A REPORT ON THE DEVELOPMENT OF A HANDBOOK ON COMPUTER LITERACY FOR TEACHERS AND PRINCIPALS

GEORGE WITHERS

A REPORT ON THE DEVELOPMENT OF A HANDBOOK ON COMPUTER LITERACY FOR TEACHERS AND PRINCIPALS

BY

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ABSTRACT

The handbook stresses the need for teachers and administrators to prepare themselves for teaching in the age of computers. Teachers and administrators must be willing to become computer literate to provide a relevant education for the present or future generations of students. The students of today need to prepare for jobs in the "Information Age" or "Information Revolution" which will transform society in the next twenty years.

The main purpose of this handbook is to make educators aware of the need for computer literacy and provide an opportunity for them to acquire a general knowledge of computers, their uses in society, as well as applications in education. All teachers regardless of subject speciality need to become computer literate in order to integrate computers into their teaching strategies.

The handbook is divided into ten chapters. The first six chapters introduce the reader to the term computer literacy, defines it, and presents basic information about computers, computer languages, programming and some social problems that have arisen or are being exacerbated by the widespread use of computers. The remaining four chapters are designed to inform the reader

about the educational applications of computers - their uses and limitations. The writer recognizes the need for in-service education to precede the introduction of computers into schools. If computers are to be utilized to the fullest extent and today's students are to become computer literate citizens, then teachers and administrators must become knowledgeable of computers, their uses in society and their educational applications.

The writer believes that this handbook will offer teachers and principals an opportunity to acquire a general knowledge of computers and their use.

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CHAPTER I

GENERAL INTRODUCTION

A Brief History of Computers

A modern computer is an electronic device that manipulates symbolic information according to specific instructions called a program. However, computers of a sort have existed for milleniums. The abacus was the first general purpose computer and its use spread from China to the western world. It was adapted by the Greeks and the Romans and survives in the present century.

As the "dark ages" came to an end and exploration and trade revived, a need for calculating devices arose. A number of calculating machines were devised. In 1614 Napier's "rods" or "bones" appeared. Invented by John Napier, this machine made multiplication simpler for the operator.

In 1642 Blaise Pascal invented a mechanized adding machine. It operated in a manner similar to the odometer of the modern automobile.

In 1694 Gottfried Wilhelm Leibiniz developed a machine that could multiply and divide.

In 1725 Blaise Bouchon constructed a loom that was controlled by holes punched in a roll of paper. The holes in the paper controlled the pattern of the weave. Bouchon's ideas were advanced by Joseph Marie Jacquard.

He used punched cards to control each line of the weave. The concept of a programmed machine was now a reality.

In 1823 Charles Babbage presented his ideas for the construction of a "difference engine" which could compute logarithm tables. Before the difference engine was completed, he started work on an "analytical engine". The proposed analytical engine had many of the characteristics of modern computers. Information would be input using punched cards, it had a memory, and information would be output on a printer. The technology to produce such a sophisticated machine did not exist until the Twentieth Century, so the analytical engine was never built.

Rules of logic developed by George Boole, known as "Boolean Logic", were to become particularly useful for computer applications. Boolean logic is based on time-false conditions which can be represented by an on-off switch, the presence or absence of an electric current, or the presence or absence of a hole in a card.

In 1890 Herman Hollerith constructed a machine for calculating data for the U.S. Census Bureau. The machine used punched cards to input the data. Each time a steel pin passed through a hole in the card, an electronic circuit was completed and another number added to the counting dial. He completed the population count in only six weeks. The Census Bureau had predicted it would take 12 years.

A significant development in computer technology was the invention of the vacuum tube in 1904. A vacuum tube amplifies electrical signals making it possible to use electrical impulses to process numbers.

In 1939 the first electronic digital computer was built by Dr. John Vincent Atanasoff. It used vacuum tubes and digital numbers.

In 1944 a Harvard University team completed the Mark I. It was a huge machine that used electricity to work mechanical relays. The many moving parts caused frequent mechanical failures.

In 1946 another "elephant" was completed. It was known as the Electronic Numerical Integrator and Calculator (ENIAC). ENIAC was capable of making computations 1000 times faster than any other machine available at that time. Parts of the computer had to be rewired to program it.

The invention of the transistor in 1948 led to the construction of smaller computers. It could amplify electrical signals without producing heat and therefore could be placed much closer together than vacuum tubes. Transistors are also much more reliable since they are not subject to burn-out.

In 1949 the first computer capable of storing programs was completed, the EDSAC. It used paper tape for input and a teleprinter for output.

In the 1950's the first computers were marketed commercially and in 1959 the first integrated circuit was produced on a silicon chip. By 1970, it was possible to place 1000 transistors on a single chip and in 1979 microchips containing one quarter of a million transistors were available (Evans, 1981). The integrated circuit led to the development of mini computers in the 1960's.

The production of the 8080 silicon microprocessor chip by Intel in 1972 led to development of the microcomputer in 1975.

Since 1975 the world has experienced a revolution in the production and sale of microcomputers. In 1977-78 Radio Shack (Tandy) and Commodore began marketing microcomputers. They were joined in 1979 by Apple, Atari and Taxas Instruments. The microcomputer of the 1980's is smaller, more powerful and cheaper than its predecessors. The availability of numerous peripheral devices has increased the microcomputer's usefulness in a number of applications. Education is no exception.

Development of Educational Applications of Computers

The history of computers in education is relatively short. During the 1960's a major effort was launched to harness the educational potential of computers. Many millions of dollars were spent to launch an "educational revolution" which was always perceived to be "just around the corner" (Coburn, Kelman, Roberts, Snyder, Watt, and Weiner, 1982).

Among the most publicized early projects were:

- The "Talking Typewriter", which was supposed to effectively teach reading and writing to two and three year olds. The cost per learner was astronomical.

- I.P.I., "Individually Prescribed Instruction" project, which created a set of elementary school learning objectives and programmed a computer to provide daily tests and lesson assignments for all the students in a Pittsburgh elementary school. The project made a point of including no learning objectives that were not readily measurable. Grammar was included in the curriculum, creative writing was not.

- The activities of Patrick Suppes at Stanford University who predicted that in the future every child could have ...a personal tutor as brilliant, patient and creative as Aristotle.

(Coburn et al. 1982, p. 170)

Coburn et al (1982) identify several reasons why these projects (later known as computer assisted instruction) failed to become a significant on-going part of elementary and high school programs in the sixties and early seventies. The cost of computer hardware required to reach masses of students as well as the high cost of developing good quality educational software were much too high. The cost of providing a computer terminal to a school was many times greater than the cost of a microcomputer. It was also frustrating to operate a program on a timesharing network because when the "host" computer was "down", all terminals in the school ceased to function. If a school has several microcomputers available, it is unlikely that any more than one will break down at one time. Classes will not be interrupted because of the failure of a single computer.

Another problem was created by the early computer advocates themselves. Their rhetoric about computers being better teachers than humans was offensive and created fears amongst the teaching profession that their jobs would be lost to computers and technicians. Some of these fears could have been eased by providing adequate teacher training. No organization seemed willing to recognize this need or provide a remedy for it. It is unlikely that any innovation will be implemented successfully in the schools unless teachers and school administrators are informed about the materials and equipment that is essential for its implementation. When the CAI proponents failed to address this very obvious weakness and continued to press their exaggerated claims, the result was failure to be successful in even a modest way.

