures or What is History For?* London: Thames and Hudson Ltd.

Chidgey, G. (1991). Graphing Software in the Classroom: The Artistically Talented and Other End Users. In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group* (pp. 227 – 232). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Chopping, E. (1988). Algorithm Description Methods for the Junior and Senior Computing Studies Syllabus: An Introduction for Teachers. In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference (*pp. 223 – 233). Cheltenham NSW: NSW Computer Education Group Ltd.

Christensen, B. (1982). Programming Languages for Beginners and the Global Challenge. In I. Webster (Ed.), *NSWCEG Notes Two, New South Wales Computer Education Group, Computers in Education Working Conference* (pp. 132 – 135). Broadway: Hydro Majestic Hotel.

Commonwealth Schools Commission (CSC). (1984). *1984 Computer Education Program*. Canberra: CSC.

Computer Education Unit (CEU), (1988). *Newsletter ComputEd*, Erskineville, NSW, 4(3), 1 – 2.

Computer History Museum. (2006). Exhibits: Timeline of Computer History. Retrieved June 7, 2011 from http://www.computerhistory.org/timeline/? year=1987

Cooper, R. (1972). Experimental Courses in Computer Methods. *The Australian Mathematics Teacher*, 28(2), 35 – 39.

Corbin, S., & Strauss, A. (2007). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, *3rd Edition*. California, USA: Sage Publication, Inc.

Coupland, M., & Crawford, K. (2006). Many Dimensions: the Complex Picture of Student Encounters with a Computer Algebra System. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Volume 1* (pp. 155 – 162). Pymble, NSW: MERGA.

Dailhou, P. (1991). Grab em by the .. or How to get Primary Teachers to Adopt Computers. In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group (*pp. 59 – 73). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Dailhou, P. (1992). "Kids, Curriculum, and Computers." In S. Wawrzyniak & L. Samootin (Ed.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 3 – 5). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Daniels, R. V. (1972). *Studying History: How and Why, 2nd Edition*. Englewood Cliffs, New Jersey: Prentice Hall, Inc.

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage Handbook of Qualitative Research, 3rd Edition.* London, New Delhi. Sage Publications, Thousand Oaks.

Donelay, L. (1991). Using One Computer in a Kindergarten Maths Environment. In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group* (pp. 75 – 81). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Doig, B., Carss, M. & Galbraith, P. (1992). Calculators and Computers in Teaching and Learning of Mathematics. In B. Atweh & J. Watson (Eds.), *Research in Mathematics Education in Australasia 1988 – 1991, RMEA 1988-1991, MERGA* (pp. 153 – 162). Queensland University of Technology: Mathematics Education Research Group of Australasia, Sponsored by the Centre for Mathematics and Science Education.

Downes, M. (1988). Macintosh (The Best of Both Worlds?). In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference* (pp. 235 – 239). Cheltenham NSW: NSW Computer Education Group Ltd.,

Dwyer, T. (1980). Some Thoughts on Computers and Greatness in Teaching. In R. P. Taylor (Ed.), *The Computer in the School: Tool, Tutor, Tutee* (pp. 113 – 118). New York: Teacher's College Press.

Dyson, S., & McShane, R. (1989). Classrooms, computers and the needs of Industry. In D. Sutton (Ed.), *Hands On: Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd* (pp. 153 – 161. Cheltenham, NSW: NSW Computer Education Group Ltd.

Felton, M. (1992). But I Can't Draw Miss!! In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 127 – 133). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Fitzgerald, D., Hattie, J., & Hughes, P. (1986). *Computer Applications in Australian Classrooms*. Canberra: Government Department of Education, Australian Government Publishing Service.

Fraser, L. (1989). Implementing Computing Studies 7 – 10, Some Considerations and Implications. In B. Atweh & J. Watson (Eds.), *Research in Mathematics Education in Australasia 1988 – 1991, RMEA 1988-1991, MERGA* (pp. 171 – 179). Queensland University of Technology: Mathematics Education Research Group of Australasia, Sponsored by the Centre for Mathematics and Science Education.

Fraser, L. (1991). The Warp and the Weave ... LOGO in a Cross - Curricula Classroom. In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group* (pp. 245 – 249). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.,

Fraser, N. (1992). Future Education Pathways: Jumping off Point or Jihad? In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 59 – 62). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Frost, G. (1989). An Introduction to LOGO. In D. Sutton (Ed.), *Hands On: Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd.* (pp. 41 – 52). Cheltenham, NSW: NSW Computer Education Group Ltd.

Geiger, V. (2006). Standing on the Outside: A Tale of How Technology Can Engage Those Working on the Margins of a Community of Inquiry. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Vol. 1* (pp. 246 – 253). Pymble, NSW: MERGA.

Gibbons, P. (1989). The Problem of Teaching Problem Solving. In D. Sutton (Ed.), *Hands On, Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd* (pp. 53 – 55). Cheltenham, NSW: NSW Computer Education Group Ltd.

Gilderhus, M. T. (1987). *History and Historians: A Historiographical Introduction*. New Jersey, USA: Prentice-Hall, Inc.

Glenn, C. & Gray, L. (2013). *The Writer's Harbrace Handbook, 5th Edition*. Wadsworth, Boston, USA: Wadsworth, Cengage Learning.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. Newbury Park, Calif: Sage Publications.

Handlin, O. (1979). In *Truth in History*. Cambridge, Massachusetts, and London, England: President and Fellows of Harvard College, The Belknap Press of Harvard University Press.

Harrison, T. (1988). Computers in the Primary School: Tool, Context, Stimulus. In D. Sutton, *Making it Happen, Proceedings of 6th Annual Conference* (pp. 37 – 41). Cheltenham, NSW: NSW Computer Education Group Ltd.

Horton, B. (1987). LOGO for Secondary Mathematics Teacher Trainees. In *Mathematics Education Lecturers Association, Mathematics Curricula: Change and Challenge* (pp. 14 – 20). Sydney: The Association,

Horton, B. (1988). LOGO Complementing the Junior Secondary Mathematics Curriculum. In D. Sutton, *Making it Happen, Proceedings of 6th Annual Conference* (pp. 47 – 50). Cheltenham, NSW: NSW Computer Education Group Ltd., Ed.

Howell, M., & Prevenier, W. (2001). *From Reliable Sources: An Introduction to Historical Methods*. Cornell University, USA: Cornell University.

Huggett, R. J. (1976). A Computer in a School. *The Australian Mathematics Teacher*, 32(1), 16 – 19.

James, J. S. (1974). Computer Studies as a Higher Schools Certificate Subject. *The Australian Mathematics Teacher*, 30(3), 85 – 96.

James, T. (1984). Bringing Computer Education Software Technologies into the 1980's. In J. Hughes (Ed.), *Computers and Education: Dreams and Reality* (pp. 244 – 246). Broadway: Computer Education Group of New South Wales.

Johnson, B., & Christensen, L. (2004). *Educational Research: Quantitative, Qualitative and Mixed Approaches.* Boston, USA: Pearson Education Inc.

Juliff, P. (1984). Programming as an Intellectual Activity. In J. Hughes (Ed.), *Computers and Education: Dreams and Reality* (pp. 343 – 345). Broadway: Computer Education Group of New South Wales.

Kazlauskas, A., & Sheehy, P. (1987). The introduction of Computers in a K – 12 School. In *Doing Something You've Never Done Before* (pp. 106 – 113). Broadway: Computer Education Group of New South Wales.

Kelman, P., Bardige, A., Choate, J., Hanify, G., Richards, J., Roberts, N., Walters, J. & Tornrose, M. K. (1983). *Computers in Teaching Mathematics*. Reading, Massachusetts: Addison-Wesley Publishing Company.

Kent, G. O. (1985). Clio the Tyrant: Historical Analogies and the Meaning of History. In S. Vaughn (Ed.), *The Vital Past: Writings on the Uses of History* (pp. 302 – 310). Athens, Georgia: University of Georgia Press.

Kissane, B. (1990). The Computer as a Tool for Mathematics Education. In K. Milton & H. McCann (Eds.), *Mathematical Turning Points; Strategies for the 1990s: A Collection of Papers Presented to the 13th Biennial Conference of The Australian Association of Mathematics Teachers* (pp. 47 – 67). Hobart: The Mathematical Association of Tasmania.

Krystyn, J. (1987). The National Software Coordination Unit. In *Doing Something You've Never Done Before, Proceedings of 5th Annual Conference of the NSW Computer Education Group* (pp. 124 – 128). Broadway, Sydney: Computer Education Group of New South Wales Ltd.

Lander, K. (1993). Producing Technical Documents using TechWriter. In S. Wawrzyniak & L. Samootin (Eds.), *Sharing the Vision. Proceedings of the 11th Annual Australian Computers in Education Conference (*pp. 79 – 84). Macquarie University, Sydney: New South Wales Computer Education Group.

Lewis, E. (1993). Cybernetic Manipulatives and the Integration of Concrete, Pictorial and Symbolic Modes of Representation in K – 6 Mathematics. In S. Wawrzyniak & L. Samootin (Eds.), *Sharing the Vision. Proceedings of the 11th Annual Australian Computers in Education Conference* (pp. 219 – 225). Macquarie University, Sydney: New South Wales Computer Education Group.

Lloyd, M. (2003). *Enacted cultural myth: computer education in Queensland (1983-1997).* Brisbane: Queensland University of Technology.

Lowery, V. (1992). "Kids, Curriculum, and Computers and..." Making the Most of Telecommunications. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 313 – 321). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Luke, M. (1991). Hyperscreen – Easy Multimedia for Apple IIe and IIgs. In P. Nanlohy (Ed.) *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group* (pp. 381 – 384). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Mason, P. & Mason, K. (1992). Inexpensive Software Opportunities Educators Should Consider'. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 91 – 95). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Mathias, M. H. (1988). Mathematics, Computers and the "Real World". *The Australian Mathematics Teacher*, 44(4), 2 – 6.

Mattei, K. C. (1974). Courses about Computers – For Secondary School Students. *The Australian Mathematics Teacher*, 30(3), 118 – 121.

McCluskie, P. (1988). Why Teach Computing Studies. In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference* (pp. 241 – 248). Cheltenham, NSW: NSW Computer Education Group Ltd.

McCrae, B. (1979). School Mathematics in the Computer Age. In G. Booker (Ed.), *Research in Mathematics Education in Australia, MERGA*, *Vol. 2* (pp. 78 – 84). Melbourne: MERGA.

McCulloch, G. & Richardson, W. (2000). *Historical Research in Educational Settings*. Suffolk, Great Britain: St Edmunsbury Press Ltd, Bury St Edmunds.

McDougall, A. (1975). Developments and Directions in Secondary School Computer Studies. *The Australian Mathematics Teacher*, Adelaide, 31(6), 195 – 206.

Meade, C. (1989). Inquiry Learning in Number Space and Measurement 'Hands on Data.' In D. Sutton (Ed.), *Hands On, Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd* (pp. 69 – 71). Cheltenham, NSW: NSW Computer Education Group Ltd.

Meade, C. (1991). Learning Software K – 6: Why, What, How? In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group (*pp. 103 – 113). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Messing, J. (1985). Computers and Mathematics. In *Computers in Education '85* (pp. 102 – 106). Hydro-Majestic Hotel, Medlow Bath: N.S.W. Computer Education Group Ltd.

Messing, J. (1987). Tooling Up to Teach Computing. In *Doing Something You've Never Done Before, Proceedings of 5th Annual Conference of the NSW Computer Education Group* (pp. 140 – 147). Broadway, Sydney: Computer Education Group of New South Wales Ltd.

Messing, J. (1988). Now You Can Really Make CAI Happen. In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference* (pp. 171 – 180). Cheltenham, NSW: NSW Computer Education Group Ltd.

Messing, J. (1991). Hypermedia: What Database Should Have Really Been. In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group (*pp. 385 – 395). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Mocciola, M. R. (1977). Children's Delight: A Tutorial Computer-Assisted Gaming Paradigm to Initiate and Reinforce General Mathematical Problem Solving Strategies in Children. In *Research in Mathematics Education in Australia, Volume 1* (pp. 229 – 237). Melbourne: MERGA.

Murray, S. (1987). Thematics Teaching, Learning and Computers in Australia. *The Australian Mathematics Teacher*, 43(1), 19 – 21.

Nanlohy, P. (1988). Organising School Based Inservice. In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference* (pp. 327 – 339). Cheltenham, NSW: NSW Computer Education Group Ltd.

NACCS (National Advisory Committee on Computers in Schools). (1983). *Teaching, Learning and Computers*. Woden, ACT: Commonwealth Schools Commission.

NACCS (National Advisory Committee on Computers in Schools). (1985). *Teaching, Learning and Computers in Primary Schools*. Canberra: Commonwealth Schools Commission.

Newell, G. J., & Pike, D. J. (1982). Computer Simulation Games in Mathematics Teaching. *The Australian Mathematics Teacher*, 38(3), 8 – 10.

Newton, B. (1987). The Incorporation of Micro-Computer Technology into School Mathematics: Some Suggestions for Middle and Senior Mathematics Courses. *The Australian Mathematics Teacher*, 43(1), 22 – 25.

Norton, S., & Cooper, T. (2001). Factors influencing computer use in Mathematics teaching in Secondary Schools. In J. Bobis, B. Perry, & M. Mitchelmore, *MERGA 24: Numeracy and Beyond, Volume 2* (pp. 386 – 393). Sydney: MERGA Inc.

Noss, R. (1983). Doing Math While Learning Logo. *Mathematics Teaching,* 104, 5 – 11.

New South Wales Dept. Ed. (New South Wales Department of Education). (1983). *Computers in Schools: A General Policy Statement*. Sydney: The Department.

New South Wales Department of School Education. (1989a). In *Computer Education Program Guidelines: Funding for Classroom Application 1989 and 1990*. Erskineville, NSW: Computer Education Unit.

New South Wales Department of School Education. (1989b). *Mathematics K-6 Syllabus*. Sydney: The Dept.

New South Wales Department of School Education. (New South Wales Department of School Education). (1992a). *Education 2000*. Sydney: The Dept.

New South Wales Department of School Education (New South Wales Department of School Education). (1992b). *Priorities* 1992. Sydney: The Dept.

NSWGSCECC (New South Wales Government Schools Computer Education Co-ordinating Committee). (1985). *The Commonwealth Computer Education Program, N.S.W. Government Schools Sector : 1986 information booklet / NSW (Government Schools) Computer Education Co-ordinating Committee*. Sydney: The Committee.

Nunan, T. (1982). The Irrelevance of Education Technology. In I Webster (Ed.) NSWCEG Notes Two (pp. 7 – 13). Broadway: New South Wales Computer Education Group.

NSWCEG, (2011). NSWCEG NSW Computer Education Group. Retrieved June 20, 2011 from http://www.nswceg.org.au/og_about.htm

Oakley, J. (1987). A Study of Problem Solving Techniques using LOGO. In *Doing Something You've Never Done Before* (pp. 172 – 176). Broadway: Computer Education Group of New South Wales.

Papert, S. (1980). MINDSTORMS: Children, Computers, and Powerful Ideas. Basic Books Inc.: New York, USA.

Patahuddin, S. M., & Dole, S. (2006). Using the Internet in Teaching Mathematics in Primary School. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Volume 2* (pp. 400 – 407). Pymble, NSW: MERGA.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods*. Thousand Oaks, London, New Delhi: SAGE Publications.

Perkin, H. (1985). The Uses of History. In S. Vaughn, *The Vital Past: Writings on the Uses of History* (pp. 68 – 71). Athens, Georgia: University of Georgia Press.

Pierce, P., Herbert, S., & Giri, J. (2004). CAS: Student Engagement Requires Unambiguous Advantages. In I. Putt, R. Faragher, & M. McLean (Eds.), *MERGA 27: Mathematics Education for the Third Millennium: Towards 2010, Vol. 2* (pp. 462 – 469). Sydney, NSW: MERGA Inc.

Placing, K. (1992). Using LogoWriter in Mathematics and Science and Technology K – 6. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 161 – 167). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Porter, R. (1988). *Computers and Learning in the First Years of School: A Beginner's Guide for Teachers*. Wentworth Falls, NSW, Australia: Social Science Press.

Preston G. D. (1992). Software Copyright Issues for Schools. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 97 – 102). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Ransley, W. (1990). Some Pedagogical Possibilities for Advanced Spreadsheet Software in the Mathematics Classroom. *The Australian Mathematics Teacher*, 46(1), 7 – 10.

Reiner, G. J. (1961). *History: Its Purpose and Method*. London, Great Britain: George Allen and Unwin LTD.

Rice, M., & Crouch, W. (1990). Is LOGO a Vehicle for a Constructivist Approach in the Classroom. In K. Milton & H. McCann (Eds.), *Mathematical Turning Points; Strategies for the 1990s: A Collection of Papers Presented to the 13th Biennial Conference of The Australian Association of Mathematics Teachers (*pp. 459 – 470). Hobart: The Mathematical Association of Tasmania.

Robinson, B. A. (1973). A History of Computing Courses in Canberra Secondary Schools. *The Australian Mathematics Teacher*. 29(1), 32 – 39.

Ross, S. (1989). LOGO as a Design Tool in the Classroom. In D. Sutton (Ed.), *Hands On, Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd.* (pp. 165 – 169). Cheltenham, NSW: NSW Computer Education Group Ltd.

Rowse. A. L. (1946). *The Use of History*. Great Britain: Hodder and Stoughton Limited.

Ryan, J. (2010). *A History of the Internet and the Digital Future*. London: Reaktion Books Ltd., Johnny Ryan.

Samootin, L. (1992). Computing Studies Year 11 – 12. What Hardware? What Software? What's Available? In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 263 – 288). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Samootin, L. (1993). A Multi-Platform Philosophy for Schools. In S. Wawrzyniak & L. Samootin (Eds.), *Sharing the Vision: Proceedings of the 11th Annual Australian Computers in Education Conference* (pp. 129 – 142). Macquarie University, Sydney: New South Wales Computer Education Group.

Sandry, P. (1982). Four Questions. In I. Webster (Ed.), *NSWCEG Notes Two* (pp. 43 – 54). Broadway: New South Wales Computer Education Group, Computer in Education Working Conference.

Schofield, J. W. (1995). *Computers and Classroom Culture*. Cambridge, NY: Cambridge University Press.

Seldon, A. (1988). *Contemporary History: Practice and Method*. Oxford, UK: Basic Blackwell Ltd.

Sheerin, E. (1989). Teaching the Year 11/12 Syllabus. In D. Sutton, *Hands On, Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd.* (pp. 197 – 200). Cheltenham, NSW: NSW Computer Education Group Ltd.

Sheerin, E. (1993). Using Word in Maths and Science. In S. Wawrzyniak & L. Samootin (Eds.), *Sharing the Vision. Proceedings of the 11th Annual Australian Computers in Education Conference.* (pp. 85 – 89). Macquarie University, Sydney: New South Wales Computer Education Group.

Sherwood, C. (1988). Time to Break the Mould? *Australian Educational Computing, 3*(1), 19 – 29.

Sinclair, K., Holmes, N., & Nylander.J. (1984). Computers in the High School Curriculum: A Model for Teacher Education. In J. Hughes (Ed.), *Computers and Education: Dreams and Reality* (pp. 356 – 359). Broadway: Computer Education Group of New South Wales.

Stephens, L. D. (1985). Lessons, analogies and predictions. In Stephen Vaughn (Ed.), *The Vital Past: Writings on the Uses of History* (pp. 323 – 330). Athens, Georgia: University of Georgia Press.

Storey, W. K. (2009). *Writing History: A Guide for Students, 3rd Edition*. Madison Avenue, New York: Oxford University Press.

Tatnall, A., & Davey, W. (2004). Streams in the History of Computer Education in Australia. In J. Impagliazzo & J. A. N. Lee (Eds.), *History of Computing in Education* (pp. 83 – 90). Assinippi Park, Massachusetts: Kluwer Academic Publishers / IFIP.

Tatnall, A., & Davey, W. (2012). Reflections on the History of Computer Education in Schools in Victoria. In A. Tatnall (Ed.), *Reflections on the History of Computing: Preserving Memories and Sharing Stories* (pp. 243 – 264). Heidelberg: Springer.

Tatnall, A., & Jenner, P. (1986). How State Education Authorities Recommend Computer Systems for Use in Australian Schools. In *Australian Computer Conference (ACC'86)* (pp. 619 – 634). Gold Coast, Queensland: Australian Computer Society.

Taylor, R. P. (1980). Introduction. In R. P. Taylor (Ed.), *The Computer in the School: Tool, Tutor, Tutee* (pp. 1 – 10). New York: Teacher's College Press.

Templer, R., Klug,, D., & Gould, I. (1998). Mathematics laboratories for Science Graduates. In C. Hoyles, C. Morgan & G. Woodhouse (Eds.), *Rethinking the Mathematics Curriculum* (pp. 140 – 154). London: Falmer Press.

Thomson, D. (1969). In P. Wilson CB (Ed.), *The Aims of History: Values of the Historical Attitude*. London: Thames and Hudson.

Tillett, P. I. (1970). Secondary School Computer Courses. *The Australian Mathematics Teacher*, 26(1), 9 – 14.

Tillett, P. I. (1974). Computer Studies in Secondary Schools. *The Australian Mathematics Teacher*, 30(4), 134 - 138.

Tolhurst, D. (1989). Methods of Algorithm Description. In B. Atweh & J. Watson (Eds.), *Research in Mathematics Education in Australasia 1988 – 1991, RMEA 1988 – 1991, MERGA* (pp. 201 – 209). Queensland University of Technology: Mathematics Education Research Group of Australasia, Sponsored by the Centre for Mathematics and Science Education.

Topolski, J. (1976). *Methodology of History*. Dordrecht, Holland: D. Reidel Pub. Co.

Tosh, J. (2010). *The Pursuit of History: Aims, Method and New Directions in the Study of Modern History, Fifth Edition*. Dorchester, Dorset: Pearson Education Limited, Great Britain by Henry Ling Ltd., at the Dorset Press.

Trevelyan, G. M. (1985). Clio, a Muse. In S. Vaughn (Ed.), *The Vital Past: Writings on the Uses of History* (pp. 189 – 198). Athens, Georgia: University of Georgia Press.

TROVE, National Library of Australia, (2011). Enacted cultural myth: computer education in Queensland (1983-1997). Retrieved January 15, 2012 from http://trove.nla.gov.au/work/153094196

Author of the thesis is: Lloyd, M. (2003). Brisbane: Queensland University of Technology.

Vaughn, S. (1985). Introduction. History: Is it Relevant? In S. Vaughn (Ed.), *The Vital Past: Writings on the Uses of History* (pp. 1 – 14). Athens, Georgia: University of Georgia Press.

Vale, C. (2001). The "Struggles" in selected computer-based Mathematics classrooms. In J. Bobis, B. Perry & M. Mitchelmore (Eds.), *MERGA 24: Numeracy and Beyond, Vol. 2* (pp. 491 – 498). Sydney: MERGA Inc.

Vale, C. (2006). Equity and Technology: A Case Study. In P. Grootenboer, R. Zevenbergen & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Vol. 2* (pp. 512 – 518). Pymble, NSW: MERGA.

Walters, J. (1991). How Can a Teacher Run a Whole Class Activity with Only One Computer? In P. Nanlohy (Ed.), *Taking Time: Proceedings of the 8th Annual Conference of the NSW Computer Education Group* (pp. 177 – 179). Macquarie University, Sydn`ey: New South Wales Computer Education Group Ltd.

Watson, J. M. (1982). How can the Microcomputer Best Aid Mathematics Teaching? *The Australian Mathematics Teacher*, 38(3), 2 – 6.

Webber, C. (1992). Multi-System Computer Rooms. In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 213 – 216). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Webster, I. (1981a). Editors Notes. In I. Webster, *NSW Computer Ed. Group Notes 1981* (p. 1). Broadway, p. 1, NSW: NSW Computer Education Group.

Webster, I. (1981b). Computers in New South Wales Schools. In I. Webster, *NSW Computer Ed. Group Notes 1981* (pp. 2 – 14). Broadway, NSW: NSW Computer Education Group.

Webster, I. (1981c). Secondary Schools Board Survey. In I. Webster, *NSW Computer Ed. Group Notes 1981* (pp. 15 – 16). Broadway, NSW: NSW Computer Education Group Ltd.

Wesley, A. (1988). Using the Computer for Problem Solving. In D. Sutton (Ed.), *Making it Happen, Proceedings of 6th Annual Conference NSW Computer Education Group Ltd* (pp. 119 – 125). Cheltenham, NSW: NSW Computer Education Group Ltd.

Wharton, J. S. (1989). Mathematics and Computers – Hands On! In D. Sutton (Ed.), *Hands On: Proceedings of 7th Annual Conference N.S.W. Computer Education Group Ltd* (pp. 107 – 114). Cheltenham, NSW: NSW Computer Education Group Ltd.

Wikipedia, (2012a). Logo (programming language). Retrieved October 11, 2012 from http://en.wikipedia.org/wiki/Logo_(programming_language)

Wikipedia, (2012b). HyperCard. Retrieved June 7, 2011 from http://en.wikipedia.org/wiki/HyperCard

Wikipedia, (2013a). History of Microsoft Office. Retrieved May 16, 2013 from http://en.wikipedia.org/wiki/History_of_Microsoft_Office

Wikipedia, (2013b). Microsoft Works. Retrieved May 16, 2013 from http://en.wikipedia.org/wiki/Microsoft_Works

Wiktorowicz, R. (1981). Appendix1, New South Wales. In I. Webster (Ed.), *NSW Computer Ed. Group Notes 1981* (p 26). Broadway, NSW: NSW Computer Education Group Ltd.

Wilcox, J. F. (1983). To Mathematics via Computing. *The Australian Mathematics Teacher*, 39(1), 6 – 9.

Wilcox, J. F. (1986). Technology: A Challenge to Mathematics Teaching for Lower Secondary. *The Australian Mathematics Teacher*, 42(2), 6 – 9.

Williams, A. (2006). Spreadsheets in Year 5 Chance and Data: A Professional Development Experience. In P. Grootenboer, R. Zevenbergen & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Vol. 2* (pp. 559 – 566). Pymble, NSW: MERGA.

Wills, S. (1984). Doodle Design Debug: Process vs Content Issues in Classroom Computing. In J. Hughes (Ed.), *Computers and Education: Dreams and Reality* (pp. 90 – 96). Broadway: Computer Education Group of New South Wales.

Wiske, M. (1988). *How Technology Affects Learning*. Teaching Office of Educational Research and Improvement (pp. 59 – 73). Newton.

Woodcock, P. & Dailhou, P. (1992). Computers in Our Primary Schools... ...Who Uses Them? In S. Wawrzyniak & L. Samootin (Eds.), *Kids, Curriculum, and Computers. Proceedings of the 9th Annual Conference New South Wales Computer Education Group* (pp. 175 – 187). Macquarie University, Sydney: New South Wales Computer Education Group Ltd.

Zahra, P. (1977). Computers in Secondary Schools. *The Australian Mathematics Teacher*, 33(1), pp. 83 – 89.

Zevenbergen, R. & Lerman, S. (2006). Using ICTs to Support Numeracy Learning Across Diverse Settings. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *MERGA 29: Identities Cultures and Learning Spaces, Vol. 2* (pp. 591 – 598). Pymble, NSW: MERGA.

Zinn, H. (1970). *The Politics of History*. Boston: Beacon Press.

Every reasonable effort has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

Appendix A

Consent Forms

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: ____

Signature: ____

Date: ______________________________

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: Barbara Holland

Signature: Barbara Holland.

Date: 3 August 2010

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: ______Stephen Arnold____________

Signature: Stephen Arnold

Date: ____26th July 2010___________

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: Bob Baker

Signature:

Date: 28/10/2010

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: CHRIS THOMPSON

Signature: Chris Thompson

Date: 29/7/2010

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: JOAN FRANCES WILCOX

Signature: Joan Wilcox

Date: 10-10-10

Curtin University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: MARY BARNES

Signature: Mary S. Barnes

Date: 21/10/10

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: MARY COUPLAND

Signature: M Coupland

Date: 26 - 7 - 2010.

Curtin
University of Technology

CONSENT FORM:

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
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- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: RICHARD WIKTOROWICZ

Signature: R. E. Wiktorowicz

Date: 24/7/10

Appendix B

Curtin University of Technology

Title of Research Project

The History of Computer Use in Senior School Mathematics Teaching in the Government School System of New South Wales: 1971 – 1992.

Curtin University of Technology

School of Science and Mathematics Education

Participant Information Sheet

My name is Peter Sollorz. At the moment I am finishing my research for my Doctor of Mathematics Education degree at Curtin University of Technology.

Purpose of Research

I am currently studying the history of computers in mathematics education in NSW.

Your Role

I am interested in finding out as much information as possible concerning this history, over time period of the late 1970s to the mid-1990s.

I would like to find out several things, such as when computers first started to be used in mathematics education. The role that programming played. The role the government played. The types of changes that the usage of computers underwent over the intervening years.

I will ask you a number of questions, such as:

- Tell me about yourself; when did you start using computers?
- How did you use computers?
- Why did you use computers?
- What were some of the problems?
- What were some of the benefits?

- Tell me about early policies you were involved in.
- Tell me about the polices.
- Tell me about the practices of that time.
- How did it develop?
- How did it change?
- Why did it change?
- What factors drove these changes?
- Tell me about programming and the various languages used.
- What sort of computers were used?
- What was their popularity?
- Is there anything else relevant to this topic that you could talk about?
- Do you know somebody else who might be able to help?

If there is time, I would like to investigate further the following **Questions**

- Was the focus taken away from maths as computers became applicable to other subjects?
- Did maths become less of a part of a computer related subject as the "Computer Education" course became a part of the curriculum?
- How were the teacher inservice courses implemented?
- Did they teach how to implement the technology into the classroom?

The interview process will take approximately 60 minutes. If more information needs to be gathered, and you do know that information, another interview may be required, but this will only be attempted your full permission and agreement.

Consent to Participate

Your participation in this research is completion up to you. If at any stage you wish to withdraw from the research you may do so, without it affecting your rights or my duties to you as a person. After you sign the consent form, I shall assume that you have agreed to participate in this research and allow me to begin to use your data for this study.

Confidentiality

The information that you provide shall be kept apart from any personal details that you shall give me, and the only people that shall have access to this is myself and my supervisor. The interview transcript shall not have any identifying features applied to it, in accordance to the policy of the University. The interview tapes and sound files, with the transcripts, shall be locked away in a cabinet for a minimum of five years, after which a decision shall be made as to whether to destroy it or not.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (the Approval Number is: SMEC-65-09). If you have any concerns of would like more information about this research, please feel free to contact me on:

Phone: 02 9724 3417

and

email: petesollorz@bigpond.com

Alternatively, you can contact my supervisor, Bill Atweh on:

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and

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I would like to give many thanks for your participation, it is much appreciated and I am very grateful.

Appendix C

Interviewee 1 email answers to interview Questions

- Tell me about yourself; when did you start using computers?

I started using computers as part of my undergraduate studies in Computer Science at the University of Sydney.

As part of my Diploma in Education studies also at the University of Sydney, there was a compulsory unit of computing for Mathematics method students.

In 1979 I taught an 'Other approved study' class of year 11 students in Computing. This was my first year of teaching. The content of the course was mostly programming.

In 1980 I transferred to the then Mount Druitt High School and was instrumental in the development of 'computing' at that school. This included the preparation of grant proposals, installation of the hardware, inservicing of other teachers, development of school policies and teaching with them in my Mathematics classroom.

- How did you use computers?

In the late 70s early 80s, it was unusual to have more than one or two computers in a classroom. This led to innovative ways of teaching with them.

When programming, students were encouraged to develop their solutions using pen and paper and they used the computers to test their solutions.

When using the computer as a teaching tool, it tended to be primarily in demonstration mode, with all students gathered around the computer, either myself, or a student controlling the keyboard.

The computer was connected to a large monitor to allow the entire class to see it more clearly.

The computers where place on multishelved trolleys, so that they could be easily moved between rooms and the storeroom, where they were locked at night.

- Why did you use computers?
  - To help spark interest
  - Belief that this was the way of the future
  - Provide different experiences for the students
  - Added 'something' to my teaching/allowed me other ways of explaining concepts

- What were some of the problems?
  - Cost of the hardware – took a while before Governments provided targeted funds to schools
  - Range of software – the fledgling personal computer industry was not necessarily aimed at an education market in the beginning, this changed rapidly with the realization that there was a huge market waiting for decent software
  - Reliability of hardware – if hardware failed there were no substitutes so teachers had to be flexible in their planning.
  - Numbers of computers in the school meant that the faculty with the responsibility for them generally had the easiest access. In many cases this tended to be the Mathematic faculty given the inclusion of a computing topic in some senior syllabuses.

- What were some of the benefits?

As above in the why

- Tell me about early policies you were involved in.

The use of computers at the school level

As a consultant I was involved in syllabus implementation, examination setting and marking and the development of a range of resources to support teachers in schools.

- Tell me about the polices.

Really little more than a set of rules governing the use of the computers in the school. How when why what etc.

NSW Computers in schools policy provides information on the use of computers as a learning tool, as a focus for learning and as a tool for administration purposes.

- Tell me about the practices of that time.
    - Majority of teachers didn't/wouldn't use computers in the classroom they were worried about 'what would happen if…'

- How did it develop?

Slowly, I did a lot of team teaching, demonstration lessons, running of professional learning sessions.

I showed how productivity could increase with the use of certain software tools

Instituted electronic timetables and report cards

- How did it change?

  More people started to use the hardware and software as numbers of computers software range increased.

- Why did it change?

Realization that there was a benefit from the use of the computers

- What factors drove these changes?

  Accessibility to the equipment.

- Tell me about programming and the various languages used.

Basic, LOGO were the main languages the students used in the early days.
Hypercard
By the 90s object oriented programming languages were to the fore.

- What sort of computers were used?

  Canon Canola, Tandy TRS 80, Apple II (and all of the subsequent models), Microbee, Apple Macintosh

- What was their popularity?

  Extremely popular, elective classes in 'computing' were always popular as parents perceived this as a way of gaining employable skills – an advantage over others who hadn't had these skills.

- Is there anything else relevant to this topic that you could talk about?
- Do you know somebody else who might be able to help?

If there is time, I would like to investigate further the following Questions:

- Was the focus taken away from maths as computers became applicable to other subjects?

  Yes and no, though not as many maths teachers are using computers in their classrooms as would be expected. I think the biggest change came with the addition of the 'Computing studies' courses. In many schools this course tended to monopolise access to the computers, restricting access for all except those students and teachers involved.

- Did maths become less of a part of a computer related subject as the "Computer Education" course became a part of the curriculum?

In NSW the Computing studies courses were so different to that which was offered in a maths course. They were more holistic courses with consideration of much more than programming, including the social issues, graphics, robotics etc. The computing component of the Mathematics syllabuses was removed.

- How were the teacher inservice courses implemented?

  Mainly held at regional level, some state office – face-to-face, exchange of ideas, provision of information and hands-on time allowed.

- Did they teach how to implement the technology into the classroom?

Depends on the course, could have been application specific, but most included a strand of classroom technique and application to learning area.

Appendix D

Interviewee 2 email answers to interview Questions

- Tell me about yourself; when did you start using computers?

In 1974 I did a year of teacher training at what was then the Catholic College of Education, Castle Hill, where one of the courses introduced Fortran programming. We used primitive machines to punch out program cards, which were taken each night across to Macquarie University to be run on the mainframe computer there, and errors brought back the next day to be corrected. This was my only formal training in computing and my first use of computers.

I began teaching in 1978 and, by 1980, was actually working as a Head of Mathematics at a small 7-10 Catholic boys' school in Sydney (Marist Brothers Penshurst). The Principal decided that the school should be brought into the "computer age" and charged me with the task of purchasing the "school computer". I seem to recall a budget of $2000. I actually remember going through several models on approval (there was a Dick Smith one, and a Tandy TRS-80), tried each for a few days then took it back. I finally decided on an Apple IIe. This was then set up in a staff-supervised area and students were permitted to use it at different times to run some of the tutorial-type programs that were available at the time.

I remember the most effective use was on the school "Open Night" when parents and students were permitted to use the computer and play a few games as well as some cross-curricular quizzes.

- How did you use computers?

By the mid-80s I was setting up a brand new school on the South Coast (St Josephs at Albion Park, which seven of us began in 1982) and by 1984 I was setting up the school's first computer room.

These were around 25 networked computers which were available for a variety of subject areas, and I recall the Social Sciences making increasing use of them at that stage, overtaking the use by the Mathematics Department.

I had also done a 10-week PD course in Sydney (one evening a week) on LOGO for the classroom, which opened my eyes to all the possibilities, not just for teaching with computers but for teaching mathematics through a problem solving and physical engagement approach.

I ensured that, as Head of department, these elements were built into the teaching programs and encouraged and trained my teachers to make full use of the available technology. It was an uphill battle for some, and the conservatism of maths teachers became obvious – they wanted textbooks and chalk, not computers. Obstacles included means of display for the computer screen, which limited use to the computer room, and the hassles of moving classes.
I continued to explore new ways to use the technology for my own teaching, and tried to get my classes scheduled as often as possible in the computer room.

Right from the early 80s when I was canvassing the available software, I discovered that there existed software that did all the algebra that we currently spend the high school years unsuccessfully trying to teach our students. Computer Algebra Software (muMath in particular) really captured my attention, because I believed that this must impact upon our teaching of our subject, but was really unsure how. So I began to experiment and read and play around this area. Budgets were tight so there really was not an option to purchase such software, since I could not justify that it would be used by anyone other than me!

Graph plotters were plentiful – I remember ANUGraph for Mac and CapGraph for PC were very popular in schools. There were also game/learning packages like Green Globs that cleverly disguised the learning experience and engaged students, and of course LOGO remained a powerful classroom tool, for those of us who knew of it. I ran many inservices for my own teachers and for those from other schools introducing the possibilities in terms of both software and pedagogy.