The failures of the sixties can be a lesson for us in the eighties. The microcomputer boom has created new life for the advocates of computerized instruction. Computers are now available to schools at costs of less that $1000. According to Latta, Dunn and Stevenson (1982) there were approximately 35,000 microcomputers in use in Canadian schools and about 100,000 being used in U.S. secondary schools in 1982. Latta et al. (1982) also report that the number of computers used in American junior and senior high schools is expected to reach 400,000 by 1985. A public statement by Ontario's Minister of Education promises every child in Ontario access to a computer by 1990.

If the effort to introduce computers into the schools in the 1980's is going to be more successful than the attempts of the 1960's, then there is a need to avoid problems that led to failure of earlier efforts. The microcomputer makes cheaper hardware available, but along with the hardware there must be good quality software as well as trained and informed teachers to use it.

Teachers must have an opportunity to learn about how the computer can be used to enhance and supplement human instruction. The advantages of using a word processor for creative writing, or a statistical package for business education, or the convenience of using the computer as a super calculator, need to be recognized along with the conventional CAI applications. The successful integration of computers into the schools rests heavily on the effort made to make teachers and principals aware of the instructional and administrative applications of computers in education. School boards must budget not only for the purchase of hardware and software, but also provide funds to support in-service education.

CHAPTER II

NEEDS ASSESSMENT

Statement of Need

The introduction of microcomputers into the schools on a grand scale in the 1980's offers teachers an opportunity to turn good teaching into great teaching (Doerr, 1979). Doerr (1979) goes on to say that "computer education can be the most relevant study in the curriculum" (p. 11). Students should learn about the capabilities of computers, understand their role in modern society, and protect themselves from possible computer abuse.

However, before teachers or principals can use the computer as an instructional aid (CAI), as an object of instruction, or as a tool for generating materials and record keeping, they must become computer literate. To become computer literate requires acquisition of a basic knowledge of computers and their uses. The following are common elements of many computer literacy programs:

1. General knowledge of the history of computers.
2. Understanding of the basic structure of a computer.
3. Use of problem solving techniques.

4. Awareness of the range of uses of computers.

5. Simple use of a computer program.

6. Awareness of the impact of computers on job activities and the economy.

7. Discussion of the social impact of computers now and in the future. (Wilton, 1981. p.59)

Wilton (1981) identified three reasons why teachers and administrators need to become computer literate:

i) All teachers, in their dealings with children are likely to be faced with questions about how computers affect their environment, their ability to acquire and process information or the subject under study.

ii) All teachers will work within a system which makes increasing use of computers for its administration-scheduling, maintenance of records, etc.

iii) All teachers will, within a relatively short period of time, have at their disposal, computing resources as aids in their teaching. (p.57).

If the predictions of the above paragraph are accepted, then how ready are the present teaching staff to respond to the changing educational environment that is needed? The results of a survey of this question were presented by S.D. Milner at the National Educational Computing Conference in 1979. Milner (1979) identified six conditions which may be hampering the development of adequate teacher computer literacy:

1. Lack of experience and certification requirements for teaching computer related courses.

2. Lack of educators' knowledge of computer applications in education.

3. Lack of training courses or programs.

4. Low priority given to instructional computing.

5. Lack of incentives for teachers.

6. Need for greater administrative commitment and recognitions (p. 38).

There is a concern that research and development in computer use in education will precede training. Wilton (1981) states that such a condition already exists in the United Kingdom and that there is an urgent need for a teacher training program to parallel the educational research and dissemination of curricular materials. Teachers must be informed of the developments in educational research as well as become knowledgeable about the applications of computers in education.

There is a need for all teachers and school administrators to become computer literate. There is no reason for computer studies or computer appreciation courses to be the exclusive domain of the mathematics teacher. It was stressed at the first World Conference on Computers in Education (WCCE) "that it is neither essential or desirable" for a computer appreciation course to be relegated to the mathematics teacher (Wilton, 1981, p.55). According to Bell (1979),

> A strong wave of opinion favours breaking the traditional role of the mathematician as the one teacher most suited to teaching computer studies and involve teachers of non-science subjects (p.23).

At the 1981 meeting of WCCE there was an increasing awareness that the goal of universal computer literacy was larger than "one course at one grade level and in one set discipline could meet" (Wilton, 1981, p. 57). If universal computer literacy has become a goal of all society, the methods of achieving a basic level of computer literacy have spread beyond the structure of a single course. Use of computers in instructional activities heightens student awareness of computers and their applications in society. However, before the computer will be used extensively in all subject areas, teachers themselves must be informed of the computer's instructional uses. The integration of computer literacy goals through the use of computers will not happen automatically. Careful co-ordination and planning are needed to avoid inappropriate use and waste of scarce resources (Thowaldson, 1981).

Moursund (1982) believes that it is no longer appropriate for elementary teachers and principals to consider computers acceptable only for use in high schools. There is a need for the elementary school to recognize the potential of the computer as an instructional aid. The computer literacy program should begin in the primary grades and continue into the junior and senior high school grades. "Appropriate topics should be identified and introduced from K - 13 both by the use of computers in classrooms as tools of learning and by the study of computer-related issues as they fit into particular curricula" (Wilton, 1981, p. 58).

It is probably safe to assume that most teachers are not aware of the use of computers in subject areas outside business education or mathematics. Klassen and Rawitsch (Kepner, 1982) report that a survey conducted in 1970 found that only 3 percent of all instructional computing occurred in social studies and a follow-up survey in 1975 showed that this particular use had only increased by 1 percent.

There are a number of ways in which teachers and administrators can be informed of the uses of computers in education. One way they could be informed is through computer studies courses included in their pre-service education at university. However, as Wilton (1981) points out, the major drawback to this approach is that most teachers in the schools have completed their pre-service training and, therefore, will not be reached by university education courses in computer studies. Even if courses about computers in education are offered at the undergraduate level, many teachers and administrators are likely to stay away because of the lack of incentive.

An approach that might be more successful in reaching a majority of teachers is to inform them through in-service education. Ragsdale (1982) identifies three stages in the development of an in-service program. The first stage involves experts giving half-day sessions aimed at giving a maximum number of teachers a minimum amount of exposure to the uses of computers in education. The second stage involves several days of instruction spread over a number of weeks. Throughout the process each participant is given the opportunity to use a computer for the duration of the course. This will give the participants some "hands-on" experience and eliminate any fear of the machine that the user might have. An opportunity to examine some educational software is also provided.

In the third stage of the in-service program, a series of courses covering a number of topics are offered. Each course is approximately ten weeks in length.

In order for school boards to offer extensive in-service programs to all teachers, they will be required to appropriate a significant portion of their budget for this purpose. Given the economic realities of the early eighties, it is unlikely that school boards will be able to launch a full scale re-training program.

Another possible source of information about computers is through personal contact with people who are knowledgeable in the educational computing field. There may be a member of the staff who has acquired a knowledge of computers and that person may be willing to share it with other staff members. However, there is a shortage of such people in the schools and it would be unwise to leave the important task of educating teachers and administrators to chance.

The school library, with its collection of popular and professional magazines and books, can play a role in developing an awareness of the usefulness of computers in education. The librarian could make teachers aware of computer technology through special displays and talks. The presence of a computer in the school library offers some interesting possibilities, especially the opportunity for the classroom teacher to acquire "hands-on" experience, as well as use some of the software. There is a need to encourage all teachers, not just the computer hobbyist, to become aware of the potential uses of computers in education.

Through conversation with many teachers, the writer determined that there was a need for a document to introduce teachers and administrators to computers. This document would have to be brief, assume no previous knowledge, and be written in a language that educators could easily understand. Technical aspects of computer operation would have to be kept to a minimum, but at the same time give the reader enough information so that he can branch out to other sources. The document would serve as a starting point from which the reader could expand his knowledge.

Alternative Solutions and Summary of Available Materials

Once the writer had determined, in an informal way, that there was a need for such a document, and teachers and administrators responded positively to the idea of having a booklet available that would introduce them to computers in education, the author was faced with two alternatives to writing one. The first alternative was to search for some material that had already been prepared to meet the need. The second was to see if materials existed that could be easily adapted to meet the need. The writer began to search existing materials in his own school library, but found nothing appropriate to suit the purpose.

The search was expanded to the library at Memorial University of Newfoundland, the Center for Audio-visual Education (CAVE), the Curriculum Materials Center, as well as the Instructional Materials Centers at the district and provincial levels. The author examined numerous materials, print and non-print, but was unable to discover materials to meet the need of teachers and administrators.

Having determined that no suitable materials existed locally to meet the need, the author conducted a computer search. Again there were numerous articles and books on the subject of computers but most of them were too technical or assumed previous knowledge of computers. Others were too specialized and provided a lot of detail about a single topic.

The author discovered some books and A-V materials which he considered to be good for general background but which were inappropriate to meet the specified needs. Listed below are some of the books the author examined along with reasons why the writer considered them inappropriate to meet the need:

1. Billings, K., Moursund, D. <u>Are You Computer Literate?</u>, Portland, Or., Dilithium Press, 1979.

   Billings and Moursund introduce the reader to the concept of computer literacy in a non-technical way. However, the scope of the book is narrow providing the reader with very little information about the history of computers, how they work or how they can be useful for educational purposes.

2. Coburn, P., Kelman, P., Roberts, N. Snyder, T., Watt, D., Weiner, C., Practical Guide to Computers in Education, Don Mills, Ont.; Addison-Wesley, 1982.

This was probably the most useful book that the writer examined. It is directed toward teachers and administrators and examines many of the issues relating to computers in education. However, it is lengthy and discusses issues that may not be appropriate at the introductory level. The section on computer programming ignores BASIC and concentrates on LOGO. It is also weak in the discussion of computer languages and societal issues.

3. Kepner, H.S. (ed.), Computers in the Classroom, Washington, D.C.; National Education Association, 1982.

This book includes a collection of articles written by people who are expert in their field. The book is divided into two sections. The first section includes articles about computer uses in education while the second part concentrates on computers in the curriculum. It provides good reading for the reader who has some previous knowledge. Some articles would present some difficulty for the novice. There is no information about what computers are, their uses and limitations, or the societal issues related to computer use.

4. Lieberman, M., McFadden, N.G., and Steeves, G., Computers Don't Byte: A starting Point for Teachers Using Computers, Toronto, Ont.; Ontario Secondary School Teachers Federation, 1981.

The resource booklet provides the reader with a good introduction to educational applications. However, it is very restricted in its discussion of the categories of use.

It provides a very brief history of computers and fails to address the societal issues or the role of computers in an information age. There is very little reference to computer programming.

5. Moursund, D., Teacher's Guide to Computers in the Elementary School, Eugene, Or.; International Council for Computers in Education, 1980, 1982.

This booklet is written for pre-service and in-service of elementary school teachers. It assumes some "hands-on" experience with computers. Moursund provides good reading for elementary school teachers who are interested in using computers for instructional purposes.

6. Noonan, L., The Age of Computer Literacy, Toronto, Ont.; The Oxford University Press, 1983.

A textbook designed for teaching computer literacy to students at the high school level. It provides good reading on a number of topics ranging from the history of computers to the uses of computers in society. He also includes a chapter on programming as well as a lot of information on kinds of computers and how they work. Because the intended users are students, it does not address the educational applications of computers in very much detail. It is recommended as a good text for secondary school students.

7. Papert, S., Mindstorms: Children Computers and Powerful Ideas, New York, N.Y.; Basic Books, 1980.

Papert provides the reader with an idealistic view of the use of computers in education. Papert believes that in order to get full benefit from computers in education, there must be a re-thinking of the whole school curriculum. He advocates a departure from CAI applications to a more user active application where the child is in charge of the computer. Provides very interesting reading but assumes the reader has already had experience in computer use and has knowledge of traditional computer applications in education.

8. Ragsdale, R.G., Computers in the Schools: A Guide for Planning, Toronto, Ont.; OISE Press, 1982

   Ragsdale examines some of the issues related to computer use in the schools. He discusses the concept of computer literacy and how much knowledge of programming a teacher needs. He focuses on problems associated with evaluating educational software. He also addresses the question of teacher training. Ragsdale offers good reading for the educator to broaden his knowledge of issues in educational computing.

The author located two filmstrip series that would be particularly useful for teaching about computers at the junior or senior high school level. Both series are available from Encyclopedia Britannica Corporation. The first series, Understanding Computers, consists of five filmstrips and cassette tapes under the following titles:

1. What Computers Can Do.
2. How Computers Work.
3. How to Get the Computer to Do Something.
4. Telling the Computer What to Do
5. What Computers Cannot Do.

The second series also has five sound filmstrips under the heading Computers in Society. The titles of the five filmstrips are:

1. Computers in Everyday Life.
2. Personal Computers in the Home.
3. Computers in Schools and Business.
4. Computer Careers.
5. Computers Change Society.

These filmstrips could be used for teaching about computers in a computer literacy course or they could be integrated into other disciplines. They could also help the teacher become more knowledgeable about computers and their uses in society.

The author also examined numerous periodicals and found many of them contained articles on computing directed towards educators. Magazines such as <u>Byte</u>, <u>Compute</u>, <u>Popular Computing</u>, and <u>Creative Computing</u>, although they are not published specifically for educators, frequently include articles of interest to educators. Educational periodicals such as the <u>Computing Teacher</u>, <u>ECOO Newsletter</u>, the <u>AEDS Journal</u> and the <u>Canadian School Executive</u> are good sources of information. Locating these articles can be a very time consuming task. Even when the articles are accessible to educators they may be too narrow or technical in the treatment of the subject and assume previous knowledge.

Since there are no materials readily available to meet the need, the writer then considered the possibility of modifying some existing booklet or book. The search for existing materials convinced the writer that no materials which could be easily modified were available. The decision to produce a booklet was made after determining firstly that no material existed to meet the need and, secondly, no book was available that could be easily modified to meet the need.

Rationale for Development of Handbook

All of the materials that were examined during the search of available materials proved to be unsatisfactory for the kind of booklet the writer believed would be most useful for educators. The writer does acknowledge the availability of a number of excellent books and articles about computers and their applications for education.

However, none of the existing materials met the need that the writer had identified. Much of the material was limited in scope - discussed only a particular topic, or was too technical. Many of the articles and books that were examined assumed previous knowledge of computers and their uses.

After the search of the materials was concluded, the writer decided that the best way to meet the need of teachers and principals was to produce a handbook for them. The writer has done this. Every effort has been made to produce a handbook that is not too technical; brief, but covering the main issues. The writer hopes that it will provide a basic knowledge of computers and their applications in education. The aim was not to produce a booklet that would enable teachers to become expert, but to create an awareness of the uses of computers in society and education as well as their limitations.

Outline of Development Process

The development of curriculum and instruction strategies is a complex activity. Taba (1962) has suggested a seven-step plan for curriculum development based on the assumption that "there is an orderly method for making curriculum decisions and that pursuing it will result in a more thoughtfully planned and more dynamically conceived curriculum" (p. 12). Taba suggested the following plan:

STEP 1: Diagnosis of needs.

STEP 2: Formulation of objectives.

STEP 3: Selection of content.

STEP 4: Organization of content.