In 1987, I became aware that Hewlett-Packard had made handheld devices that not only drew graphs (the first graphing calculators – from CASIO – appeared in 1985) but also did symbolic algebra. They were slow and difficult to use, and the screen was very small, but at last I saw possibilities for classroom access to these powerful mathematical tools. I applied to the Principal for a grant and purchased 8 devices, enough for one between 3 in a senior class. I also signed up and did a research Masters in Education in Curriculum Evaluation, and conducted a detailed evaluation study over the next 12 months of my classes from year 7 to 12 using these tools.

This involved developing curriculum materials that would guide their use, and through action research these were honed and improved to be fairly effective. Afterwards, I bundled these together into a book which sold through the Australian Association of Mathematics Teachers, called “Mathematical Investigations in the Senior Classroom – A Technology-Based Approach”.

This proved a springboard which eventually took me into tertiary education, taking a lecturing position at James Cook University in Townsville (I had also completed a Masters in Pure Mathematics some years before, so the double Masters proved appealing). I left this position to take up a PhD scholarship through UNSW and from 1992-1995 researched the ways in which students, teachers and preservice teachers used tools like graph plotters, tables of values and computer algebra systems when these were known and available.

I created a contextual environment using HyperCard on the Mac which presented questions and tasks, along with ready availability of a range of computer tools. It also recorded the time spent on each card, the buttons pressed, and prompted them with questions both when they chose a tool, and when they finished with it. All these responses were dropped to a text file which I then analysed.

Generally, I found that all groups loved graph plotters – the immediacy, visual appeal and congruence with their existing experience all made this the tool of choice. Those that used computer algebra tools generally required prompting and while they were found to be useful, generally spoke of feeling like they were “cheating”, like “looking up the answer in the back of the book”.

The obstacle had less to do with the tool than with the prevailing culture of mathematics learning, especially in NSW, which valued individual unassisted completion of set tasks. Respondents from states such as Victoria, which explicitly valued problem solving and collaborative learning demonstrated far less resistance.

- Why did you use computers?

I used computers because they ENABLED my teaching of mathematics in ways that were not possible without the assistance of technology, in all sorts of visual and dynamic learning experiences. They also served as a catalyst for a more student-centred pedagogy that I came to believe was far superior to the teacher-centred approach that was the norm.

- What were some of the problems?

The problems were practical on one level – issues of access and affordability, and problems for multiple teachers accessing and sharing relatively few resources. On another level, as noted above, the more serious obstacles lay in the prevailing culture of mathematics teaching, which valued teacher-centred instruction, chalk and talk, and an unwillingness to change their behaviour on the part of teachers – too much to learn and, if it did not translate into direct exam improvements, they could not be justified.

- What were some of the benefits?

The benefits were much higher levels of student engagement, substantial improvements in student attitude towards mathematics, in which they went from being passive spectators to being active participants and even creators of mathematics. They also translated into improved results, although these are always difficult to validate since there are always multiple variables involved: classrooms are far too complex systems to be able to conduct strict scientific experiments since you can never hold all the variables constant.

If I set up a comparative (control group) study in which one group had access to technology and the other didn't, then there became ethical issues and parent issues, wanting to know why their children were missing out. Even within my own class, was it the technology that led to the improved results, or was it some other effect, such as my own relationship built up with the students?

Nonetheless, research worldwide supported my own findings that the effective use of technologies for learning translates directly into improvements in attitude, results and engagement on the part of students.

- Tell me about early policies you were involved in.

Early policies tended to centre around equity and access, ensuring that scarce resources were available to as many students as possible. They assumed that learning benefits would accrue from use of the technology that the school had purchased, and so worked to ensure that students were in no way disadvantaged.

I do not recall policy that prescribed technology use by teachers, although much later in a school in the late 90s that had required all students to purchase graphing calculators, such a policy was put into place: that all teachers of mathematics would make frequent and regular use of the tools. It took almost 5 years of regular PD and support before all teachers could be said to be making good use of the tools in their classrooms.

- Tell me about the practices of that time.

The 80s were a time of great experimentation, willingness to try new things, and this was probably not unrelated to the increasing access to technologies which made new opportunities possible. Although the freedom of the school-based curriculum movement of the seventies had been replaced by much more hard-headed policy-level pragmatism at the system levels (syllabus and curriculum documents were heavily prescribed and schools were require to implement these according to fairly strict guidelines). Nonetheless, there was freedom within this implementation and the documents themselves prescribed general use of technology, so it was not hard to justify.

In practice, however, in my experience, perhaps 10-20% of mathematics teachers embraced technology. For the rest, it was all too hard, for all sorts of reasons.

- How did it develop?

I do not believe that all that much has changed in NSW schools. I have done PD in hundreds of schools across Australia and overseas over the past 15 years, and the vast majority of NSW teachers remain highly conservative and critical of technology. There may be a grudging acceptance that some of it is OK, but there are just too many obstacles to these teachers actually using it in their classrooms. And you can never get into “the computer room” because it is always booked for computer studies or social science!

- How did it change?

In the early to mid-80s, computers were directly owned by the mathematics department, and there was a natural tendency for maths teachers to explore ways to use them.

As other software became better and better, social science, science, music, languages and other curriculum areas began to take over. The mathematics software often remained little different to the early multiple choice tutorial type and this could not compete with “Where in the world is Carmen Sandiego?” or the like.

- Why did it change?

Mathematics teachers remained unconvinced that they really needed to change their practices: chalk and talk worked well for them, it was how they were taught, and it was quick and efficient – moreso than explorations and investigations, which were very time-consuming. It was easier to just show them!

This culture of learning made the technology an “optional extra” in the mathematics classrooms, something to fill in a Friday afternoon or if you finished the program early.

- What factors drove these changes?

Natural conservatism on the part of maths teachers, and a lack of understanding on their part that the ways in which they were taught did NOT work for the majority of students, only for the few.

So the changes in effect, were more about teachers NOT changing. After some early flirting and experimentation with new technologies and new pedagogies, the majority remained firmly fixed in the 50s as far as curriculum and pedagogy were concerned – and continued to complain bitterly because their students were disinterested and disruptive.

- Tell me about programming and the various languages used.

BASIC became the standard language throughout the 80s, but by the mid-to-late 80s, programming had all but died out. It was no longer required to be taught as the maths teachers handed over their special relationship with computers to the other subject areas.

- What sort of computers were used?

Once PCs became popular they took over because of affordability and familiarity; Apple computers remained popular amongst the few, and remain popular in a relatively small proportion of high schools (more popular in primary schools).

- What was their popularity?

PCs were generally preferred because the teachers and students were more likely to have these at home, and the argument that "this is what they will use in the real world".

- Is there anything else relevant to this topic that you could talk about?

I think I have covered most issues.

- Do you know somebody else who might be able to help?

Sorry, not really.

If there is time, I would like to investigate further the following Questions:

- Was the focus taken away from maths as computers became applicable to other subjects?

Yes – discussed in detail above.

- Did maths become less of a part of a computer related subject as the "Computer Education" course became a part of the curriculum?

Yes, part of the same natural progression.

- How were the teacher inservice courses implemented?

Don't really know.

- Did they teach how to implement the technology into the classroom?

There were attempts but overall these tended to be piecemeal – but I was in the Catholic system, so cannot really speak for the State system.

Appendix E

All interviews were transcribed by a professional scholar. The interview transcripts were not edited to keep the information as true as possible. The transcripts are as close as possible to those received by the transcribers themselves.

Interview 3 part 1

(I: Interviewer, P: Participant)

I: This is Peter Sollorz on the 28th of the 10th on the Thursday. Interviewing Interviewee 3 at about 1:10 and I'll start with, tell me about yourself when you just start using computers.

P: Okay. I first started I guess in my Dip Ed year. We had two, three hour sessions on teaching Fortran programming in the Maths course, I was trained as a Maths teacher and that started me getting interested in computers. And then I got my first appointment in a school which was very interested in computer education, so they had a special course in Computing running at that school, so I got into it in 1971 which was my first year of teaching.

I: So they were using computing back then?

P: Well the Principal there was interested in getting into it, so that was the first year that he wanted to do something, so he wanted to run a kind of a general course that all of the first year students would take and it was really focussed on using, well it was up to me really, to design what they wanted to do. So we did it in the context of Mathematics using programmable calculators. Canon Canola's, I don't know if you've come across Canon Canola's. So we got into that, so we were running courses in sort of programming there and then Macquarie University was offering a service to schools where you could write up code with some punch done, mark sense cards, send them off to Macquarie University and they'd send them back. Send back the print out from them a few days later.

I: So was that coordinated with the school or was that separate?

P: Well the school was responsible for organising it and me as well.

I: And what school was that?

P: That was Port Hacking High School.

I: Boys or girls?

P: It was both you know, boys and girls school, yeah. So and that worked pretty well. It went for a couple of years and I started to develop teaching programs around the Canola Calculator. That went on for three years. We also did some general Computing Awareness in History type stuff as well and talking about what role computers might play, 'cause in those days, they weren't very widespread, so, but still we tried. And so that was really my first taste, so I got into programming, programmable calculators effectively and then the micros came in a Tandy TRS-80's, I bought a Tandy TRS-80 and played around with programming that.

I: So that was a computer as well?

P: Oh yes yeah. It was one of the first micros. It was about the same time as the Apple as being released, so there were Tandy's, Commodore 64's, MicroB came in a little bit later, but Atari's, the main ones coming into schools a bit later were the Apples. And then IBM came onto the scene as well, but in those days they weren't in schools in very big numbers. I was there for three years, '71, 2 and 3, and then I started a Masters in Mathematics at Macquarie University so I moved schools so I was closer to Macquarie.

I: So was that Maths teaching or pure Maths?

P: Maths teaching. Well the Masters was in, was a Mathematics Masters, it wasn't in Teaching, so it was just pure Mathematics Masters and in that Masters of course there were two things happening here, but in that Masters, it was mainly course work, but there was project work as well, but one of the components of that was Mathematical Computing, Finite Methods and using computers for approximation, so solving, so the early days yeah. And Queuing Theory and setting up a simulation.

I: What's Queuing Theory?

P: Queuing Theory is the theory about how queues, you know people waiting in line for something or planes waiting to land and so on, how to simulate that process of how queues lengthen and what happens when there are two or three possible queues and distributing [00:05:20] [overtalking]. So simulate what would happen as planes randomly arrive, how long it takes to process the planes.

I: Is that QUEUEING?

P: Yeah as in forming queues and how to process queues. And so we ran this simulation to see what happened when, how sensitive it was to changes in the frequency of arrivals of planes, how sensitive it was to how quickly a queue was dissipated, how sensitive it was to how you distributed arrivals over different queues, if you favoured one queue rather than another, would that make it easier or harder to process a plane. But anyway the point was it was using Mathematical Methods implemented on computers, you know a Mathematical problem, which is queuing. Queuing theory.

I: Back to the Canolas, I was meaning to ask you, what could you call the programming language of that? Was there a name for it?

P: Well no, it was just called the Canola programming language or whatever, but it was closest to I guess, a similar language, the kinds of instruction were things like, load into memory, read from memory, add two things together, divide things together, load a number into the accumulated devise, so it was more a sort of assembly level code, so step by step. Anyway the instructions were "jump to", "go to" a particular instruction, so there was a jump on zero, so you'd do a calculation and check if the result was zero and then you'd jump back to another part of the program. So there was some control structures.

I: That was all done by card wasn't it?

P: Yeah you'd do it by card. You'd punch out the instructions on a card yeah, on the early ones yeah, that's right. So you'd have these cards, about 10cms maybe long, and about three centimetres wide and a little bobby pin or something to push through the holes, so you'd have a set of coded instructions, the instructions were printed on the back and you'd sort of say, "read memory 01, read memory 02".

I: And what would that mean?

P: That would mean, "take whatever's in memory 1 and put it into an accumulator and then read memory 2 and take whatever's in memory 2 and put it into the accumulator?" So you'd normally say "add", so "read memory 1, add memory 2 and then store memory 3" would take the two values and add it.

I: But how would you say "add" on the card? Do you have to do that on the card?

P: Yeah there'd be an instruction called "add".

I: And when did that phase out, the Canola do you know?

P: Well it was still going, well a course was actually started and I was there in the early phases of it, at Wright High School just where I went. I transferred from Port Hacking to Wright High School so I'd be closer to Macquarie, that was in 1974 and they already had a Canola course going, so I got involved in that and started to develop that as well. So that went for three or four years and then Apple started to come in and the Canola's kind of faded out.

I: Could you give me an approximate date on when the Apples came in?

P: Gosh, it would have been late '70s or middle to late '70s yeah. Certainly around, they were pretty well established in the early '80s, late '70s too I guess. But there was also Commodore 64's then.

I: These other computers, I know the Apple would use Fortran, is that correct?

P: Apple? No Apple used its own, used Basic.

I: So what was using Fortran?

P: Oh well Fortran was really on mainframe computers, so you had to run it on ...

I: Oh is that the really big computers?

P: Yeah so something like the one at the UNIVAC 1106 I think it was at Macquarie University, so they offered this service of the mark sense cards and they'd run them for the students and then send the results back. So you'd have to use that. In the '80s, there were some Pop11 machines, what were they? Sorry PDP-11s and there was one given to each region by whoever made them, Univac or whatever.

I: Is that a computer is it?

P: Yeah it was a mini computer, so about the size of a table maybe two meters tall, so you know reasonably sized ones.

I: About this table?

P: No a standard kitchen table. About that wide and about two metres tall I suppose. It might have been a little bit narrower and there was one in each region and they were given to the regions in order to try out these things in a classroom and it would be mainly for programming purposes and again they'd use Fortran as well.

I: So when the kids used Fortran, 'cause I know they did it for a course in the '70s yeah, how would they know how to program words, like did they just go by computer data or how did they know to learn it?

P: Well it was part of the Mathematics syllabus, so teachers would teach them how to program in Fortran and they'd ...

I: What I mean is like, in the future of that time, like in the '80s, they would probably use an Apple and they would type into the Apple computer language and they would get results straight away, is that the case with Fortran?

P: No, because the machines that they were running on were card based machines, punch cards.

I: Like the Canola?

P: Well yeah, I might have one, their cards were about, they were called Holdsworth cards, they're about 3, 4cm tall, about 8cms long.

I: So a bit smaller than the Canola cards?

P: No about the size of, a bit longer than a postcard, about the same height as a postcard. The unusual thing was you'd punch the cards on a card puncher machine, so it's a keyboard and you'd punch instructions on the keyboard and the card would get punched and then you'd put in the next card and same story, so you'd just punch one instruction per card and then the cards are stacked up, they're submitted for processing, so the computer operator would take your submission deck, which would be 10cms high. You'd put control cards at the beginning and control cards at the end to instruct the computer to start reading these and then you'd wait. Sometimes it might take three hours for your job to come up, then you'd get a print out and the print out would be put into a box which you would then check every 10 minutes to make sure, see what it came out and you'd just wait for your printout to come out and the printout would contain a listing of your program and then the data, would be the results of your calculations or whatever it was at the end. Now if the kids were doing it from home, they'd pack the cards up, we'd post them off to Macquarie University and then Macquarie University would pile them up and maybe two or three days later or a week later, they'd get round to running them overnight, just pile up all the cards and the printouts and post them back to us.

I: So they'd print it out on a big paper?

P: On a line printer, the one with the perforations down the side that you rip the edges off. So that's the output for this. That's what the students would get, they'd get a bundle of paper and some results and then they'd have to, if there was a problem, they'd have to fix their program, replace the cards, punch out a new card with the correct instruction, put it back in the deck where it's supposed to go and then post it off again. So none of this instant turnaround, you know if you'd make one simple mistake, you'd have to wait a week or more to get the result back.

I: Was that the whole time, Fortran, was it always like that with Fortran or did it change?

P: I have to say I'm not aware, I guess there are Fortran compilers now that run on [00:15:02] [overtalking], but in those days it wasn't. The language that was used on micros in those days was Basic and it was actually Basic written by Bill Gates. The same with MS DOS machines, Microsoft DOS machines used Basic as well and Basic was actually built into the computer, it was actually in the firm ware.

I: In the PC of the IBM?

P: Yeah. The IBM or the Apple?

I: Oh even the Apple had it?

P: Yeah, yeah.

I: From Bill Gates?

P: Mmm.

I: I'll get back to my questions on the sheet. How did you use computers? If you think you've answered these that I say, just tell me and I'll move on.

P: Well in those days, that's how we used them. When the Apples came in and this is later in the '70s and the other machines, they were used for other things, like word processing, for database work, so other subjects started to get interested in it. Like History started to get interested in databases of well, facts and so on. People started to write educational programs for these machines.

I: Sorry about this I'm just checking if the light's working. It says record so.

P: So the English people started to get interested and historians started to be interested in it, geographers started to get interested in it, 'cause there were programs starting to develop on database of facts about geographical locations and so on. Then there were adventure games.

I: Yeah I love those.

P: So very simple ones, so there was becoming a wider and wider interest in other applications besides this programming, so programming started to take a back seat.

I: And this was in the mid '80s was it?

P: No, this was early '80s.

I: Can you give an approximate date or just early '80s, that's alright.

P: Yeah look I can. Just to give you an idea, this is the proceedings of a World Conference on Computers in Education. This was the fourth World Conference and that was in 1985, so 1981 was the first World Conference on Computers in Education. You get an idea of the kinds of things being discussed there from the index.

I: So it's a kind of thick book too. I was meaning to ask, I didn't put it on the sheet, but it might be a good question to ask. I tend to ask it to most people now, is how could you explain the relevance of computer programming and all other aspects to Mathematics?

P: Well it's an interesting question. In 1982, I was a consultant for the Department of Education and I was K to 12 Computer Education and K to 6 Mathematics, so I started to move out of Maths education, but anyway at that time, in answer to your question, in '81 or '82, I gave a paper to the Maths Association of New South Wales conference on the coming backlash against Mathematics and Computers because Mathematics teachers were pretty much involved right from the beginning in this thing. The Maths syllabus was getting a little bit behind the eight ball. They started to introduce Basic into it, but the syllabuses didn't really tend to adjust to what the role of Mathematics in Computing were, what their joint roles were. So I suggested that maybe Mathematics people need to let go of Computing a little bit and sort of rethink what the role of computers in Mathematics should be. And it was just a little bit after that that rethink happened. In my view the role is to do the sorts of things I was talking about, simulations, trying to implement algorithms, trying to get the understanding of what's behind finite methods in continuous process because Mathematics deals with both continuous and discreet processes and the question is how do you actually manage to address continuous processes using finite type machines. So it was looking at the nature of computation itself, computers are computation devices, so Mathematics should look at what the role of computation is and how computations can be viewed from a computing point of view as well as a Mathematics point of view. But also using spreadsheets for simulations and the like, doing what if type things. Rather than doing a straight, making it more experimental I guess. Experimenting with numbers and looking for patterns and seeing what would happen if, so moving away from the kind of formulaic thing, you start with equations, you work blah, blah, blah, blah, there's your answer. Playing with numbers and seeing the effect of doing this or that or the other thing is what happens with an equation when you change, you know one parameter and you can do it easily with a computer. So you graph in two lines, what happens if you change one of the parameters, you know the lines sort of change like this and what happens to the solution? How sensitive is a solution to changing the parameters so you can explore equations and so on in that way with computers, rather than just rely on working algorithms in a standard sort of a way, so that was the way I'd see it. So using other tools besides the programming to do it and there are quite a few programs that came out around those times, which enabled that kind of thing. You know quickly plot equations and then cross programmable graphing calculators came out as well, so students could actually plot sign, verbs and plot two equations, have them intersecting to find roots of equations all graphically. So it was changing the way you thought about Mathematics, but it wasn't a comfortable time for Mathematics really.

I: Why is that?

P: Well I think it was just changing the way Mathematics was viewed in terms of moving away from just well known algorithms and students learning techniques with doing this, solving equations and doing algebraic things, learning number facts and to play with numbers, experiment with numbers and Mathematics wasn't considered an experimental science.

I: Still might not be.

P: No, still may not be, that's right.

I: Unfortunately. Maybe I should move on because I've got a lot of questions and I don't want to take up too much of your time. Why did you use computers? Maybe we can talk about that.

P: The first time purely out of interest and circumstances meant that I had the opportunity to do it. I was fired up after my Dip Ed course and this was a golden opportunity to actually continue with something which I found interesting and so it was just lucky that that circumstance opened up. So why I started was because I had an interest in programming really and then I started to get more interested in what computers could do more widely. You know what the potential was, there were more and more interesting things. You'd get into spreadsheets and databases and this sort of stuff as well and graphic packages and so it was a personal interest and then how that can be relevant to teaching. So you start to look at how other parts of the faulty besides Maths could use them for things like trying to introduce teachers to word processing which was quite novel in those days in English for example. So databases as well, so just started to move out from there, I just became more and more interested in what the potential was for these things, but it just grew out of a personal interest in programming. That's what started me and I think it's the same with a lot of Maths teachers in those days. You asked a question about the number of Maths teachers in the Computer Education unit, well there was ……… [00:25:22] who I think you might have interviewed.

I: I have yeah.

P: …….. who's died, he was a Mathematics teacher as well and myself and the only non-Maths one was ……… who was a Social Science person.

I: So there were four of you?

P: Yeah four. We were called the "Filthy Four". There was actually, Australian Personal Computer ran an article on the Erskineville Four because we were based at Erskineville and interviewed us and how we thought we'd go, so just as an indication of the fact that there was some kind of wider interest in this. There was something on the 1985 syllabus. That was our background, but we'd all drifted away from programming and computers in Mathematics into other applications of computers and looking at the wider uses of computers across all parts of the curriculum. And that's one of the briefs of the Computer Education unit, to look at computer use across all of those areas including Mathematics.

I: When was it formed, the Computer Education unit?

P: I was a Regional Consultant in 1982, I came in in 1983 and it was officially formed in 1984. So 1983, the four of us were bought together in head office under what was then Services Directorates, but we weren't officially a Computer Education unit but we were housed together basically. Well actually two of us were in the Services Directorate and two were in Curriculum Directorate.

I: How did you form?

P: It was called Studies. It was formed by the two Directors of Studies Directorate and Services Directorate, in auspices of the Government of course. The year before that there was a general statement about the role of computer technology in Education, but there was nothing there to implement it. No sort of guidelines, no nothing, so part of the responsibility of this unit was to be to work on policy directions and so on and so forth. So we got together in 1983 and the unit was opened in 1984 officially, August 1984.

I: When you say officially, is that by the Government?

P: Well by the Department really, Department of Education as it was then.

I: So did they ask you to form before you officially formed?

P: Oh yes, we were interviewed, I was a Regional Consultant, so some of us were approached and they said there's going to be this unit, do you want to come in for an interview and that was at the end of 1982 and then I was appointed and I was appointed to the Studies Directorate and we sat in head office and the others were appointed to Services Directorate, they were somewhere else and we'd meet once a week and we'd be doing policy type things. I worked on the policy, there's a general policy which was released in '83 and I worked on it, Computers in Schools.

I: Yes I've had a good look at this from Fisher Library.

P: So I was on the group that developed this policy, that was one of our first tasks to actually work on policy.

I: Just for the note taker, it's Computers in Schools, a general policy statement 1983.

P: So that was worked on in the end of '82, we were appointed at the beginning of '83 as this was just being formulated then.

I: And that's by the Education Department?

P: Yeah that's the Department of Education document.

I: And you made this before you were officially ...

P: That's correct. This was released in '83, the unit was officially formed and opened in 1984 but we were working effectively as the Computer Education Unit before that but we didn't have a title or anything like that.

I: Oh no title t all?

P: Not at that point and then officially we became the Computer Education Unit in 1984. And it was in 1984 that the Commonwealth Schools Commission actually introduced a Computers in Schools program across the Commonwealth. And so we had, one of our responsibilities then was to start to implement that three year program, so we then expanded quite a lot from four to you know, 30 with Commonwealth money. We had to put together a program, we got in people in Professional Development, so we had a Professional Development team, we had a Software and Hardware team, we had a Curriculum Development team, which I led. We had an Information Systems team and we had a Special Education team and so those teams were all responsible for various components or aspects of introducing computers into schools and covering all those, we developed curriculum documents, we worked with syllabus committees to develop new syllabuses. We worked with Special Education people, we worked with other parts of the Department in particular areas, like with Mathematics teachers, with Music teachers, with Art teachers to develop materials that would help those disciplines introduce computers into the classroom.

I: I know this might sound a bit redundant from what you've already told me, like you've done this, but how much say did you have in the group? How much say did they have in the general terms, like what you say would generally be accepted and done?

P: Yeah, we were set up as kind of a one stop shop. So in policy matters, before the unit was officially formed, the person who got us together was a guy called …… and ……. was an advisor to the then Minister. So ……… kind of led the, not quite unit yet. So he was responsible for sort of setting things up and getting things going and establishing what sorts of things would be done. Then the unit was officially formed and we got a Chief Education Office, …… from Wollongong, who became the leader of the unit. Now …… didn't start until a few months into the unit. The unit was formed before Ian joined, so I was acting sort of head of the unit for a few months and then ….. joined the unit and it was officially opened and then the Commonwealth money came and it all sort of expanded.

I: So how many members did you have when it was officially opened?

P: Well officially opened, there were just four of us.

I: Oh okay. I sort of picked up the names, but you said ….. and was he .....

P: …... had left by then, so when it officially opened, officially …… was the Chief Education Officer, he was the head of the unit.

I: And was he a Maths teacher?

P: No he was a lecturer at Wollongong University, he lectured in Computing, he was a Computer Science lecturer. There was myself, who was head of the Curriculum Development team, there was ….. who was in Hardware and Software mainly and there was ….. who was in Professional Development and …... who was a Social Scientist, issues and implications type person. So that was the four of us.

I: I've got three questions off of the top of my head from what we were talking about. I might actually write them down before I forget while you're answering one of them. How much of this, I know you had changes like you were having other subjects getting involved, what sort of Maths things were you involved in, like for Mathematics? Because that's my topic of interest, what sort of Maths based things were you doing at that time for the group?

P: Well initially in'81 I gave talks to teachers under the auspices of the Maths Association of New South Wales and that was about programming but also about using things like spreadsheets and the like in Mathematics. It was more oriented towards to actually doing Mathematics and programming 'cause that was part of the syllabus in those days as well. Then I started to drift away from the Mathematics area and so in 1982 when I became a joint consultant in Maths and Computing, I was starting then to move away from that, other than doing what I do with other subjects, like how could computers be used in those areas. But they were the main things, how to use spreadsheets in Mathematics and how programming fitted into the Mathematics curriculum as well.

I: And was that sort of put into the curriculum, spreadsheets and the programming?

P: No, it wasn’t. There was still debate about the role of calculators, you know people were still arguing about whether calculators would mean that students wouldn't be able to do their Mathematics in their head, because they'd dive straight to the calculator and there's some evidence of this as well. So there was a complete readjustment about how do fit in calculators into Mathematics where before we'd rely on the students being able to do mental arithmetic and sort of add things up by paper and pencil when they can just go, tick, tick, tick. So there was a move towards, well students need schools in assessing order of accuracy of something, so they'd see what's 38 x 460, then they'd need to know it's not 19 million, that's too big, so it moved towards, they can get an answer but then is that reasonable. You know how big would expect the answer to be? Is 50 reasonable for 38 x 460, no, not really, 500? So there was a change in how you viewed Mathematics, but it was still kind of debateable really.

I: So it was more on calculators at the time would you say?

P: It was, but I'm just using that as an example to say, you can see this churning about using calculators, imagine what it's like using spreadsheets and other sort of complicational tools as well. So there was a bit of a rethink about the nature of Mathematics and what we should be teaching in schools and I guess it's the same now. I mean you've got instant access to information all over the place, so how does that change the way you think about the nature of learning when you've got instant access to knowledge, so it's not enough to say, leaning's about accumulating knowledge, it's about how to know where, and how and how to adjust the effectiveness of knowledge and the accuracy of it and being able to know where to go in order to get information. So there's a change in just how you view what Mathematics is and what anything is, you need to know how you can effectively use a spreadsheet or whatever.

Graphing tools and simulations, modelling and so on, but as I say I moved then away from Mathematics at that time and I haven't really had much of a connection back to Mathematics. I'm still interested in Mathematics, but it's not changed. Computing is what I do and Maths is an interest and hobby and it used to be the other way round.

I: A question I haven't asked. I was meaning to ask, when did the changes, I know it must have happened before the unit took place, but the changes where it started getting, like you said History was getting interested in computers and other subjects? Can you give me an approximate date when that sort of started to happen?

P: Well if you get an idea from here, the sorts of things being addressed back in '85, but it was starting to happen, people were doing this in our schools in '81, '82 even '83.

I: As early as '81 you would say?

P: Yeah, yeah. Certainly in '82 when I was a Regional. There were the Music teachers were getting interested and so my brief was across all of these. History teachers were, so there were people developing sort of learning games, adventure type games, there were hypercard, which was on the Macintosh and that came out, so that's 1984 we're talking about here, was a great tool for teachers, 'cause they could then develop a sort of database interactive type applications and they were doing things like virtual tours of sites, of historical sites and so students could explore these historical sites and go from one screen to another and take a walk through a Greek ruins or whatever else and click on a button to see what was under this rock and that sort of thing. So those kinds of interactive games were being developed in the middle '80s and so we got a lot of the people who were interested in that kind of thing to do work for the Computer Education Unit. So we got people in to help us with this.

I: How long was the Computer Education Unit formed for? Like how long was it a group and then when did it dissolve?

P: I left the unit in about '90 and it kind of started to fade in the early '90s and there were a lot of theories about why this happened.

I: What's your opinion?

P: Well one is, I think it's a mixture of these things. One is that there was a lot more interest in more widely so that the job of the unit in spreading the word if you like and developing resources and so on, was being taken over more and more by regions and teachers were starting to become more and more familiar with it. Policies setting this were in place, the syllabuses had been developed, so the unit no longer had a role there, but there was also, I think some political effects as well that because the unit was kind of a one stop shop, it was considered to have maybe too much power and influence 'cause we were approached for policy decisions about various aspects of computers in schools, so we gave policy advice. We were involved developing syllabuses in writing documents on how computers could be used in these various areas and so other parts of the Department were probably thinking, well you know, you're getting into Maths curriculum here by saying our computers can be used in Mathematics, you're getting into whatever else. And some of those things got picked up by other parts of the Department, so there was a Curriculum Unit out at Ryde which was responsible for writing support documents for schools. I mean the key learning areas came in, they took over the responsibility of writing documents on the role of technology in those key learning areas, so they developed some quite nice documents. Have you seen those, the Mathematics Technology? I'll just show you.

Interview 3 part 2

(I: Interviewer, P: Participant)

I: Continuing the interview with Interviewee 3 at 2:00. Very interesting.

P: It's all based on classroom practice, the teachers were asked to formalise the stuff they'd done and you can see a whole range of different kinds of software being used in these key learning areas. So these were end of '97, I think probably a bit before that for some of them as well.

I: Sorry that was in ...?

P: Nineteen ninety-seven. So this was after the computer education unit. You can see that things had moved on quite a bit from what was originally done by the Computer Ed Unit and the other key learning areas were getting more and more interested and they had excited teachers who were using computers and so the unit really had no real role to play anymore in that.

I: Why were the early members Maths teachers?

P: Why were they Maths teachers? 'Cause that's what they did. That was the real entry point into Computing in those days. They were talking about the early '70s, as far as I'm aware there was no reference or use of computers anywhere else in the curriculum. There was no Computing curriculum. Some schools developed other approved studies, so they can develop a course internally and have it approved by the Board for a HSC. So there were a few of those and we developed one at Ryde, of approved studies as well, but that's where most of the initial interest came and most of the computers would have bought initially for Mathematics as part of the Mathematics budget in the school. There were sort of debates about this as well 'cause there's other subjects wanted to get more and more interested in it. There were issues about how the computer time would be distributed and who should have computers. Should they be in the classrooms or should they be in labs and so on. That was where most of the interest came because that was part of the curriculum, programming and the things you could do were probably mostly Mathematical in those days, but things changed of course in the '80s with the introduction of Apples and the IBM PC and PC Junior.

I: Was there a computer called PC Junior was there?

P: Yes, yeah. Yeah that was the first one. IBM actually ran quite a large program training teachers, pulling them out of schools for weeks on end and putting labs of PC Juniors into classrooms.

I: You mean labs?

P: Yeah putting numbers of computers into schools.

I: Like in computer labs?

P: Yeah computer labs.

I: Well it's about 2:00, it's up to you.

P: I can go for a little while. If there are any burning issues or questions you want to ask.

I: Well I've got quite a few, so I've got to cut them down. I know which ones I need and which ones I need more than others. So I might just stick to these ones up here. What can you tell me about the computer education group? Do you know anything about them?

P: Yeah not very much. I've got some, this is one of the early conference. The computer Education Group I think started in very early '80s, maybe '80, '81. Eighty-four for Computer Awareness syllabus. There's other ones of these as well for other key learning areas.

I: What was it anyway?

P: Well it was a group of teachers who were interested in computers in education. Not all Mathematics teachers, you can see from that, that was fairly early.

I: Did they have any say in policies and that?

P: No.

I: Like what did they do and what was their purpose?

P: It was a group of interested teachers who ran in-service courses for teachers, collected materials and distributed them back to teachers. They had an annual conference and they'd run workshops and in-service courses for teachers as well. They later became affiliated, there's a body of professional associations that have some influence on policy. The group that Governments go to for advice, community advice if you like and so the CEG was the official teacher representative group if you like on that body, so when the Department was after consultative groups to discuss a new policy or new syllabus or whatever else, the Computer Education Group would supply a person to that group. So they had influence in that way.

I: So they'd supply someone to the policy makers?

P: Yeah to work on committees or to go into consultation and so on, so they gave advice in that way.

I: Did they help the Computer Education Unit?

P: No not really. There weren’t affiliated in any way. People on the Computer Education Group would also work with the Computer Education Unit when we had people in to write materials and so on, they would also happen to be on the Computer Education Group. ….. who was with the unit was a foundation member of the Computer Education Group.

I: So some of the members were members of both?

P: The Computer Education Group, it was like a club effectively and then it became a kind of a representative body for computer education teachers. Interestingly now, there's a new association formed, Computing Studies Teachers Association which was more oriented towards Computing Studies teaching. Computer Education Group was broader, it was interested in computers across the curriculum and it had teachers of Mathematics and anyone interested in using computers in any key learning area. And just general issues about the role of computers in learning. The Computing Studies Teachers Association was more focussed on supporting the syllabuses, the official Computing Studies syllabuses and just recently, like in the last few months, the two bodies have decided to merge. So the Computer Education Group has abandoned itself and they've formed a new group with Computing Studies Teachers Association and that new group will be the kind of official representative, affiliated with the Association of Professional Associations, I'm not quite sure what the title is, but I think there's a federation of professional associations which in under an umbrella group of professional associations and so this new group is the kind of official affiliate with this professional association group. And most of the association no doubt and the same with the Maths Association, would be the official voice of Mathematics educators when there's advice.

I: And that's recent?

P: Yes like a month. And they're still working out the details, but the Computer Education Group now no longer exists.

I: With the Computer Education Unit, why did it focus on other subjects, like why was it saying let's put it into these subjects as well as Maths and not just Maths 'cause I know the Maths teachers were, do you know what I mean?

P: Well I think the policy that drove a lot of that stuff, so the computers in schools policy talked more generally about the general role of computers in education, the need for students to be aware of technology and how it can influence their life, how technology can enable students to learn better and so on and so forth and there's no mention of where that could happen. So it wasn't ever, it took no congress in where and whether it's in Mathematics or Science or whatever else, so at this point, you know even in the early '80s, the association with Mathematics was kind of, if there was one ever, just wasn't there.

I: It was drifting was it?

P: These things were happening in the background. ….. for example is something like, he's kind of like a technology person in the sense of a broader view of technology and the influence of technology on society in general. So this was growing, but there was no, it was just in the early '80s that this started to come into a school, into effective schools. So it was just developing and Mathematics was kind of, that's where the teachers first came from, but Mathematics wasn't a real spark for any policy development or direction or anything else. It just happened that there was people who were originally in Mathematics it happened, that actually were around and they got involved early and they happened to be the people on the ground. It wasn't anything about the nature of Mathematics that this stuff grew from. It was coming anyway, it was just this move towards this role of technology and learning and so on and the people who initially picked it up were Maths teachers and we very quickly drifted away from our connection with Mathematics in that sense. We didn't keep a connection with, well this is really a Mathematical tool, we started to sort of change our views as to the nature of computing I guess.

I: Can you tell me why that was?

P: Well I think it was the same as all things, it was a policy issue that Government saw this as being a broader policy issue, not just about Mathematics education. They had money available, Commonwealth money came in in 1984 for introducing computers into schools, there was a growing interest in all sort of other different areas about how computers can help us in the classroom and so there was grassroots from all other people, policy directions and the Federal Government and the Computers in Schools program saying this is a more general approach not a particular subject area.

I: And who wrote the policy the Government?

P: Which policy? The Computers in Schools?

I: Yeah.

P: The Department of Education policy yeah. There were guidelines before this and they were sort of endorsed by the government of course, the Minister and was initiated no doubt by the minister and the to-ing and fro-ing between the Department and the Minister. I don't know about all the machinations behind the scenes, but it's an official Department policy.

I: And what drove their changes that they were doing, what drove it?

P: Well there was a general interest earlier with technology advisors, I mean the realisation that technology is influencing Governments and work in all sorts of different work. The nature of work and so on, I guess it becomes inevitable that if all of these changes are starting to appear on the horizon that they should get reflected back into the school system and the schools need to start to develop in order to take these changes into account. I certainly grow out of a need from particular areas of the curriculum, it was a kind of a broader thing from outside. Together with grassroots interest in using computers in the classroom and the Computer Education Group was one that pushed that. They weren’t so interested in sort of influencing policy as supporting teachers and offering advice when they were asked to join the committees and so on.

I: Did they have a lot of say, the Computer Education Group?