STEP 5: Selection of learning experiences.

STEP 6: Organization of learning experiences.

STEP 7: Determination of what to evaluate and ways and means of doing it (p.12).

Taba's plan was used as the basis for establishing an instructional development model which was followed in a manner appropriate for the development of this handbook (Figure 1). At each stage of development, there was provision for evaluation and revision.

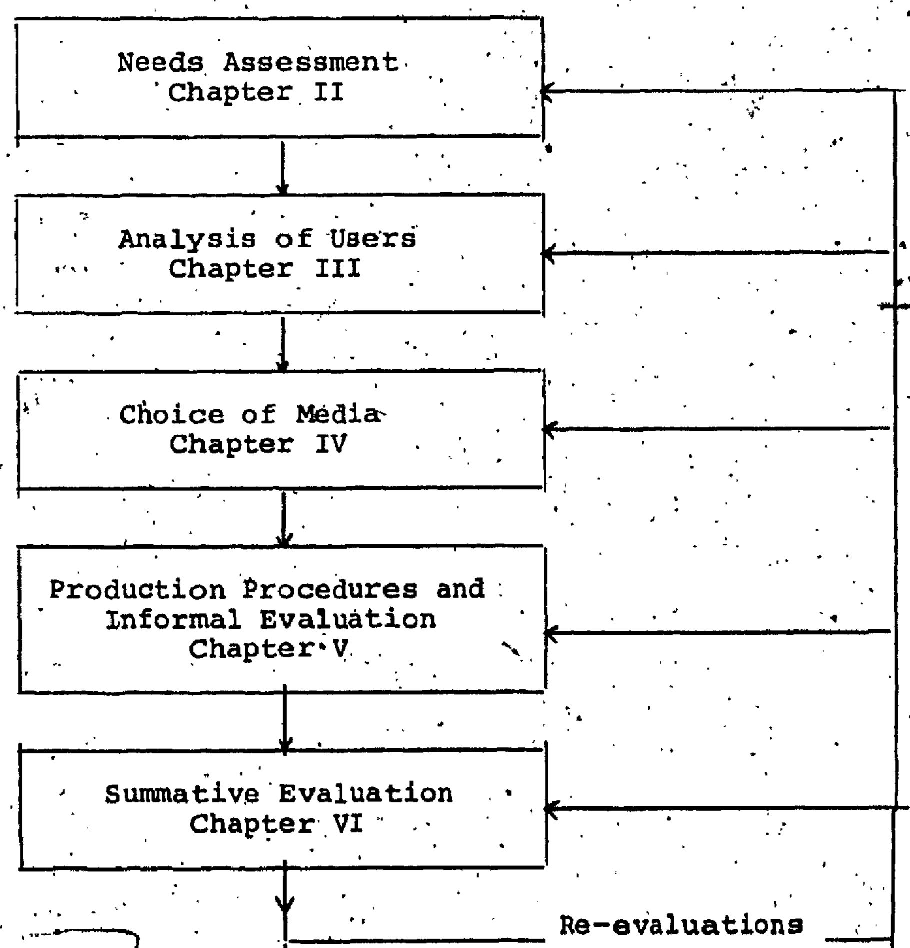

Figure 1. Instructional Design Model

CHAPTER III

ANALYSIS OF USERS AND STATEMENT OF HANDBOOK PURPOSES

Intended Users

The primary audience that this handbook is prepared for are the teachers and administrators in the schools of Newfoundland and Labrador. However, the contents of this handbook are not restricted to any one geographical area. The concerns that this project addresses are relevant for educators throughout the western world.

The handbook assumes no previous knowledge and does not require the reader to have access to a computer. Having a computer available, however, would be helpful.

Conditions of Use

The writer places no restrictions on the use of this handbook. All who are interested in its contents may avail of its use. It will be made available to schools or individuals through the Learning Resources Clearinghouse, Memorial University of Newfoundland.

Objectives of Handbook

The handbook is designed to help the reader:

1. develop an understanding of the concept of computer literacy and an appreciation of the need for it;

2. appreciate the historical antecedents and evolutionary trends of computers;

3. develop a functional understanding of computer hardware, software and systems operation;

4. develop an awareness of a number of computer languages and an understanding of how high level languages make programming a computer possible for the non-expert;

5. identify some of the social concerns created by the widespread use of computers;

6. understand that a program is a series of instructions that must be presented to the computer in an ordered and logical sequence;

7. foster an understanding of videotex through an examination of Telidon and realize its implications for education;

8. develop an awareness of the ways in which computers can assist with administrative tasks in education;

9. differentiate among the major classes of instructional/learning applications of computers;

10. participate in efforts to introduce and integrate computers into a school.

CHAPTER IV

RATIONALE FOR CHOICE OF MEDIA

Preference of Intended Users

In Chapter II the author has described the process for determining the need for teachers to be informed about computers and their educational applications. The search of available materials revealed that no materials existed to precisely meet the need. In fact, there were no materials that could be easily adapted to meet the need, so a decision was made to produce suitable materials.

Having identified the intended audience and the objectives for the materials, the next step was to decide on the best method for presenting the information to the users or learners. Through an informal survey conducted among teachers in the St. John's area, the writer determined that there was a preference for a booklet.

Having given consideration to the scope of the project, and the preference of the intended users, the writer decided to produce a booklet.

Other Considerations

1. Print medium does not require the use of expensive equipment, facilities or laboratories during the production phase.

2. Print material can be copied easily and inexpensively for distribution to the users.

3. Print material can be used independently. No special equipment is required.

4. Print material can be used in a variety of settings - in the home or at school, indoors or outdoors, etc. because it is independent of hardware.

5. Print medium is one that is familiar to all the intended users and one for which they showed preference.

It is commonly accepted that choice of media can affect the degree of success of any publication. Therefore careful consideration was given to the preference of the intended users. A decision was made to produce a handbook that would provide teachers and principals with a broad general knowledge of computers and their applications in education.

CHAPTER V

PREPARATION PROCEDURES AND FORMATIVE EVALUATION

Preparation and Organization of the Handbook

Initial production procedures have already been described in previous chapters. After determining the need and establishing the most appropriate medium, and it was determined that there was no alternative except for the writer to produce materials, the writing of the handbook began. Purposes for each chapter were identified and material was collected and organized to meet them.

Each chapter of the handbook is subdivided for the convenience of the reader and for clarity of purpose. Chapter I introduces the reader to the concept of computer literacy, defines it and discusses the need for teachers and principals to become computer literate.

Chapter II provides the reader with an overview of the developments in calculating devices that eventually led to the development of the modern computers. It is designed to create an appreciation of the historical antecedents and evolutionary trends in computing.

Chapter III is designed to introduce the reader to the different types of computers, as well as the various types of hardware and software that are available. The writer does this in a non-technical manner.

Chapter IV introduces the reader to computer languages such as BASIC, LOGO and FORTRAN. This chapter also illustrates a progression from machine language to languages that are more "user friendly".

Chapter V discusses computer programming. The purpose is to develop an understanding that programming is a series of instructions presented in an ordered and logical sequence. The reader is introduced algorithms, flowcharting, as well as programming in BASIC and LOGO.

Chapter VI discusses a number of societal issues that are emerging or have already appeared as a result of the proliferation of computers. This chapter also discusses the question of artificial intelligence.

Chapter VII introduces the reader to Telidon as an example of a large information storage and retrieval system. The effects that videotex systems may have on education are also discussed.

The first seven chapters were designed to inform the reader about computers and computer systems, and how computers operate in a language that teachers and administrators can easily understand. Chapters VIII, IX, and X are presented for the purpose of acquainting educators with ways that they can use the computer for instruction and administration.