P: Not as, well they had representatives on various committees so it's hard to say. I don't know what went on in those committees so I can't say, but they had representation in syllabus committees and in policy groups and so on. They still do, so in syllabus development now, when a committee is appointed, well when people are interviewed there's a Computer Education Group representative on the panel that appoints members to the Examination Committee for example, so they still have that kind of influence if you like.

I: Not to contrast them too much, but is the Computer Education Unit, did they have representatives as well or were they more of a body working together?

P: In the initial days we did. We had teams on the syllabus committees, in fact we wrote a lot of the drafts of the syllabuses. There'd be the committee and then the committee would make decisions and say oh we need to develop this, this, and this. Computer Education Unit representative would go away and would actually write drafts and elaborate on the ideas that came out in the committee, take them back to the committee and then they'd be pulled apart or elaborated or whatever else, so the Computer Education Unit in the syllabus area became a kind of, the backroom sort of writers because members of the committee, you don't actually have a lot of time to write this stuff in a committee although it does happen. But the way syllabus is written has changed now, it's different, but in those days, that was one of our roles, to actually supply writers and members of the committee. So Denise was in the Computer Education Unit and she was on the Senior Syllabus Committee and wrote material for that. I was on the Junior one, 7 to 10 and I did the same thing.

I: Was that when you got more members?

P: Yeah, expanded yeah, that's right.

I: Is that how you met?

P: Yeah it's is actually yeah. Yeah we met there.

I: Do you know anything about the relevant governing bodies at the time, like the Commonwealth Schools Commission or the National Advisory Committee on Computers in Schools? What can you tell me about them?

P: Well I don't know about how they operate everywhere else, but the Commonwealth Schools Commission was responsible for implementing this three year, $22 million for New South Wales program and so my contact with them was through that program and we had to set up a group which was called the Computer Coordinating Implementation Group. And so there was members of the unit on that but there were members of the CEG, there were representatives from parent organisations, from the Premier's Department, from you know, it was a large group and it was responsible for implementing the program, the Schools Commission program. So that was our contact with them. Our head, ….. used to go along to Commonwealth meetings in

Canberra I think it was, he was the contact obviously with there, but then it came back and there was coordinating groups, so that was my contact with that program 'cause I was the leader of the CICG. It was called the Computers in Schools program here. A part of it went towards hardware, part of it went towards developing documents like this, but we had to put together proposals for funding. So some of the funding was direct to schools, they put proposals in. One of the proposals was from the Computer Education Unit to actually fund and increasing staff and so we put together a proposal for curriculum development teams, software development team, hardware development team, so that was where the core of the expanded unit came from, but we actually ended with a number of these different teams from the original four. That was partly in response to the Commonwealth program. And then it was funded later on from Department funds, it was a three year program and then it started to drop again.

I: Is that the one from '84 to '86?

P: That's correct, '84 to '86 yeah. So part of that funding went towards expanding the unit, the Computer Education Unit and then the Computer Education Unit in turn was responsible for a number of programs funded from that which had to go through an approval process and we had to put submissions in and so on.

I: How much of it got approved from the Unit? Like did a lot get approved?

P: Yeah almost all of it yeah. We were given a ballpark saying, you know it's up to this, but you know if your proposals don't come up to, because we put in a number of proposals for different components, most of got up after much argumentation, like months and months of argumentation, we had to justify what we were going to do and we had to change some of the focus of the program to ensure that it wasn't just set on people sitting in head office. That it was actually involved work in regions and schools as well, so it had to be a direct influence on schools, direct effect on schools. But it was a rigorous process, and then CICG was set up responsible to approve that spending and also to monitor it, so there were regular reports on how the program was advancing and what we'd done, how the money was being spent.

I: So CICG, what does that stand for again?

P: I think, I can't remember exactly, I think it was Curriculum Implementation Coordinating Group.

I: And that were part of the Unit?

P: No, no this was separate from the unit.

I: So you had the Computer Education Unit, Computer Education Group and this one as well?

P: Yes, yeah.

I: Did they have a lot of say this group?

P: They had a lot of say in how the money was spent. The same as in all states, the states don't like the Government telling them what to do.

I: You mean like [00:22:22]

P: Each state, particularly New South Wales, wants to make decisions about exactly how Commonwealth funds are spent and what sort of structures are put in place to do it and so on and so forth.

I: So this was a Federal body this on, this group?

P: No this is a state one. The function of the CICG to provide the central support and coordination necessary to ensure as far as possible, properly planned programs which are in accord with the aims and principles of the appropriate syllabuses and support statements, ultimately are available to all New South Wales school students.

I: And sorry, I don't know if you said this already, but they work for the Federal Government?

P: No this is a purely State ...

I: Like Nick Greiner sort of thing?

P: Yeah it's a State, this is a State body and there's one in each area, there's a Music Curriculum, Music CICG, there's Talented Children CICG, Visual Arts CICG, so there's a CICG for all of these areas. So there's a Computer Education one, this is the Computer Education CICG.

I: And when did they form?

P: This was in early '80s, mid '80s and it went for a few years. This one was, I've dated it '87 so this one may have started in '87, 1987.

I: Okay. Is there anything else relevant to this topic that you could talk about?

P: Well there's been a lot of development in the syllabus, Computing Studies syllabuses over that period of time. We've gone through a number of different variations on the syllabus. There was a complete rewrite of the syllabuses. There is a big push for syllabuses developed in the key learning areas and there was a complete rewrite of the structure of the curriculum.

I: When was this?

P: This was in, '89, '90.

I: So they did a big restructure about that time?

P: Yes I mean the courses we all oriented around two units, so two of the courses, Maths became two unit courses, instead of having four unit, they were two unit and two unit extension, so it was all two unit structure, the courses were extensively rewritten, there was argument about whether it should be one, two, three or many computing syllabuses. There ended up being two with slightly different focuses, one on programming and software development and the other one on Business Information Systems, Information Processing, so there were two different developments, they were quite a way from programming so Information Processes syllabus has no programming at all in it. Whereas the Software Design one has quite a substantial amount of programming in it still. I mean there are lots of changes, I can't say much about the Mathematics and how that's influenced, all I can say is that there hasn't been much influence from Mathematics on the direction of these changes in technology. I think these documents indicate that there's quite an influence on technology in Mathematics.

I: So when you say about Maths, how it went to two units, were there also the three unit, four unit?

P: No. Instead of doing four units, students do two units and two unit extension, so they do four units, but it's not a four unit course, it's a two plus two units. It was watered down a bit, so some courses have two units and one unit extension so they are effectively three units. So it's a one unit extension.

I: So is that like a technical term for it?

P: Yeah. So it's two unit extension and two unit 00:27:42 [overtalking]

I: So it's actually four units but it's called two unit extension. Last question. I think I might move onto the last question. It's almost 2:30.

P: And I need to get away to marking.

I: Do you know someone else who might be able to help?

P: I don't know who you've talked to, but I'm trying to think. Have you talked to anyone from the Computer Education Group?

I: No. I could try. I don't know how to contact them.

P: Yeah okay. I'll give you someone. The person to talk to, it might be …….. I'll just see if I've got a number. Sorry it's …... Okay now her home number is -------.

I: And what does she do?

P: She has been head of the Computing Studies Teachers Association and she was involved in this merger if you like between the Computer Education Group and Computing Studies [00:29:40], so she might be able to give a bit of background on the role, how she sees the role of the professional associations in this whole business. You would have talked to someone from the Maths Association. Have you talked to ……….

I: Yeah [00:29:59] Studies too, a few people up there.

P: Well …… was involved with Maths Association from the early days, from back when I first started doing stuff. He was more established even then. So that's going back late '70s, maybe mid '70s. So from that point of view, …….. would be worthwhile talking to and she might be able to then give you someone in the Computer Education Group so they can give you some ideas there.

I: Yeah that'd be good.

P: She might also be able to tell you about some people who are involved at the grassroots level basically, maybe some teachers or some consultants.

I: That'd be good.

P: Mention my name, that's okay, so she can blame me.

I: Okay it's 2:30 and I'll end it now. That's the end of the interview. Thank you ………

Appendix F

Interview 4

(PETER: Interviewer: INTERVIEWEE 4: Participant)

PETER: This is an interview with Interviewee 4 on the 23rd of September at 4.25 pm, I'll start with – tell me about yourself, when did you start using computers?

INTERVIEWEE 4: I won't tell you all about myself, I'll just tell you about the fact that I'm a maths teacher, I was a maths teacher I started teaching in 1980, I probably first used computers and it would have been an Apple Mac in the mid 1980's when I worked at a school called John Paul II, which was senior high school in Marayong near Blacktown.

And in that school the Deputy Principal taught many of the staff that were interested in how to use effectively, I think it was Microsoft Works which was the combined word processor, spreadsheet database program and I also taught in the 1980's Maths in Society which was maths course that had some optional topics, one of which was I think maths in computing or yeah, maths and computing – I forget now the name but it actually had some elementary BASIC programming as it's subject matter.

PETER: Do you remember in particular what year that started with the BASIC?

INTERVIEWEE 4: I think Mathematics in Society was first examined in 1983 / 1984, one of those two years I think, it was called 2 Unit A Maths I think prior to that, the library and ….. would have that on record so you'd be able to get an exact, get the exact years.

Well we could get, we could get – our, our even in terms of development our HSC exams probably are bound and go back to the first HSC examination in Maths in Society so we'd go to find that fairly painstakingly because if you go back to 1983 and it's Maths in Society and then in 1982, that math's exam is called Maths 2 Unit A well that was the, that's the only way that I know to how to sort of find exactly what year it was.

PETER: Do you know what 2 Unit A means, like is that …?

INTERVIEWEE 4: Well it was just a categorisation, there was yeah there was 2 Unit A and there was 2 Unit, the 2 Unit A was an easier course but from memory had no computing in it whatsoever, even though you are allowed to use calculators in the course, and I believe in the examination actually but I don't think you're asking me about calculators here.

PETER: No, no. How did you use computers?

INTERVIEWEE 4: Initially I think I used the Apple Mac I'm talking about to write maths tests, I also remember in the 80's, because I bough an Apple Mac 2E and a printer trying, we had a handwritten reporting system and I tried to, using a database, a mail merge to print my reports out so I used to enter the details neatly on the computer top, print them out, do a mail merge to print and then sign effectively a hand written report.

I think the only problem was everybody else was still handwriting theirs and I think the perception of some people, some students got a typed out report signed and others got a handwritten report maybe at some point, there was pressure on me to stop doing that because it – you know the question was obviously, "Why doesn't everybody use a computer to print out their report"? But since that time virtually every school's got some sort of a computerised reporting system.

PETER: And when you test creation was that, there were questions about computers in the test or were they …?

INTERVIEWEE 4: No they were maths tests, they were maths tests, I'd be writing maths tests.

PETER: And you would be writing them on computer?

INTERVIEWEE 4: Yep, just to try and make them neater and because it means that you could keep them on file you know you could recycle them, you could edit them, even in that stage though whatever the early version of equation in it or math type was, it was a non tribual thing to get integral symbols and other mathematical symbols into a document.

So from memory I think in those days I'd probably type everything bar the mathematical symbols and then neatly handwrite the symbols or draw the diagrams by hand.

PETER: And would that be through Word?

INTERVIEWEE 4: Through?

PETER: Through Microsoft Word?

INTERVIEWEE 4: I think we used in the 1980's a package on the MAC called Microsoft Works which was that integrated package, it wasn't quite exactly the same as Word, probably the word processor wasn't quite as sophisticated but it would have been a derivative of Word yeah.

PETER: And the programming did it take a peak or a major part of the course or …

INTERVIEWEE 4: No.

PETER: … what sort of per centage would you say?

INTERVIEWEE 4: Maths in Society, the options – I'm guessing but I think the options were you know something like 15 or 20 per cent and the kids did two of them so we're talking for Maths in Computing, probably a maximum of 20 % of that course would have been, it could have been slightly smaller it could have been 15.

But I mean that information you can verify it from the past exam and probably past maths – Maths in Society went right up until 2000, I think you can go to the Board's website right now and find Maths in Society examinations.

PETER: Oh okay I might try that.

INTERVIEWEE 4: Like the course of the post-Maths in Society in 2001, the first examination in 2001 was general mathematics, you can certainly go right back to 2001 and access general maths exams which – oh well they have any computing content but I believe on the Board's website you'd be able to find Maths in Society exams.

And I don't think the structure changed from say 1983 to 19 - to 2000 so whatever the proportion was in 2000 would have been the same proportion in 1983 / 84 or something like that and definitely, I mean it was definitely being taught on exam and I went to a school called John Paul II …

PETER: As a student or a teacher?

INTERVIEWEE 4: No as a teacher and my, my first year there was 1984 and I was teaching Maths in Society and I think I actually it to Year 12 students as well as Year 11, so it was definitely examined in 1984, I've got a suspicion it was also examined in 1983 but we could check by looking up past papers.

PETER: Was it also in the School Certificate like Year 9 and 10 or …?

INTERVIEWEE 4: No, no …

PETER: … or was it Year 11 and 12?

INTERVIEWEE 4: … no the Year 9 and 10 then and for a long time had, there were three courses advanced, intermediate and it was originally called standard and each of those were examined, actually half way through Year 10 by an examination called a Reference Test.

So that's through the 90's and probably the 80's all the Reference Test, and the Reference Test was a standard maths examination, it had no computing element whatsoever, the students I think were allowed to use calculators but that's probably not neither here nor there to you.

And the, the Reference Tests were used purely and simply to inform the student – the school as to how many Grade A, B, C, D's and E's to give because in those days for the School Certificate schools gave students grades and in English, Math's, Science, I'm not sure that might have been it, the grades were actually not what the school wanted to give.

But they were, the number of A's and B's and C's was determined by how your cohort of Year 10 students went in those tests that I'm talking about, in particular compared to the rest of the state so across the state there was a national distribution of 10 % A's, 20 % B's, 40 % C's, 20 % D's and 10 % E's.

And because that was a state-wide distribution you know the top 10 % in the state in performance in the Reference Test, say in advanced mathematics, those schools got told that they could give an A out, well if you were a strong school like a selective school, you might have had a large proportion of your students in that top 10 % of the state.

If you're a comprehensive school or a struggling school you might have been lucky some years to get any so you didn't have any A's to give but, so the students didn't get the mark that they – students didn't get their own mark directly back from those tests.

They were really a, the purpose was if you like to even out the level of performance that corresponded to an A, B, C, D or E in advanced math's, intermediate math's and standard math's, so it sort of seems strange now but at the time people accepted it.

Now of course people get like the grade from their school, which the school determines and a mark for the performance in the School Certificate Maths test and English test.

Now I'm not sure Peter whether you went through the New South Wales Education system and you actually did, when you did your School Certificate and your Higher School Certificate but yeah, you may or may not be familiar with things like the School Certificate tests as opposed to the Reference Tests.

The cut off year for going from one to the other was 1998, 1998 was the first year of the School Certificate tests as opposed to what we call Reference Tests that were in typically early August.

I: So that was like in the 80's it was all Reference Tests?

P: For School Certificate yeah, if you go back far enough and I'm getting a bit hazy now because I only started teaching in 1980, if you go back far enough there might have been actual School Certificate tests that students got marks for, like when I did my School Certificate in 1973 I don't think they were called Reference Tests, they were just tests and I got a mark or a grade.

But I think that's probably not directly related to your research area, but there was definitely nothing about computing in them they were …

PETER: There was no computing?

INTERVIEWEE 4: .,, no there was no computing element to either the teaching and learning or to the tests other than maybe a few pioneering teachers, don't forget your talking about well depending on how far back you go and in the 1980's when I first started to use computing myself as a if you like an aid to a teacher, a teachers aid there was definitely no internet in existence.

So the only thing I could have used them for was, there was no, no point being connected because there was no connectivity, the only thing I could use them for was you know stand alone applications in particular, word processing, desktop publishing which …

I: Could you easily have applied that for maths, word processing and desk top?

P: Well, I mean the, the thing I remember trying to do was to try and type up my maths assessment tasks to get the topic tests and exams and you know, the beauty of that is that in those days you'd go to maths conferences and find other teachers who were starting to use you know, similar Microsoft sort of products to do topic tests.

And somebody would stand around with a floppy disk and you'd you know, you'd put whatever you had on it and you'd copy whatever other people had done so it was like a, a form of test sharing without people having to go off and photocopy a massive numbers of them so that was the first time you know, we're talking three and a half inch floppy discs and all that sort of stuff.

Oh maybe uh I, I don't have too much recollection of using the five, the bigger, the bigger actual bendable floppy discs, by the time I started I using Mac's they had the three and a half inch discs which, I forget now what the memory of them was, but it's probably tiny.

When I bought my first computer, which was about in 1987, I bought the computer, it didn't have the hard disc at all, it had a just two floppy disc drives and I remember

– and that was about three or four thousand dollars so it was you know a big, a big commitment for a teacher anyway.

And 12 months later for some reason, I think I'd done HSC markings and I had some money to spend I bought a hard disc, a hard drive to go with my Mac and that cost me about $1400,00 so that was you know, all together with the printer I had you know, I'd outlaid about $5,000,00 for a computer so not every teacher at that stage had a computer like they do now sort of thing.

PETER: Was that for home use or did you use it at school?

INTERVIEWEE 4: No, I used it home, the school's started to get Mac's, the school I was at was a Mac school, it started to put Mac's into a room where teachers could go an use them and then they shared a printer and that sort of thing, you know it was definitely home use and my kids used them you know.

My son is now 27 and doing a law degree, I'm sure he was whatever age, probably five or six when I bought my first computer and there was a simple little computer game called Dark Castle I think it was called, which was his introduction to gaming and he kicked on from there.

PETER: You were talking about – I might focus on programming for a minute.

INTERVIEWEE 4: Oh yes.

PETER: Because we were talking about programming before, how basic was used – I know, like LOGO was a popular language how was, was that ever implemented into or …?

INTERVIEWEE 4: Well I can remember, people could have used LOGO in teaching concepts like, well direction and problem solving, there was strand in

[14:14] terms of mathematics called, I think it was called problem solving and, and you know part of it was a bit more exploratory learning.

LOGO I think was used by a number of maths teachers to get kids thinking about solving problems, maybe also – maybe it was used in introductory, or what I might call it Introductory Algebra and I forget now you could, you could use variables I think to you know strengthen some concepts in algebra concepts.

Maybe in reflection it was also used a little bit to give students ideas about geometrical concepts because you know, it was like from memory it was you know you're forward 30, you know right, right 90 it was basically combining directions forward and backward and left, right and then the left or right turns …

PETER: Turns …

INTERVIEWEE 4: … were and you'd put in a degree in, degrees a turn in degrees so I think it was meant to try and challenge students to either draw shapes or to come up with some geometrical like any that clearly determined that the exterior angles of a polygon added up to whatever they add up to but you know to reinforce some of the geometrical concepts that you were working on.

Like angle the sum of the triangle or external angle, the external angle of a polygon but I, I played with it myself I think I probably had an early version of LOGO or a version of LOGO which, I'm just trying to think whether I would have bought it or whether I would have got it through school, because again I think you're talking before the internet now.

PETER: Yeah it is, yeah.

INTERVIEWEE 4: And I used it, although I don't remember doing too much work in class with it because it was never part of the – unlike basic which was part of the Maths in Society Course, then you could teach it as an option and you know, get an HSC exam question on it, there was never any likelihood that LOGO would be examined.

PETER: So it was never part of the curriculum?

INTERVIEWEE 4: It was only in a sense that you know, if you might remember in Years 7 and 8 when you're teaching students algebra there's a lot of, what do you call them? Concrete you know, teaching aids to get kids thinking about variables you know or it was just an aid, but a slightly more sophisticated aid to get kids thinking about it so a bit like a bit of an extreme chore.

Overhead, pens, Powerpoint presentations and you know YouTube or it was just a slightly more sophisticated teaching aid which, which you know a lot people, maths teachers that were interested in, in you know because we weren't sure how the computer was going to affect maths and maths teaching so.

And, and in the early days the maths department often provided the people in the school who were often looked to for leadership in how to use computers in schools, I think that changed though in particular in the 90's where it was you know, clear that you know not so much that maths teachers were dinosaurs.

But the computing was more about, the computers was less about mathematics and, and mathematical concepts which might have underlined some of the computing programming you know, I mean like people realised that computers weren't about programming, that people could buy off the shelf products, not know how they were coded but certainly used them you know for things like word processing, spreadsheets.

Even spreadsheets you know maths teacher's probably had a slight advance in being able to think about you know, what do you call them? Fixed and you know, fixed variables and what else was variables, whatever they're called but as for the variables that sort of thing, I mean those concepts probably played a bit more [18:18] initially to math's teachers but I think in schools now it's the exception rather than the rule that the maths department provides leadership in the way the computer were used in schools.

PETER: So it was set down for the math's department in particular?

INTERVIEWEE 4: Yeah, well in the 1908's maths departments often informally provided some sort of group of teachers who knew a bit more about computing on average than an English department or a Visual Arts department or a Social Science Department but I have a feeling that's changed in the last 20 years a lot.

PETER: But that's something I wanted to sort of focus on, like I know it's not in the questions and I apologise for that but there's some things I - and I know I'm asking questions that aren't in here and I do apologise.

But that's something I wanted to focus on was like maths using computers, like why were they so focussed on it? Like why was it all in the start they were the one's that – is there a particular reason for that? Is it the way computers were developing?

INTERVIEWEE 4: Oh well …

PETER: Because it's obvious that they were sort of the first one's wasn't it? Like they were the first one's using computers.

INTERVIEWEE 4: Well see the, the early computers weren't nearly as user friendly so I vaguely recall for example that the Apple 2E, that people had used with this basic, uh I forget now what sort of program we used, I mean it was very much what I'd call a green screen interface.

It was a Windows interface before, before you know what you'd see is what you get or whatever you have you know the four menu's and Mac and you know the Mac interface revolutionised things so every time you entered something on the computer and this is sort of – and I'm not talking about word processing I'm talking about you know, putting code in, you know if you made one little punctuation sort of error and the program didn't work.

So it was a bit like you know in the 70's at Sydney University when I did my Math's degree and then you know, teacher training many other people who did say mathematics and then became maths teachers, either have also done some computer programming.

And in those day's computer programming was effectively getting little cards and punching things in cards and you know, I didn't do that of course so I can't tell you but understanding is A), it took a great deal of time and the trouble and B), if you made one little error in wherever you punched the whole in the card the program didn't run so …

I: Really?

P: … so lot's of maths teacher who had some experience because they went to uni and did computing studies or whatever it was called had, had fairly clucky programming or well you know maybe more, more sophisticated programming.

So that's why some of the maths teachers in schools in the late 70's, early 80's when the first computers came on the scene, I think, "Hey you know something about computers because you've done a Math's Science degree and you did Computing 1, 2 and 3 or whatever at uni can you …", you know.

Not so much run a course but you know, what were they used you know there was, there was a lot of the earlier programs, programs I think prior to Mac and Word and

Word Works were programs that used a Windows, what am I thinking of? A DOS, a DOS is a …

I: Yeah, yeah.

P: … but the people who could drive computers effectively could talk in DOS or write DOS stuff, which is a bit like code and so that was left to the maths person.

But as soon as DOS and that clunky interface disappeared and everybody could turn a computer on and get into by clicking on inter programs and eventually onto a network or even onto the internet then, then it suddenly became, “Hey you don’t need to get a maths teacher who’s done programming, you can actually do this”.

So I think that’s probably the underlying reason why it was often maths people that got into computers or were looked at schools to be the drivers of the computers.

I: Because of the programming?

P: Because they would have done programming more likely than an Arts, than a - not so much a person with an Arts degree, very often maths teachers have done Arts Degrees but maths teachers may typically have done lots of mathematics, do an applied.

And maybe in even in mathematics a little bit of coding but certainly they were likely to have done computing, whatever the you know whatever the university’s called computers in those days computing studies yeah they would have had specialised names yeah so I think that’s the underlying reason.

And you know I didn’t think about it at the time but you know, it may well have been more younger maths teachers than older maths teachers because when I went into teaching in 1980, I didn’t know much about computers but probably the maths teachers that were more likely to know about computer programming were one’s who had been through uni in the last 10 years rather than one's who went in the 60's or the 50's, I think it's probably something they didn't think about too much okay?

I: And about programming, I was just thinking as you were talking it, what about programming makes it centred for maths?

P: Well the programs that we did, the programs that we got kids to write in basic in the 80's were, you know you'd, you'd - I think they were designed to teach students some of the basic [24:18] loops and I'm struggling here but like a four next and while and till? Is that right?

I: I don't know.

P: That, they were if you look at what's called – even now in software design and development it's called Pseudo code which is basically just a sort of a universal coding language, you can see that you can describe simple little algorisms, algorisms that you can write in eight lines or maybe even less.

And all they're doing is putting numbers into some variables, doing things with numbers like squaring them, cubing them, replacing one variable with another and doing that until they find you know, doing the sort putting them in order.

Most of those things were the sorts of things that you'd get students to do but you know as I say while you know, calculators existed at this time so that it was not something particularly special to find the square root or the, the square or the cube of a number.

The kids, you know the kids were rapidly underwhelmed, the kids were excited to do a course, they weren't doing a course called Math by Computing, they were doing a course called Maths in Society and we'd chosen an option topic called computing.

So all of a sudden the kids thought, “We’re going off in to the computer room and …”, you know often kids, even in those days thought, “Computers equals games”, so they were thinking there would be some games to play, they weren’t thinking about internet or emails or anything like that because that didn’t exist.

But instead of playing games, we got them to write down 10 or 15 lines of code or you know, maybe that much where when they’ve pressed you know, return and the whole thing worked and often it didn’t work because of some minor punctuation thing, all they got was on the screen a list of the numbers from one to 100 and their square roots, squares, cubes you know.

I mean I think my, my overwhelming memory is they were pretty underwhelmed, when they finally got the whole thing to work, they got the computer on and they got a disc in that maybe gave them basic of some sort and they’d carefully typed in without deleting it or crashing it the bit of code, and they’ve pressed return then they’d simply got something that was a mathematical result.

And well I mean basic computing programs that were short, often the best you could do in such a program like basic was to, you know was to print out, print out some numbers or print out some words, some of them might have you know, some of them might have repeated a word a hundred times or something.

But I mean I think the intention was to show them some logical algorithms that, that they were supposed to go, “Okay I’m putting this number here and then I’m squaring it here and then I’m …”, you know, “Making the computer prints these numbers until it gets to 10 and as soon as it gets to 10 it stops”.

And they’re trying to think through, because what people in software design and development now do is sort of like desk checking I think they call it, I’m not sure Peter whether your area is computing or whether …

PETER: Oh it’s maths and computing.

INTERVIEWEE 4: Yeah whether I'm making any sense to you or not.

PETER: Oh yeah, yeah but when they did the programming I thought this might be relevant, did they ever design their own programs?

INTERVIEWEE 4: Oh yes they – we would give them, we would give them you know the basic – I'm just trying to think of some of the simple codes there's , no they had that nested structure so that you had left X equals you know, two left Y equals and then.

Then they might have while X is less than 10, left Z equal XX squared then next what was it? Then they'd have an increment you know, left, left X equals X plus one so that X would be incremented and you'd do only for a while or a, you know I'm a bit hazy on some of the actual …

PETER: Hmm I understand.

INTERVIEWEE 4: … algorithms and I think with that you could give them examples like the text book it was a text book, it was a fairly traditional way of teaching maths so they had text book examples, here's the next thing for a while and they had to learn it, there's some examples printed and then they'd have to go away, we'd probably give them an exercise from the text book.

So they'd probably type what was in a text book into the computer and wait press, press return and see what happened but they could have done their own and maybe in many schools teachers got them to be a bit more creative, but as I say I think they rapidly realised that it wasn't going to be fun and games in the computer room and it could take a whole list of coding, something that was a bit more ambitious in terms of the program.

And at the end of it, if they pressed return and the bell had gone and they realised that they'd made a mistake somewhere and it didn't run, you know they'd become frustrated and a whole lesson's worth of typing disappeared down the tube so my – I personally never recalled too much constructive or creativity taking place.

A better idea is to the sort of things that they actually would do or will be able to do would be you know, did you look at past Maths in Society paper's and look at the computing option?

PETER: Yeah I've sort of seen some of the late 70's, late 70's early 80's sort of papers where they were using Fortran before basic.

INTERVIEWEE 4: Oh well they wouldn't have been, they wouldn't have been mathematical examples …

PETER: No 2 Unit A, 2 Unit A

INTERVIEWEE 4: Oh 2 Unit A, oh okay so maybe – I'm not sure whether that was an option or whether that was core but I taught 2 Unit A in 1980 and in 1981.

PETER: Well it might have been before then.

INTERVIEWEE 4: But I can't recall …

PETER: It might have been before 80 because it was, the one – the paper I was looking at today was like 77 and they've had a Fortran example like it had a …

INTERVIEWEE 4: It was a maths exam?

PETER: For 2 Unit A yeah.

INTERVIEWEE 4: Oh okay, well I'm not doubting you but it may be, have been an option that I didn't teach or maybe the course actually evolved from 1970 like I didn't, I wasn't teaching in 1977, I was at uni and happened to miss all the computing courses that I could have possibly done so maybe when I went and starting teaching in 1980 and I had a Year 11 class I believe in 1980 in 2 Unit A in maths.

PETER: Well it might have been all before then, I don't know.

INTERVIEWEE 4: The course could have changed.

PETER: I'll have to look into it at the library maybe.

INTERVIEWEE 4: So how did you get hold of those 1977 …?

PETER: Oh …………. had them, do you know …………….?

INTERVIEWEE 4: Oh yes I was speaking to her yesterday, so you've spoken to …………… have you?

PETER: I had an interview with her a few weeks ago, about a month ago.

INTERVIEWEE 4: Okay yeah well she, she could go back probably – oh well she may well have, I don't know when she started teaching.

PETER: She actually had the books like the, the solution manual sort of like you'd have the paper with the question and then you have the solution …

INTERVIEWEE 4: Oh yeah [31:35] of past papers.

PETER: Yeah past papers yeah.

INTERVIEWEE 4: But as I'll show you the library here should go back to, well if not 1977 it might go back to close to that, early 1980's, the first HSC exam well the first HSC exam was in 1968 I believe …

PETER: Oh really?

INTERVIEWEE 4: … and I'm not sure whether you can get it on the internet but you know you can certainly get hold of it when I was a teacher, past HSC papers …

PETER: Is that on the Board of Studies website?

INTERVIEWEE 4: Well the maths, I mean probably not ones that go back to 1968 where everyone was, you know the web's the Boards website probably started sometime in the 90's, I'm not sure whether we digitise papers back to 1968, especially if the courses have changed.

But I remember being in a school where you'd get kids in the 1980's, 1990's to do the past HSC exams and you'd go back – if they were keen you could go back to about, well the course changed a fair bit in 1975.

The papers prior to 1975 were you know, different to the one's after 1975 so for a student to go back and try a 1968 maths exam they almost certainly were doing a different, you know there'll be some questions they wouldn't normally be able to do.

PETER: I know we're limited of time so I might get back to some of these questions here, what were some of the problems in using computers in particular with maths?

INTERVIEWEE 4: Well the, the number of computers in a school might have been in, of the order of 15 so as opposed to now where virtually every student has a computer at home maybe even they've got their own person laptop, there were only a very small number of computers in a typical school.

I was in a senior high school in the mid 80's, we might have had to start with one room full of computers which might have had 15 computers say like one between two but that's so as soon as they started teaching computing courses like computing studies or a Computer 2 Unit or there were computing courses and those courses were in the room you know, they were timetabled into that room, it was not easy to get actually access to computers so that was one thing.

The Macs were revolutions in the sense that they were easy to use compared to DOS and as soon as – well the only maths course that required any teaching of computing at all was Maths in Society and even that was an option and so if a teacher decided it was too much trouble to use the computer room, they just taught maths in navigation or maths in construction, there were all sort of other options available.

So it was in the, in the it could have been in the too hard basket because of access, because they were you know still and you could still do basic even if you had a fairly accessible interface using the Mac basic program in, program in general there was something that was good for the fanatics and good for people that were really interested in programming.

But for the vast majority of students programming sucks, like the number of students who do software design and development is of the order of between one and 200 students out of 67,000 so only a very small number of students really want to do programming.

Even if they love computers they might and they might be very good at web construction so they might do a bit of you know they might know a bit about JAVA or they might know how to do things in HTML, which means they've probably got some programming capabilities.

But they don't want to actually lean Fortran or learn basic that, they really want some sort of visual solution typically, they want to do something that's actually got a pay off.

I think in those days in particular there wasn't much in a way of a pay off for someone who could do computing other than a computing nerd who wanted to go to uni and be a computer nerd and there were a few of them but I mean they weren't necessarily the best mathematicians always.

PETER: Oh okay that's interesting.

INTERVIEWEE 4: Probably the other thing is that you know maths, the good mathematicians the bright mathematicians where typically they might have been good at physics or good at chemistry, they might have done a computing course but you know, they didn't have too much time if they were in Year 11 and 12 to play with computers.

Kids that are good at computers now, more kids who are confident with different software programs and know how to solve problems and if they get stuck they can work out where to go, it's not necessarily kids who know how to program.

Even spreadsheets, most kids who are quite competent at word processing and the internet usage and emails and all the other things, Face Book and thing are probably not that sophisticated, they use spreadsheets.

I mean most adults are not particularly sophisticated users of spreadsheets but as spreadsheets are an enormously powerful tool if you know how to use all the different things that are on them I understand, I'm not actually that good at doing it myself.

So what are the problems? The number of them because they were expensive, schools didn't have many, they were a limited return, the fact that you didn't have to use them – they were always an option, even if they were in the Maths in Society course yeah that's probably enough.

PETER: What about the benefits, were there any major benefits?

INTERVIEWEE 4: Well I mean it was clear even in the 1980's that computers were going to make a difference to society to how people and that because the computerisation of school records, ultimately a computerisation of library's and things you know, more and more people saw uses of computers in outside of school needs so at school it meant, "Oh okay here's something", you know it's not going to go anyway time soon.

And of course you know, a bit beyond the time frame you're thinking about is the explosion and the use of computers, what about like things like the internet and emails but so the benefits?

Well in terms of mathematical thinking you know good maths teachers probably, good maths teachers who decided to use computers in their teaching and learning probably engaged students to think about variables if they used spreadsheets, to think a bit about geometry if they used, if they used something like LOGO.

Very quickly it'd be some of the problems with computers were the expense and the number available were the two things went hand in hand so myself in the 1980's, I got hold of graphics calculators for a tiny fraction of the price you know for the cost of one computer you can buy a class set of TI84's of whatever they were then, and you can get kids to do – not so much LOGO, I'm thinking that the screens were a bit small on graphic calculators for LOGO's.

But you could get kids to do things using financial mathematics and statistics; you could get them to display statistical graphs you know, [39:26] plots frequencies to grams and polygons.

I'm thinking in Geometer's sketchpad but I think actually Geometer's sketchpad is something that is a bit of software that's used more in computers than in software.

PETER: It was yeah.

INTERVIEWEE 4: And I think if you're talking about the use of computers in maths education up to about 1990 …

PETER: The early 90's.

INTERVIEWEE 4: The early 90's, well probably Geometer's sketchpad and what's the other one? There was another competing French program which who's name I forget now but I think they, if they weren't being used in the early 90's they were certainly on the horizon, maybe they were available yeah.

PETER: That leads to something I'm meaning to ask about like graphics, was that used much in, in maths?

INTERVIEWEE 4: The graphics calculators?

PETER: No just the graphics …

INTERVIEWEE 4: Oh the graphic …

PETER: … the graphic computers that everyone …

INTERVIEWEE 4: Oh what do you mean by graphics?

PETER: … experimented with? Just pictures or graphs …

INTERVIEWEE 4: Well one of the,

PETER: the monitor has colours you know, do you know what I mean?

INTERVIEWEE 4: … one of the interesting things - yes but probably the only thing I can think of was in the early, in the early days of computing there was also an interest in something called a Chaos theory and Mandlebrock patterns and there was quite a bit of interest in professional associations, in you know how does you know what are these, what are these recursive algorithms that can give you – I'm trying to pull some names out of the air.

Sierpinski triangle and Mandlebrock, Mandlebrock patterns and they were, they were algorithms that generated, some of them are algorithms which you might have been able to put into you know like a Mathematica style package,

I mean Mathematica I think Mathematica was available, at least in the mid 90's, I got hold of an early version of Mathematica, I'm pretty sure it was not the 80's but sometimes in the 90's when you know the, the increase in the use, not so much use but the potential for the use of computers snowballed in the 90's and people you know came onboard with programs like Mathematica.

And lots of maths teachers I think like me, got hold of a copy, played with it a bit, probably made a judgement that for most students it was too sophisticated, some teachers would have used it but it's mainly used at university level now.

PETER: So it started after 92, it started around …?

INTERVIEWEE 4: I think so, I mean maybe …

PETER: … graphics sort of …

INTERVIEWEE 4: … is you know Mathematica if you're familiar with it is a Wolfram, Wolfram is the research person who I think started it or the, the, the originator of that software was a fellow called Wolfram after whom the Wolfram software group is named.

But my guess is even if he was, he obviously he was alive prior to 1992 and his, probably his ideas were in development and may even be commercially available but I don't think I'd heard of Mathematica until probably at the earliest the mid 90's yeah.

INTERVIEWEE 4: What about things like Geometer's sketchpad, was that before that period or was it used?

PETER: Geometer's sketchpad I think was maybe available in the early 90's, was it used? Again you're talking early adopters may have got kids to explore some geometrical concepts that you know, people would have been using it teachers - like I'm going to a maths conference myself the week after next, maths teachers who came onboard early and got proficient at it you know, were much more confident with using it with their class.

The interesting thing about computers is that for many teachers that were my generation or maybe a bit older it was rapidly the case of kids were quicker at picking up things in computers than adults, older adults so you know in most, in most lessons even today, where you're doing something with computers you know in second group, senior and second in particular, you can bet your boots that there'll be quite a few people who are probably more knowledgeable about some of the stuff that's being used than you are.

Or can solve a computing problem more quickly or are just more confident generally with computers because they know they won't break them, so like I'd have to say that there was an expectation in the late 80's, early 90's that the computers were going to revolutionalise the mathematics curriculum.

But I think you know with the benefit of hindsight 20 years later, I don't believe that computers have revolutionalised school mathematics curriculum, even thought they're much more readily available and lots of students and their teachers use them for some purposes.

As you're aware, students still do the [44:43] HSC examination in mathematics without the use of a computer, in general maths they can use a graphics calculator but even there the majority of students wouldn't, they're expensive.

And the sort of mathematics students are learning in Year 11 and 12, I've got a daughter in Year 12 who's just about to do her HSC and you know for a 2 Unit Maths course you know, she would have done almost exactly the same course had she been doing it 20 years ago than she did now.

PETER: Really?

INTERVIEWEE 4: Yeah the maths course, what I mean is rather than the maths course hasn't changed you know, basic calculus is basic calculus.

PETER: That's right.

INTERVIEWEE 4: I'm doing some university courses and I think computers have impacted more on – well certainly statistics courses, to be honest the only maths course I've done in the last few years has been a course at uni that was delivered over the summer period.

And it was actually very much a traditional maths course without the use of computers to be honest, but that probably the choice of the lecturer so it didn't …

PETER: But how's it revolutionalised maths teaching in the sense …

INTERVIEWEE 4: No, no.

PETER: And what have revolutionalised other areas like it's, it's come to like design and technology you know, sort of you know the music they use it into the, you can put music in and you can compose songs on the computer but with maths it's not so not developed.

INTERVIEWEE 4: Oh well design and technology are the good example where some students do a design and technology project, it might be a woodwork project but the documentation of it, the expectations they'll document is in using computer applications so they'll use you know, some sort of a desktop publisher, maybe Word but often more sophisticated.

They'll import pictures and graphics into their text, they'll do a fairly professional looking job in presenting their [46:39] timeline or the other things they might put together and they get stuff off the internet and they do you know, you can do as an industrial tech or a design and technology project, a multimedia project which is purely a computer based project or graphics.

But as opposed to those sorts of subjects where computers have had a profound effect, the subject matter of mathematics like the Pythagoras theory, unless, the teacher happens to want to use computers a lot in the teaching and learning and I'm talking anything from a Powerpoint presentations to electronic you know whiteboards to the internet to You Tube to all sorts of other things, Noodle etcetera as sort of a management tool.

The subject matter is still the Pythagoras theory and the vast majority of teachers are probably still presenting the concepts and some examples and then the students go off and practice in the same way as they did 30 or 40 years ago.

PETER: Yes sure.

INTERVIEWEE 4: So I don't believe that it's a revolution yet and I'm 53 so even if I go back to the classroom tomorrow, well a lot of things will change and in particular the way schools use computing generally to, to research student's use them all the time, schools put things up on sort of things sort of like networks and Noodle management tools, those sorts of things.

I mean I think often at schools the maths department are probably perceived to be now rather than in a [48:13] of the use of computing and of course there are exceptions because of different personalities, I think maths teachers are often regarded as some of the more conservative …

PETER: Really?

INTERVIEWEE 4: … teachers and departments in the uptake and use of computers, well for example we, we are exploring at the Board of Studies students being able to use computers when they do the HSC exam or the School Certificate test, now …

PETER: Is that for anyone in particular or was it …?

INTERVIEWEE 4: Oh well it's because there's an expectation oh and kids who do virtually everything that they do in their school and their home environment using computers, word processing in particular, you know they suddenly have to relearn how to do, you know how they use this for, for in particular histories and English and things.

So there's a demand from students and society generally, their parents that where they've used a computer almost all their lives in some cases that they should be able to use – I mean that some students are very quick at their, their typing skills and their ability to go back over things to order things on the page, you know as an editing tool you know, it's a lot easier to use than a pen and liquid paper or crossing out.

So the students are used to that and, and there's a – and so we, we are looking at the possibility of one day students being able to do their English exam or their history exam or their economics exam via a computer.

But one of the last exams that we're going to be able to manage that for, we think is mathematics where it's much easier for students an integral and a symbols and an equals and then do their calculation, it's actually had to go to some sort of interface where they had to click on symbols then, well that's slower for most students they've never done that so we and they've got to draw diagrams and things like that.

So we believe it's going to take a lot longer for, for students to get to do HSC exams in mathematics than in other subjects, Peter I don't want to cut this too short but …

PETER: But I was just about to ask you because …

INTERVIEWEE 4: Well I mean unless there's a particular question that you think that we haven't covered I'm conscious that A) you've been waiting a bit before I started but B) you've got someone waiting for you.

PETER: That's alright.

INTERVIEWEE 4: But I actually do – I'm hoping to catch a 5.30 pm train so we should wrap it up in the next 10 minutes.

PETER: Okay, okay so I'll just ask one more question.

INTERVIEWEE 4: Yeah sure.

PETER: I might make it into two because – no I won't do that but the question and the main one I just thought, is there anything thing else relevant to the topic that you could think about?

INTERVIEWEE 4: I think when I was between graduating and in my early years of teaching, in my mind knowing about computing was not that different to be able to program, I think I remember – I had a book up until not too long ago that was a computer program that I did a course on, it was an in service course as a teacher so it would have been in the early 80's.

And I think the program was called FTP or, no I think I've got that wrong, TPS – I forget what, no one's ever heard of this program probably now but I know FTP is probably a file name and TPS is probably a, a name for a topic in software design and development.

But there was a you know, as a maths teacher I was interested enough to go to a in service course, it was on at Sydney University, it was about a language that was – the language had been around for a long time, since the 60's, it wasn't a language that was like basic or Pascal or like Fortran that was popular in, in banking or popular in other areas it was, but it was apparently it was a purer language in terms of it's you know, it was internally consistent.

I went and along and I thought it was interesting but I you know, like a lot of things you go to an in service on Power Point or something and you, you and you're really going to be proficient at a lot of that thing if you practice it over and over again, it's a bit like mathematics itself.

So I went and did it and then went back home you know, I was a maths teacher and I was busy and I didn't do much you know, and I wasn't a programmer so I didn't take it up but there was a feeling in those days that you know, there was a strong link between computers was about programming because that's how computers worked using programs and that maths people, that there was a link between maths and programming.

Well as I said that, that vanished I think in particular with those you know, drop down menu and icon driven programs that suddenly you didn't have to know any kind of code, you just had to remember how to get from A to B using DOS so you know, the strong link that sort of existed in the sense that maths people were the people in schools that often knew a bit about computers, you know it was there definitely in the probably late 70's, I only got to school as a teacher in the early 80's.

It was there in the early 80’s and disappeared, you know if it wasn’t gone completely it certainly disappeared in the 90’s.

PETER: Okay and could I ask a quick question if – oh well maybe I can email it to you?

INTERVIEWEE 4: Oh ask me now?

PETER: Do you know of anyone else who might be able to help in my research?

INTERVIEWEE 4: You’ve spoken to Interviewee 7, the only person who – especially if you’re coming back to look at the library here you might be, there’s a number of ex-maths teachers like myself here, some of whom are a bit older and a bit more experienced, one of them is nearly 60.

A fellow called -----, now if you’re happy for me to do it I’ll – do you know when you’re coming back to look at the library?

PETER: Uh next Thursday.

INTERVIEWEE 4: Thursday of next week, what time?

PETER: Well actually -----– I haven’t worked that out with ----- …

INTERVIEWEE 4: Well I’ll email ….. and tell him that …

PETER: Well I’ve already tried to contact him like ….. …

INTERVIEWEE 4: Oh is that name familiar to you.

PETER: … no ….. actually gave me his name.

INTERVIEWEE 4: Look I'll – I won't necessarily see him tomorrow, I may but if I don't see him I'll drop him an email to say, you know we had a chat, the chat we had is probably about an hour but you'd probably be, I mean if he's got 15 minutes he, he goes back a bit further into the late 70's, I presume as a teacher than I do so he might be able to give you some insights as to what he did then.

PETER: Oh good.

INTERVIEWEE 4: He was a – I mean he is and was a maths teacher of some standing and he did publications and became the maths inspector here before pre- [55:11] etcetera.

PETER: Oh great yeah well thank you for this, thank you for that interview.

INTERVIEWEE 4: Thank you.

[END OF RECORDING: 0:55:18

Appendix G

Interview 5 part 1

(I: Interviewer; P1: Interviewee 5; P2: Waiter)

P1: There were, the only computers available were the big mainframes, as they were called, and even though the Wang computer was small by those comparisons, unless you had access to a university or a business that had a computer that had the Basic language on it there was no way that students could test their programmes on a machine.

I: So they would write a programme…?

P1: They would write a programme and the teacher would probably tell them whether they were correct or not, if the teacher knew. Not many teachers knew much. I think I was the only person in New South Wales in teaching that had a computer qualification because first of all, computers, there w-, there wasn't a computer course and going way back, and then when that did come in to the universities anyone on a teachers college scholarship was forbidden to do computer science.

I: Really?

P1: Because the department was afraid that they would then not stay in teaching.

I: Oh.

P1: They would go elsewhere. So there was a dearth of people. They were mostly…

I: Is that because there was a shortage of teachers?

P1: …that was a, yeah, always in maths teacher, yes. Yes, and there still is. So that militated against anyone having any real qualifications. I did mine of course as a mature aged student and the only way I was able to do the course I did and stay in teaching as I did was because it was such a Johnny-come-lately course that the only time that the University of Sydney had rooms available was after 4:00 in the afternoon and I could get there after school. I was teaching fairly locally at Kogarah, and I could race in and get to a lecture at 5:00, 4:00, or whatever, a tutorial or whatever. So I was able to do a full-time university subject after school.

I: [laughs]

P1: Only because that was the only rooms available, lecture rooms and tute rooms at the university at the time so I was very lucky.

I: When about was this? When was it?

P1: When I did it in, I did the first course in 1972. It says that there in your…

I: Oh okay.

P1: …in your script.

I: And also, about the programming: I was meaning to ask you that as well. I'm not changing the subject…

P1: No, no, no.

I: …but just before I forget, um, what time was that, when they were programming without knowing the results?

P1: For this Level 3 course.

I: What's a Level 3 course? Is that the 2 Unit A?

P1: That was, that preceded 2 Unit A…

I: Oh, okay.

P1: …and when that happened, I don't know but my dates, my memory dates probably mean that this course began to be, was examined first in '72. Now I could be wrong there because, but I know that I did the in-service course in January in 1971 and I would only have been doing it if the draft course had come. That's why it was on, and I was running the maths department trying to know something about it and I got hooked. [laughs] [0:03:39.7] and I also believe that you can't just rely on the notes from someone. You've got to know yourself. So I wanted a university qualification and so I looked around and Macquarie Uni was offering a one semester course but they didn't want to know me because I was only doing one course. They had enough to fill their courses many times over with their own students. So Sydney University had this one year course and so, "Oh, okay," and they had this la-, mainly late hours so I could do it, and I did that in 1972. I know that because the following year I was seconded to the Teachers College staff and I'd done that the year before. That's why I think that was probably '72 was the first year that this was examined.

I: So the Level 1, Level 2F and 2S used computers?

P1: No. There was no, no computers. No computers were used in schools, not even for admin.

I: But they used programming?

P1: No. Not at all.

I: Oh, they had nothing with computers?

P1: They had nothing to do, and I wrote you a rationale there to say why.

I: Oh, okay. Sorry, I didn't read that.

P1: They brought, no, no, that's alright. They brought it in because they felt that this was a high level maths courses. They were going on to do things that where they would encounter computing in some form and it was felt that all students of that level should have some exposure to this wonderful magical thing that was happening to us, and so they put it in the course for the students who were at the lowest level of mathematics.

I: And that's Level 3?

P1: Level 3, mm.

I: So what were the levels?

P1: Well there's Level 1. Level 2F full, 2 short S, and then Level 3.

I: Oh, okay, that's [0:05:37.4]. And Level 3's the only one that had programmers?

P1: That's right, yes.

I: And that was [0:05:43.4]?

P1: Mm, yes.

I: And when did that begin, approximately?

P1: That's what I'm saying. The first example is...

I: '79 to…

P1: …'72.

I: …great. That's something I need to know.

P1: Well I'm pretty confident about that, though I found a record somewhere else that contradicted that and I know I'm right [laughs] 'cause I know how it effected my life, you know.

I: And how long did it run, the Level 3?

P1: Well that's what I don't know because it merged into 2 Unit A and they had the same thing. They were doing four train programming too.

I: Yeah, 'cause I have a document which was printed in 1973, syllabus…

P1: Yes.

I: …but it doesn't say when it was mean to start. 2 Unit A.

P1: Is it called 2 Unit A?

I: 2 Unit A, but it doesn't say if it's…

P1: Right.

I: …meant to start till next year…

P1: Well if I'm right…

I: …or that year.

P1: …about this, that the, that was first examined in '72 and you've got something dated '73 it wouldn't have happened any happened any later than in '74, would it?

I: Mm.

P1: You would think, because it would have come out, I don't know, they put out a draft syllabus first and then a draft. Well it was a draft and then it was a syllabus. But they put out draft examination papers. Sample paper was always sent out. So you'd have to have that before Year 11 started really, so I would think it would have been…

I: '74.

P1: …might have been '74, might have been '75, the first. But it would have been introduced probably '74, '75. Maybe examined '75. That suggests…

I: Do you remember how long the three, Level 3 was, used…?

P1: No, I know…

I: Even two years maybe? Maybe two years?

P1: Well, yeah, but it seems strange but it wasn't just maths of course. They were the levels when the HSC first started.

I: So they were used for a while?

P1: They were, but not that strand of programming. That came in as an option. There were…

I: Is that, I remember hearing you mention Part B. Was that Part B at the time? Was, did you mention Part B or…?

P1: No, I thought it was called "D"…

I: It was D?

P1: …but it wasn't. No, it wasn't. It was called "3", but I just had "Level D" in my head so maybe, I don't, it wasn't. Because of the original HSC, those were the levels: Level 1, Level 2F, 2S and Level 3, but the optional programming bit didn't come in immediately and I'm confident I'm right when it came in, and it was an alternate. At the end of the paper there were nine questions and then you had to do either question 10 or question 11 and…

I: So it was a choice of two?

P1: Yeah, and you had to choose between modular arithmetic and ah, I wrote it down there for you, whatever it was called: Latitude and longitude, or you did the programming, and I understand, I was, I'm not sure, I never examined that course. I was always an examiner for Levels 2 or 3. I mean 2S or 2F, but it wasn't, by then it was oh, was Level 2 and Level 3 by the time I was an examiner. But people who'd never done the course looked at it and thought, looked at question 11 and thought it was much easier [laughs] than question 10 so they did it without ever having being taught.

I: [laughs]

P1: [laughs]

I: How did they go?

P1: Probably did reasonably well. [laughs]

I: [laughs]

P1: It was very predictable.

I: Really?

P1: Mm.

I: And can I ask, with 2 Unit A, do you know when it merged into Maths in Society? Would you know the dates?

P1: It didn't merge at all. It was totally different and I've got a thing there about Maths and Society when I thought…

I: Probably on the other side.

P1: …it came in. Do you see Maths in Society?

I: There it is.

P1: Yes.

I: I've replaced about 1980.

P1: Yes, and it was totally different structure, because there was a core course and there were options, I think seven, and you had to do four. That's my memory, um, hoping for the best. [laughs]

I: [laughs]

P1: Pretty sure of that [0:10:15.2].

I: I can prove it because I, at the Board of Studies they have the syllabus and I can actually look it up.

P1: So you've been to the Board of Studies?

I: Ah, yeah.

P1: Oh, good.

I: But I had, I'm going to have to come back there again for more information.

P1: I think, do you know …..? Did you meet …..?

I: No, I've never heard of his name.

P1: No? He's at the Board of Studies. I've put him down there and I also put down somebody that didn't come out on the printer which I'll write it for you.

I: Great, ah, there's a…

P1: There's a person called …... Have you, you know that person?

I: Okay, no, I've [overtalking]

P1: He evidently wrote a PhD in 2006 on the History of Maths Examinations In New South Wales…

I: Oh, that would be interesting.

P1: …which would be interesting to read. I don't know where he did that PhD. Maybe your ….. would be able to find that out, or I might be able to find it out on Saturday night because there's a dinner to celebrate 100 years of the Maths Association on the Saturday night.

I: Oh, wow. [laughs]

P1: So I will ask.

I: That should be exciting for you.

P1: Yeah, well I'll ask all my mates or anyone who's not my mate…

I: Thank you. [laughs]

P1: …do they know, because he was evidently the speaker at a fairly recent conference.

I: That would be good.

P1: Mm. I don't know where he did it, but once we know that you could look up the, I mean if he did it at Sydney you can look up their record of theses or wherever he did it they'll have, it will have been submitted and there'll be a record.

I: It might be in the digital theses too. I think [0:11:49.4] on the internet.

P1: Oh, that's possible too.

I: Yeah, because it's modern.

P1: If that's permitted.

I: 2006.

P1: Yeah, I refuse to allow my theses to go on, with a 10 year moratorium because I didn't want people pinching my thesis. I want them to buy it.

I: Oh, okay, that's fair enough.

P1: Yeah, [0:12:05.8] I guess.

I: No, no.

P1: I mean I sold about 100.

I: That's your personal…

P1: I sold about 100 but it's coming out, it will come out soon of the 10 year moratorium.

I: Oh, right. What was it called, can I ask?

P1: It's nothing to do with mathematics. It was for a Masters Honours in Theology. [laughs]

I: Very interesting. I love theology. I love it.

P1: Yes, well, I belong the Uniting Church and I did my post graduate study there and it was on…

I: I'm actually thinking about doing theology after I do this doctorate.

P1: See? There's a great relationship between God and mathematics.

I: [laughs]

P1: Very close I believe. Yes, so I did that on the Lectionary, the Revised Common Lectionary we use in church.

I: Sorry?

P1: The Revised Common Lectionary.

I: What's a Lectionary?

P1: A Lectionary is a set of readings. This one's a three year set of readings that's used world wide. The Catholic Church brought it out after Vatican Two and then it became revised and used in Protestant Churches and some Catholic Churches in America and Canada, all over the world. So I wrote all about that.

I: Wow, very interesting.

P1: Mm. Now…

I: I would like to talk more about that the interview…

P1: [laughs] Oh, ok.

I: …it would be good.

P1: [laughs] We'll get on with mathematics. Yes, now.

I: I just might get these questions out because…

P1: Yes.

I: …I'm running out of questions and we might see what I…

P1: Oh well I…

I: Sorry?

P1: I put down everything I could think of there…

I: Oh, good, good.

P1: …if, you say at your, at the beginning that your topic was really maths and technology which is much wider than maths and computers.

I: Oh, no. It's a, just maths and computers.

P1: It really is computers because…

I: Yeah, because it's not graphics calculators or…

P1: Well, I wrote what, see there was, they were, they were not unconnected.

I: Yeah, like the Canola.

P1: Well, we had hand calculators first of all that were simple little, just numbers type, usually with one memory. That sort of thing. So they became influential in all the controversies about whether children should use them, what they did about number facts and all of those sorts of issues, and then they became programmable. So we're verging into the ideas about programming languages there that…

I: Oh, I see.

P1: …they were, they weren't a language. They were very simple, I mean you'd almost say down to machine code because you had codes for the numbers and codes for multiplication and you know.

I: What sort of code would you have for a number like seven.

P1: Well, it would be a binary number…

I: Really?

P1: …that's a-, yeah, they'd have been binary code.

I: So you would have typed "7" in, you'd use a binary code?

P1: Oh no. Oh no, you didn't type anything, I'm telling you. You punched holes…

I: [laughs]

P1: …or you shaded boxes. That's what you did.

I: Is that the programmable calculator?

P1: Yeah, yeah, that's this, they were desk calculators. Like, jobs like that, and then they…

I: I should actually try and get photos of these things and put them in the document. That would be interesting.

P1: Well I think you prob-, well if you look up, I can't remember, they had numbers. They were the Canola something and the Sharp something. But if you looked up, I don't know, "programmable calculators", you'd probably Google it, you'd probably get some…

I: Mm, I should do that, maybe even the Canola, type it in.

P1: Well that's right…

I: Tilt things up.

P1: …that's, see what comes up. That's right. We had those. I was at college by the time they came in. We had those, and then, see then there were all these machines that came and I date them, where do I date them? Hand calculators, programmable. Home computers. That year, 1970 pr-, was the year, was I saying that? I'm upside down. Tandy.

I: The late 1970s and in 1978.

P1: Yes. 1978 Tandy here in Australia offered them for Christmas, the Tandy computer. This was what your family must have for Christmas and they were programmable in Basic.

I: Was that for home?

P1: [overtalking] that hard wired, they were all for home, yes. Now some of my students at teachers college had, one in particular I remember had bought an electronic kit so he could make himself a computer from, in a kit form. But these were…

I: Is that the Micro B?

P1: No, no, much, much later Micro B. Much…

I: Oh, okay. This is early days. [laughs]

P1: I'm talking about this hour, this time, '75, '76, something like that. You could buy electronic kits but that was the first one that penetrated into Australia when you could buy it for Christmas, and then we had all these other versions that came out.

I: There's a lot there.

P1: There are, there were. Competing brands. The Commodore 64 was pretty popular. It had a keyboard that was about that big. A ti-, it wasn't a detached keyboard. It was all one unit though they were all like that. Tiny little keyboard…

I: Commodore 64?

P1: N-, I think, is that, I think it was. Maybe it…

I: I bought a p-, we got a games…

P1: Oh, well it may have…

I: …we, it's got the big keyboard…

P1: Ah, that, well it wasn't the 64 then…

I: …it had a…

P1: …it must have been one of the others.

I: …it had a cassette drive, yeah.

P1: Oh, the Pet, probably the Commodore Pet.

I: Yeah.

P1: Yes.

I: I see, I see.

P1: I think the Commodore Pet.

I: I've never heard of that one.

P1: There were all these ones, now…

I: Commodore Pet.

P1: …they got to having tape entry…

I: Yeah, is that like a cassette?

P1: …like cassette mu-, like little music cassettes, they were, but they were for programming.

I: Were they micro or were they normal size?

P1: Ah…

I: They wouldn't have micro then, would they?

P1: No, I only ever saw micro ones for telephone answering messages. But the one that was different was the Sorcerer and the Sorcerer had a cartridge that you stuck in the side. A cartridge about that big and we bought a cartridge, we couldn't afford an Apple, they were too dear. They were $1,000 or something…[laughs]

I: That was a lot in those days too, yeah.

P1: It was too much money. So we bought a Sorcerer because it had, it was alleged that it would have different cartridges and when you put them in that was Basic. You put that one in, it was Fortran. You put that one in it was something else.

I: Really?

P1: And we…

I: But the other ones had Basic, Fortran cassette…

P1: Just Bas-, no, no, no. No Fortran was ever to my knowledge in the Micro. Only Basic and…

I: And all these computers you mentioned here, they had all Basic?

P1: They did, they did.

I: And this is the only one that had Fortran? Exo-, Exogear Sorcerer?

P1: Yes, yes.

I: But it was spirit cartridge?

P1: But we didn't, we, I'm not sure if they ever managed to do it because we don't, we thought, "Oh, that's the better one to go because whatever language comes out we'll be able to use it." It revolutionised the whole idea of computing as far as I'm concerned because prior to that we were using big, we used the mainframe at the University of Sydney when I was at college.

I: What would you call a mainframe? Is that the big ones?

P1: Yes.

I: Oh, okay.

P1: Bigger than that bit of the end there.

I: [laughs]

P1: Huge and you just crunched cards and you submitted them to an operator and depending on how high up in the pecking order you were, all students had overnight turnaround. So you put in a programme and you got, you must have seen this sort of stuff, you got this coming out at the end.

I: Oh, okay. Yeah, I did that at uni once. Stuff like that. Yeah.

P1: Yeah, with the answers. Now I did that when I was teaching students. I supervised them doing that, took their programmes down, they…

I: Was that at school?

P1: No, this was…

I: At uni.

P1: …at college when these were teacher-trainees in maths.

I: So you're a, like a lecturer?

P1: I lectured, yes. I was a lecturer, and when we got these other little ones the interesting thing was that you got immediate feed-back and that was unbelievable.

I: So the big ones took a long time to kick in then?

P1: I've well, well, overnight turnaround and there was, they were not interactive. So you could never do type, say in the Basic function, you could never use input because you could only use Read which read from a data line. You had your data and you had a command that said Read, same as Fortran, and it read from your data line and produced whatever. But when you can't…

I: But when you say, "you can't put input" what do you mean?

P1: Well there's n-, well input, you have to have someone there putting it, typing it in.

I: So I would say, "What is the height?" and you'd type it in…?

P1: And you'd type it in. This couldn't happen before…

I: Oh, okay.

P1: …because you were remote from it. You just typed up your programme and your data and you put it in and it talked to its data mind and gave you the result. It's all, it was not interactive.

I: Can you tell me what year it changed? Can you remember the exact year?

P1: These, well when we got these, they were in, they, you could…

I: ’76.

P1: …be interactive. You could be interact-, no, it was much later than that. Much later than that.

I: Oh, okay, sorry.

P1: I don’t know when, 1980…

I: Oh okay, sorry, yeah.

P1: …’80 plus. Then y-, then you sat there…

I: You couldn’t put…

P1: …and you could, your programme could say, as you say, input, “The height of the building is…” in the input and you typed it in and got back an answer. It blew my mind. Absolutely revolutionised how anyone could interact with a computer because when, we take it for granted these days it’s interactive. It never was. It was amazing, just amazing.

I: [laughs]

P1: So that then of course, [0:23:17.9] well then, yeah. Gradually schools got numbers of them and whatever and so on. No, do you want to know about Logo? Are you interested in Logo?

I: Yeah I do, I do.

P1: ‘Cause your ….. should…

I: Yeah, I like logo. It’s maths-based. Sorry?

P1: Your ….., he was very once interested in Logo.

I: Was he?

P1: He was.

I: Oh, he never told me that, yeah. [laughs]

P1: I've got an article on it he wrote.

I: Really?

P1: Mm.

I: Ah, 'cause I got some writings on Logo, but I'd like to expand upon it.

P1: Well, it came in, it was well, this, you know all about it? This was the man who…

I: Not that much.

P1: …developed it.

I: So Per, Per, is that…

P1: Papert.

I: Papert.

P1: Papert his name was.

I: …he actually developed Logo?

P1: Yes, at the Artificial…

I: That I did not know.

P1: …at Artificial Intelligence Lab at Massachusetts Institute of Technology. This book he wrote, first time he may have written a [0:24:14.7] of papers, but this was 1980 that he published that…

I: And is that when he developed the language too?

P1: Well previous to. I mean this was the final, this is it. This is the book about it, so it would have been developing there and that was his turtle…

I: [laughs] That's big.

P1: …and that's how…

I: So that's drawing there?

P1: Ah, yes. It had a pencil in it's, pen up and pen down. It really had a pen up and pen down in its tummy and that…

I: They don't use that any more, that sort of stuff, do they really?

P1: I've no idea.

I: Not in schools sort of thing.

P1: I've not idea. I…

I: [0:24:52.3] spine.

P1: Well, I found it amazing. I was going to write my thesis on that but tell no one, I, set the tape here, but the University of Sydney stopped my doing that.

I: Oh, why is that?

P1: Well, we were amalgamated into the University of Sydney and the Faculty of Education hated us, particularly the professor and he did everything he could to stop me doing my thesis, and in the end I gave up.

I: When you say, "He hated us," was it a group of people?

P1: Hated us was, we were the Sydney Institute of Education which was the CAE that Sydney Teachers College became and we had to be part of the Faculty of Education and they hated us.

I: Because you were from the other group?

P1: We were, yes. Scum of the earth, and he really put everything, every barrier he could in my way. He wouldn't let me have the supervisor that I'd started with and he insisted I had somebody who actually needed to be coached to get through the HSC in mathematics for whom I had no respect at all. He was a [0:26:09.9]. So I, I…

I: But you didn't give up and…

P1: …I gave it up, I gave it up.

I: …did the theology. But I mean it's good that you went on and did theology.

P1: Oh, we know, yeah, that's true but I mean you can't, you know…

I: No, that's not, that's inexcusable though, I mean that's…

P1: Well I, when I was looking for stuff for you I found a pile of papers, like that high, of all the research I'd done. I went to the University of London and Toronto…

I: Really?

P1: …and MIT and got all the stuff because I was writing it on Logo and it's relationship to mathematics learning.

I: It would be very interesting to hear what you have to say about Logo since you know so much about it.

P1: Well I did say, and I haven't given you a paper on it, but I've given you some papers here that you may find interesting.

I: That's it right there.

P1: Sorry?

I: I can hear you.

P1: That's my copy, not yours, what I've given you. These are some papers that I wrote.

I: Do you have copies of them?

P1: These are for you, these are for you, and those are…

I: Oh, thank you.

P1: …computing things and these ones are to do with the calculator…

I: I don't want to take your originals though. I…

P1: Oh, they, they're just aged my dear, they are ag-, that's why they look yellow. [laughs]

I: Oh, okay, yeah.

P1: They're not, [laughs] no, they're not the original.

I: I was a bit worried about it.

P1: No, no, no, no.

I: Yeah, I don't want to take your things, you know.

P1: No, no. I have copies of everything I'm giving you and this was, this was a development from the turtle called "Big Track" that ran on batteries…

I: [laughs]

P1: …and you programmed…

I: That's a big machine. What is that?

P1: Oh, it's only that big.

I: Oh, it's a [overtalking]

P1: It's just like a little toy. A little toy racer and it just had a thing on its back for its forward, back, left and right, and all its, so that…

I: That was on the back of it?

P1: That was on the back of the, and you just…

I: So press "Right 9" and it will go 9cm…

P1: Yeah, yeah, that's right…

I: …was it 9m…

P1: …and one unit was its length.

I: Oh, so "9" would be nine units of its length.

P1: Of it's length, yep, yep.

I: And "down"? Would that be nine of its height, breadth?

P1: No, no, no, that was whichever direction you wanted it to go. Forward, back, left or right. It didn't draw anything, you just…

I: It would be like a car.

P1: Yeah.

I: And how big would it move? I think I got that wrong. Like if you did one…

P1: It was about that big, so if you'd said to go "1" it would go that far.

I: And what about going that way? Like backwards?

P1: It's the same…

I: It would go the same [0:28:40.8]?

P1: …backwards, yes, I'd, anyway it tells you in there [laughs] if you want to look it up. I've forgotten, I've forgotten.

I: Oh, thanks very much for this….

P1: But you can have all those.

I: That's a lot to read. That's a lot to read. Thank you.

P1: Oh, well, if it's any use to you [laughs].

I: Well I'm doing a section on programming and Logo…

P1: Yes, yes.

I: …and I'm going to put Logo in there so it would be good.

P1: Well I can send you something else on other, if you want, I didn't give you an article on Logo but I can post you one if you want one.

I: Oh, thank you. Thank you. That would be great.

P1: Yeah, and of course I can tell almost without looking at the date, that one was my mother's typewriter. This was when we managed to buy and electric typewriter [laughs]…

I: [laughs]

P1: …eventually we got on to, I don't know if there's any one of them there. Oh that, I don't know. I think that's, I'm still on typewriter I think.

I: [laughs]

P1: So there's no soft copies of these. Unless they're scanned.

I: It's when they, when they made the…

P1: Unless they're scanned in.

I: [laughs] When they got the computer going it made such a difference.

P1: Well word processing for a start.

I: Yeah, copy and paste, and printing. It's just so, you can correct and…

P1: I know, it's just mind blowing, and when I think I used to, when I was teaching programming and we were doing text processing, I'd get my students for instance to write a little programme early in their ideas, that would count the number of words in a sentence. [laughs] You know, you think, this is, so much of this is embedded. You just press a button if you want to know the number of words [laughs]. All of that. It's just, when I think of the programming that underlines what I now use, and I did my thesis in computer science on creating Escher-like drawings. Do you know Maurits Escher?

I: No.

P1: No, well he did…

I: How many theses did you do?

P1: Only t-, only those two really that, I did one f-, when the post graduate working computer science. He was a Dutch graphic artist who, do you know anything about the Alhambra in Spain and the geometric patterns there? They're interlocking patterns all of the same module. It's like tilings, tessellations, those…

I: Yeah, I've heard of that, yeah.

P1: …that's, yeah well I wrote that programme for these drawings and it was all on huge, the basis of it was huge matrices, inverting matrices and reflecting ma-, doing all that. Now, [laughs] you can just call up a programme.

I: [laughs]

P1: Print these.

I: [laughs]

P1: It's amazing, just amazing. So I feel I've lived through it all because the professor I had at Sydney…

I: Yeah, really…

P1: …was the one, one of those that worked on the first British computer in Cambridge.

I: So you did your computer science course in Sydney too?

P1: Yeah, yeah, when I was teaching.

I: Was that after the…?

P1: When I was teaching.

I: Yeah, that was after the problem with the other guy?

P1: Oh no.

I: Or was that before?

P1: No, no. You'll read my story there.

I: Okay.

P1: After the in-service course I was hooked and that's when I arrived at Sydney and I was still teaching at, running the maths department in Moorefield. So I did that course and I came to college and they said, "You know, you'd better keep on with this." So I thought right, "I'll do a post-graduate course," which I did. First year of college, crazy, and ran the Maths Association as its secretary. I embarked on this diploma course [laughs], post graduate diploma and I was lecturing for the first time.

I: [laughs]

P1: I thought, "How stupid can you be?"

I: [laughs]

P1: But I know it was much, much later than that when I, when we were amalgamated into the University of Sydney in the late 1980s I think.

I: Mm, sorry to hear about that.

P1: Oh, it's all past history. He's dead now so it doesn't matter.

I: Yeah. [laughs]

P1: But it was nasty.

I: Yeah, nasty business.

P1: I was awarded the University's Excellence in Teaching Award. When you applied you had to go through the head of the school and so I told this Prof this what I'm doing, this is it and you need to sign it off, and gave it to him a fortnight before it was due. When it came just to when it was due, he said, "You know, can't, oh no. He's, professor's far too busy."

I: You're joking. This assignment?

P1: Yeah, so I said to the people at, the admin people at the university, "No, no, no. I've got everyone else signed it, but the Prof won't, hasn't got time." [0:33:50.0] had 13, had to submit 13 copies [laughs]…

I: [laughs]

P1: …and I had my copies, signed by the Head of the Department, the Head of this group, the Head of this group. All the ones I had ready, and I said, "Wait, well when he signs it, send us the 14th." They knew him. They knew what he was like.

I: Did he end up signing it?

P1: Yeah, a week or two later. But it didn't matter to them, because they knew what e-…

I: Oh good. They knew what he was like.

P1: They knew what he was like, and he was very surprised.

I: You got it.

P1: I got it.

I: Oh good. Well done.

P1: He said, "I 'spose I have to bow low now?" and I said, "Yes." But he was, it wasn't just me really.

I: Everyone knew about him.

P1: Everybody knew about him because he would not, he did not want any of his staff to get promotion or had no Ass Pros, Associate Professors in [0:34:51.2] in school. The most he would let anyone get to was a senior lecturer. Power mad. They knew what he was like. Anyway.

I: Sorry to change the topic ………., I'll just start with the…

P1: No, let's get back to this.

I: …two main questions before…

P1: Yes, 'cause, yes. Before you…

I: …that I can only think of…

P1: Oh, okay.

I: …'cause we do have more time but I can't seem to think, unless you think of some issues, but…

P1: No. I'll go through…

I: …um, there was…

P1: …what's here if you like. That might spark something else 'cause you really haven't got time to read it. No.

I: Ah, Papert, is that how you say it again?

P1: Papert.

I: Papert.

P1: Papert, they called him, Papert.

I: Do you know the exact date, not the month or whatever, the year that he designed Logo? 'Cause I've been trying to get that.

P1: Well, as I say, well this is the book. This is the book…

I: So it's 1980?

P1: … published in 1980 and he…

I: So when he published the book he gave out the programme could you say?

P1: Well, I guess so. Whether, over in America they'd had some trials and so-on, probably they would have, wouldn't they? But the world knew about it in 1980 with this book. That's the book, and…

I: "Mindstorms", yeah.

P1: "Mindstorms", yes, and he was very interested in Piaget and his…

I: I've heard of Piaget, yeah.

P1: …his understanding of how children learnt. He wrote it as a tool for experiment for mathematics, not for anything else. That's what it…

I: Why is it so relevant to maths?

P1: Well, unless you know, well it's two things: I never had children because I was, by then I was at college teaching students and I did all these in-service courses and so I got a lot of teachers coming back, coming to learn more and so they were adult learners and a lot of them were primary teachers who were not, maths wasn't their fondest subject in many cases. So I sort of saw them as second time learners and they learned so much about geometry that they had no idea. I think it's one of these…

I: Is that through Logo?

P1: …yes, one of these articles I think spoke, I quote a student, it mightn't be in this one. But I remember the student saying she had never understood what an angle was because it's a funny thing…

I: That is an abstract sort of thing, isn't it?

P1: Well, it's a turn, isn't it?

I: Yeah.

P1: I mean it's not measurable in the sense of length or whatever. It's a turn and you can do all sorts of really interesting things with learning about turns. I did a lot of interesting stuff. I'd better give you the article on Logo. They called it "A Second Look at Mathematics." I didn't print it off because I wasn't sure if you were interested in that but…

I: Oh, it is a good issue.

P1: I'll send it to you, for what it's worth.

I: Oh thank you, thank you.

P1: I use, talk about Logo in this one I think, and there's all s-…

I: Focus on languages in there.

P1: …sorts of things. Yes.

I: I find it very interesting that you said it was solely for maths.

P1: Mm.

I: Like he invented it not for anything else.

P1: Well it, for learning. For children…

I: Yeah, just for maths.