In Chapter VIII the use of the computers for record keeping, testing, scheduling, time-tabling and budgeting is examined. The idea of teaching through and with computers is also introduced.

Chapter IX leads the reader into a practical discussion of questions relating to management of the computer hardware and software in the school. Such questions as where will it be located and who will co-ordinate its use may well determine how much and for what purpose the computer is used. The important question of inservice education is also discussed.

Chapter X draws together in summary form many of the issues discussed in previous chapters and makes some observations about the future of computers in education.

Scope and Limitations

The booklet is a brief, non-technical account of the history of computers and what types of computers exist, as well as a discussion of programming and programming languages. There is no attempt to include in this booklet all of the uses of computers in society or their cultural impact. The target audience are educators, so much of the booklet contains information which the reader considers important for teachers and principals to know. Considerable emphasis therefore is placed on the instructional/learning and administrative applications of computers.

The writer has also devoted a separate chapter to integration of computers into the schools. The final chapter also traces the history of computers in education and discusses reasons for the failure of earlier efforts. The writer hopes that this handbook will help educators avoid some of the pitfalls that led to the failure of computerized instruction in the 1960's and that it will motivate teachers and principals to learn more about the computer's potential for use in the school.

Formative Evaluation

Formative evaluation is a continuous process. Ragsdale (1982) suggests that formative evaluation, evaluation that is conducted during the developmental stages, is the most important form of evaluation, because it is often the only evaluation information that gets used. The informal evaluation process is internal, on-going and supportive. It provides feedback at each stage of production offering suggestions for revising the content of the material so that it will more likely meet the needs of the target audience.

During the development of the booklet, the author consulted with a content expert at Memorial University of

Newfoundland. A copy of the handbook was submitted for examination to a professor lecturing in a graduate computer studies course. The content was also verified by other persons who were expert in the field of computers and computer programming.

Consultation with instructional development experts led to a number of revisions of the handbook as well as inclusion of an additional chapter and a glossary.

Copies of the booklet were shown to several teachers and principals, as well as personnel at the school board and government departmental level. The author received many excellent suggestions for improvment from these sources and has now incorporated these changes into the handbook.

To complete the formative evaluation, a questionnaire was designed to allow the developers to rate how well the booklet met the specified objectives. (See Appendix B). Ratings were placed on a scale of 1 to 5 ranging from poor to excellent. The informal evaluation instrument also included a section for comments and recommendations. The recommendations were very helpful and some minor changes were suggested. The ratings for the eleven objectives showed that the evaluators felt the material was adequate to meet the needs of the intended users. Ratings ranged from good to excellent. (See Table 3).

Table 3

Results of Ratings

n = 6 Objective	Rating 1	2	3	4	5	Mean
a) Develop an understanding of the concept of computer literacy and an apprecia-tion of the need for it.	0	0	1	4	1	4.0
b) Appreciate the historical antecedents and evolutionary trends of the computer.	0	0	1	3	2	3.7
c) Develop a functional under-standing of the computer hardware, software, and systems operation.	0	0	3	3	0	3.5
d) Develop an awareness of a number of computer lang-uages and an understanding of how high level languages make programming a computer possible for the non-expert.	0	0	1	3	2	4.2
e) Identify some of the social concerns created by the widespread use of computers.	0	0	1	1	4	4.5
f) Understand that a program is a series of instructions that must be presented to the computer in an ordered and logical sequence.	0	0	2	3	1	3.8
g) Foster an understanding of videotex through an examina-tion of Telidon and develop a realization of their impli-cations for education.	0	0	2	3	1	3.8

Table 3 (Cont'd.)

n = 6 Objective	Rating 1	2	3	4	5	Mean
h) Develop an awareness of the ways in which computers can assist with the administrative tasks in education.	0	0	0	4	2	4.3
i) Differentiate among the major classes of instructional/learning educational computer applications.	0	0	1	4	1	4.0
j) Participate in efforts to introduce and integrate computers into a school.	0	0	3	1	2	3.8
k) Identify in-service education as a necessary strategy for integrating computers into a school.	0	0	1	2	3	4.3

CHAPTER VI

SUMMATIVE EVALUATION

Definition

Summative evaluation is sometimes referred to as formal evaluation. It is usually one-shot, conducted by evaluators who are external to the project, and asks the evaluators to judge the degree to which the project has met the stated objectives. Summative evaluation, therefore, is used after the project is completed to determine the author's success in meeting the stated objectives of the task.

Preparation of the Questionnaire

In consultation with the supervisor, it was decided to prepare a questionnaire which used a five point scale to evaluate how well the objectives stated for the handbook had been achieved. In addition to rating of handbook objectives, the writer decided to include a section of general information relating to the experience and certification of the respondents. Respondents were also given space to comment on the strong or weak points of the handbook.

The questionnaire that the author used is included in Appendix B of this report.

Submission of Handbook and Questionnaire

After the questionnaire was completed, copies were made of the handbook and questionnaire. A total of twenty-four copies were made available to teachers, principals and supervisors. Because of time constraints placed on the author, it was not possible to mail out copies of the handbook and questionnaire. Copies were personally delivered to twenty-four teachers and administrators.

Results of the Questionnaire

Of the twenty-four questionnaires that were delivered to educators, a total of twenty-three were returned. The high return rate can be attributed to the author personally delivering and picking up the questionnaires.

The experience of the teachers responding ranged from seven years to thirty-two years of teaching experience. All teachers responding had a Grade IV teaching certificate or higher.

Only three of the respondents reported that they had completed an education course at university relating to the use of computers in education. None of the respondents was involved with the use of computers in schools at the time of completing the questionnaire.

A summary of information of respondents' teaching experience and teaching certificate held is provided in Tables 1 and 2:

Table 1

Teaching Experience of Respondents

Years of Experience	1-5	6-10	11-15	16-20	21-25	26-30
Number of Teachers	0	12	6	0	2	3

Table 2

Teaching Certificate of Respondents

Certificate	I	II	III	IV	V	VI	VII
Number of Teachers	0	0	0	2	5	10	6

Section B of the questionnaire contains a list of objectives that the writer had decided that the handbook should meet. Respondents were asked to rate each objective on a five point scale from poor to excellent according to the degree they felt the handbook had achieved that objective.

Respondents registered their rating of each of the objectives by circling one of the numbers on the five point scale. The results of their ratings are shown in Table 3.

Table 4

Results of Ratings

n = 23 Objective	Rating 1	2	3	4	5	Mean
a) Develop an understanding of the concept of computer literacy and an appreciation of the need for it.	0	1	3	10	9	4.2
b) Appreciate the historical antecedents and evolutionary trends of the computer.	0	0	6	12	5	4
c) Develop a functional understanding of the computer hardware, software, and systems operation.	0	1	10	9	3	3.6
d) Develop an awareness of a number of computer languages and an understanding of how high level languages make programming a computer possible for the non-expert.	0	3	5	10	5	3.7
e) Identify some of the social concerns created by the widespread use of computers.	0	0	3	9	11	4.3
f) Understand that a program is a series of instructions that must be presented to the computer in an ordered and logical sequence.	0	0	7	10	6	4
g) Foster an understanding of videotex through an examination of Telidon and develop a realization of their implications for education.	0	2	2	16	3	3.9

Table 3 (Cont'd)

n = 23 Objective	Rating 1	2	3	4	5	Mean
h) Develop an awareness of the ways in which computers can assist with the administrative tasks in education.	0	0	4	12	4	4
i) Differentiate among the major classes of instructional/learning educational computer applications.	0	2	6	12	3	3.7
j) Participate in efforts to introduce and integrate computers into a school.	0	0	7	9	7	4
k) Identify in-service education as a necessary strategy for integrating computers into a school.	0	0	3	10	10	4.3

The ratings of the objectives by each of the respondents was very positive. The lowest mean rating for an objective was 3.6 while the highest was 4.3. The overall mean rating was 4.