P1: …to learn, and his idea was that they would learn by experiment. Now that isn't the way a lot of, all children learn, but certainly I found it tremendous for reinforcement of previous learning and so on, but…

I: Did they learn quickly or is it a slow process, or it depends on…

P1: Well it depends. In this book, I haven't read it for years, but in this book he had children coming in for, I don't know whether it was an hour a day or an afternoon a day, a week or something like that, and charted their learning and so on. But when we got it into schools and primary teachers picked it up, unfortunately my perhaps anecdotal memory is that they would give the students something to type in and then they'd admire the output. The more pretty the rings or whatever, the more exciting.

I: Oh, is that what usually happened is it?

P1: So all that they were really obtaining was familiarity with the keys of a computer and…

I: Where was this?

P1: Oh, when it was…

I: Sorry, not when, I mean where?

P1: Well in primary school when it was taken up. See, the Department of Education put out a disk for use with the Apple 2 that implemented the turtle on a screen.

I: Oh, so all schools would have this?

P1: Well it was free. Free software from the Department developed by people like ……… and ……… and others whose names may have fallen from my head. Turtle was a triangle…

I: Triangle.

P1: So you could tell which way it was looking and you typed in the language and it moved around the screen depending on what you had. It didn't, there was no robot with it.

I: But the problem with it was that it wasn't allowing the kids to do what Logo was meant for: which is to learn the concepts of angle. Is that right?

P1: Well you, they have to be, they have to be guided.

I: Sorry?

P1: They have to be guided. You just can't sit there and type "forward 3, left," whatever. I would set up a pattern and say, "What happens if you change left and right? What happens if you change back and forward? What happens if you increase the angle of turn?"…

I: Yeah, and that's how they would learn.

P1: …and you would watch and by experiment, and these questions you can see things. I had senior people drawing graphs using concept of the tangent, the angle of the tangent, drawing parabolas and so on and all those kinds of things. I'm sure I hadn't given it to you there [laughs] but I, but they're more general, those articles. I don't know. Let me see what I s-, you have that. Let me see what I said. Let's go through what I said there and if I put my glasses on…

I: [laughs]

P1: …it will improve what I am doing.

I: Did most of the teachers when they taught Logo, did they do it with your approach, or did, and, or did they use what you were telling me…

P1: Ah I, I, well, well…

I: …remember you were saying that they were using fancy drawings and…

P1: I honestly don't know. I ran, I'll tell you there, I ran all these computer courses for teachers and we stopped counting once we got past 1000 enrolments. [laughs]

I: [laughs]

P1: These were the courses. It star-, that's the first course, was second term '79 and people just came to course after course.

I: Is that for teachers?

P1: For teachers but they were, it was run by the Teachers College. I've said…

I: I think ………, I'm not sure how to say his last name, he was involved in that. Did you say how you met him, or…?

P1: He would have run courses himself. He, I don't think he ever came to m-, oh this is another game thing. But anyway, what I'm talking to you there about the first is the HSC course at the lowest level of maths. That's the first thing, then…

I: This is Level 3?

P1: Yeah, then the ideas about [0:42:56.4] programme, we've looked at those. The Micro B you mentioned. There were two, at the top of the page there were these two. I don't think there were any others that were actually on contract. The makers were on contract to the department to produce the machines…

I: Is that the BMS map and the Micro…

P1: BMS map. Now the…

I: I haven't heard of that.

P1: …well it was…

I: Was that a…?

P1: …it was that big…

I: Yeah.

P1: …and it sort of had plywood top or something like that [laughs], and sides.

I: Yeah.

P1: It was fed by the Canola blue cards. They would use the different…

I: So the Canola was still in use?

P1: No, no, no. The cards were still around.

I: Oh, the cards, sorry.

P1: They were, as I said they were pre-cut so you could programme it that way and it was a wonderful machine because its output, and it was done deliberately for schools, but its output, the letters were that high on a normal screen. Now if you put them on a screen like a school, a classroom computer, a classroom…

I: They had screens up here?

P1: …screen, a screen on wheels.

I: Okay.

P1: What do you call that anyway?

I: I forget. Oh, an overhead projector, or…?

P1: No, no, just a big screen. It was just a screen like they show here for the racing and so on. They're wall screens, but these were this sized screen.

I: But that's about 23 inches.

P1: Oh no. A bit more than that.

I: Twenty-five?

P1: Six.

I: Twenty-six inch?

P1: Well that would be, oh no, that would be 30? I don't know.

I: Thirty inch?

P1: I can't remember, something like that.

I: I'm not very good at this sort of measurements.

P1: I mean the diagonal measurement was how they were measured so that would be about two and a half feet, wouldn't it. Maybe not quite. Maybe 24 inch.

I: Twenty-four inch.

P1: And when you had that in the classroom and the letters were that big and kids could see it. So you could demonstrate with the BMS map. You couldn't possible do that with anything else because their things were so bi-, about that big and they come up to be about that big on a screen.

I: So how big would it be, and how many centimetres would you think?

P1: Two.

I: Two centimetres high, the letters…

P1: Yeah.

I: …and the normal was about…?

P1: Oh, five, 5ml, yeah.

I: Five millimetres, yeah.

P1: Something like that. So you could, I mean everyone in the whole class could see it. But…

I: Was it popular?

P1: …they couldn't keep up with Apple. Apple was also on contract as well. They couldn't keep up the production. They were being done by a young man in his grandfather's garage. He knocked them up. [laughs]

I: Is that the Micro B?

P1: No, the BMS map.

I: Oh, okay.

P1: He knocked them up in his grandfather's garage.

I: So they had troubles producing them out…

P1: They couldn't keep up. They couldn't keep it up and when the Micro B was written by a 16 year old kid, or he might have been 14 who knew nothing about formal languages. He was a self-taught one and he had no idea nor did anyone, no one else it seemed in the whole of Australia knew apart from me, knew that there was in fact a standard for Basic. You know we have a Standards Association?

I: What does that mean?

P1: Well there are all sorts of things are standardised and there's a standard for Basic, there's a standard for FORTRAN. So that people when they use the language all use the same thing, same words, same, all the same rules. It's a standard, like you can have a standard for machine to, various other things.

There's a Standards Bureau here and ours was at North Sydney at the time. Well they had no idea anything about standardisation so they made up there own Basic and it wasn't, it was non-…

I: So was it called "Basic" or…?

P1: …standard. Yes, it was called "Basic"…

I: They called it Basic but it was [0:47:23.6] Basic.

P1: …it was non-standard. It was non-standard. Now that didn't matter if the Micro B was being used in a school; they could learn that. But if you're using it for examination purposes…

I: Yeah, one little wrong word…

P1: …it made, no, it, what do you do?

I: So, for example if you had a language from Micro B Basic would you get different expressions for the normal Basic and the…?

P1: No, you'd get, no, you would get the errors because that's not recognised. When I wrote "Beware", I wrote it greatly annoyed about the Micro B, though I was trying to be polite but I've pointed out where it was non-standard and if people…

I: Is that why it fizzled out? Because of the non-…

P1: I don't think it did fizzle out. [laughs] Or no, any more.

I: …because I have a document that was written in 1985 and it says the percentage of computers in New South Wales, and the Apple was a high percent…

P1: Yes.

I: …about 47…

P1: Right.

I: …I'm not sure exactly how much, and the Micro B was almost 42…

P1: Yes.

I: …but now it's…

P1: Gone.

I: …like this much.

P1: Oh no.

I: So it's, would that be because it's not standard?

P1: Well it was only for programming and programming is not a big deal these days.

I: Oh, okay. So that would be the reason why…

P1: Whereas the Apple you've used because of its software, "educational software", I put that in inverted commas. I'll tell you, I didn't write it in my notes here but what, that was a problem. See, I wrote text books for courses. I didn't bring them to you because I can't find one of them…

I: That's okay.

P1: [laughs] This one…

I: You wrote that?

P1: …was when it came in for, into the junior school and…

I: Did you write that, did you?

P1: Well I wrote the data processing one which is at the end.

I: I think I might have used that.

P1: Excellent book.

I: Oh yeah.

P1: It's a good book. [laughs]

I: [laughs] I don't know if I used that. It looks very familiar though.

P1: I'm actually very proud of this.

I: Maybe as a teacher I used it, but it looks very familiar.

P1: Well when the syllabus came out there was about that much lines to describe what the course was about and I would have to write a text book. So I thought, "Okay, I'm doing what I want." So I began by teaching Logo and then flow charts, then we got on to Basic. I think we're up to Basic there, aren't we?

I: So what, can I ask what year this was about?

P1: Yes, it's '83.

I: And the course is Modern Maths?

P1: This is the advanced course. This is the advanced course. It was the Year 10 course which had options in it.

I: So that was an option in Course 3?

P1: Yes. It was an option in all three courses, 1, 2, and 3. So we had the core topics and then we had the options.

I: So what's 1, 2, and 3? Is that different levels?

P1: Course 1 was the lowest level. [laughs] Course 2 was the middle intermediate, and Course 3 was…

I: Advanced.

P1: Yes, and they were called "lobes". That's the words. Core topics and lobes.

I: Ah yes, lobes. [laughs] And how long did that last for, would you know?

P1: No.

I: It just went on until…

P1: I retired in ’93, so…

I: That’s what I’m doing it up to, so…

P1: No, I don’t know what happened. [laughs]

I: After ’93, or…

P1: I was still…

I: …then up to about ’93 that was still in?

P1: I suppose so.

I: Oh great. I can use it.

P1: I guess so, yeah. Anyway that was a problem for examining because non-standard Basic made it impossible really but they had to accept anything at all that student wrote that looked as if it was reasonable.

I: Because of the Micro B?

P1: Because of, well yes, particularly the Micro B. So I was annoyed about that but you know, “Oh look, ………’s...”, that’s “………’s”, not “……..’s”.

I: [laughs]

P1: But what happened, and I’m saying their best machine there was for teaching was the one produced by the BBC, the real BBC in London [laughs] for English schools. They had…

I: And it was called the…

P1: …fantastic software. It was called the BBC and it was bought by particularly some private schools bought them for their students, but Apple always underpriced it just that bit, like…

I: And that's how they've beaten...

P1: …it might have been, say, I don't now, but say the BBC was 1,200, Apple was 1,000 or something like that.

I: Yeah, and that's how they made, yeah.

P1: Made enough and…

I: It was just enough.

P1: …just enough, and unfortunately too, P&Cs which had many business men possibly among their ranks thought, "Oh we can't, we've got to have an IBM because all businesses have IBMs. So we'll have to have IBM in the schools." And IBM had no software educationally of any value whatsoever. They just had, you know…

I: So is that why they got in, because they were…

P1: [0:52:59.2] P&Cs thought that we should have them.

I: What's a P&C?

P1: Parents and Citizens.

I: Oh, okay.

P1: And the Parents and Citizens, particularly the parents, male parents who were in business thought, “You’ve got to have an IBM. We can’t have anything else.” It was a disaster.

I: Why, what sort of things happened?

P1: Well, only that there was no software available, so that if you were trying to use the computer to support other subjects or any learning there was nothing.

I: Did they have languages, like Basic, FORTRAN…?

P1: Oh, yes but that wasn’t…

I: …or was it all DOS?

P1: …yes, there would have been I expect, because the first IBM desk, smaller ones, the IBM XT was programmable in Basic. The XT gave way to the AT, all these other variations. It wasn’t easy to use. These days of course they’ve had to put Windows in which is an Apple copy…

I: That’s right, well they…

P1: …attempted.

I: …they were going to sue them over that.

P1: Yeah well. I mean, and you can’t do anything...

I: They didn’t succeed but…

P1: …unless you've got Windows these days 'cause, but it, you had to type in codes that, to get yourself started and you had to know it was this, this, slash, whatever…

I: Oh, in DOS?

P1: Yeah. Terrible, I'd, I don't have anything to do with IBM.

I: [laughs]

P1: I'm an Apple person. A Mac person, I am.

I: I'm for IBM because that's all I ever used.

P1: Yeah, yeah. [laughs]

I: But I know the story and the history and I know how unfair it was, and like Windows 7, I love it because it's so easy and…

P1: Yeah, because it…

I: …but there's a history to it. I know, I know the history.

P1: Yeah, yeah.

I: Anyway, there was something I was meaning to ask, and that's the big question is: How is all computing and programming, how is it all related to maths?

P1: Well it's not any more, and if you're going to do programming I believe it should be somebody who knows, well…

I: Well, maybe just computing then? How is it…?

P1: Well, well, nothing at all and these days I would say. But if you're going computer science or even computer studies, if it still exists. Does it?

I: I think so.

P1: It probably has a programming strand in it, and you really do need a maths background and I don't know what the situation is in the university today, but I suspect that anyone who's doing any computer science course has to have some mathematics. They have reduced it a lot because I know when I…

P2: Is there anything else I can get for you?

P1: No. Do you want me to pay you?

P2: Sure, I'll bring the money over if you like.

[recording ends]

Interview 5 Part 2

(I: Interviewer; P1: Interviewee 5; P2: Waiter)

P1: When I did the course, the third year, Computer Science 3, but it wasn't called that but it was, you either had to have Maths 3, I think it might have been pure Maths 3 as distinct from Applied Maths 3…

I: Is that Open Universities?

P1: …or either as a pre-req or a co-req to do it and it was very, it was called "Numerical Analysis and Automatic Computing" which I still think is sweet.

P2: Sorry. You don't have any points on there but I…

P1: No.

[recording ends]

Interview 5 Part 3

(I: Interviewer; P: Participant)

I: [QUESTION NOT RECORDED]

P: Well I'll say that I learned more at Applications of Mathematics, let me say, than I ever learned in Applied Mathematics. I was not a scientist so I knew nothing at all about mechanics, any of those things. And all the Applied Maths that the University of Sydney taught at the time was that sort of thing. Whereas when I did Computer Science we were doing Fourier Series, Applications of Fourier Series, application of all these things in pure mathematics which was my delight. And I had a wow of a time, you know ...

I: So you learnt it all during computer studies?

P: I had a wonderful time doing it. And it was very, very mathematical. And I was also able, in my thesis, to do all the stuff that I liked to do too.

I: Through your experience what could you say makes computer studies, like in that context, thinking how it made you do maths, how does it make you do maths? What makes it so mathematical?

P: Well, it's logical for one thing. This goes back to actually using a hand calculator. You have to have some idea of the output to know whether or not your result is reasonable. If you don't have any idea, you just believe what comes up, you're lost. You must have some idea, approximation, estimation, whatever that technique is that you really need otherwise you're at the mercy of the technology. But if you have some idea of what's coming that's fine. Also I found that if you know some mathematics, and when you were programming, you could put some test cases in. Like one of the examples my maths trainee students didn't realise for instance that the standard formula for the gradient of a line, in terms of the coordinates of the points, you know that gradient, that formula doesn't work if the two points have the same abscissa because the gradient ...

I: What's the abscissa again?

P: The X coordinate. Same X coordinate, you've got a vertical line and so you've something over zero you see. So exploring those ideas with a computer, great fun, you know. Yeah, but I'll tell you the terrible sort of software I don't know whether I can blame IBM for this but this was their sort of standard, was the people who first wrote software were mostly young men who ...

I: Not women?

P: ... were into war games and stuff. I mean, they still are. I mean, all other stuff. So there was this game, now I'm not, I use the word Smurf but Smurf is not the right word but it was something like Smurf and it was meant to test your number skills. So you had all these random blobs that would appear on the screen and then you'd get a number fact, like six minus two, and if you typed in four you got the opportunity to fire a missile at one of these blobs that were called Smurfs or whatever they were. And they were of different sizes and they were a father Smurf, it wasn't a Smurf ...

I: Was it blue?

P: I don't know but the name wasn't Smurf it was something like that, a father Smurf, a mother Smurf or a baby Smurf. And let's say you got two points if you hit a father Smurf, say five points if you hit a mother but 10 points if you hit a baby [LAUGHING].

I: Is that because it's smaller?

P: Yeah. But this was, I mean, "What was being learned?" you cry. That was the standard of some of the software and I fear it may still be that sort of thing. But anyway, so be it, and there's a huge lot of remedial programs now for learning of mathematics aren't there that are all computerised? There's whole courses of them.

I: My nephew's playing Number's Up at the moment. I'm thinking of getting it for him.

P: Okay. Well, I mean, some of them say they're helpful.

I: Is there anything else you might think that is relevant to what we're talking about or should we end now?

P: One thing I can write down is this other person who's name is .....

I: Are they both at the Board of Studies?

P: No, no, no. This is the person, …… who wrote this thesis. I'll try and find out more about it or you may be able to Google it somehow.

I: I'll Google it on the ADT. It's a digital thesis website and see if I can get his thesis.

P: Yeah. I think it's called The History – this is what they told me – of what did I tell you, The Maths Examinations?

I: Maths Examinations, yeah.

P: Probably mathematics exams in New South Wales. It won't be abbreviated will it in the title of a thesis but it was 2006 and that's his name and that should give it to you shouldn't it?

I: Yeah.

P: Now, what else can I, I mean, I don't know whether you want this kind of stuff at all? This was a handout. These are in handouts that I gave to my students. That was my summary of Basic, that was a two page summary of Basic. These are students and that's going back isn't it? Look at that. That's the Sorcerer's keyboard.

I: That is very unusual. What do all those symbols mean? If you press it does that come up on the screen, like, the halves and the triangles?

P: I'll have to remember what that was, oh, this is the graphics screen, the low res graphics, that's their low res graphics screen. So you can make patterns with, that's right.

I: So on the screen that would be on there?

P: Yeah. And you could make that beautiful pattern, yeah.

I: And you could press that key and that picture would come up?

P: That's right. And that was my comparative summary of commands in those which must have been the ones we were using at the time, you know the comparative commands. And that would have been, there again how to do certain things, yes, to get what you wanted. So that made it difficult.

I: So they're different commands you use in the different computers?

P: Yes, yes.

I: Did you have to use all that many computers?

P: We did.

I: Was that at uni or at school?

P: Yeah. It was at uni. See, we bought them as they became available because I was teaching all these in-service courses and the students who came would have one of those at their school or one of those. And they couldn't, you know, they had to learn on their own machine. That was one of the beauties of the courses, that we had all the machines at the teachers' college.

I: So with the in-service you taught programming?

P: Yes. That's what I taught.

I: Did a lot come?

P: As I say we gave up, I got a certificate when we went over the thousand, number of participants, and I was still teaching courses. If you look, after that, I mean, I just did nothing else. My life was spent on doing that.

I: Because I know ..... – is that the right way to say his name?

P: I really don't know. I know who you mean.

I: Did he do ...

P: He wouldn't have done a course with me.

I: I know he did in-service courses but not with you?

P: He would have run them but not with, yeah. But this one was 5:30 to 6:30 throughout June, July and August that one. That's the first one I ran. The next one here that's on a Wednesday night in September, October and November.

I: Could I ask what time? Same time?

P: What time was that one? It was 5:00 to 6:30, yes. This one ...

I: Sorry to be picky: was that 5:30 or 5:00 o'clock to 6:30?

P: This is 5:00 o'clock to 6:30. And then this one's a three day course, must have been in the holidays, Tuesday, Wednesday and Thursday from 9:30 to 4:30. I tell you I did nothing else.

I: When you do an in-service course, like as a teacher ...

P: These were funded. These were, teachers who went to them were supported, State school teachers.

I: Were they maths teachers?

P: Yeah. They were almost all at the beginning.

I: State school teachers?

P: State school, no, no, they were government schools but also private schools came and I presume they were probably funded by their school. But these attracted in-service funding to State schools. Here's one again: Monday, Tuesday, Wednesday ...

I: And if you were, say if you were doing ...

P: Wednesday evenings ...

I: Say if I was a teacher and I wanted to do one of these courses, how many days would I have to go?

P: Well, if you did mine you either did Wednesday evenings for three months ...

I: So once a week?

P: Once a week or you did three full days every day.

I: And you learn a lot of language codes and ...

P: You learn everything there was ...

I: Was it Basic?

P: No, well, my first one I did programming in Basic and then I did – I did three courses: Extensions and Applications was new courses then this one ...

I: Is that like applications in the classroom?

P: No, no. Not so much. Let me see what it's saying.

I: This is very good because I need to know more about in-service courses.

P: This one says what I was using was subscripted variables, like this was Extension, subscripted variables including matrices and graphics, functions, interactive and batch processing, sorting techniques and further programming strategies. That was the Extension course.

I: There's a lot in there. There's a lot I don't know what the meaning is [LAUGHING].

P: Sorry?

I: There's a lot I don't know what it means.

P: You don't know what that means?

I: Yeah. Like, sorting batches and ...

P: Well, it was just sorting techniques, you know, how do you sort data in order. I went to a computer education course once – I don't know why I kept these but I found them in the garage in a pile of stuff ...

I: Well, what it's done is it's reminded you of information that's very useful to me.

P: It has. That is true.

I: Because I'm going to use it and say they're three month courses and ...

P: Yeah. I did Logo courses. They're not here either but I did those. I was going to say I went to this course once and to my great surprise I was the first on the list. And I said, "How come? Because I know I wouldn't have been the first to register." And they said, "We had a little trouble with our sorting program and we did it in reverse." [LAUGHING] An alphabetical sort you use, of course the alphabet of course is stored numerically and so they had just misused the less than or greater than sign in their program.

I: Oh, because it's ……….?

P: Yeah. ……… came up first. Never happened before [LAUGHING] in an alphabetical list.

I: You usually come last [LAUGHING].

P: Well there are some that follow ...

I: Unless it's a "z".

P: Yeah. But I couldn't believe I'd have been first. It was out of character to be first. It was only because of using the wrong inequality sign in the program.

I: Well, before I end, would you like to add anything more?

P: No. You can read what I've, you know where I live ...

I: Okay. I'll look at the notes.

P: ... and I can send you a thing on Logo.

I: Would you like to send it by email or mail?

P: I'll have to send it by mail, my dear, because ...

I: I'll give you my address then. I don't think you have it.

P: Okay. Oh, I don't do I?

I: No.

P: No. Right. Let me write it down.

I: But I'll stop this.

P: Yes. Okay.

I: So, I'm ending this interview with Interviewee 5. It was on the 14th October. And it's ending at quarter past four.

[INTERVIEW CONCLUDED]

Appendix H

Interview 6 Part 1

(I: Peter - P: Interviewee 6)

I: It's the 21st October at about 2:23pm on a Thursday, Peter Sollorz interviewing Interviewee 6.

P: Okay.

I: Okay, tell me about yourself and when did you start using computers?

P: I worked in the universities mainly. I was tutor and then a senior tutor in Mathematics at the University of Sydney and we started using computers in teaching at that level, in the mid 1970's before computers had monitors. So that we were inputting data, we were using a program that someone in the department had written for investigating abstract groups, structure of groups and the second year course for honours students in group theory we were using this. And I would sit with two students beside me, we would put commands into the computer and the printer would churn out pages and pages of information and then we would go away and study it.

I: And what computer was that? Was that the Canola?

P: It was, no it was mainframe. We simply had a terminal attached to a university mainframe computer. So I don't know what kind, whatever the university had in those days. It was the university's computer. We didn't have individual computers in departments. So that was the first thing. And then around about 1980 when personal computers became more readily available I got myself an Apple 2E and we started using it and my husband began writing stuff for it. HE was producing a book and he was writing and he produced, he wrote programs that would get the printer to wind, print out the thing and then wind back and use a different head and print the mathematical characters. Some things had to do three passes because you needed three different heads onto the printer to get all the characters you wanted.

So this was before dot matrix printers and so on. If you wanted good quality stuff you had a print head on the printer and that was.

I: So what's a print head? What is that?

P: Well it had the type face on it.

I: Oh okay.

P: It was a ball shaped thing with all the different type, you had to have a different one for each type face. You'd change your type face, so it was hard metal with the type face on it, and it rotated and printed the character and rotated and printed the next character and so on. When did we actually start using it in mathematics teaching at the university level? In 1984 I set up the mathematics learning centre at the university. That was to help students who entered the university without the background in mathematics that was required for the courses they were doing and they would come to us, it was, we ran supplementary tutorials, we ran bridging courses and drop in centres that people could come if there was something that they hadn't done or that they'd forgotten that they needed. It was mainly for first year students. We had some second year students and students from other parts of the university not studying mathematics, but having to do statistics for some course or other. So, there were a lot of public health students and nursing students and one or two medical students came along because they needed statistics and they hadn't had a background in that sort of thing.

And at that stage we set up computers and I went around the world on a trip and had a look at what people were doing in other places and an awful lot of it was the programmed learning sort of thing and I wasn't impressed.

I: So, what's programmed learning?

I: Well that's the sort of thing where oh, it was sort of a little bit of explanation and then questions and you answer the questions and the computer says right or wrong. So you weren't actually using the computer to do mathematics. It was just testing you and I don't think much of that at all. The one thing I found that was really exciting was in England I met ….. and I found out about his software that he had written and I got that and I brought it back and there you were able to explore ideas in calculus using the software. If you'd like to switch off that for a moment I'll go and get the thing.

Interview 6 Part 2

P: Yeah in the maths learning centre we had some Macintosh's and we also had PC's and we ran David Tall's material, "A Graphics Approach to Calculus" in there and students could use that to explore and help them understand ideas and we also got ANU Graph which was written for the Macintosh by a couple of people at the Australian National University. Now have you, have you been in touch with them at all?

I: No.

P: ….. and.

I: Is that …..?

P: ….. and I forget the name of the second person. I can probably find it out. But ….., I think they've probably both retired by now, but that was very flexible for any sort of graphing of mathematic functions of all kinds and you could do lots of nice stuff with it. Of course it's totally superseded by graphics calculators and all the new graphing utilities, but it was way ahead of it's time.

I: Yeah, and this was in '82 was it?

P: That was in '84, 85 that was available. I don't know when it first came out, but that, it would have been in the early 80's. And that's basically that, so that's where and then I wrote a graphics approach, now what is it, Investigating Change, which is an introduction to Calculus for Australian Schools. That was starting in about 1988 that we started planning for it. The first half was published in 1991 and the second half in 1993 and I don't think it has dated. We made a conscious decision at that stage when we were writing that to include computer and graphics calculator use without being specific about which because we didn't know quite which way the technology was going to go. And so I used ANU graph to produce all the graphs that appeared in the books but it was written so that, with the intention that people could use graphics calculators or a graphics utility on a computer to do the investigations and again it was written with the idea that you do exploratory investigations. Now, where from there?

I: Just a quick question about ......

P: I've sort of answered how I used computers, yes?

I: Do you have his contact?

P: Who?

I: ...... Well, let me see if I can find the contact.

Interview 6 Part 3

I: Continuing the Interview with Interviewee 6 at 2:38.

P: Yeah, so I've told you about when I started using computers and how we were using computers, why? Why, because it seemed the best way of helping people explore mathematics, investigate and.

I: Can you, I find that very interesting because I've asked, I've had a few people I've interviewed and I asked them, "Why is computers so important to maths?" Would you be able to answer that? Like because I'm very interested in, part of my thesis I want to write the relevance of computers to maths and I want to get as much detail on that as possible.

P: I think because computers can get rid of the computational detail and allow you quickly to get to the key ideas. If you're thinking about, if you want to investigate a function for example, and functions are central to a great deal of the maths that we do in school. One of the investigator function, if you do it without a computer or a calculator, a graphics calculator, is really a mini computer and I sort of group them together, if you do it without that you've got to do a lot of calculation. You've got to plot points. There are all sorts of possibilities for error. You can plot the point, you can calculate the coordinates wrongly, you can plot the points wrongly, you can miss things because there's a, you're not plotting frequently enough so you can miss a discontinuity if you don't understand what you're doing. A computer allows you to focus on the key ideas, the key properties of something without having to do so much computation and without so many errors. It removes margins for error in unimportant things and lets you focus on the important things.

And then because it allows you, for example, to, again thinking about functions, it allows you go graph many different functions one after another all at once and look at them and compare them and see what changes when we change one coordinate, what changes when we change something else? And so again, it allows you to relate one thing to another and all that can be done with pencil and paper and hand computation or an ordinary scientific calculator, but it takes a heck of a lot longer and there are more margins, more possibilities of making mistakes and getting confused. And if you're spending a long time doing computations and plotting points and so on, you forget the purpose of what you were doing. You lose track of what it was all about.

So that's for things like Algebra Functions, Calculus, Graphing. For statistics, again, it removes the computation and allows you to focus on the ideas and that's I think what it's all about. See if you're doing statistics without a computer you've got to find sums of coordinates and sums of squares and you're spending ages adding and squaring and calculating and so on and you lose track of, the focus becomes a formula and calculating a number rather than, what does that number mean? What does all this tell me, which is why we're doing statistics to try to be able to interpret things. So that's why I think computers are important. I think they have already, but in the future, have much more potential to absolutely revolutionise, changing the priorities and getting rid of all the routine jumping through hoops, doing routine computations, following a recipe, learning formulae and get into, what's mathematics for? How can we use it? What does it mean? Okay?

Uh, what were some of the problems? I guess the problems with using computers are two fold; one is the kids who are very negative about computers and I think there's probably less of them around now than there used to be. But, there were always kids, and I'm thinking more recently, I'm thinking to the 90's rather, the early 90's rather than the 80's when I was doing professional development work in schools around the use of computers and the use of graphics calculators, and there were always some who said, "I can't do this" and they were ready to give up the slightest little thing that didn't quite work the way it was supposed to and, "I can't do this." And they just sort of retreated into negativity.

I: What sort of implementation was that at that time? Was it with programming? Was it?

P: No it wasn't with programming. I've never worked, I've never, I don't program myself and I don't and I've never had anything to do with programming in schools. Never. And I don't think that programming, I doubt if programming is particularly relevant to the teaching of mathematics.

I: Can I ask why you think that in particular? What is it about programming that you?

P: Because the focus is on getting a program that works. The focus is not on understanding mathematics.

I: Like the concepts?

P: The kinds of programs I've used are the graphing programs that help in understanding Algebra, Coordinate Geometry and Calculus, the Statistics programs that help in getting to the understanding of what the data mean and the Geometry programs, Geometer's Sketch pad and Cabri Geometry which I've used extensively and again, they get to the understanding of what the properties of a shape are. And they allow for creativity and the use of imagination and so on.

I: What about Logo? Do you think that's?

P: I haven't really used Logo much. I'm sure it can be, but, sorry I actually haven't used Logo at all. I've looked at Logo and thought, yes interesting but it didn't get me excited and I haven’t used it. So the things I have used are Graphing programs, Geometry programs and Statistics.

I: When you say programs themselves aren’t very good for Maths is that like Basic and [8:28 -Fortran?] Is that what you mean?

P: I can’t see that there’s a place for teaching Basic or Fortran or any other programming language in the mathematics classroom. If you want to teach computing then fine. Again I don’t know whether Basic and Fortran are the languages that you would want to be teaching, but they were the languages that were popular. Basic was very popular but I don’t see that that has a place in a Mathematics classroom. I think you’re wasting time that could be spent on understanding Mathematical ideas on trying to get programs to run. And I’ve never been involved in that. So that’s sort of the limitations of what I’ve done are sort of the Geometry things and Statistics and the Graphic programs.

I: So when did you start using computers in Maths in schools?

P: Well, I wasn’t teaching in schools. I was in the University until 1991. I was working, I was developing ideas for schools, I would do workshops with teachers in schools, but I wasn’t actually teaching in a school. And then after 1991 I retired from the university and I did even more PD work with teachers in schools, but it was usually senior classrooms and it was mainly well again it’s the sort of stuff I’ve talked about. That was what I was doing, using computers in teaching Calculus in teaching Statistics, in teaching Geometry.

I: And you mentioned that there were some other kids, like I'm not sure how many there were that had problems.

P: There were always a few in each class, one or two. You’d come across them all the time. There would be one or two who would be very, very negative about it and as soon as they hit a wrong key or something they would sort of give up and say, “I can’t do this,” and they would leave it to someone else.

I: So would that be like in using Geometers Sketch Pad and stuff or?

P: Geometers Sketch Pad or a Graphing program or anything. And then there were always some who wouldn’t stick to what you wanted them to do but they would go off and experiment and explore, who really loved the technology and who would go and explore and do other things and it was hard to keep them on task. But that didn’t bother me quite as much as the negativity of the ones that just pulled out altogether. But, there weren’t, it wasn’t a big problem. I don’t think it was a really big problem and with a little bit of encouragement, if you had the time to sit down with them and say look it’s alright, if you’ve hit a wrong key here’s how you get out of it, here’s what to do and with a little bit of encouragement, but they started off with a negative attitude and it needed a bit of work to encourage them.

I: Please excuse my inability to work this out; you say you didn’t work in schools.

P: No.

I: But, so were these uni students or?

P: No, no, no, what I'm talking about is when I was visiting schools.

I: Oh okay so sort of to implement the.

P: I wasn’t working in schools but I was visiting schools. I was, there was a period when I spent several weeks as mathematician in residence at a school. I’d be a week at one place and then a week at another place and so on. And what they wanted me to do there was, the school had a focus on mathematics for that week, we did mathematical activities, usually I gave a talk at assembly, then I would go into different classrooms with different teachers and we would do usually computer based or graphics calculator, it was mainly computer based activities, but sometimes some other things as well.

And then I was doing professional development with teachers. I did teacher training. I taught at the university from all along, all the time from when I started, when I first came to Australia and in 1978 there was a sort of, cut back in university funding and my job was a year to year appointment because I didn't have a PHD. I was only a tutor or senior tutor. I wasn't a lecturer and I thought I'd better have additional qualifications.

So at that stage I did a Dip Ed and I got all the qualifications, so I'm qualified to teach secondary mathematics. And it was at that stage that I met ……… and at that stage that I had a brief encounter with Logo and Basic and things like that but wasn't that interested. And then my job at the university was reconfirmed and that was alright and then I moved into a permanent job at the university as Director of the Maths learning centre but I was still, I established that link with school teaching and I'd established my interest in teaching mathematics at the school level and the mathematics learning centre was looking at students who came from school without the background they needed.

Perhaps because they hadn't chosen the appropriate course at school, also we were looking at people that had been away from study for a long time, mature age entrance and so on. But there was a particular focus at that stage in the Maths learning centre on Calculus, because if students hadn't done any Calculus or hadn't done much Calculus at school they were at a real disadvantage coming into university Mathematics courses. And so we were doing a lot of catch up, bridging courses in Calculus and that sort of thing. So I was thinking about the learning of Calculus, the introduction of Calculus and then I got a grant from, it was a project set up by the commonwealth to encourage the participation of girls in Mathematics in 1988 and it was out of that that the introductory Calculus project came about and I was appointed as the author. I had an advisory committee but I was the author. I wrote the books. Have you seen *Investigating Change*?

I: No.

P: You're not familiar with it?

I: No.

P: I have copies here.

I: I'll just stop the tape.

Interview 6 Part 4

P: So, while I was writing that I was visiting schools in 3 states; New South Wales, Victoria and Western Australia. I had a coordinator in each state and as we wrote drafts it went to the schools and the schools tried the ideas out and I would go down to the schools and observe lessons and talk with the kids. So, that was right throughout that period '89 to '91 I was in schools regularly trying out the ideas.

I: So how many schools would get this book?

P: I don't know how many, I mean it's published by Curriculum Corporation. It's available for everyone, for anyone that cares to buy it. It's available overseas too if people want it.

I: So it was optional to them to buy?

P: Oh yes, it wasn't a thing that was given out. It didn't get sent to schools. Schools had to buy it. It's a [1:06] replacement for a text book. Now, in Queensland some schools used it and every kid had to have copies. In New South Wales most schools I think got a set and it probably went and collected dust on the shelf because teachers prefer to have a text book that covers the whole course and not just Calculus. In other schools, in other states it was taken up more widely but I don't know how widely. I've really no idea. But a lot of people, in New Zealand, people in New Zealand were using it. I've had a lot of feedback from New Zealand and I've been across to New Zealand twice to give talks and so on about it. Most recently in 2005, in fact that's what I was busy doing when you just arrived. Somebody had asked me about one of the things I do in these books and how do you do it on a graphics calculator? And I looked up the talk I gave in New Zealand and sent her off a copy of it. So yes. So, that's my connection with computers. Are you familiar with Cabri Geometry and Geometer's Sketch Pad?

I: Oh I've used Geometer's Sketch Pad and I've heard of Cabri Geometry.

P: Cabri is very similar and it does the same sorts of things. Slightly different logic to it but once you get used to it, if you've used Sketch Pad there isn't anything very different in Cabri.

I: So that's one of the questions I have, maybe we can talk about that. It doesn't say programming but I'll focus on programming. [3:06] some of the programs like Cabri, Geometry, so you mention the statistics one; what was the statistic, do you remember the name of it?

P: Hmmm. Oh there's the big one. Oh God. I did statistics most on graphics calculators. TI-81, TI-82, TI-83, I used all of them in turn and we used, we did statistics on that, but there's SPSS and we had SPSS in the Maths learning centre but I didn't do so much. I wasn't so expert in statistics and the Maths learning centre someone else did most of the statistics. But SPSS used to be very clunky and hard to use and then it became very user-friendly. They developed a much better user interface.

I: So, at first it wasn't very friendly?

P: Oh no. At first it was sort of complicated and awkward to use and.

I: Can you remember when it came out?

P: SPSS was, I think SPSS existed from the days of mainframe computers when you submitted [4:45] cards and then it got gradually adapted and adapted but at the time when I'm saying, it was clunky and difficult to use with a difficult interface it was mainly that they'd done a minimal adaptation of the original thing and it was still more or less treating the thing as if you were submitting a deck of cards, a deck of punched cards. And then they improved the user interface and eventually I think it could run on Macs as well as PCs, but.

I: So what are some of the other programs you can talk about that you were using?

P: Well, that's the programs I've said. ANU Graph [5:40] whatever it's called, A Graphic Approach to Calculus. I never got, I haven't got into the more recent graphing things, and then the Geometer's Sketch Pad and Cabri Geometry. I think those are the main things yeah.

I: Okay that's good. I might get back to some of the questions here. What were some of the benefits?

P: Well the benefits were I think twofold. I think student engagement on the whole because students found using computers, they enjoyed it – most of them apart from a few. Students would be more engaged and the other thing as I've said was that it was being able to focus on the principle, on the big ideas, looking at how one thing, not just whether it's Geometry or whether it's Algebra or Calculus, not just looking at the one thing but looking at how that's related to something else. Being able to understand how things change and how things are related to one another. Mathematics is about relationships and I think being able to get rid of the computational, all the tedium that can be involved in Mathematics and focus on the main ideas was the big advantage of using a computer. But the other big one was that an awful lot of students were more engaged. Yeah.

I: Well we'll skip the policy questions.

P: Yes, I wasn't involved in policy so.

I: If you think you've answered this already, just tell me. Tell me about the practices of?

P: I think I've answered that as well as I can.

I: And how did it develop, how did it change, why did it change? Do you think you answered why did it change?

P: It changed because the software improved. It changed because people writing software got better at the user interface so that kids could use it more easily.

I: Did it improve maths wise?

P: Hmm. I guess so. Yeah, because bit by bit they develop ways of doing more and more things on the computer, yes, yeah.

I: Well we don't need to do the programming.

P: I've talked about popularity. I don't know what kinds of, what sort of computers we used.

I: You mentioned the Apple II.

P: An awful lot of schools had and have PCs and some of the software I wanted to use was written for Apple. I've always been a Macintosh person.

I: So when you say PC is that like an IBM?

P: An IBM, yes yeah. Or Anything that runs IBM software yes.

I: Do you know when the IBM started coming out, or started being popular or because I know that the make.

P: I know that the Apple II must've started in the late 70's. I think the IBM came out a year or two later. We got an Apple in 1980 and I must've got a Mac about 1984. A little Mac. They had this little Mac that was a, the screen and the keyboard so it was all in one.

I: So is that like an Apple Mac?

P: An Apple Mac. There is no other. There is no other Mac. A Mac is an Apple.

I: So, the Mac is an advanced version of the Apple II. Is that right?

P: Uh it's a whole new, a whole new thing. It was very different from the Apple II. There must have been an Apple I before the Apple II but I don't think it could have been very widespread. You'd need to go back to the, just I would say google Steve Jobs and see.

I: How do you spell his last name? I might just do that.

P: Jobs.

I: Oh okay. I might just do that.

P: He's the inventor. He invented it in his garage.

I: I might look him up.

P: Built the first Apple in his garage.

I: [11:11] about the Apple I.

P: I don't know. I do know that when my son, we had a year in the United States in 1975, '76, September '75 to June or so 1976. My son went to a Junior High School there. He was 12, 13 and they had a computer in a computer room in a little cupboard! And sort of privileged students were allowed to use it and he was one of the privileged ones. And that was one of the very first, it was a personal computer, it wasn't a big thing. It wasn't a terminal for a mainframe somewhere. It was a personal computer and he started doing programming, but that and so that was when PC, Personal Computers were just starting. And I have no idea what brand or model or anything it was, but it was 1975.

I: 1975?!

P: Yes. End of '75 and there was a computer in that school in the United States. Maybe not many schools had them.

I: Oh yeah, probably because it's in the US, it just started out and.

P: I don't know. But I do know that he got hooked on computers at that stage.

I: How old was he?

P: Thirteen, twelve and a half.

I: Oh okay, because we're near the end of the interview. There's about six questions left. Is there anything else that you might think that is relevant on the top or your head sort of thing?

P: I don't think so.

I: And do you know anyone else who, apart from ………?

P: I thought of ………. Did she put you onto anyone?

I: She did but I can't remember the names off the top of my head.

P2: Can I suggest the Maths Learning Centre people?

I: Maths Learning Centre is that, where would that be?

P: The Maths Learning Centre at the University of Sydney. I don't know whether they could help much because they all came in later than I did. The people that are there now came in later than me and you're really interested in schools aren't you?

I: Schools, yeah.

P: You see ….. and ….. haven't ever taught in schools and they've got no connection with schools.

I: I might talk to my supervisor to see if I can extend it to universities.

P: No, you're probably better, if you're doing a PHD, you're better to limit your questions, better to limit the range and go deep rather than.

I: Yeah, I'll take that advice.

P: Yes, rather than, if you start widening that out to university teaching of Mathematics you're introducing a whole new ball game because universities were doing all sorts of different things quite early because there were people in Maths departments that were doing programming and developing programs and using them in all sorts of ways so I don't know what they're yeah.

I: Okay, so four to go. Was the focus taken away from Maths as computers became more applicable to other subjects?

P: I don't have direct experience because I wasn't working in a school but that is certainly my impression. That teachers in other subjects seized on using computers and teachers in Mathematics were a bit less enthusiastic.

I: So they were actually less enthusiastic?

P: I think so, yes.

I: Did they use it less?

P: I don't know because I wasn't in a school actually doing that. I was visiting schools but I couldn't, I tended to visit a school and I'd be talking to the people in the Maths department and I'd be in Maths classrooms teaching Maths lessons. I wouldn't be sort of, didn't get a view of how much computers were being used in other departments at all.

I: Because you were Maths based you focussed on Maths teachers.

P: My focus was always on Maths. I've just had this.

I: But as the years went by.

P: This impression that all sorts of databases and so on became available and word processing became a big thing because everybody was expected to hand in their assignments word processed and looking beautiful and so everybody was using and I've had Maths, the definite thing I know is that Maths teachers complained when I suggested things that could be done on computer. They complained that they couldn't get access to a computer room.

I: So was that at first, when you first came or did it come more later like in the '90, '99?

P: I'm talking more about the 90's, talking to teachers in the 90's.

I: But before that, sorry to be a bit pedantic here.

P: I can't be as specific because before then what I was doing was with special schools where teachers had elected to participate in writing these books, well in trialling the materials in these books. And so they had negotiated use of computers, use of the computer room or whatever.

I: Oh okay, but about the early 90's.

P: We're talking about the time when there was a computer room in a school and you had to book it and it required organisation and then you've got to get your class from wherever they were normally to the computer room and teachers said it was a hassle.

I: Is this maths teachers?

P: Yes, which is why graphics calculators were welcomed by many maths teachers because this was a nice little thing that you could carry a whole set in a carry case, bring them into the classroom, distribute them to all the kids and then you've had your lesson right away without having to book the computer room. So, I do know that access to the computer room for maths teachers was a problem.

I: And that was about the early 90's?

P: That was certainly the case in the early 90's. I'm not so sure about before that.

I: Do you know anything about teacher in service courses, because that's questions about that?

P: Yes, "How were teacher in service courses implemented?" Well, I was invited to do some teacher in service courses. How were they implemented? What I'm talking about is where a group of teachers come to a particular centre and then we do.

I: Were you involved in it, were you part of it?

P: I would be presenting.

I: What are the things that?

TALKING OVER EACH OTHER

I: What sort of things were you talking about in like these?

P: Calculus, mainly teaching Calculus.

I: Oh okay so you were teaching them how to use?

P: I was giving ideas on how to teach Calculus.

I: Was it using David's program or?

P: Using things like that, David Tall yes.

I: That's good. That's interesting. Well I think that ends the interview, unless you have anything else you want to add?

P: I don't know. All I want to say is, do you want to, would you like to take this away, I'm not quite sure what all is in here. This is the, I think I've added some materials, you've got it all discs for the IBM PS2 model 25 or Tandy 1000. So there's two discs there if you can find a machine that will run them!

I: Well I might just end the interview formally.

P: Thank you.

I: Yeah thank you Interviewee 7 for that interview. We're ending it at quarter past three.

Appendix I

Interview 7 Parts 1 & 2

(I: Interviewer: P: Participant)

Date: 9th August 2010

Time: 3.45pm

PETER: It's the 9th of August at 3.45 pm and I'm Peter Sollorz interviewing Interviewee 7 and I'll begin with tell me about yourself, when did you start using computers?

INTERVIEWEE: Right, computers or computers in maths teaching?

PETER: Oh I – you can use, we can talk first with just generally computers and …

INTERVIEWEE: Okay.

PETER: … I focus on maths at the – I should mention that, yeah we're doing maths teaching yeah, focusing on maths teaching but late 70's or, even earlier than that if it's possible to early 90's.

INTERVIEWEE: Okay.

PETER: Yeah.

INTERVIEWEE: Alright. Well I first started using computers during my Bachelor of Science degree at the University of Sydney which was 72, 73 and 74 and what we did with computers in that degree, in the 70's remember it's long before personal computers, we had punch cards and we would write programs in Fortran as part of our mathematics course.

And each line of, of, of the program was punched onto a punch card so when you finished typing in your program it was basically a box of cards you know …

PETER: Really?

INTERVIEWEE: … like a couple of shoe boxes in size and you would take those down to the computing centre and they would be read by a card reader and the job would run overnight and the next morning you'd go back and collect your job and it would be an output which did whatever the program instructed it to do, so that way how – that was my first experience with computers.

PETER: Oh and Fortran, that was the first language you were using at the time?

INTERVIEWEE: That was the Fortrans, transformation or translation I think and it, it's a standard mathematical programming software, it's still used today and then later I did a bit of programming in basic, in 1975 I was doing my Dip Ed and I had a part time job in the Department of Econometrics and they used a Wang computer as well, all the forerunner of a desktop but it took up about a dining room table in size.

But the good thing about that was you didn't have to have the cards, you could type in your program line by line and I used basic, the language basic and my, my job at that time was to help with some research in the Department.

And then 76 I was, I was out at – I was just away having a year off, 77 to – 77 I was teaching, no sorry 76 I was teaching at Narrabeen High School.

PETER: Oh okay, was a girl's or boy's school or both?

INTERVIEWEE: It was, it was a co-ed school, it was the first year it had become co-ed but I don't remember using computers at all in that year, 77 I had a year off and travelled overseas, 78 to 87 I was at Ascom.

PETER: Was that another high school?

INTERVIEWEE: Ascom is the girl's school in the Eastern Suburbs …

PETER: Oh okay.

INTERVIEWEE: … and it's a private school and we used computers there, now what did we use them for? Mainly in Richmond, it was the very early days of the personal computers, a lot of high schools at the time had Apple 2E, Apple 2 and the letter E, you've probably heard other people …

PETER: Yeah I have, I've read about it yeah.

INTERVIEWEE: And some schools even used a computer called a Commodore, that basically is the early personal computers and at Ascom we had, well we didn't have Apples we had Tandy Radio Shack, So T-R-S-80.

PETER: Oh okay.

INTERVIEWEE: Hmm, I don't know if you've heard of those?

PETER: That's interesting yeah, no I've read the name but I don't know much about it.

INTERVIEWEE: Right.

PETER: Yeah.

INTERVIEWEE: Right.

PETER: Yeah.

INTERVIEWEE: Well we had the – mainly because, oh it's interesting how these things happen, mainly because the father of the Head of the Department of Maths worked for Tandy and was keen that the school should get to use some computers.

Now when this personal computer surge came out there was very little software so you know the, the idea of Microsoft Office I mean that just didn't even exist it was very, very basic, it was basic programming that was what you, you did.

PETER: Hmm, it focused on programming at the time.

INTERVIEWEE: Yeah it focused on programming, that's right and then gradually software like spreadsheet software and early word processing software became available, but in the very early day all we had was programs in basic.

PETER: Can I ask you about the TRS-80 and the Commodore, were they used much in other schools? Do you know anything about that?

INTERVIEWEE: Yes. There were, there were other school around the state where individual maths teachers got really keen about computers and so they would write little programs to do interesting things or games or puzzles and use them with the kids.

And there was also something called the Motorised Mark Book, I'm not sure exactly when that came in but it was basically a software that would handle things like class marks, you could enter all your marks during the term and it would add them up for you and give a rank order and a way to understand the deviations and things like that.

PETER: Oh okay.

INTERVIEWEE: So that was, that was quite popular and there was improved versions quite – I think even until now.

PETER: Yeah.

INTERVIEWEE: Yeah.

PETER: And, oh okay so what, what were the main – I just thought I'd ask, I might like on my, on my questions here but since you mentioned these computers I just though it'd, because they're new to me – I didn't know they were used in schools what, what are the main ones? Do you know much about what were the main ones used in schools in that, in that time …

INTERVIEWEE: Yeah.

PETER: … period in the 80's, right in the beginning?

INTERVIEWEE: In, right in the beginning well the government schools had Apple 2 and the TRS-80 and then later the Macintosh.

PETER: Oh okay.

INTERVIEWEE: So the Apple computers really got in to government schools in New South Wales, I think through doing some contracting things with the Department of Education.

Private schools more or less did their own thing and possibly a lot of private schools when, when the IBM launched their PC, the private school got the business.

PETER: Okay.

INTERVIEWEE: Yeah.

PETER: So the TRS-80 wasn't that …

INTERVIEWEE: No it wasn't as popular as much at all there wasn't much around, I remember the programs that we did have came on cassette tapes.

PETER: That is an old way back, a long way back.

INTERVIEWEE: A long way back, a long way back.

PETER: The olden day's hey?

INTERVIEWEE: Yeah. And, and I remember spending one Christmas holidays trying to show how it would be possible for us to do our class lists this way on a computer, so this is before there were databases available to us on computers and it took me a couple of weeks just to, to type in the names of one year group and get them, the machine to sort them alphabetically and it really wasn't very convincing for the admin staff. But then a couple of years later there was database software available and they were doing it in any way that it could be done.

PETER: Okay I'll go onto the next question and I'll try it, it you think you've answered it that's okay just tell me, how did you use computers?

INTERVIEWEE: Well I used it, the TRS-80 mainly for showing kids how, what a computer program was, we had a computer club and we would meet once a week after school and learn how to write programs.

And the programs weren't terribly flash, they were – I remember for one of the school open days we wrote a programme which would ask the person using it for their birth date and it would tell them what day of the week they were born so you know, it was that kind of level of single input single output yeah.

PETER: Okay. I'll just stick with some of the questions I've got here otherwise, uh you know what I mean, why did you use computers?

INTERVIEWEE: Well I had a personal interest at that stage because Ascom was a girls school and I wanted the girls to have a chance to use computers because it was quite clear, even in the early days, that computing was seen as a male occupation in a male scene and I wanted our girls to have a chance to actually see what a computer does.

PETER: So when, when was this?

INTERVIEWEE: Uh that would have been late 70's early 80's.

PETER: Oh okay, oh that's good, I find that interesting actually. What were some of the problems with new computers?

INTERVIEWEE: The problems were the clunkiness, the cassettes and later the large floppy discs and if you had an Apple you had format the discs before we could use them for anything and it was very easy to over write stuff, the whole data storage issues wasn't anything as easy as it is today, other problems were just the lack of software in the early day's.

PETER: So it's a real software problem issue?

INTERVIEWEE: Well there just wasn't software there wasn't any, there wasn't any educational software, a lot of people were keenly writing their own thing in basic and that was good but apart from that there wasn't much software.

PETER: Sliding off the questions here when did that start to change?

INTERVIEWEE: Now that's a good question, I think when IBM launched it's PC and Microsoft – well it must have been Microsoft I guess.

PETER: So they started the change?

INTERVIEWEE: Microsoft Office yes.

PETER: Yeah.

INTERVIEWEE: There was something before Microsoft Office, before that [11:03], it was called something else and it had a little spreadsheet in the word processor - I forget what it was called.

PETER: It's not Word?

INTERVIEWEE: It used to …

PETER: Its not Word because that's what's out now …

INTERVIEWEE: Works, Office Works or something.

PETER: There's Works as the work processor and in tables and spreadsheets …

INTERVIEWEE: Oh okay.

PETER: … but it's not – like I get that with my, I got a new laptop, I've got Works …

INTERVIEWEE: Yes.

PETER: … and I had to buy Office separately.

INTERVIEWEE: Yes. I think before Office was affordable people just had Works yeah I and, and then that started to change things, there was also within maths education there was also a program called ANU Graph, Australian National University …

PETER: Australian National University …

INTERVIEWEE: University, ANU sorry Australian National University, someone there wrote this software which enabled Macintosh users to draw lovely graphs into the X, X graphs outside, that kind of thing and that became very popular in high schools that would have been in this time I think, in the 80's.

PETER: Around mid 80's?

INTERVIEWEE: Yeah I think so.

PETER: Yeah around the 80's.

INTERVIEWEE: Interviewee ….. might know more about that.

PETER: Yeah.

INTERVIEWEE: You should go and talk to her.

PETER: What was – I've asked that one, what was some of the benefits?

INTERVIEWEE: The benefits were the excitement of being there right at the beginning, I think the benefits were that what – well what were the benefits for the students? I think just that they could say that they were in a computer club and, and they were you know doing something interesting and different but it wasn't very long before the benefits became more obvious when workplaces started to use computers a lot.

PETER: With the computer club was that maths based at all?

INTERVIEWEE: It tended to be a little bit maths based yeah.

PETER: Hmm. Just a little bit or …?

INTERVIEWEE: Well, well there wasn't much you could write in basic programming other than things like maths, like you could write and equation to, to solve a quadratic, you could write a program to solve a quadratic equation or you could write a program to stimulate the throwing of a dice 500 times, you know it was easy enough to do that kind of thing.

PETER: Yeah. Okay you might have already answered this, tell me about the practices of that time?

INTERVIEWEE: With the computers?

PETER: Yeah in maths.

INTERVIEWEE: In maths? Well if you went to a, a conference for example a maths teacher's conference there'd be several people who were way ahead of me and had, had got this name for being really clever with the computers and they had written models of software that did things and, and it was very – so the practice at the time for a math teacher would be probably to go to an in-service or to a conference, see what these other people were doing, get really excited and then come home and try it in their own school, that would have been the practice.

PETER: Okay. And I know this isn't in the question, it just occurred to me was there must about professional development in your area?

INTERVIEWEE: Well as I said if you, if you were going to a conference or a math teacher presence there was always someone there, if it was a general conference like the NSW Conference which happens every year, or with AAMT the Australian Association of Maths Teachers Conference every, every big conference like that would have someone talking about how to use maths and how to use computers in maths.

PETER: And they were at a main conference at the time?

INTERVIEWEE: Hmm, hmm.

PETER: Okay. How did it develop?

INTERVIEWEE: Well I think if we're talking about computers in maths teaching the development came with the better software and with all these ideas and then there was also a, a course called Mathematics in Society have you heard about that?

PETER: Yes.

INTERVIEWEE: Yeah, it was before general maths and there was a very keen person called …… at teachers college back in the 70's maybe.

PETER: I've heard of her.

INTERVIEWEE: Yeah, well you should go and talk to her actually.

PETER: I haven't been able to get in touch with her.

INTERVIEWEE: I can give you her phone number.

PETER: Oh that'd be great, thank you.

INTERVIEWEE: Now …….. and some other on the Silver's Committee wrote an option topic around programming in basic and so that got, once that course was in schools that was, that was that contributed to the development because teachers could see how they might use basic programming to teach the mathematical topics.

After that there was an organisation in New South Wales called The Computer Education Group, they started having conferences and news regulars and things.

PETER: I think I've got some of their documents on that, they were involved in politics was that correct?

INTERVIEWEE: Yeah.

PETER: Yeah.

INTERVIEWEE: Yeah.

PETER: Alright. How did it change?

INTERVIEWEE: Well I think the changes were very gradual and, and then in some ways there hasn't been a change there's always been a few people ahead of their time who really could see possibilities and develop wonderful software in teaching methods and so on.

And, and then what's changed is that their ideas gradually got taken up by the other teachers and by syllabus writers and so on so I think that's how it's changed, it's changed through individuals having great ideas, possibly also through outsiders from America and England visiting Australia and giving talks about it …

PETER: Oh.

INTERVIEWEE: … about how to use computers in maths.

PETER: Spreading their ideas.

INTERVIEWEE: Spreading their ideas, what other things? And of course just the, the popularity of computers but the personal computers, the idea of the laptop even you know, that was huge, the idea that you might have a whole classroom of laptops or, or you might have a computer laboratory where you could take your maths class and use spreadsheets or let them look at, uh I don't know anything.

Budgeting, personal finance or even something really mathematical like geometric theories and things you know so, so what caused the change was personalities with great ideas, better software better hardware, money being put into it by schools and by education departments.

PETER: Oh good.

INTERVIEWEE: And also I think the people could see that computers were useful in the workplace.

PETER: Hmm. So was that a major …

INTERVIEWEE: Oh yes.

PETER: … thing?

INTERVIEWEE: Yes that would have been a major thing.

PETER: Hmm.

INTERVIEWEE: With something like MYOB you know, Mind Your Own Business or something …

PETER: Yeah I think that's what it is.

INTERVIEWEE: It's an accounting software.

PETER: Yeah.

INTERVIEWEE: That didn't exist.

PETER: Yeah.

INTERVIEWEE: So when, when we were starting so people weren't aware that a computer could be a great tool for business, people knew about big computers you know the mainframe computers but it's taken a while before math teachers were convinced that they could it on their personal computers.

PETER: Can I ask how long you think it took approximately …

INTERVIEWEE: Well look I reckon …

PETER: ,.. like just roughly?

INTERVIEWEE: … yeah well I reckon if you, if you consider that in 74 I was at uni using punch cards and Fortran and then probably in the 80's I was using TRS-80 at Ascom and Apple 2E's I knew about Apple 2E and, and towards the late 80's I had a Macintosh.

So I reckon that period in, in the late 70's early 80's it would have been the key time so if you can find out how many computers were sold in Australia in that period you'll get an idea.

PETER: Well I've got a, a document which talks about how many computers were in 85, 1985 and it's from an approximate percentage ratio's given like there was Apple, Micro B they were the major ones that were at that time.

INTERVIEWEE: Oh yes the BBC one.

PETER: Is that a BBC one …

INTERVIEWEE: I really don't recall.

PETER: … or is that the Micro B?

INTERVIEWEE: Oh no maybe it was the Micro B, yes there was a BBC computer.

PETER: Yeah.

INTERVIEWEE: That was one of the early ones yeah.

PETER: Right yeah.

INTERVIEWEE: Yeah. And so it was in the 80's? Hmm.

PETER: Okay. So tell me about programming in the various languages, you mentioned Fortran.

INTERVIEWEE: Yes.

PETER: What other languages – I think you mentioned basic didn't you?

INTERVIEWEE: Basic, I didn't personally ever learn COBOL but I was aware that business programming got done in COBOL.

PETER: Business programming?

INTERVIEWEE: Yeah, I don't know what COBOL is.

PETER: Hmm. Was LOGO, is that a programming …?

INTERVIEWEE: Oh LOGO? Oh yes I forgot about LOGO, now LOGO there was, there was a big movement, people became really enthusiastic about LOGO and Seymour Papert and, have you read his books?

PETER: No, I've read the Practice one in Schools.

INTERVIEWEE: Yeah he – well he was one of the international guru's that, that came over and got people excited, was he behind Turtle Logo or something else?

PETER: He may have been, I'm not 100 % sure off the top of my head.

INTERVIEWEE: Okay so …

PETER: I can look that up on later on.

INTERVIEWEE: Yeah look it's, it's interesting talking to you now more and more is coming back to my memory, now LOGO and that whole idea that the kids could, could learn programming by giving a little animal, a turtle a serious of just – in such inside go forward 10 steps, turn left go forward and …

PETER: Yeah.

INTERVIEWEE: … and that kind of thing, that was really popular and someone who visited Australia around about that time was .….

PETER: Yeah right.

INTERVIEWEE: ….. and you should – if you look up here biography it's about, it's about I should think it would be about this whole era of getting computers into schools but she was, she was one of the big names yeah and that was really exciting and ……… will be able to tell you more about that too.

PETER: Oh good …

INTERVIEWEE: And …

PETER: … I'll have to …

INTERVIEWEE: … I'll write these names down and I'll get an appointment for you with ……...

PETER: Thanks for that, that'd be good.

INTERVIEWEE: And ….., …..is in London of course you'd – she's an English math educator yeah but Turtle, Turtle maths and that, that really took off in a big way, you've either got the physical Turtle that moved around on the floor or you, you got LOGO which moved something on the screen.

PETER: On the screen yeah.

INTERVIEWEE: Hmm.

PETER: That physical LOGO, that one on the floor was that actually used much? Was it everywhere or …?

INTERVIEWEE; Oh no it wasn't everywhere, only a few schools could afford it yeah.

PETER: Yeah that would have been interesting.

INTERVIEWEE: Yeah it was, it was.

PETER: Okay. What sort of computers were used?

INTERVIEWEE: Well I've talked about the TSR-80 …

PETER: Right and the Apple 2E.

INTERVIEWEE: The Apple 2E and the Commodore.

PETER: The Commodore.

INTERVIEWEE: And whatever that BBC one was …

PETER: Yeah. At the time of 1995 Micro B was popular but I don't know if that's a BBC one, I'll have to look that up and do a search on that somehow.

INTERVIEWEE: Yeah.

PETER: I'll just contact the company or something because that was a B – that was almost as popular as the Apple 2E in 1985.

INTERVIEWEE: Is that right?

PETER: Yeah, yeah. Well I guess we've covered what with their popularity do you think?

INTERVIEWEE: Popularity mainly came with you know, individuals being really keen to do things with it and then that option top again, Maths in Society, something but I've always thought we missed the boat on was spreadsheets, I really think you could teach amount of maths with spreadsheets and I do now use Excel in my lectures for instance to, to demonstrate things and not, not just statistics.

PETER: Can you give me a general idea on what you can teach through it, through the spreadsheets?

INTERVIEWEE: Oh well you could go graphing, I'll show you some of the spreadsheets I've got, I've designed if you like, you can draw graphs with Excel, you can demonstrate numerical differentiation you know with the integration with Excel.

PETER: Hmm.

INTERVIEWEE: Language that became popular later of course were the computer algebra system like derive …

PETER: And that was the language was it?

INTERVIEWEE: Hmm.

PETER: Oh mathematica?

INTERVIEWEE: Hmm.

PETER: Anything else?

INTERVIEWEE: Well these, these were now we're talking around the 90's…

PETER: They're the yeah, yeah.

INTERVIEWEE: … with computer algebra systems. Something called Macsyma M-A-C-S-Y-M-A I think was around before then yeah. There's a little bit of a survey of some of the early computer algebra software in my PhD thesis chapter two, the literature review, and that's online at Wollongong University.

PETER: Oh how would I get, get to …

INTERVIEWEE: Just go to the internet.

PETER: And look up your name?

INTERVIEWEE: Yeah.

PETER: On the digital thesis?

INTERVIEWEE: Yes, digital thesis.

PETER: Yeah I've got that website.

INTERVIEWEE: Hmm.

PETER: Yeah I'll look it up.

INTERVIEWEE: Yeah.

PETER: Yeah is it just – how many, oh you obviously would have done only one thesis?

INTERVIEWEE: Well can I tell you something

PETER: It sounds like you did two or three.

INTERVIEWEE: No, no that's alright. It's a literature review.

PETER: A literature review.

INTERVIEWEE: I'm pretty sure it's chapter two, yeah.

PETER: Alright. This is just a very broad question is there anything else relevant to the topic that you could talk about?

INTERVIEWEE: Well I think the spreadsheet thing is, is an important one …

PETER: After looking for spreadsheets out they're were, they were not used as …?

INTERVIEWEE: Well yeah, I'm just really puzzled that maths teachers didn't you know, grab onto it and use it, I guess the problems are probably things like how would they do it because unless you've got a projector in your classroom you can't really get 30 kids around one small computer screen.

There’s always this argument from maths teachers that it was difficult to get into the computer labs because …

PETER: Yeah, yeah.

INTERVIEWEE: … because as soon as computing became a subject the kids could study it so …

PETER: That’s right so it’s all taken up by the other subjects?

INTERVIEWEE: Yes.

PETER: Computer science and yeah.

INTERVIEWEE: Yeah.

PETER: Computer studies I mean.

INTERVIEWEE: Yes …

PETER: Yeah.

INTERVIEWEE: … computer studies and you know it’s such a shame I …

PETER: Yeah.

INTERVIEWEE: … I really think you know more could be done, even though I think maths teachers could do a lot more with computers in their teaching ...

PETER: Well that’s …

INTERVIEWEE: But then that's not really your area is it?

PETER; No, it's the …

INTERVIEWEE: It's the history …

PETER: … the past.

INTERVIEWEE: Yeah.

PETER: Just as a point of interest there, there are – have you seen the Smart Board now they've got …

INTERVIEWEE: Yes.

PETER: … like at some schools I've been too …

INTERVIEWEE: Yes.

PETER: … as a casual teacher they've got Smart Boards, that would have been really useful now for, for maths teachers yeah.

INTERVIEWEE: Yes, yes.

PETER: Uh this question was the focus taken away from maths as the computers became applicable to other subjects? Uh yeah we were just talking about how …?

INTERVIEWEE: Yeah. When you say the focus taken away from that way, if you mean did other yeah, did other teachers take it on, I think you have to yes I think in the early days it was the maths teachers who were also the computer teachers because they could write programs and the early programs were mainly mathematical anyway.

But so I don't know if the focus has been taken away from as it's more that as the software became easier to use, other teachers like geography teachers could use it more for statistics and things.

PETER: Oh I've thought of it just now as you were talking it brought something to my attention which I hadn't thought of, the programming that was done by the maths teachers what was it focused on? Like what sort of areas was it, do you know much about that?

INTERVIEWEE: Well we can have a look at that's Old Silvers Maths in Society to see …

PETER: Okay.

INTERVIEWEE: … to see what's in there in the basic programming, there would have been programming – basic stuff to [11:40] and some standard deviations and so on before that, before it was a button on the calculator you see.

PETER: Mainly to understand the deviation.

INTERVIEWEE: What else would they have done with it? I remember there was one guy down in Bathurst who wrote amazing software where on and Apple 2E, I don't know what language he coded it in, possibly in basic, but the idea what it showed the algebra break equation and then a student using the software could do something like type in add two to both sides.

And what would happen is the software would show what happened to the algebra break equation where you added two to both sides and, and that might give you the answer for X or it might not and then you could do another step which might multiply both sides by seven and the you know it was …

PETER: Oh like it was just X divided by seven equal two …

INTERVIEWEE: Yeah.

PETER: … times both sides by seven.

INTERVIEWEE: Yes and it would show you what, what would result from that.

PETER: Oh.

INTERVIEWEE: So this was brilliant stuff I think …

PETER: Yeah.

INTERVIEWEE: … because it, it didn't matter if the student typed in the, an inappropriate step because the software correctly did what that step told it to do.

PETER: Yeah so no that's a good way though.

INTERVIEWEE: Yeah marvellous, brilliant.

PETER: It's innovative.

INTERVIEWEE: It's very innovative and I think similar software now is available through GioGebra or you know …

PETER: What's it called?

INTERVIEWEE GioGebra.

PETER: GioGebra.

INTERVIEWEE: That's new software.

PETER: Oh so that's not relevant thought.

INTERVIEWEE: No, it's not historical stuff.

PETER: Do you know what that was called this one? That might be something too …

INTERVIEWEE: Oh something like equation solve or something, I mean it was just a program that he had written himself to help his own student.

PETER: Oh.

INTERVIEWEE: But what a clever idea, very innovative.

PETER: Hmm, yeah for that time too.

INTERVIEWEE: Yeah.

PETER: Yeah. Did maths become less a part of a computer related subject as the computers study course became a part of the curriculum?

INTERVIEWEE: Yeah I'd think so, yeah.

PETER: Hmm. And how were – and this is a, it's not really related to those questions so I know, I do know that's it a bit – you know what I mean it's a bit of a sort of at a, at a different angle, how were the teacher in service courses implemented? Do you know much about that?

INTERVIEWEE: The maths ones?

PETER: Yeah.

INTERVIEWEE: Or maths and computing ones?

PETER: Yeah the course – for the courses, the teachers in service courses you know where they would go, would go to a place and learn how to use computers for maths.

INTERVIEWEE: Yeah are you asking who ran them?

PETER: Or do you know how they were implemented? You know like, oh it does sound like I'm asking you who ran it aren't I, what I mean is how did it take place? Like did they – was it successful, did it happen a lot, was there a lot going on with the service courses?

INTERVIEWEE: Oh yes I think so, in New South Wales MANSW, M-A-N-S-W, Maths Association of New South Wales ran lots of in service courses. The Catholic the, the Systems ran in service courses like so we had the Catholic Education Office ran in service courses for the teachers of Catholic Schools. DET ran in service courses for teachers of government schools, the AIS the Association of Independent Schools ran in service courses for teachers at independent schools.

PETER: Oh that's right.

INTERVIEWEE: Yes so, so you know you've got all these different groups running in service courses and then Apple itself funded quite a few in service courses and, and conferences and things hmm.

PETER: Hmm yeah, a very good comment. The last question, did they teach how to – because one of the criticisms I read in one and it was just in one paper in one of these, it wasn't a merger proceedings there was a conference proceedings, I think it was from MANSW …

INTERVIEWEE: Hmm.

PETER: … and I – his name was ….. and he was criticising that somebody in service course were saying they didn't teach how to implement the computer in the classroom, they just taught say the hardware …

INTERVIEWEE: Oh right, right, right.

PETER: Is that correct or do you know much about that if that's correct?

INTERVIEWEE: I think that would be a very big generalisation to make.

PETER: Yeah. So I should not quote that – you believe I should …

INTERVIEWEE: No you should quote it but, but …

PETER: But mention it's a big generalisation or …?

INTERVIEWEE: Well what was he talking about?

PETER: Generally about in service courses you know training, training teachers to use computers.

INTERVIEWEE: Okay so he, he went to these courses and he found that they were mainly about how to use a computer rather than how to use it for teaching.

PETER: Yeah.

INTERVIEWEE: Look that might be his experience and there probably was a time when not many people were using it in their classrooms, you see it's a new thing and maybe it took a while before enough people knew, we doing it themselves in classrooms to be able to show others you know what I mean?

So it could be a valid reflection of his experience but it wasn't as though anybody was hiding anything from them, it's just that there probably weren't enough experts out there, it would be interesting to follow up on that.

Yeah I, I could see how that might have some – how someone might, might get that impression because there probably weren't many courses in the early days about how to use it in your classrooms because no one had used in, in their classroom and yeah, yeah that's interesting a bit of controversy but I'm, I'm kind of not surprised if it was in the early days yeah.

PETER: Yeah.

INTERVIEWEE: Yeah but I think that's changed recently, I think you'll find if you look at recent MANSW conferences there's lots, there has been lots of presentations about what I do in my classroom you know, it's real [18:32] about what they, about what they do in their own classrooms with computers so I guess it's just taken time to shift.

PETER: Yeah. Because I wasn't sure how much of it was his personal experience or from talking to others and …

INTERVIEWEE: Yeah, yeah.

PETER: … maybe I should ask a bit more about that or even …

INTERVIEWEE: Yeah.

PETER: … dig a little deeper.

INTERVIEWEE: Try and find out if he's still around and …

PETER: Yeah.

INTERVIEWEE: … what his opinion is now, if it's changed a bit yeah.

PETER: Yeah I might do that.

INTERVIEWEE: That's interesting.

PETER: Yeah.

INTERVIEWEE: Yeah.

PETER: Well I think that is the questions, I guess the final one I can ask is there anything you could add, I think I've already asked that bit on the other page but just before I end it is there anything that you think that is important to add to what we've been discussing?

INTERVIEWEE: Well let's think, we're talking about computers in classrooms aren't we?

PETER: Yeah, New South Wales, late 70's well as early as possible I suppose to 89.

INTERVIEWEE: Right well I can give you a few other names to go and talk to …

PETER: Oh that'd be …

INTERVIEWEE: … some of the people at the Board of Studies who've been around for a while like ……., he's be worth interviewing.

PETER: I've got from the Board of – I think it's the Board of Studies, have you heard of ……….?

INTERVIEWEE: Yes.

PETER: …..?

INTERVIEWEE: Yes.

PETER: Yeah I'm …

INTERVIEWEE: Oh you must talk to ….. .

PETER: Uh he's not from the Board of Studies.

INTERVIEWEE: No …

PETER: ….. .

INTERVIEWEE: ….. yes they're at the Board of Studies …

PETER: Yeah.

INTERVIEWEE: … and ….. there as well.

PETER: Uh I might try and talk to him.

INTERVIEWEE: Yeah go and chat, chat to those guys.

PETER: ….. has sent me an email, answering the questions through email …

INTERVIEWEE: Yes good.

PETER: … and I went through it last night.

INTERVIEWEE: Yeah.

PETER: Yeah so …

INTERVIEWEE: No he's definitely one of the early leaders, he did a lot with computer in maths …

PETER: Yeah.

INTERVIEWEE: … in his own classroom and, and spoke about it and …

PETER: Yeah.

INTERVIEWEE: … and I think he's now a lecturer in Maths Ed in Darwin or somewhere isn't he?

PETER: Really? I know he lives in the country somewhere I'm not sure where, if it's Kiama or I'm not sure exactly where, I'm not sure exactly where he lives now but I remember it was very far and that's why we decided to do it by email because he, he suggested it himself, he said, "Oh it's a long way for you to go and …", and so he suggested email …

INTERVIEWEE: Yeah, no he would certainly be one of the leaders of, of the whole thing.

PETER: Yeah.

INTERVIEWEE: And see [21:00] yeah, in fact I think he did his PhD in Maths Ed about using hyper cards, now that's another piece of software from, from the early days of the Macintosh, see this is before HTML and the internet – it's even before the internet can you imagine that?

Hyper cards were, were like a series of pages on the computers that, that linked you know with what the way the hyper links work now with that.

PETER: Yeah they're a bit like the HTML …

INTERVIEWEE: Yes it's a bit like that.

PETER: … you basically click on something and then the page comes up.

INTERVIEWEE: Exactly …

PETER: Okay.

INTERVIEWEE: … exactly.

PETER: And is it, is it on the hard drive or is on the disc?

INTERVIEWEE: Uh I think it's, basically you build a file and it's all …

PETER: Oh okay.

INTERVIEWEE: … and it's all on one computer yeah.

PETER: Yeah, yeah.