The comments made by the respondent who rated objective "c" as fair, felt that if a glossary had been included in the handbook, they would have had a better understanding of the content. Other respondents also stated that a glossary would be helpful. The writer has added a glossary to overcome this weakness.

Other comments reinforced the author's recognition of the need for such a handbook. All the respondents felt it was a very useful and informative booklet.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The writer, as a result of reading extensively for preparation of the handbook and reading the comments of evaluators, draws the following conclusions:

1. The general purposes or objectives identified for the handbook have been successfully achieved.
2. The majority of respondents had little or no previous knowledge of computers or their uses in education. There is a definite need for more in-service education for teachers if computers are to be successfully integrated into the curriculum.
3. There is a need for teachers to become computer literate so that they will be able to provide students with an education that will prepare them for the post industrial society that is emerging. Knowledge of computers will be essential in a post-industrial society based on

storage, analysis, and retrieval of data.

4. It is necessary for teachers to recognize the limitations as well as the potential of computers so that myths that abound about computers can be destroyed. Computers may change the role of the teacher and student, but will probably never replace human teachers.

5. Schools need to recognize, and to take steps to correct problems that arise as a result of differential access to computers. Existing social differences may be exacerbated and sex-role stereotyping may be reinforced.

6. There is a very real need for more research about the effects of computers on young people.

7. Computers can be very helpful in performing administrative tasks at the school and district level.

Recommendations

The writer recommends:

1. That a greater effort be made by school boards to in-service their teachers to make them aware of applications of the educational applications of computers in education.
2. That the provincial government set up a collection of educational software programs and make them available to schools through the Instructional Materials Division of the Department of Education.
3. That guidelines be prepared for the purchase of computer hardware.
4. That curriculum guidelines be established for the introduction of computers into elementary schools. As computers become available to more and more young children, the need for computer literacy in the primary and elementary grades increases.
5. That school libraries acquire a collection of materials - books, magazines, as well as A-V materials - for teacher and student use.

6. That computer literacy courses not become the exclusive domain of mathematics and science teachers. It is necessary for all teachers to become involved and for this reason a single course in computer literacy is inadequate. Students will become more computer literate if computers are integrated into several subjects.

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APPENDIX "A"

A HANDBOOK ON COMPUTER LITERACY FOR TEACHERS AND PRINCIPALS

Contents

Chapter I

Introduction

1. Definition of Computer Literacy

Throughout the 1970's a concept most frequently referred to today as computer literacy evolved. There are still varying views of what this term means or should mean. Literacy is itself a vague term that often refers to a person's ability to read and write in his own language. There are various stages of literacy. One may only be literate enough to read the newspaper while another may possess the skills necessary to be a journalist or a creative writer. The first has mastered the skills necessary to become functionally literate while the second has become expert in the mastery of language symbols. To what degree must a person be aware of and able to use computers before he is considered computer literate? Is one computer literate if he is aware of the uses of computers in society and their impact on our culture. Or, must he be fluent in "computerese" and expert in writing programs? Just as there are levels of literacy in reading and writing in society, there will exist varying degrees of computer literacy.

Nontheless, there is a need to come to an understanding of what computer literacy should be to determine what the schools need to teach students to make them computer literate citizens. There are certain minimum levels of competency that must be attained before one can be considered computer literate. Noonan (1983) states that to be computer literate you must know something about the following areas:

- What computers are
- How to use a computer
- The history of computers
- Kinds of computers
- Computer hardware
- Computer software
- Computer systems
- What goes on inside the computer
- The languages of computers
- Programming
- How computers work for us
- Computer problems
- The future of computers

(p.2)

For Coburn, Kelman, Roberts, Snyder, Watt, and Weiner (1982) computer literacy is the "general range of skills and understanding needed to function in a society increasingly dependent on computer and information technology". (p.56). They distinguish between the computer illerate (a person who knows nothing and wants to know nothing about computers) and the computer literate - a person who is able to:

a) program to achieve personal academic and vocational goals;

b) use pre-programmed materials and judge their suitability and understand their limitations;

c) understand the growing economic, social and psychological impact of computers on society and its components;

d) use ideas from the world of computer programs and computer applications as part of their strategies for information retrieval, communication, and problem solving. (p.57).

Klassen and Anderson (Kepner, 1982) state:

> Computer literacy is whatever understanding, skills and attitudes one needs to function effectively within a given social role that directly or indirectly involves computers... Students need to know how to use the computer as a tool in their schoolwork and they need to know about the limitations, general capabilities, and social implications of computers for coping with computerization in their everyday lives. (p.26).

2. The Need For Computer Literacy

Throughout the past decade the switch from an industrial society to a post-industrial society based on information gathering, storage, retrieval, analysis, and distribution has become increasingly obvious. LaConte (1982) states that "the curriculum in the schools does not impart the skills necessary for an information society. Students need skills in the following areas: message compression; decoding and interpreting condensed messages; Kinesics (interpretation of body language); synthesizing information; visual literacy; rapid analysis and evaluation of message validity". (p. 30). More than half the

U.S. workforce is engaged in the information industry. (LaConte 1982).

Arthur Luehrman (1980) stated that "The ability to use computers is as basic and necessary to a person's formal education as reading, writing and arithmetic". (p.98). As early as 1975, at the World Conference on Computers in Education, a proposal was made that universal computer literacy should be the goal for the instructional use of computers in the 1980's. (Wilton, 1981).

Klassen and Anderson (Kepner, 1982) found that young people were not much better informed about computers than the generation that preceded them. Their survey showed that mere exposure to computers is not enough to eliminate the myths that abound about the technology. Young people influenced by writers such as Isaac Asimov, and filmmakers are often convinced that computers can think and that robots are human-like in their appearance. According to Andrew Molnar (1978) computer illiteracy is a problem we must solve; computer literacy is as important to an information society as energy to an industrial society. (p.[illegible]). There is a need to make the computer an integral part of our educational system from primary grades to university. It is not enough to have a course introduced at the secondary level to introduce students to computer programming. There is a need to create within our young people a knowledge and an understanding of the uses of computers in society. They must become manipulators of the technology and not just be manipulated by it. The computer has made redundant some industries and occupations. It would be foolhardy for educators to overlook its implications and uses for education in the 1980's. Ignorance of computers will create a new form of illiteracy which is just as serious as a person's inability to function in the traditional "3 R's". Computer literacy has or will become a prerequisite to functioning effectively in an information society. It is, therefore, a responsibility of educators to ensure that computer related curricula are introduced into our schools so that our students will no longer be graduating with an incomplete education.

3. Implications For Educators

In addition to having knowledge about computers and their applications in society, educators need to be familiar with every aspect of computers as it relates to their profession. They need to be able to differentiate among the classes of the instructional/learning applications of computers and appreciate the roles of student, teacher and school. Educators must have the skills and knowledge to evaluate and select hardware and software, as well as develop strategies for their introduction into the school and school curriculum. Without such knowledge, the success of computers in education is not assured.

The success or failure of computers in education is as much dependent on the way they are introduced into the schools as it is on the expertise of the teachers in selecting suitable hardware and software for use in different educational settings. This is an important consideration for any teacher or school administrator. The success of computers in schools is dependent upon accessibility, portability and flexibility of the computer hardware and software. In order for schools to take advantage of a microcomputer's attributes - smallness, portability and "independence" - the microcomputer must be mobile. More will be said on this issue in a later chapter where the problems of integrating computers into the school will be discussed.

It is important for teachers to be aware of the three basic ways that computers can be used in schools. The computer can be used as the object of instruction; the information included in the first five chapters of this handbook is the type of instruction that would be given in this mode. A second way is to use the computer as a tool. Numerous software packages exist to offer the teacher a selection of programs ranging from simple drill and practice exercises to word processing or statistical analysis packages. The third function of computers in schools is as an aid to help teachers, school administrators and school board personnel to manage instruction more efficiently.

Chapter II

History of Computers

1. Pre-1940's

The first computer was probably the hands. The use of ten fingers for counting may have led to the decimal number system. The abacus (invented by the Chinese in 2600 B.C., and later developed by the Greeks and Romans) became a portable counting machine. The Romans began to use counting boards which were used for counting and calculating until the 1600's. As the need for more complex calculations grew, so did the development of calculators. The age of exploration and trade brought with it the need to be able to perform complex navigational calculations for ships. It was also an age which rendered obsolete the comparatively inefficient Roman numeral system and led to the adoption of the Arabic numeration system with its place values and concept of 0.

In 1614 John Napier first published a table of logarithms which eliminated a lot of calculations for mathematicians. They could now refer to Napier's table. Napier also invented one of the earliest machines to be used for multiplication. It was referred to as Napier's "rods" or "bones".

Another advancement in computer technology took place when Blaise Pascal, tired of adding long columns of figures for his tax collector father, invented a mechanized adding machine in 1642. It was called the "machine arithmetique". It was very expensive to construct and was never marketed successfully because human labor was cheaper.

In 1694 Gottfried Wilhelm Leibniz developed a machine that could multiply and divide. It was the forerunner of the present day mechanical calculators.

A great advance in computers took place in 1725 when Blaise Bouchon constructed a loom which was controlled by holes in a roll of paper. The holes in the paper "programmed" the loom to produce a particular pattern. In 1801 Bouchon's invention was modified by Joseph Marie Jacquard. His machine used punched cards to control the pattern of the weave. Over 1,000 needles could be controlled at one time to create very intricate designs. Needless to say, it reduced the amount of labour required for weaving cloth. Some modern day computers may still be programmed using punched cards. The cards may also serve as storage devices for programs or data.

Charles Babbage, considered to be the father of the modern day computer, developed the difference engine in 1822. It could be used to compute logarithm tables. Babbage began, but never completed, an analytical engine which had many of the characteristics of the modern computer. Information was to be input using punched cards and the results output on a printer. However, the technology of the day could not produce the precision tooled gears and levers necessary for it to operate. Although the mechanics failed the concept of a programmable calculator had been conceived. When Babbage died in 1871, technology still had not caught up to his ideas.

In 1854 George Boole developed rules of logic which is known today as "Boolean logic". These rules are based on true and false conditions. If two things are true, then a third must occur. The logic is simple but it is the simplicity of it that makes it so useful for computer applications. Boole's logic can be reproduced in electronic computers by on-off switches, or by the presence or absence of an electronic current, or by the presence or absence of a hole in a card. Noonan (1983) gives this example of Boolean logic: "If you are standing outside unprotected and it is raining, then you will get wet". (p.46).

Another development in the modern computer took place in 1890. The U.S. Census Bureau were concerned because it would take twelve years to tabulate the information gathered in the 1890 census. There was a need for a machine to complete the 1890 census before the one for 1900 was taken. Herman Hollerith developed a calculator which used punched cards and electronic signals to calculate the census data. As each card passed through the machine, metal pins were brought down on the card, passing through any holes in the card, completing an electronic circuit. Each time a circuit was completed, a number was registered on the counting dial. By 1892 the census date was processed. The technology developed by the industrial revolution, coupled with the use of electricity, allowed Hollerith to succeed where Babbage had failed.

In 1904 John Ambrose Fleming invented the vacuum tube which made possible such inventions as radar, radio, television, as well as powerful computers. The vacuum tube amplifies electrical signals which make it possible to use electrical impulses to process numbers, as in early electronic computers.

In 1924 Herman Hollerith's company became known as International Business Machines (IBM). It became the largest computer manufacturer in the world. IBM marked the end of an era; from this time on teams of inventors were assembled to replace the individual working alone. In 1937 IBM funded a Harvard University team of scientists who began working on an automatic computing machine. In Germany, Konrad Zuse was working on the construction of an electronic digital computer. In England, a group of English scientists under the leadership of Alan Turing was also working to develop an electronic computer that could decode German messages. This was a dedicated non-programmable computer. It was completed in 1943.

2. Post 1940's

During the 1940's the Second World War lent impetus to the development of computers. When the war was fought on battlefields such as the Sahara Desert, the military discovered that distance and elevation tables for artillary didn't work. John W. Mauchly, a physicist, and J. Presper Eckert thought that an electronic computer would be useful for calculating trajectories for artillary ammunition. In 1943 they began work on the Electronic Numerical Integrator and Calculator (ENIAC). It was constructed using vacuum tubes rather than mechanical relays.

Meanwhile, the IBM computer being constructed at Harvard University was completed in 1944. The MARK I (as it became known) was a monster. It measured 51.5 meters in length by 2.4 meters high and weighed 5 tons. MARK I contained over 800 kilometers of wiring. It could be programmed with punched paper tape and once the machine was started, it operated completely on its own power by electricity to work the mechanical relays and switches. The major drawback to the MARK I was frequent mechanical breakdown. It was also non-programmable.

The ENIAC was completed in 1946 and it, too, was massive. It weighed 30 tons and filled a large room. The ENIAC was capable of making computations 1,000 times faster than any other computer available at that time. In only two hours it solved a nuclear physics problem that would have required 20 men five years to complete. The major disadvantage was frequent breakdown as a result of vacuum tubes burning out. The computer had to be kept in an air conditioned room because of the great amount of heat generated by the thousands of vacuum tubes. Another problem was that the only way it could be programmed was to rewire parts of the machine, a time consuming task.

In 1949 Maurice Wilkes completed the construction of a computer known as the Electronic Delay Storage

Automatic Calculator or EDSAC. It used paper tape to input instructions and a teleprinter for the output of the results. The EDSAC was the first computer capable of storing programs. This was a tremendous breakthrough because now a program could be changed while the computer was executing instructions.

In 1948 the transistor was invented. This invention was to help create much more reliable computers since it was capable of amplifying a signal without producing heat. It was also much smaller than a vacuum tube and because it produced little heat, transistors could be placed close together. Computers could now be smaller, more reliable and operate without the help of extensive air conditioning.

By 1951 the first computer was being marketed commercially. Previously, computers were owned by governments and it was commonly believed that a country would only need one to meet its needs. The Universal Automatic Computer (UNIVACI), however, appeared on the market in 1951.

In 1953 the first "real time" computer was completed at MIT, the Whirlwind. This computer was referred to as a "real time" computer because it simulated an event in the same amount of time it would have taken to complete in real life. It was the first machine to use magnetic core storage which had been invented at MIT in 1949 by Jay Forrester. MIT engineers also invented test equipment that has been used all over the world to test computers.