INTERVIEWEE: It would be like running a Word document and having some links from one page to the next.

PETER: Yeah.

INTERVIEWEE: And so some teachers were exploring with the idea of computer rated teaching and computer rated learning, you know where you see a page that introduces Pythagoras [22:12] and then you click when you finish and then the next page has a question and you click when you've done that.

PETER: Yeah.

INTERVIEWEE: And you know, that kind of thing computer aided designing, uh computer aided learning.

PETER: Oh.

INTERVIEWEE: And you could, you could construct these things called hyper cards stacks and each one was like a, a learning unit. They weren't physical stacks but they were files which had, which had all these links in them.

PETER: Hmm, very interesting.

INTERVIEWEE: Very interesting.

PETER: Okay well thank you Interviewee …

INTERVIEWEE: No you're welcome.

PETER … I'll think we'll end it there and it's 4.25 and I'll press stop now.

[END OF RECORDING]

Appendix J

Interview with Interviewee 8 Part 1

(I: Interviewer P: Participant)

I: Thursday 9th September 2010 and I'm interviewing Interviewee 8. Can you please tell me your last name because I'm not too sure…

P: ----

I: Okay and we'll start now. It's 3.40 p.m. All right. Tell me about yourself and when did you start using computers?

P: In my, I finished school in 1969 and went to Armidale Teachers College then. Armidale Teachers College we, it was somewhere between 1973 that I saw my very first computer. It was an Olivetti um, they used to take up a whole room and I didn't think that computers would do anything. So computers came in after I started teaching and the very first programmable device that was placed on Government contract was the Canon Canola, which was a programmable calculator. So we started using the Canon Canola mainly to as teaching aid though some of the kids did learn how to programme it. We then, I then got involved with that and then of course the Apple II went on Government contract I think 1979…

I: In schools?

P: In schools and I got rung up in June 1980 to whether I was interested in a position at Head Office developing curriculum material for computer education. Prior to that and probably we'll talk about the funding model for in service NSW there are two types of funding for in service NSW. One is regional based and one is state based.

The regional based ones were dictated by the regions. So people would put submissions and have a conference each year. The Liverpool Maths Teachers Association because there was a Liverpool Region, was very active in this area and they used to have a Maths Conference at the Hydro Majestic every year. Um, and the lecturers were all teachers from the Liverpool Region and of course it was all about mathematics. But it was also had a lot to do with the Canon Canola. And even prior to that there were books like this one "Games on a Calculator" so even prior to that, to, when the calculator first came out, and this was even before they were even allowed, we used to carry boxes of calculators into class and the kids used play games. Anyway in June 1980 I was appointed to Head Office and started travelling around the state running training courses for teachers. So we would go to Coonabarabran, we'd go to Broken Hill. So going back. At first the staff was all regional based and I would travel when I was at Head Office, I would travel to various regional conferences. They were predominately Maths Teachers Conferences though I was involved, a number of them were Science, um, LOTE um…

I: Oh okay.

P: Languages other than English um, where the Soul of Adventure game was good for the development of language so um, and then we started developing at Head Office materials that the schools could use. In the early 80's, no – yeah in the early 80's, 83 I think it was the Computer Education Unit was formed. And that was a result of what I was talking about before. That, when, back then anyway, when a department identified what could be a priority area they would get the different branches of the department together to put a policy statement together. So that services and material could be co-ordinated for schools. The up swell of the number of computers in schools and as I told you before Ian, in the 80's there was what, early 80's, 300 by 83 there were 1800, so because of the big up surges the schools were crying out for money for materials in the schools. Because back then, there weren't any commercial software. Back then I think I remember there was word processing. There was the big argument, which word processor was better SANDIS or SARDEX, um, even back then people used to argue about which one was better. They could never see they're both bloody word processors. They both do the same thing. Anyway, so back then in the commercial software fields there was only word-processing and VISICALC being…

I: What's that?

P: Spreadsheet, the very first spreadsheet.

I: BISICALC?

P: VISICALC. Yeah V-I-S-I-C-A-L-C. So the schools were crying out for curriculum materials, the schools were crying out for software. So they got together and they formed a what was called then a Curriculum Project team and the thing about the Curriculum Project team – oh it's got written here "the department has established the Curriculum Project team in Computer Education which is responsible for curriculum planning, design in this field for all stages from Kindergarten to Year 12. This policy statement represents the basis from which the team will work". And what they did was, the Curriculum Project team, was said there are three major areas of, with the use of computers in schools. And the three major areas were learning about computers and computing, using computers for learning and using the computers for management. And so therefore they would then start developing the materials. Now using the computers for management or to that side of the Department that looked after it and the people from Studies and Services were looking after the learning about, and I've got some of the materials there you can look at later on. Okay so that's basically what it is.

Now the use of computers was basically back in the early days cause there was lack of software. We used to write or get either write programmes or um, get the kids to write programmes to help us teach certain concepts. For example how to calculate the volume of a box, how to do Pythagoras theorem. So we, the main use when I first started teaching was ah, was for as a teaching tool.

I: So you'd use it to teach kids?

P: Other things, yes. Other things and that's when the Apple II first came on contract why it was a big hit. It was, not only could you teach contextually, you could teach visually because of the graphics involved,

I: So it was mainly visually?

P: Yeah, for example if you wanted to draw a histogram, all the Canon Canola could do was print out a row of asterisks for you whereas on the Apple II we'd draw a coloured histogram for you so the kids got motivated and that sort of stuff. So we mainly used them, the, I think it was late 70's that computing was actually part of the mathematics syllabus.

I: Yeah, I remember I was in the sort of exam FORTRANS used in the HSC exams.

P: No. I don't remember FORTRAN ever being used. If anything, would have been used, would have been BASIC.

I: Oh okay.

P: Because that's when the microcomputers came out. That's what was available. Now the FORTRAN, the only schools that would have been doing FORTRAN, would be I think, those schools didn't have micros but had what would have been called mini computers back in those days.

I: What's a mini computer?

P: Well that's where you've got one computer and you've got dumb terminals serving out of the computer. So there's no processing power in the screens. All the processing power is in the computer and the terminal is like a window onto the computer, you know.

I: That's interesting.

P: There were at that time too, I'm just looking through here for example, there were two main avenues for the teaching of programming in schools. One of the programming in schools um, method was in that what was called the balance of the course where in Years 9 and 10 back then um, you had your core, which was tested in the School Certificate and then you had what was called balance of the course and they were optional topics. And I've got a booklet here somewhere, as we go through it I'll dig it out where we actually taught programming as balance of the course and I actually went to a um, this is late 70's, this was before I went into Head Office, that we, and it was done by …..? -- I can't remember now, who was the Mathematics Education consultant of the state and he was running this Balance of the Course. So the teaching of programming was in Years 9 and 10 at those schools who can handle it. And the other method back in those days is what was called Other Approved Studies. What would happen is you'd have your courses that were developed by the Board of Studies and they were the ones assessed in the HSC but schools could put up other courses if they wanted to. And they would have been locally assessed and all that sort of stuff but the Board would say "Well you can't just put up any course. What you've got to do is submit the course to us and if it's got the rigor that's required for the HSC, we will approve it". And back in 1980 they published a list of Schools and what other Approved Studies and…

I: So the school would set the course?

P: Yeah.

I: They designed it?

P: Yep, yep.

I: Do you know about how many sort of…?

P: Here.

I: That’s in there?

P: See all these pages? Yeah.

I: That’s a lot.

P: I don’t know whether there’s a number on it? Nah.

I: How many schools designed a complete course?

P: Well, well what have you got here? About 60 per page.

I: Something like that, a lot.

P: Yeah there’s one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-five, twenty-six, twenty-seven, twenty-eight, twenty nine.

I: About thirty.

P: We’ll say thirty because of these are two lines. Some of these are one line. So say thirty. One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-five, twenty-six, twenty-seven. That's 81. 81 schools put up their own courses.

I: There'd be more than 81. 30 a page.

P: Oh yeah, sorry, yeah.

I: 4800. 600 810…

P: Sorry it's not 27 times 3, derrr. Maths teacher. Yes 27 times 30. Yeah you're right. So it's 810.

I: Do you know if they collaborated, the schools?

P: Oh they would have. They would have cause um, you know, um that's where that the networking amongst the Maths teachers used to be. You know you'd go to a Maths Conferences, over a couple of beers you'd say "oh look, I want to put a Other Approved Study in, do you anything?" or each region back then had it's own Maths Association and they'd have monthly meetings, so the exchange and flow of ideas. So the back in those days we had for example, we had Molong Central and Nowra High had calculating devices and calculator studies. So I don't know what they were. But you have here um, one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen fifteen, sixteen, seventeen, oh more, look.

I: It's the whole page.

P: Yep. Even across to here. So you'd have a, well that's thirty we said. So that's thirty-five, forty…

I: So that's not computers…?

P: No, no, no this is, that 830 and…

I: General or…?

P: Yeah that 810 was all the Other Approved Studies. Right. Including ceramics, child development, computing, so on. So.

I: Okay. Maybe about 40.

P: Yeah.

I: I don't think they can do that today, can they?

P: Yeah I think they can. I think they can.

I: Oh really.

P: But there's a like, in Computing you wouldn't do it anymore because Computing's well covered off these days which you've got your um, IT – that's your Information Technology which is a VET subject. You've got IPT, which is Information Process and Technology. You've got Software Design, which is actually coding. The others aren't. Um, IT is more about hardware. IPT is more about processes. You've got Software Design um, and you've got Computing Awareness, which is just the general use of a computer. So the computing side is well covered, so you wouldn't do it. And the same as, the computing has disappeared from the Mathematics curriculum too.

I: Oh right.

P: Well you see it's a process of evolvement. Um, we use it a lot but we use it predominately for teaching purposes. We didn't use it for the predominately of teaching programming, though we did teach programming. So now we have subjects in Years 9 and 10 called IST which is Information Software Technology and multi-media so for those kids who want to learn programming can. And that means that there's a focus on using the computer for, for the teaching of and as you know in Year 9 and Year 10 every kids got a laptop. Right. And um with my Year 10 for example, I spent the first term using a package called GEOJEBRA, it's a graphics programme, an amalgamation of geometry and algebra. It's free.

I: Oh that's good.

P: Yeah it's open sourced. So it's free.

I: Is that now, it it?

P: Yeah.

I: Oh okay.

P: So it's on, every kids got a laptop on it.

I: Actually I have two questions about something you said very early on.

P: Yeah, go on.

I: One's about the Canola. Can you tell me a bit more about it? How it worked and how big it was?

P: Yeah. As you can see it was a big clunky thing. Look at the keys on it. All right. And you had um,

I: Yeah they're big. Does it have the whole alphabet on there?

P: No, no alphabet. It was all codes. So every instruction had it's own code. Like a plague jump which is indicated at the beginning of a loop, used to have it's own code, 107. And so what you'd do you would using these blue pre-punched cards punch out the codes that, that you want. So you know if you look at um, yeah there's an example of a programme. Ah what does it do? Noughts and Crosses.

I: Oh. So you can play that? Noughts and Crosses.

P: Well some of these programmes are very rudimentary Noughts and Crosses strategy you know.

I: So do you play on the computer, Noughts and Crosses or do you play it different?

P: I think this one wouldn't have been, would not have been intelligent enough to be able to give it any strategies cause remember it was a very, it wasn't a computer it was a programmable calculator. Right, so and it had some limitation because it was a calculator not a computer. It was a calculator. So what we would do for example, some of the maths topics like um, one of the favourite ones I remember back from those days is like um, the limiting series, the limiting sum of a series. So that when each term in the series gets smaller and smaller and smaller the thing approaches a certain value but never gets there because each value is getting smaller and smaller. And it was great to be able to programme a limiting sum and say, "Okay for this series give me the sum to ten terms. For the same series give me the sum to twenty. For the same sum, you know". And you could see like the first ten, it'd be getting close to a certain number and then if you take the next twenty it's getting closer and closer to that. So you could teach concepts like that.

I: So it would be generally as a teaching tool?

P: Yeah, generally as a teaching tool.

I: But you did, did you say that you would use, people would use it say for programming in the main?

P: Yeah, yeah we would teach programming but um, only to the better able kids because you want to concentrate on the curriculum for your lower ability kids. So the, in a lot of cases still your better ability kids could do the programming for you. You know if you say, for example, write me a programme that ah, calculates the compound interest over 20 years um, where the interest is paid monthly, the interest is paid quarterly, interest is paid yearly, you know you can do that. You can say to the better kids write me a programme to do it and then let's analyse the results whereas for the lower ability kids you'd say "Feed these values, like here's the programme, feed these values in and now let's talk about the results". [0:20:14.9] based on the different abilities you would do different things. Okay.

I: Could you call it in the sense, I'm just thinking in my way sort of an evolved calculator to computer [0:20:29.7]?

[SPEAKING OVER EACH OTHER]

P: Oh yeah, the next step. It was the next step. Um, because of this I think that when the computer was first placed on Government contract, that caused the quick take up because I think a lot of people who were using these, just moved, saying "Oh great", that was good, you know. Because I remember one game that we play was that um, was a moonlander using this where you'd feed in your acceleration and how long and then it would give you a printout of how far above the ground it was and what velocity was going. So you know, the printers going chug, chug, chug you know. They'd feed in more. Well the very first thing we did with the Apple II we made it a real simulation. We actually had a rocket coming down and if you gave it unique ignition sequence of some sort it would either move up or slow down. You know, so.

I: Yeah. Was it very mathematical? Like you'd use sort of equations and that?

P: Yeah.

I: Um, the other question I wanted to ask was about the regions. You were mentioning that the conferences were regional. I just wanted to ask you what sort of regions were involved? If you knew that.

P: Ah the problem with regions is that they keep bloody changing how many they are. I think when I first started, I think there were 12, 12 regions. Um, and…

I: Is that in NSW or …?

P: One, two, three, four, five, six, seven, eight, nine, ten. Okay so there were ten. Oh yeah when I first started in the 70's there were 12. Then in the 80's they cut them back to ten. All right. Now the ten regions are geographical spread. There were um, four I think in the metropolitan area. There's metropolitan east which was um, based around Parramatta. No metropolitan east was based around here, that's right the St George area. Now there's metropolitan west, which was based around Parramatta. Then there was obviously North Sydney, which was all not just North Sydney, it used to go up to Gosford, I think. Um, yeah so what's that? One, two, three oh four because there, there was Liverpool region. All schools out that way. So there were four um four city and six country regions and they were like based on the Hunter, um, Riverina, South Coast, Western but how much money was actually spend upon In Service was a total regional decision.

I: Oh the whole regions together?

P: No, no each individual region. Yeah so ah the Maths Teachers Association would always get funding from the Liverpool Region every year. Um, some of the other regions had there own Maths conferences. Probably not as big but yeah.

I: Okay maybe I should move onto one of the next questions.

P: Okay.

I: I'd ask you which one you think we're up to because you've answered…

P: Let's see. Okay some of the problems.

I: Okay that's a good one. What were some of the problems?

P: Mainly was software.

I: Software.

P: Software. If you look back to the early days obviously the Canon Canola there was no software. But that was okay. That was the way it was used. But when the Apple II came along the only and this limited the spread of it too, the only software that you had was the stuff you developed yourself. Right. And when the computers first came on, when the Apple II first came on you didn't have disc drive. Disc drives weren't invented then.

I: Yeah.

P: Right. There was an um, there was one disc drive for the Apple II. It held 10 megabytes, not gigabytes. Not like that thing over there which has got 500 gigabytes in it but megabytes and it was this big and if you turned it on it sounded like an aircraft carrier. It was the noisiest thing but anyway but the problem, so when the computers first came out, it was cassette storage. The programme was actually an audio on a cassette and then you'd have to load it and the problem became if the programme took more than about two minutes to load it usually fell over. [0:25:31.6]

I: Oh right.

P: Because audio, if you remember back to when Kirk Telecommunications first started when they used the old acoustic coupler, again because it was acoustic, um, it wasn't super reliable. It was when the modem came out that things became more reliable. Anyway back then, so the only software you'd [0:25:55.8] for your Apple was the stuff you developed yourself. I remember back in the Maths conference days we used to sit up to all hours having a few beers and copying each other's software. Yeah. Someone would say, "I've got a programme I developed to do this" and you'd say "Oh great can I have a copy of it", "Yeah, yeah here you go". "Now what have you got", you know. So these conferences became about swapping software. Obviously the main issue became um, software and when the software did first come out for Maths it was horrible. It was absolutely horrible. It was the old CIA or CAL they used to call it. The Computer Aided Instruction style, right, question, give me an answer. Wrong, here's the question again, give me an answer. Wrong here's the question. So all it was, was question and answer…

I: No instructions?

P: Nah.

I: Really?

P: Yep.

I: So when did that begin to change, to start to change?

P: Oh it started to change gradually. Mainly at the behest of teachers who just wouldn't take a bar of it. They were saying, you know, here we've got this great technology and you want us to do more practice, you know.

I: So what was the potential of the Apple?

P: Mainly because of the graphics.

I: Yeah.

P: You know. It had colour, it had graphics, it had sound. You know.

I: What sort of colours did it have?

P: 256.

I: Oh yeah. The first ones?

P: Yeah. Yep.

I: Oh that's good. Okay, what was some of the benefits?

P: Oh the same benefits that happen today. Increased participation of the children. Um, improved learning outcomes. Basically it hasn't changed.

I: And um, do you know much about the policies? Can you tell me about the policies?

P: Well like I said it comes back to the Computer Education Policy statement.

I: And I do think I have a copy of that so.

P: Okay, which dictated the use of computers in schools. But…

I: Did the schools follow the policies?

P: Oh yeah, in their own way. Of course they did. In their own way. Everyone did their own way but more importantly this thing was, computers in schools was a schools driven thing. Even before the department started acting in the middle 80's, schools were crying out. They were saying, "we've gone as far as we can go, we need to go further and we can't based on our school resources". And that's when the Government, oh not the Government, the Department of Education started acting on it. They said, "Right, okay". But they said, they didn't mandate to schools that this is what you have to do but, they did give an indication that this is how they will develop resources around these areas. And so it just meant that schools went well if we're going to be given these resources based upon these principles we'd better sort of come along with it otherwise we will still have to maintain all our own stuff.

I: Would you know, this is just a general question that I've been thinking. I haven't asked in the sheet but um, would be able to give a general of when computers actually started being, when they first began to be used in schools? I just….

P: Well 1980, I think it was 1979 was when the Apple, well you look back through this. This is in 1980 the Apple II went on contract I think in 1979 but you'll notice for example that this school here, in New England had two Apples. Right. But this school here had a PDP 11.

I: Is that a different…?

P: Oh that would have been more powerful than that. Now the only way, not the only way, sorry, just being pedantic but they probably got sponsorship. Because I know that when the school that I'm at, that, that used to be a, a school sponsored by Prime Computers and Prime donated all the computers to the school. Right. So they had a lab of Prime Computers um, donated by Prime. So some of the schools started off in the late 70's, but you wouldn't have had prior to the Canola you wouldn't have had anything in schools. But you've also got to realise that, I don't know whether it's coincidence or not but in the 1970's is where the Baby Boomers came through and all started teaching, all the people around about my vintage. So we were all young. You know all in our early twenties and here is something that's come along. And now prior to that I don't know what the average age of the school population or the teaching population was. So you've got in the early 70's you've got a bunch of young keen people coming through. This started presenting itself to us and decided to see the sorts of things that we could do with it and even to this day um. I, I now teach programming because I teach both Maths and I teach Computing because I'm Head Teacher of both at the moment. And I even looked around ah, when I had, I just come across a programming language to teach my kids, I had a look around and everyone is using Visual Basic and I can't stand Visual Basic. I think it is an unprintable language. So I went searching um, for a language. I found an exceptional language called Scratch, ah of which three four years ago I would have been one of only about twenty people in Australia using Scratch. Now there's, there's quite a few hundred people. I've been lecturing at Macquarie Uni, an In Service course there. There's a whole pile there. Computing Studies Association has just taken Scratch on board.

I: Is that a really good programme?

P: Yes it is. For teaching of kids it is bloody excellent and it's free.

I: Yeah. Wow. Incredible free.

P: And then my girls went from 9 to 10 into eleven and twelve, I went looking for a senior language, ah that would be very similar and I came across ALICE and I'm one of four people in Australia that run, that do ALICE at high school. So, yeah if technology is there and it's exciting, with some of these kids I teach, are much better programmers than I am and some of them are heaps more creative than I am, that's for sure.

I: So just a question, before I continue, ah, that was interesting though but a question about the Canola, when did that actually begin? So I can get a date on it.

P: Yeah I'm just trying to think. It was in my early years of teaching, very early. Let's have a look. Sorry, ah, first published 1975.

I: 1975?

P: This was published in 1975. So I would have thought that it would have been 74.

I: That's a good rough date to use.

P: 74, 75. It would have taken Ted, who developed this a while to develop the materials, the problems and probably would have tested it out with his kids ah, before publishing a book so I would say it was published 1974.

I: Okay. Ah, tell me about the practices of that time?

P: Practices, what do you mean by practices?

I: Um, I think you talked about that already, didn't you?

P: About the uses?

I: Yeah you could say uses or practices, sort of same thing.

P: Yeah. Oh well basically the uses were for as a teaching aid, um, for the teaching of programming. Programming wasn't taught very, one of your biggest problems of course and even to this day people whinge and complain about it cause it still hasn't gone away, is how do you manage one computer amongst 30 kids. Secondary school teachers don't seem to be very skilled in multi tasking, getting different things. They all like people to do the same thing at the same time. Primary school teachers are heaps better in terms of multi tasking, having one group do this, another group do that, another group do that and that sort of stuff. And of course the Canon Canola wasn't too bad because it had the punch cards and there was a way that the kids could go home write a programme, prepare a programme, come in the next day and run it through. You know, so we'd use the Canon Canola up the front of the classroom in the middle and the kids just walked past and wiz there programmes through and at lunch times they would come up and do it. So, but…

I: Is it true, oh sorry.

P: No, no. I'm only rambling so go on.

I: Is it true in the early days Canola, the Apple there was only probably in the school one or two?

P: Yeah oh yeah. Well you've got to, the price of these bloody things um, back, I bought my first Apple II in 1980. So I bought a computer, um, I don't know whether you've ever seen a dot matrix printer.

I: I think a long time ago.

P: Very cheap and nasty. Actually if you go to um, Harvey Norman they still use a dot matrix printer.

I: Yeah?

P: Yeah as a receipt printer.

I: Oh okay.

P: They're very noisy and it's made up by dots and they were very cheap back in those days. By very cheap I mean $800 for a printer. Right. What can you get for, I bought my wife a laser printer for, for her birthday one year. The laser printer was um, 8 pages a minute and cost me $4,500. All right. So what my long winded response is, is that when I first bought my Apple II with a green screen, ah and a dot matrix printer and a disc drive, ah and 64, no 48 K RAM, that's right 48, after I bought it Dick Smith had a special on where I could buy 16 K RAM, 16 K of RAM for a $100. Oh this was great news so I could take my computer to 64. It cost me all up $3000. Okay back in those days schools didn't have that sort of money. Now back in those days, there was also the Commonwealth funding called Disadvantaged Schools. Now your disadvantage schools, the school I was at was one of the, we could afford one computer and hope that every year that we would get another one, you know.

I: Was $3000 a lot more back then than it is now?

P: Took longer than three grand. Like three grand back then, like twenty years ago is what? Six, seven or eight who knows? With inflation over that time because oh, I'll give you an example. Um, my, because I remember to this day, I started teaching 1973, my annual salary as a teacher was an annual salary of $5,200 a year. Right.

I: Compared to today that's peanuts.

P: Well I think a starting teaching now is on 35 or more.

I: That's value also has changed.

P: Yeah, so the reason I remember 5200 is because I remember ah, I'd be earning $100 a week. Right, now when I was on scholarship, Teachers Scholarship, my last year of Teachers Scholarship I was being paid $48 a fortnight and I paid rent and food out of that.

I: Goodness.

P: Yeah, so $3000 was a lot of money.

I: I might just see if this is working.

Interview with Interviewee 8 Part 2

(I: Interviewer P: Participant)

I: Okay continuing at 4.20, continuing the interview with Interviewee 8. Um, I will ask, some of these questions have already been asked, um, do you think there's anything more to say about how it developed?

P: How it developed over the years?

I: Yeah. Do you have anymore to add?

P: No not really. It just that, just the process of evolving, I know that for example that the biggest boost came, I think was it the middle eighties when the Commonwealth got involved, and the Commonwealth made funds available and that helped with the establishment of the Computer Unit in NSW which helped ah, develop resources for schools.

I: So the Computer Education Unit was separate from the Commonwealth?

P: Funded 50/50.

I: In the middle 80's? After it developed?

P: Yeah. So from about from about 85 to around about 90 and this, and this is some of the stuff that the Computer Education Unit developed, stuff that people could use in the classrooms so there's your overhead transparencies. So you can just wiz them through a photocopier as an overhead transparency.

I: And I would type this in on the computer?

P: No, no what it is, is um, these are activities…

I: Logo.

P: Logo, right. So that's Logo. This is the one of the documents that I was involved with, was we um, by a guy, who was it, Bruce McKendra I think, developed a language called Programmable Turtle which is um, how do you…

I: Did he develop it?

P: He developed it. Yeah. Um, it was based on Logo.

I: So that was developed in Australia?

P: Yeah it was developed by, it was developed by ………………….. I held a workshop up at Blackheath back in the early 80's and I challenged the guys to come up with some materials that could be used for the teaching of computer awareness or for student studies or whatever. And so therefore, um, they went off and developed a whole pile of materials about computer awareness and those four guys developed the, I forget who actually wrote the original programme, but it was a mess and they had to redo it. So those four guys re did it and what it was, was just a little, a little turtle a little shape on the screen that you could give commands forward, backward, very rudimentary Logo. Very rudimentary Logo. Because Logo was out at that stage but it was very expensive for schools and schools were not super convinced.

I: Do you remember what price it was?

P: Oh 150 I think.

I: Yeah.

P: And so.

I: They weren't convinced?

P: They weren't convinced so one of the things we did, what I, I did is that, I got them to develop the language and I then did these worksheets and then the programmers made, this publication was sent to all schools and the programme was made available um, through yeah, see that's a reprint, 1985 reprint, so I must have done this around 1983. Um, yeah April 81, yep.

I: 81?

P: Yep April 81 because I was appointed June 1980. So early 81 and it had a section on the support material, it had a section on programming in Basic and this had um, "here's hope the programmable turtle will be of use in the teaching of computer awareness by being a simple and easily operated language". And we had fun. And then of course, here's another example.

I: An ideas book.

P: Yep.

I: It has a lot of stuff in there.

P: Yeah, yeah they were quite, the computer education was quite prolific in this publication.

I: So what sort of level was this at? Was it at, did it focus on the secondary or it was 12 years?

P: Yeah, but, but there were, this computer awareness stuff and the, this is all pitched at the secondary but they did also did develop primary school materials as well. Okay. Yeah here's an example of a handout that made up in 1976 and it was an In Service on Canola as a teaching aid. Um, function machining, how you know, do functions and what's this one?

I: So that would look at particular functions?

P: Yeah.

I: And you would get the solution to it?

P: Oh yeah here's "changing any number from any base on number base".

I: Oh okay.

P: How to find the mean, the mean, the variance, the standard deviation of a set of scores, ah sum of a GP. So these are the sorts of things that we were doing with the Canon Canola and that's back in 76.

I: How very interesting.

P: Oh here's one that I did in 1975.

I: It does go back.

P: To use Canola Games. What game? Target.

I: Did many people use the Canola?

P: Yeah. Well I know in the Lithgow region it was used a lot. And I used to also know that, oh here's an overhead transparency of a punch card that they used to use. Oh this is an overhead of a keyboard.

I: Wow.

P: Yeah. So yeah it was used a fair bit. Oh again this is your Lego. Oh yeah and one of the things that we did, I just remembered now, is um, we, we ran retraining courses for teachers.

I: Retraining?

P: Retraining. We used to take Maths teachers, oh not just Maths but they turned out to be predominately Maths and we put them through a 12 week training course, full time paid by the Department funded by or staged at the Retraining Unit which is in Leichhardt. One of the things we used to do. We did a whole pile of things but one of the things we did was um, sessions on programming, on how to teach programming. Right. Um, and the language I used back then was Atari Logo.

I: When was this?

P: This is going to be early 80's.

I: Early 80's.

P: Early 80's.

I: That was at universities?

P: No this was at the Department of Education Retraining Unit.

I: Oh okay.

P: Based in Leichhardt there's a school that's not a school anymore and the Department runs a retraining unit there. Where for example now, I think they're retraining teachers to become Maths teachers. Saying anyone who's got an interest in Maths, so whenever there's a shortage in a particular area, they'll put together, they'll retrain other teachers to become whatever faculty they want.

I: Can you tell me something about programming and the various languages used in that time period?

P: Ooh well, the predominant one obviously was Basic because for the Apple II or even the Apple that's the language that it came with.

I: Was that the only language it came with?

P: Yeah. Yeah. I do know that when um, when I did my post grad work in middle 80's, that they made me do machine language.

I: What's that?

P: That's where you code directly to the machine in bits and bytes and all that. No language used.

I: Is that hard?

P: Yeah. Yes. Oh no not hard really depends whether you're a programmer or not. Because the truth of the matter about programming and if I get on one of my little pet subjects, is that once you understand what the basics of programming is and you then just have to look at how does the language you want to use, does it. But the rules are the same, you know structures are the same for each language. And it's the same when I came across Scratch and Alice that it didn't take long to get the gist of how it, of how it goes. And of course the greatest thing about programming is that I don't have to be a wiz a programming anymore because the kids are.

I: They're good?

P: Yeah. And if a kid isn't, like I remember with Alice, I started teaching Alice to the kids and I came up with a whole series of PowerPoints to teach Alice but there were kids there that know stuff that I don't.

I: About Alice?

P Yeah because I've shown them something and they've stopped and played and discovered other things that I didn't discover because I didn't stop and play. I just want to get certain things across. So, every time I've taught it there's always been kids that have been better than me.

I: Yeah. Were they really basic?

P: Yeah. Oh Basic was probably not imaginative enough. Basic was cold logic and probably as a Maths teacher…

I: Could you do much with it?

P: Oh yeah, yeah. Poor mans FORTRAN basically. Um, it was supposed to have been developed, what does it stand for "Beginners, All purpose, Symbolic Instruction Code or something, so it was actually developed at the college level, so, yeah.

I: And did um, as other computers became more popular, did other languages come involved in that area? Like IBM sort of get involved?

P: No when IBM first came out…

I: Did they use a different language?

P: No, Basic, Basic. Like I said I had to do machine language. I also had to do a language called PASCAL, which was a pain in the neck language. I had to do another…

I: Do you remember when that was?

P: In the middle 80's when I did post-grad at Mitchell. Um, I also had to do PILOT.

I: Is that a language?

P: Yeah. Yeah I did [0:12:40.6] more of an authoring tool for computer assisted learning but I think at the moment, at the moment there's a whole swag of languages out there. There's PYTHON that a lot of people are using.

I: Is that now is it?

P: Yeah.

I: Oh okay.

P: There's Real Basic. So Basic is still around.

I: Real Basic?

P: Yeah. Then there's Visual Basic. If you ever, one of my biggest problems is that when I try and find a language, I went onto Google and I Googled programming languages. There's thousands of them.

I: Really but back then there was only about one.

P: Yeah.

I: What a change. What a change. Ah just a question I was thinking of as we were talking about the IBM, um, in an article I got, it talked about how a lot of schools in 1985 of that same percentage, a few percentage were sure of the Apple schools, there was a Micro B, have you heard of that?

P: Yeah, yeah the old Micro B, yeah.

I: Can you tell me anything about it?

P: It's Australian developed. Built by a bunch of high school kids.

I: High school kids?

P: Yeah.

I: Wow.

P: Owen Hill was the, was the owner of Micro B and um, I think Owen was the um, and he had, he worked out of his house at Gosford. He worked out of his garage. I think being developed by high school kids is an over simplification. I think Owen built the thing, designed and developed the thing and we [0:14:33.3] at the same time sell kit computers. So you could put together your own kit compute and then the guy I used to share a house with he, you know, he built a kit Z80 and that's how I meant Owen and that's when the Micro B came out.

I: So you could build a computer from a kit…

P: Soldering iron or…

I: Yeah. And he built the Micro B from the kit?

P: No, no I think he designed it around, I forget what the processor was. I think it was a Z80 processor. So and he used to have high school kids dropping in on weekends and after school tweak it and that sort of stuff and it was very scary to find all of these teenagers running around speaking a language till this day you would never understand properly.

I: Was it an effective computer?

P: Oh it wasn't too bad. Wasn't too bad.

I: What was better, the Apple or the Micro B?

P: Oh, Micro B was better in some ways, like for example it had a CMOS RAM. It had the RAM with the battery backup, which means that you can turn the machine off and you don't lose the contents of what's in the memory. So that was better.

I: But the Apple didn't?

P: No.

I: Oh okay.

P: The, Micro B when they first came out, only came out with cassette tapes whereas the Apple very quickly came out with disc drives.

I: Is that the square floppy ones, do you mean?

P: No before then.

I: So what sort of…

P: Have you ever seen an audiocassette?

I: Yeah, yeah.

P: That.

I: Oh okay.

P: An audiocassette was used.

I: I mean the disc drives for the Apple?

P: Oh they were, yeah took the big black…

I: The big black floppy thing. Yeah.

P: Yes.

I: Yeah cause I remember the cassette drive for my B20.

P: Oh yeah.

I: Yeah. What were the advantages of the Apple over the Micro B?

P: Oh the graphics were slightly better. Um, just the different layout. The keyboard was slightly better. A lot of primary schools went for the Micro B because it was cheaper and um…

I: And what phased it out because it's not really popular now? It sort of went out.

P: Yeah I think, see what happened was each year the computer would release specifications of what they wanted each computer to do and only those that measured up each year. Like just because you've got on one year doesn't mean you're going to stay on for perpetuity, right. I don't know whatever happened to the Micro B. I'm just assuming that either a) the company folded or b) it couldn't keep up with the revised specs. I'm just purely guessing.

I: Who set the revised specs? Do you mean like Apple got better and better or do you mean someone like actually set the revised specs?

P: Someone in the Department used to set, to specify what the minimum requirements it expected from a computer.

I: The Department of Education? Oh interesting.

P: Yeah.

I: So if you had an old computer do you still use it? Or do you get rid of it?

P: No, no, no.

I: But you've got to get a new one with the revised specs?

P: No, no, no. Revised specs just affected your future purchasing guidelines. In other words um, if you want to get the one that's the latest you would go to the Government contract and if it was on Government contract, in most cases the think got superseded anyway because you've got things like, like I remember the history of the Apple - you had Apple, you had Apple II. Now you could um, I remember when the Apple II came out you wouldn't buy an Apple because the Apple II was better. Then the Apple 2E came out. So you could make modifications to your Apple 2E, II to become a 2E. So you could buy an Apple II and modify it to be an Apple 2E but and Apple 2E was cheaper than a modified Apple II. And then there was the 2C, there was the 2GS. Just basically there was evolving and so you don't go back. Even to this day. You're faced with a computer, a new computer and a computer that is three years old what are you going to go for?

I: If it's cheap.

P: Yeah, well they have to come as cheap.

I: So the Apple had a 2C before the G?

P: Yeah.

I: I didn't know that. What was after the G? Just the Mac.

P: Mac I think.

I: Yeah.

P: Oh the Lisa was in there somewhere too.

I: The Lisa?

P: Apple Lisa was in there somewhere. The biggest flop ever known. Biggest flop. Yeah I think there was the 2C and then there was the 2GS.

I: So it wasn't just the 2G it was the 2GS?

P: I think it was the 2GS, yeah.

I: Oh okay. Yeah that's good to know because I have to clarify that. Yeah.

P: I'm quite sure if you go onto the history of computing, it would be there cause I stumbled across the website the other day that has every Apple TV commercial that's ever been show. Even back in the 80's.

I: Oh wow. So they keep them all together. Oh okay.

P: Can you stop it there please?

I: Oh sorry, sorry.

Interview with Interviewee 8 Part 3

(I: Interviewer P: Participant)

P: One of the other things we used to do back in those days is programmable devices. This a big truck which was a tank with a programmable pad and you could tell it to go forward or go back, turn left, turn right. This is what we used to do with the kids is create an obstacle course around the classroom and the kids would then have to plan the track that they would make.

I: They'd plug it in on the device or whatever?

P: No, no it's all keypad. So what they'd do is they do their planning on a piece of paper and key in their steps.

I: And then they do GO or something?

P: Yeah.

I: Oh okay.

P: So, yeah so it had a forward, this was its keypad -- a forward, back, left, right.

I: Also numbers. Um, oh we're nearly finished. Um, well this is a, I might leave that one until the end because it's a very general question. These two last ones. I might go onto this one about the focus. Was the focus, I have no doubt that it was, um, how quickly, maybe I should ask that. Oh that's a card?

P: Yeah.

I: So you would, you would sort of put this in and…

P: Yeah into the card reader.

I: And then you'd programme something and then it would put the dots on there?

P: No, no you walked around with an open up paper clip and you would punch out…

I: Holes.

P: The required code.

I: Oh, very interesting.

P: And here for example is a programme I wrote…

I: So that's a Canola.

P: Sum of an AP you keyed in um, AD and N and it will give you the sum or an arithmetic progression.

I: Wow.

P: Sorry what was your question?

I: Oh about Maths, how quickly or when or how quickly did the focus get taken away from Maths as it became more applicable to other subjects?

P: The departmental focus was never on Maths.

I: Never?

P: Never.

I: How did it, like how did, what got Maths into schools then, Maths for computers, was it the teachers?

P: Yeah.

I: Oh. So like a general consensus or…?

P: I just think it was the nature of the Maths teacher. Problem solving. Computer programming is problem solving. So your Maths teachers, maybe to some extent, your Science teachers would get involved. But your creative arts people, no. Um, so I don't, the question is a little bit difficult to answer because the focus was never on Maths but, but…

I: I didn't actually know that; consider that adults never focused on Maths. It's always seemed, like you read from books and you, you know….

P: Yeah it depends on you determine what does focus mean. Now if focus means you are doing it for Maths and only Maths, then that was never the case. All the other people were support. It was only the Maths teachers who put up their hand. So to some extent and purpose it would seem that it was being focused on Maths. It was only because that Maths teachers were driving it. Even if I look now on the mailing list called the NSW Computer Mailing list, I'd say 85% of them are Maths teachers. Most of the people who are programmers in school come from Maths. So to some extent that could be interpreted as the focus is on the Maths teacher but what's happening, like for example these days one our biggest users of computers is the [0:04:33.1] stuff…

I: Because of the graphics?

P: Mmmm.

I: Yeah. Is that with Maths as well or is that, oh you mean, cause you do Maths and Computers don't you? Do you mean when you do computers, the biggest focus is on graphics?

P: Well no it's um, the Creative Arts…

I: That's what I meant, Creative Arts.

P: We've put a computer lab into Creative Arts and they use it a lot. They use it for image editing, image manipulation, photos, movies they make movies and that sort, so their biggest thing is the graphics side of things. Um, we've got a lab in Social Science. Their biggest uses are PowerPoint for presentation purposes and the Internet for research. So and the Maths teachers continue to use computers the same way, the same way they have before. So the focus is not moved from Maths. It just means that all these other are coming in because the computers, they are now uses for them. See it started off in Maths because, if a Maths teacher didn't have a programme to do something they would write a programme to do something. And to teach programming you don't need much software because the basic is there. But if you want the kids to use the computer in English there has to be software around. So that's why it started off with the Maths teachers and probably continues with the Maths teachers but there was never like a, I, it depends on how you define focus. If you think that…

I: No I know what you mean.

P: If you think of an external focus on, no but yeah there was focus on because they were putting their hand up.

I: Is it still there the focus? Like did it go to the, from the 70's, 80's, 90's was it the same?

P: I think what's happened is that they talk about the use of computers in Maths less.

I: But it's still there?

P: It's still there.

I: Yeah.

P: Um, all my lessons, nearly all my lessons are for mathematics and nearly all PowerPoint lessons where I've done the research and done some animations. So um, I teach with a Smart board and a data projector and um, I know all my senior lessons are on PowerPoint. So I'm still using the computer and I'd do one of the things, one of the projects that I give my junior kids is that um, here's, you've been given $50,000, you are to spend it and you are um, you're allowed to spend it say 25% in Australia, 25% in America but 50% has to be Europe and when you spend money, so you create a PowerPoint slide of what you're buying with a picture of what you're buying with a price of what you're buying and how much money is left in your budget. So they then have to do the Internet research. They then have to do the PowerPoint. So, whereas before, predominately it was used for spreadsheets in mathematics, it's still being used in spreadsheets, um, because it's helped on quite a number of topics to be able to drive spreadsheets. But I think um where some of the more spectacular killer results and this is what probably grabs people's attention is in your other areas. In you areas like your creative arts people doing movies…

I: Movies and doing great things…

P: Yeah, movies, animations and that sort of stuff.

I: So one thing I've been meaning to ask and um, um, I thought since we've been talking you might be able to answer it for me is um, what makes computers programming and other aspects of computers so good for Maths, you know, so well for problem solving? Cause I heard you mention that Maths is good for problem solving, programming is good for problem solving, in what way does it develop problem solving? Is it like, how, what aspects of it, do you know what I mean?

P: There's an old computer thing called "Step Wise Refinement" or "Top Down Programming" where you have, you look at a problem then you break it down into it's components and then you solve the components and that gives you the answer to the whole. That's basically what problem solving is. Analysing and developing strategies to implement, I don't know what the academic definition of problem solving but it's basically breakdown a problem and fix it or do it. Um, well that's what programming is all about. And we teach our kids, I've got countless slides saying you know, here's a scenario either draw me a storyboard of how it works or give me the blocks. Now each blocks, in proper programming when you write a computer programme, you just don't write one solution, bang, what you do is you break it down into modules and you then ah, write code for each of the modules and then have a main [0:10:36.3] calls the required modules from time to time.

I: Thank you that clarifies it for me. Yeah. Very good.

P: Now the only other things, cause as I'm talking I'm clicking through. And um, you were talking before about the Micro B, um, I've just come across this documents which is dated – I hate it when people don't put bloody dates on this stuff – oh…

I: Yeah you get that with some older…

P: Oh here it is, 1985. Okay. These, because you, you sparked the interest about Micro B, um, have a look what was on contract in 1985.

I: Oh is that for, is that from the Department of Education?

P: Yeah, these are the models approved in 1985…

I: I might just quickly write that down, is that all right?

P: Yeah.

I: I don't want to bore you half to death with this but, with writing all this down but it's very interesting. It will be very helpful if I get the actual details down. And I notice it has an Apple 2C. So they had the IBM in 1985 but I don't think they were popular back then.

P: I used to speculate on how you would implement them in schools because they had infrared keyboards. So we were speculating of one kid could sabotage another kid's work.

I: So what's an infrared keyboard?

P: No wires. You know like a remote control for a TV.

I: Yeah.

P: So no wires connecting the computing to the keyboard.

I: And this report was done by the Department?

P: Done by the Director of Services.

I:	And what was his name?

P:	….. .

I:	Is that with 2 ‘rs’?

P:	Yeah ….. , yeah ….., yep, yep.

I:	And one ‘s’?

P:	Yes. Now this is what they…

I:	Is that it?

P:	Well no this what they measured the computer system to be able to do. The committee evaluated the computer system on the basis of the following range of applications.

I:	Shame I couldn’t get a copy of that.

P:	Do you want a copy?

I:	Is that all right? Yeah. Thanks I’ll just stop this.

Interview with Interviewee 8 Part 4

(I: Interviewer P: Participant)

I:	Continuing the interview with Interviewee 8 on the 09/09.

P:	Okay the um, the um, you were asking about the method of [0:00:27.0] service?

I: Yeah, how were the Teacher In Service courses implemented?

P: Again, I guess that's all changing because of the Institute of Teachers but basically its done at the regional level. The regions…

I: Like the regions we talked about?

P: The regions determine their priorities. Um, quite a few regions now have ah, curriculum consultants in the various subjects, like Sydney Region has its team of computer people who'll put together courses.

I: Like say the Liverpool one for example, what would it do? Would it sort of do its own, the people in the schools in the Liverpool region would go to a certain area of Liverpool and then the Sydney South West…

P: Would go to their own.

I: Would go to their own. So it was, oh okay, okay. And did they, oh one thing I was interested in because um, I read an article, there's no point bringing it up but if you want me to bring it up, I will, I want to, I was just wanting ask, when you went, did they teach how to implement the technology in the classroom?

P: Here's the B & S mini map manual.

I: Oh okay.

P: You can see how um…

I: What's a mini map?

P: That's the…

I: The little computers?

P: The computer you asked me about.

I: Micro B.

P: Micro B.

I: Oh okay. Is that like a users manual for the Micro B?

P: Yep. Oh classroom management.

I: No just to see. Not classroom, oh what I meant was did they, did they teach you when went, did you teach you how to use it in the classroom, to implement?

P: Yeah well part of the, um, whenever you went to a course there would always be discussion on the best method of use. Even back in the old days of overhead projectors, I remember sessions on effective use of overhead projectors back then, you know. So a lot of it was slow in coming in terms of that sort of stuff because I think people just assumed oh, you're a trained teacher. You know what to do.

I: Yeah but the first In Service course wouldn't show you that?

P: No. No. The introduction In Service courses were more on how to use it, themselves. Not how to use it in the classroom but the instruction was, we had countless…

I: Did they also talk about the actual thing itself? Like this is a disc drive, this is how it's made because I read an article and I just wanted to confirm that's true. It sort of said they talk about the monitor, the hard drive and…

P: I tried whenever I did the things to keep that to a bare minimum.

I: Yeah. Good. Oh okay. So it's not at a…

P: The reason why it's kept to a bare minimum is because you, we never wanted to convey to people that you have to be a tech head to use a computer. Now if you started talking about the difference between ROM and RAM and primary and secondary storage and um, a ten megabyte hard drive or a 20 gig or whatever, peoples' eyes would glaze over. Especially your primary school people because they're not interested in that. It's the same, we've viewed it the same way um, when you jump into a car, you turn the engine on. You don't care whether it's got double overhead cam split system with duel mufflers or, you couldn't give a shit. All you need to know you pour petrol in this thing and check the oil every now and again and it goes, you know. And our view of computing was in the same way. For those who wanted to talk technical, like your computer co-ordinators or the people who wanted to purchase, sure and I used to run sessions on how a computer worked. I used to run sessions on the difference on serial and parallel, you know. I used to run tech sessions but it was never, if anyone just interested in how you use a computer then we stayed away from that. We totally stayed away from that.

I: Yeah, so that thought that was in that [0:05:44.2] article is incorrect?

P: Well it depends what context that person. Maybe he was a, what I call a propeller head.

I: And that's what he's complaining about but he didn't talk about.

P: Yeah. Yeah.

I: All right.

P: It could be his perception of the fact of maybe he was treated that way because he was viewed, or he asked questions like that. Or he could have been in a group that was asking questions and he may have been one outside of the group. Or he could be because these were run by regions in a lot of cases that maybe the regional consultant decided that for their region that they would emphasis those sorts of things. I remember in the very first week that I was at Head Office I received a letter from a Principal from down the South Coast who wanted, because there were three Apple 2E's were given memory configurations and disc drives and that on contract, and he wanted advice on which one to buy. Now there were two ways I could have approached this. One way I could have written and explained um more RAM or I could explain the capacity of the disc drive, but no what we came down to do with them, we said "okay you tell me the sorts of things you want to do and we'll use our technical knowledge to give you a recommendation" and I said if you go somewhere else and they give you a totally different technical recommendation because they perceive your applications or uses differently from the way that we perceive them, you know. So no. So it's just the same as my daughter drives my car, crunches my car, has accidents in my car, doesn't matter, anyway all she knows about that car is how to put petrol in it and how to check the tyres. Now does that make her any less or better driver than someone who can slip under the car change oil or something. No it doesn't.

I: Can you tell me anything specific, oh not that you haven't, sorry that came out wrong but can you tell me a little bit more about In Service courses themselves that you mean apart from, I know enough about the technical ones, what the In Service courses that you were telling me about, um, because I read that article about his complaint, what about the ones where you actually, like did you teach programming in them or did they know programming or?

P: Good question.

I: Was that assumed knowledge?

P: Yeah like, if the audience were classroom teachers who wanted to know how to use computers in their room, programming was never mentioned, never because for a classroom teacher that's not what we want them to do in the classroom. We wanted them to just use computers in the classroom. If, I'm just trying to think, if memory serves me right we never taught anyone Basic. We just assumed that people know Basic but what we did do we'd give them worksheets out on how to teach it. Now whether then put themselves through those worksheets to learn Basic, I don't know. But there was never any specific intention to teach them Basic.

I: So what, the worksheets they would have like questions on it?

P: Yeah questions or stuff they could photocopy that they could give to kids.

I: Yeah. And, what, what sort of things would you teach them in the workshops?

P: Well what's the audience?

I: Not the tech heads.

P: Oh the other?

I: Yeah.

P: A lot of it used to be showing them different software. Um, one of the most popular ones back then was the First Fleet Convict database. They released the First Fleet Convict database on Apple 2E and the Computer Education Unit developed a whole pile of worksheets that were basically lessons that you could use for kids. So you could actually photocopy, you could load the software, make photocopies of the worksheet and hand them to the kids and the kids would then work through the worksheets. So and that's, that's what they were crying out for in the early days. They were crying out for a) the software um, then after that well we'd just heard about this software called Maths Circus for example. Now is it any good? People are asking us to spend 200 bucks but we don't know if it's any good. So the second thing became was when software became available was um, is it any good? So that happened next. There was software and then there was an evaluation, software being published. And then of course after that was the third [0:11:40.6] I've bought Maths Circus, it's a good Maths Circus, um, how can I integrate into my lessons? And so therefore various worksheets and stuff were prepared for people on how, you know, worksheets that you could actually use in their classrooms.

I: Oh that's very good to know.

P: Yeah.

I: Um, we're nearly finished. Just two more questions. The second last one will be, is there anything else relevant to this topic that you could talk about?

P: Ah, no I don't think so. Yes for example here's ah, an example, okay here's an example. You're talking about programming, okay. Here's an example of some worksheets that were developed. Some worksheets that were developed. So let's take a nice simple one at random. This programme below asks the user to input a number; it then prints the number and its square. Type the programme in and run it. Notice how the programme waits for you to input a number. Modify the programme in Part A to also find and print the cube of the number. So teachers could photocopy that. And here are more questions. So the teacher could photocopy this and or teach the…

I: And it starts at an introductory level and it gets more advanced?

P: Yeah and then goes onto flowcharts and that sort of stuff, so. And that was not a part of the In Service course that was just stuff that was handed to teachers you know, if you're interested go for it.

I: That's an interesting question. It's not looking for, picking on, but did it have solutions in it anywhere? Oh okay.

P: Most of the computer stuff doesn't need solutions because most of it's…

I: Yeah it's fairly straightforward.

P: Well no not that straight forward. Inherent in the nature of it is um, like, you see again it comes down to your philosophy on how you teach programming. This is what I like to do is when I teach programming is give the kids a programme that has been started which they then have modify. So first of all they've got to figure out what is the logic of the programme and the second thing is they then have to modify to do it. That means every kid would have a start. Very rarely would I say ah, very rarely would I say "write me a programme to do something" and give a solution. In a lot of cases in a computer programme there is more than one solution. There's more than one way, one logical path. Now you might provide the logical path that you would find but there's no wrong or right. If the programme does it, it's right.

I: I understand.

P: No these are all the first [0:15:19.6]

I: Computer syllabus.

P: God I had hair back then.

I: Who's that?

P: Me. I had hair back then.

[LAUGHTER]

I: Oh.

P: Oh here's a note on the use of computers in the teaching of history. So, yeah 85…

I: It started to get more involved, yeah.

P: Oh here's an example, I don't know why I did this overhead.

I: That one of your overheads?

P: Yeah. Back in 1985. What were are priorities? So workshops on these maths for problem solving, writing programmes special Ed. Oh yeah, special end really took off big time in the middle 80's. Um, teaching computer awareness, use of computers in science, use of computer graphics, use of computer databases, computers in special education.

I: Is it all right if I get a copy of that?

P: Yeah sure, you can have it.

I: Are you sure?

P: Cause I've got the paper original here.

I: You don't mind?

P: No not at all.

I: Oh thank you.

P: This hasn't like; this hasn't been touched for I don't know how many years. I must go through it.

I: So what can you say about the disadvantage students? How was it getting changed in the early, mid 80's?

P: My disadvantaged what do you mean? Why disadvantaged?

I: Oh I guess there's two groups of disadvantages. The handicapped and then there's the aboriginal students that were focused on.

P: Let's take the easy one first. The disability kids first. Just trying to think what I was going to say. It doesn't matter. One, with the Apple 2E one of the biggest selling devices was a thing called, I think it was called Ken:X. I think it was called something like that and what it was, was a large tablet, a pressure sensitive tablet where a kid with a head pointer could tap out the alphabet and that gave the kid, that sort of kid um, input into a computer. So even back then in the early 80's technology was proving a leveller and of course they just got better and better and better.

I: Can you give a rough estimate of when it started?

P: Oh, I know that when the Computer Education Unit was formed back in the middle 80's, one of their curricular consultants was a special ED person. This specifically looked after um, software and hardware [0:19:00.0] to put [0:19:01.1] or special needs kids. So it started in the early 80's and it just progressed since. Now the other one about the aboriginal kids, I don't think, I don't think back in the early 80's there wasn't much awareness of the needs of aboriginals. I really don't know when the Department had an aboriginal education policy but I do know that when the Department was developing the resources for the First Fleet Convict database that it consulted with the aboriginal community in Redfern about any sensitivities that they had for it. But for software that's perhaps specifically targets aboriginal kids, don't know. Don't know. I don't even, see I'm really ignorant in this area.

I: Oh that's okay.

P: Having never taught them, you know totally ignorant.

I: Okay so um, I'll just say this one before, just to get anything left that you might have, is there anything relevant to this topic that you could talk about?

P: No not really. I think we've covered everything. Oh yeah, this one. This is um, I was talking, oh ….. . I was talking earlier about how in Year 10 there was the core and the balance of the core um, and part of the balance of the course was um, matrix and codes, unusual numbers, computing, commercial arithmetic and in the computing balance of the core, this is back in 1976 we covered…

I: So it started in 1976?

P: Yeah so it was just basically, um, programmable calculators that can be used to provide pupils of all levels with an understanding of what computers can and can't do, although the major emphasis should be on the impact of computer in society, there are many ways such calculators can be used to enrich the teaching of a number subjects.

I: So why are they talking about calculators and computers at the same time?

P: Because back in 1976 that was the most powerful thing that a school had. Like there were computers out there, um, but ah schools couldn't afford them.

I: They would used, it's not a synonym for computers?

P: No, no.

I: But you would say, they would use the, are they generally talking about the Canola here?

P: I had one, I don't know if I've still got it or not, or thrown it out or sitting in that draw. No I had another one. I had hand held programmable, I had a Hewlett Packard one. Um, but the Canon Canola was the only one that was placed on Government Contract.

I: Can I be pain and ask for a copy of that comment?

P: Which one?

I: The one you just read out to me.

P: Yeah.

I: Before you do that, saves me from pressing stop on the recording, do you know somebody else who might be able to help with this research?

P: Okay. One of my biggest problems is that I, I was a teacher from 1973 through 80. I was at Head Office from 80 to 86 and I then resigned from the Department of Education and took a break of 14 years before coming back and what's happened is that in the 14 years basically the people I knew have scattered to the four winds. Um, and the same as with the people I used to know at the Computer Education Unit which is where a lot of the work was done. Um, ….. was about the only one, yeah, he's the one who put you onto me.

I: Not ….. .

P: Wasn't it?

I: He's the one, he's actually the one was saying in his article about the courses.

P: Oh was it, was ….. . Yeah well. ….. a bit of an idiot.

[LAUGHTER]

He worked for me um, in the 80's. He was, he was I can see where he's coming from.

I: Was he one of those…

P: He was a primary school teacher and he used to sit around where in the Unit where we would have discussions about hardware issues and software issues amongst the people that understood those sorts of issues or especially around the Government contract was, was released. We would then talk about the hardware merits of the various things because we were interested in both, the hardware and the applications. ….. was just interested in the software which very interestingly, if he's so interested, if he's so turned off, how come he runs [0:25:17.5] computers which sells hardware.

I: What, what was he actually involved in? Because that will give me an idea of where he's coming from.

P: He was an education officer in what team – what team was he in? What team was he in? I can't remember what team he was in.

I: That's okay. So he was one of the, like an administrator?

P: No he was a curriculum consultant in the Computer Education Unit.

I: Before I stop it, I just want to say thank you. I appreciate it very much.

Appendix K

Introduction

This appendix consists of all the relevant information gathered over the years through the various emails and phone conversations that has happened. In the information below, the information is gathered in headings, containing the date of the correspondence (such as an email), and the person with whom the email was taken from, mostly interviewees. For example, with the email below, it is given the heading of “8/2/11 Interviewee 7”, which means that I had received the information from Interviewee 7 on the 8^{th} day of the 2^{nd} month (February) on the year 2011. The dates are in chronological order and the emails are edited to keep out the irrelevant and unnecessary conversation, hence making it much shorter. Some questions have been paraphrased to make the reasoning make more sense.

The Information Gathered from Emails and Phone Conversations

8/2/11 Interviewee 7:

Question: You mentioned when we met that you have the photocopies of the 2 Unit A exams. Could you please check the starting date and the finishing date of those exams.

Answer: I have a 2 Unit A exam paper for 1976, and the year before that (1975) has papers in the “levels” system, so I think that 1976 must have been the first year of HSC exams for the 2 Unit A course.

I am not sure when the last one occurred – I have a 2 Unit A paper for 1981 and a Maths in Society for 1984. Don’t know about 1982 and 1983.

9/2/11 Interviewee 7 (providing further information on above email):

I have found a copy of the 2 Unit Maths in Society Course Syllabus, which says that it is “for introduction into Year 11, 1981”, so that would mean that 1982 would be the first year it was the HSC exam for it, rather than the 2 Unit A. So I would expect that 1981 would have been the last 2 Unit A exam.

14/2/11 Interviewee 7:

Question 1:

Can you tell me a little bit about Fortran? You said something briefly on the interview, but the recorder was not clear enough for me to gather the information.

Answer:

Hi Peter,

FORTRAN, as I understand it, stood for "Formula Translation" but I could be wrong. Basically it is/was a computing language invented (I think) for scientists and mathematicians. It was a standard thing to learn in mathematics courses in applied maths when I was at uni, 1972-1974. You can find out more at

http://en.wikipedia.org/wiki/Fortran

Question 2:

Was Fortran used only with punch card machines or with other types of computers as well? Were other languages use with these punch card machines?

Answer:

Not sure. My experience with FORTRAN was only on the mainframe computers, and we had to use punch cards, as that was the only way that they allowed students to access those computers. This was in the days before desktop personal computers.

1/3/11 Interviewee 7:

Question:

You mentioned that the Computer Education Group "started having conferences and news regulars and things." Can you tell me what you mean by "news regulars"?

Answer:

Hi Peter,

I am sorry I don't know what "news regulars" could have meant. Perhaps it was "regular meetings"?

Question:

Also, I was thinking about the Math in Society subject, and wondered when it ended. If you know could you please tell me?

Also, what replaced this subject?

Answer:

The Maths in Society subject was replaced by General Mathematics. I *think* that the first year of HSC exam in GM was 2001. A little research on the Board of Studies website should help you find that information but if you cannot, get back to me. Try the HSC Archive/Statistics etc pages.

2/3/11 Interviewee 2:

You stated in the document that you were setting up a computer lab in your school in 1984. Did the funding for that come from the government of from the school itself?

- It was funded by the school, which in turn received funding from the government to help it get set up (it was a brand new school still growing).

In what year did you take the LOGO course for the classroom?

- 1986 I believe

What does muMath stand for?

- It was the name of an early computer algebra system which in turn became a program called Derive.

When did Graph Plotters become available and used in your school?

- From when we first started using computers. I always made sure that there was mathematics software, such as graph plotters, available

Can you tell me briefly what the program Green Globs does?

- Green Globs placed random points around a coordinate axis screen and students were challenged to enter the equations of functions to pass through as many of the globs as possible. They could use several straight line graphs, or even parabolas, cubics etc.

You mentioned doing PD, what does the abbreviations PD mean?

- Professional Development

When you say PC, do you mean general Personal Computer, or non-Apple computer, or IBM computers and IBM compatible computers?

- Personal Computer, but, yes, non-Apple computer.

When did the PC become so popular that it superseded the Apple?

- I suspect that Apple never led that market, but they always certainly had a very strong presence in schools. However, this has gradually diminished as Windows computers have become increasingly more affordable, and the quality and range of their offerings has increased.

23/3/11 Interviewee 5:

Dear Peter, This is the best I can do:

Question: In 1972 there was the Levels, do you know what was before then?

Answer: Senior Mathematics courses were classified in terms of Levels with the introduction of the HSC at the end of 6 years of Secondary School. The first HSC examination was in 1967. Previously there were 5 years leading to a Leaving Certificate, with Mathematics I and II (called "double mathematics") with a separate Honours Course in each of these subjects, and General Mathematics. Mathematics III ("single mathematics") was introduced and first examined in 1963 I think.

Question: You mentioned that in 1983 there was a year 10 course which had an optional computing element in all three levels, level 1 (Advanced), 2 (Intermediate) and 3 (Basic). What was this optional element called?

Answer: Optional topics were called Lobes, of which one was Computing and Data

Processing.

Question: How long did that option last?

Answer: I don't know.

Question: I was just wondering whether you could tell me if Maths in Society always had a computing element and if not, when did it stop?
Answer: It was designed with Computing as an option (first examined 1982), but this was discontinued from 1994, presumably because of the introduction of the HSC course Computing Studies.

Question: You told me you did Extensions and Applications courses for inservice courses run to teach teachers. You said what the Extensions coursers entailed, what topics did the Applications courses have in them?

Answer: It was one course "Extensions and Applications" and introduced the participants to pseudo-random numbers, leading to probability simulations; matrices, leading to markbook programs etc.; graphics; creating simple number drill programs etc.

28/4/11 Interviewee 3:

Question: And why did the government put the Apple on contract in 1979?

Answer:
Suffice it to say that from 1971 to 1982 there was a growing interest in using computers across other areas of the curriculum, besides Mathematics. This was a grass roots movement, not driven by official Department policy as such. I can only speculate that the introduction of a more powerful, general purpose microcomputer - able to run general applications such as word-processing, spreadsheets, databases and educational software - was a recognition of this trend.
Question: You mentioned in the interview that there was a bit of a rethink after your presentation in 1981, 82. What sort of ideas did this rethink cause? What sort of effect did this rethink have (with regards to computers in maths)?

Answer:

As I mentioned above, there was growing interest across all curriculum areas, on the use of computers in the classroom. This meant a growing competition for limited computing resources in schools. Mathematics had been the driving force in the earlier years, and Mathematics teachers had been primarily responsible for acquiring these resources through P and C organisations.

My presentation to the Maths Association conference was merely an attempt to highlight this trend and to indicate that Mathematics teachers need to reconsider their role in this changing environment. I suggested that if they didn't, they may face a backlash.

I don't claim to have had any influence on what happened subsequently - but it turned out that that the Mathematics curriculum appears to have abandoned this area.

I personally feel that it has gone too far.

Question: Can you tell me a bit more about IBMs recruitment where they trained teachers, for weeks and putting labs into schools? Anything will be helpful, as I want to mention it in my thesis. Maybe something like a starting year, ending year; what they taught, etc.?

Answer:

The IBM program operated in 1985. Glebe High was selected as one of five schools in N.S.W. to be included in the Project. I don't know what the other schools were.

About four staff from each school attended a four week inservice course, arranged by IBM and the University of Sydney in the use of computers in schools. I'm sorry I can't be more specific - but the major focus was projects based around major applications software.

Sixteen IBM Personal Computers were donated to each School. I believe Sydney University also received a donation of Computers.

The CEU was only involved marginally in this project. I attended some of the training sessions.

Questions:

What can you tell me about the Commonwealth Schools Commission, and its relevance to this topic? Do you know when it formed and why?

Answer:

The CSC was established in 1973 and under an amended act in 1984. Google will take you to the acts. In general the CSC was/is responsible for researching and advising on school funding.

The Commonwealth Schools Commission within the federal government Department of Education, initialised national planning and reported to the Australian government on the need for a National Computer Education Program. This Program operated from 1984 to 1986. The program is outlined in: Commonwealth Schools Commission. (1984). Teaching, learning and computers: 1984 Information Kit. Canberra: Commonwealth Schools Commission.

30/5/11 Interviewee 7:

Question:

Also, do you know if the punch cards used for the mainframes were the same as the punch cards that were used for the Canon Canola?

Answer:

I suspect that they would have been quite different. (Made by different companies for different purposes etc).

Question:

We talked about Hypercards in our interview. I was just wondering about hypercards and how they were related to mathematics.

Answer:

My recollection of Hypercards is that they were the beginnings of linked pages in documents. They were available only for Apple Macintosh computers I think. The idea was that you created a document (called a "stack") consisting of several or many pages, (called "cards"), but within the document you could put hypertext links. The user could click on the links and go to another page or card in the stack.

Some keen users of the Mac computer made up stacks to teach maths concepts, eg algebra. The user would read the stack a page at a time on the computer (a bit like clicking through a powerpoint presentation), and at certain stages the reader could choose to go to a different part of the stack. Sometimes, based on the results of a mini test, the user would be taken to a different page in the stack. Personally I did not ever make a HyperCard stack so I am only going on what I remember from using one or two of them.

After writing the paragraphs above I just googled "Hypercard stack Macintosh computers" and found this:
http://en.wikipedia.org/wiki/HyperCard
which is a more detailed description.

28/6/11 Interviewee 3:

Question:

At the moment, I just wanted to know how I could explain or define a region.
(You mentioned regions briefly in our interview, concerning the CEU).

Answer:

In those days the State was divided into a number of largish regions (I think 10) (eg Metropolitan West covered Parramatta, Baulkham Hills, Mt Druitt etc out to Katoomba). Some other regions were North Coast, Western, Riverina etc.
Regions were later split into districts and Regions themselves were discontinued.

4/7/11 Interviewee 3:

Question:

I was just wondering when the Canon Canola came out in schools, or when it was put on government contract?

Answer:

I don't know exactly when they went on contract.

I know they were in schools in 1973 (and probably before - but don't quote me)

5/7/11 Interviewee 8:

Question:

You mentioned Sandis and Sardex, two early word processors. Did I spell them correctly?

Answer:

I am not too sure of the correct spelling but it would be closer to Sandys and Zardax

Question:

When was the Curriculum Project Team in Computer Education formed?

Answer:

About 1983, I think.

The following quotes are from documents scanned and then sent to me by email by interviewee 8:

Scanned document 1 stated, among other things:

A survey showed that in secondary schools, in 1981, there were:

"41% of schools surveyed have some form of computer education in Year 10"

"65% of NSW high schools had at least one computer."

Most schools that did not have computers said it was due to a lack of funds.

The Department considered Computer Education of a high priority and important for the whole curriculum.

Since 1979, computer related Other Approved Studies started in 1979. An example of the numbers is given In that in 1980, there were 58 and 91 in 1981, most courses for the HSC being offered only in Year 11.

Scanned document 2 stated, among other things:

The Department had developed a workshop scheduled for 1982/1983 to “investigate the use of computers in primary schools.”

Scanned document 3 stated, among other things:

The Mathematics Syllabus Committee of the Secondary Schools Board conducted a survey in 1980. This survey and additional information gathered by the Curriculum Consultant in 1981 showed that, out of the schools surveyed:

41% had some form of computer education in Year 10.

38% had some form in Year 9.

A high number of teachers are willing to teach computer courses.

65% of high schools had at least one computer.

The directorate of studies surveyed schools in April 1982; out of the respondents, (67% of schools):

77% of high schools had at least one computer.

88% that have computers said they had at least one Apple II computer.

The most common use was teaching programming, and teaching computer studies.

The two highest rated present and future needs in software were suggested by teachers to be: “Teaching computer studies and computer as a teaching aid.”

The three types of support regarded the highest relevant were: “Provision of educational software, *more in-service*, provision of computer hardware.”

The final scanned document stated:

The CPT terms of reference are:

- to develop a Curriculum Statement, for K – 12 on Computer Education
- to determine the need and to produce support materials
- to evaluate existing learning materials
- to determine new learning materials
- to design appropriate in-service
- to propose a plan for implementation
- to design a program for evaluation of curriculum implementation

10/7/11 Interviewee 5:

Question:

When did you first attend an in-service course for FORTRAN programming? What did you use?

Answer:

I attended an In-service Course on FORTRAN programming arranged by Sydney Teachers' College in January 1971?? before that strand was introduced into Level III HSC Mathematics. At the time, I was Head of Mathematics at Moorefield Girls' High School. It was a course approved by the Department of Education and used the facilities of the Computer Science Department of the University of Sydney. We worked with punched cards.

15/7/11 Interviewee 5:

Question:

I know about the early courses, which were Level 1 (Advanced), Level 2F(ull) - the second highest level, 2S(hort), and Level 3 (lowest level). And then the course 2 Unit A replaced the Level 3 course. What replaced the other levels, like level 1, 2F and 2S?

Answer:

4 Unit, 3 Unit, and 2 Unit.

Question:

What was the computing option called in Maths in Society?

Answer:

BASIC programming was one of the Options in the Mathematics in Society course.

Question:

Maths in Society was a course among many math courses, what were the other math courses entitled at that time?

Answer:

As far as I remember: 4 Unit, 3 Unit, 2 Unit, Maths in Society, and
(later) Maths in Practice.

22/8/11 Email Question and Answer with Greg Preston:

Question:

I was hoping someone there could tell me the year that the NSWCEG formed.

Answer by Greg Preston:

The NSWCEG was officially active from 1984 till 2010.

I was the "last president" before we merged/amalgamated with the NSW CSTA to form the ICTENSW

26/9/11 Interviewee 5:

Question:

I came across an anomaly, and I thought that you'd be the best one to ask about it, because you're in the know about this part of my work. Well, the anomaly, is a Memorandum that I found, which was written in 1970, and suggests that Computers were to be studied in the next year 1971. I'm not sure what to make of it, as you said that you're certain it was examined in 1972, because of the way that it affected your life. Is there any possible way to explain for this, I was thinking of possibilities myself, like maybe they meant Year 11, or maybe something happened, but this is all guesswork?

Answer:

I don't know, but I expect your guess is correct - i.e. that the 2-year course would commence in 1971 and be examined in 1972.

29/11/11 Interviewee 7:

Question:

What are some extra uses of the computer?

Answer:

Also a big thing for me is that the computer is what the professional's use, so students are "learning for life". I have always thought that we should use spreadsheets much more in the maths classroom, as they are used in industry, commerce, and many many jobs.

Question:

Computers, in comparison to calculators, did not offer much until software was formed. Is that true?

Answer:

I think you are right to focus on the software – without the software the early computers did not offer much.

22/4/12 Interviewee 8 (Interviewee 8 made some comments after reading through my thesis):

Just a couple of little things

Some of the great things about the Canon Canola 167P and 1614P, even though they were very rudimentary machines, was that it brought the concept of computer programming to the masses, you could code, test, debug etc on the spot and there was no single right way of doing it, somewhat like a geometrical proof. Another good thing was the inbuilt card reader. The computer cards were pre punched and the holes could be pushed out with the end of a paper clip. This meant you prepare programs away from the machine and run them when you were ready, a great way of sharing one machine. You could also buy a printer so that you could print out your code and take it away for checking.

One of the reasons that BASIC was a big hit was that it was an interpretive computer language, it gave immediate feedback on syntax, whereas many of the other languages were compiled.

There is very little mention of the role of Regions. Each Region had at least one Computer Education consultant and in most cases a Mathematics consultant that would work together in many cases. Their groundwork was fantastic.

In the poorer regions the schools were using Drill and Practice software because that was their focus and that's all they could afford but the better off schools were using software like LOGO to promote higher order thinking skills.

30/3/13 Interviewee 8:

This was by voice recording, this is a summary of the main points recorded:

Question:

What can you tell me about Government Contract?

Answer:

The Government called for tenders. They would decide what computer best met the students' needs. They would evaluate the computers and recommend the best ones. These choices signalled to schools what computers to buy. This narrowed the choices for schools. If schools used P and C (Parents and Citizens) funding, or funded themselves, they could choose what they liked. They had to buy what was on Government contract if they used Government funding. It also was a tool to help teachers when going to conferences.

Question:

What can you tell me about the Curriculum Development Centre?

Answer:

The Curriculum Development Centre flew a representative from each State to meet together trying to form a common curriculum.

29/4/13 Interviewee 5:

Question:

I was hoping I could ask you about BASIC, when Interviewee 7 introduced you to me, she said that you were a BASIC enthusiast. I was hoping you could explain the reasons why you liked BASIC; that would definitely be very useful. All the best.

Answer:

Initially FORTRAN was chosen for the very first course - an option in Level 3 HSC Mathematics; it changed to BASIC when the courses changed and UNIT 2A came into being, and later still as an option in all SC courses "Programming in BASIC".

BASIC would have been selected because (being simple) it was available on all home computers - Tandy, Apple II, Commodore 64, Sorcerer, etc.

The NSW Department of Education endorsed a home-grown MicroBee, whose language was an idiosyncratic form of BASIC created by a young student.
As a teacher educator, I had to learn it,

5/6/13 Arthur Tatnall:

Question:

I read how you mention the Computer Education Group of Victoria (CEGV). I mention a VCEG conference in my thesis, is there any chance they might be the same group, and if not, do you have any idea as to what VCEG might stand for?

Answer:

I am sure that VCEG should be CEGV. I haven't heard of any other organisation with that name.

Question:

In your chapter "Stream in the History of Computer Education", you mention that the Commonwealth involvement allowed for State Computer Education Centres to be set up. Not that I am questioning you, but do you know anything about a State Computer Education Centre for NSW, is it possible that this was (for NSW) the Curriculum Development Centre? Or possibly known as a Support Centre? Do you know anything that might help inform me here?

Answer:

In Victoria, the State Computer Education Centre in Moorabbin (Melbourne) was set up in 1984 with Commonwealth Schools Commission funds. It was formalised in 1985 with a series of appointments. (I was appointed as Educational Systems Analyst). The corresponding unit was at Erskinville (Sydney) I think it was just called the Computer Education Unit. I'm not sure whether it was set up before the Commonwealth funding or not, but Commonwealth funds certainly formalised its development. Computer centres in Tasmania and South Australia were in operation before the Schools Commission, but were also strengthened by Commonwealth funding. Have you read: Commonwealth Schools Commission (1983). Teaching, Learning and Computers. Report of the National Advisory Committee on Computers in Schools. Canberra, Commonwealth Schools Commission? (There was also a 1984 information kit.)

Question:

Finally, to quote your chapter: “Reflections on the History of Computer Education,” the “Government offset policy was designed to encourage local manufacture of computing equipment by requiring that foreign companies re-invest, in the state, 30% of the profits they made as the result of being nominated as a preferred supplier.” To the best of your knowledge, was the Government offset policy done in NSW in a Centre in NSW?

Answer:

NSW was certainly subject to this same rule. I knew my counterpart in NSW - Paul Jenner (unfortunately now deceased) well. We wrote a paper together about this (attached) for the ACS conference in 1986. (We were also both involved in the committee to design 'The Australian Educational Computer' for the Schools Commission - this never proceeded to completion.)