The modern computer was born in the 1960's. In 1959 a method was developed to place an "integrated circuit" on a silicon chip. The "chip" has made it possible to produce smaller and cheaper computers. In the 1960's the minicomputer was constructed using electronic circuits placed on the surface of a chip. By 1970 the technology was available to construct what is commonly referred to as the microcomputer. It was possible to place 1,000 transistors on a single chip one quarter of an inch square. Once a master circuit is produced, it can be used to produce thousands of silicon chips cheaply. In 1972 when Intel produced the 8080 microprocessor chip, the microcomputer became a reality. Personal computer build-it-yourself kits were marketed in 1974. It was also in this year that the first commercially successful microcomputer was introduced (Altair). By 1977 RadioShack (TANDY) and Commodore began marketing a computer so simple, it merely had to be plugged in to work. They were soon to get competition from APPLE, Atari, and Texas Instruments when they entered the market in

1978-79. By 1978 65,000 transistors were being placed on a chip.

The development of information retrieval systems such as Telidon began to appear in North America and Europe in 1979. These systems make massive amounts of information available in seconds to their subscribers. Terminals have now been set up coast to coast in Canada so that people may have access to the information stored on a large central computer.

Cash registers in many stores are no longer mechanical calculators but computer terminals. They record the sale, deduct one from the inventory and make sure management is aware of a low supply of a particular item. Microprocessor based heat pumps, thermostats, and patient monitoring equipment have been available since 1980.

The computer of the 1980's is becoming smaller, more powerful and cheaper each year. They are much more reliable and flexible than the "monsters" of the 1940's and '50's. Equipped with voice synthesizers, they can speak, can recognize the audible word and compose music.

Chapter III

What is a Computer?

A computer is a machine that can manipulate and compare data. It is a "stupid" machine because it can do nothing except what it is instructed to do. Some refer to it as an electronic brain because of its ability to manipulate enormous amounts of data in seconds. However, the quality of the information put into the computer determines the quality of what comes out. As the saying goes, if garbage goes in, then garbage will be output by the computer. The central processing unit (CPU) is the so-called brain of the computer. It contains the control unit and temporary memory registers which control all the operations that the computer performs.

1. Kinds of Computers

Computers may be classified in a variety of ways: Mainframe, mini, or micro; dedicated or non-dedicated; analog or digital. The main classification is analog and digital. Analog computers are best used as measuring machines. They use springs, expanding liquids, electrical current, etc., to display results on output devices such as dials, scales or machines that plot graphs. Clocks, watches and speedometers are all examples of analog computers.

Many modern computers are digital. The digital computer uses digits or numbers to calculate and compute; it will not measure unless it is connected to an analog machine. According to Noonan (1983) they have five elements:

> 1. Input devices to put data or programs into the computer;
>
> 2. A control unit which contains the arithmetical rules that are used to deal with the problem;
>
> 3. Storage devices to store instructions and data;
>
> 4. A processing unit which figures out the solution to the problem by following instructions and using data;
>
> 5. Output devices such as printers which print out the solution to the problem. (p.66).

Digital computers may be classified into two main types - dedicated and non-dedicated. A dedicated computer makes full use of the digital computer's capabilities but is programmed by the manufacturer to perform a certain task or tasks. The user cannot change the program. The automatic washer has a set number of programs set by the manufacturer and the user must use the machine within the constraints of these programs. A very common type of dedicated computer is the electronic video game. Some word processors are also examples of dedicated computers.

A non-dedicated computer can perform a variety of operations when given proper instructions. It offers the user greater flexibility since he can program the machine to perform the task he wishes, within limitations. Non-dedicated computers are usually divided into three types according to size. But with the growth in the power of small computers, this distinction is becoming blurred. The largest is called a mainframe. It is used by organizations requiring a great amount of computer time. Governments and big business use this type of computer. Terminals may be set up throughout a building, or a country, to give users access to the service of this large computer.

The second type of non-dedicated computer is the minicomputer. Today the mini can perform some tasks as well as larger machines. (Edwards, 1978). It is commonly identified by its storage capabilities as well as expandability of working storage.

Microcomputers are the smallest of the non-dedicated computers. They can perform as well as some minis given sufficent storage, expansion capability and software. The "mighty micro" has found its way into the small business office, schools and homes.

2. Computer Hardware

The hardware is the "computer equipment that contains the circuit board, chips and other devices that make the computer function". (Noonan, 1983, p.71). The keyboard, tape recorder, light pen and disk drive are examples of input devices. Any of these can be used to put information into the computer. Some common output devices are: video monitor, printer, plotter, etc. A modem may be used to connect one computer to another by way of telephone lines.

The computer itself is the most important part of the hardware and in the computer the CPU is the most important part because it controls the operations. It uses electronic signals, called digital signals, to represent binary numbers which are sequences of 0's and 1's. A single 0 or 1 is called a bit. Eight bits or binary digits make up a byte. A sequence or group of bits treated as a unit and stored in one memory location is a word. (Lieberman et al, 1981). Reference to "8 bits CPUs", or "16 bit CPUs" or "32 bit CPUs" indicates the amount of information that can be processed at a time.

The 16 bit processor can process information much faster than an 8 bit CPU.

The CPU accepts instructions and carries them out using storage areas called registers to hold information within the CPU. The information is held in the registers temporarily while the program is running. The CPU is connected by a series of parallel wires, called a <u>bus</u>, to other parts of the computer such as memory.

"The computer memory is a long string of bits that are accessible in word sized chunks, 8, 16, or 32 bits at a time". (Coburn, et al., 1982, p.46). The CPU can get data from anywhere in its internal memory because each bit of information is given a labelled memory space which is called its address. The CPU can access the information in any address directly without having to pass any other addresses. This is why its memory is referred to as Random Access Memory (RAM). Information can be moved directly from RAM to the CPU as well as moved from the CPU to any RAM address. The computer will continue to store information in RAM only while the power is on; when the power is turned off, all data held in RAM is lost. For this reason, RAM is considered volatile.

Another type of memory is Read Only Memory (ROM). ROM is like an instruction manual. It contains a program which controls all the operations of the computer. The computer can take or read information from ROM but cannot store information in it. However, there are some types of ROM which can be changed. PROM or programmable ROM and EPROM, erasable programmable ROM can be modified. ROM is nonvolatile, i.e. it is not erased when the power is off.

Peripheral devices for storing data can be grouped into three categories: paper, magnetic tape and disks. Punched paper and cards are obsolete for programming, but paper will continue to be useful for output of information. Audio-cassette tape and tape drives are frequently used as external storage devices. The cassette tape is slow and comparatively unreliable, but a cheap means of storing programs. (Coburn, et al., 1982). Reel to Reel tape drives are much faster and more reliable but the cost is high. A good compromise is the floppy disk which is cheap and provides access to any spot on the disk in thousanths of a second. Disks are coated with the same surface material as magnetic tape and information can be recorded on both sides. However, the disk drive is considerably more expensive than cassette recorders. Another type of disk, the hard disk, is 10 times faster than the floppy and holds many times more information. It is made of aluminum and requires a very expensive disk drive. The CPU can write to and read from any of these storage devices.

There are a number of peripheral devices for the user. Computers, which use typewriter-like keyboards for input send off a set of electronic pulses each time a key is pressed. These pulses are changed into a one byte digital signal that reaches the CPU. The CPU stores the digital signal in its memory and sends a copy back to a video screen or a hard-copy printer.

Printers come in a wide variety of models, but there are only a few basic types of printing: the dot matrix which produces a type of print in which the dots are easily seen; correspondence quality printing in which the dots are not as visible; and letter quality printing which is achieved by a special typewriter attached to a computer or by the daisy wheel. The laser printer produces pages per second of excellent quality print.

Additional peripherals include key punch machine, card sorter, card reader, tape punch or key-to-tape systems, optical page reader (can read typewritten pages), mouse, muppet (network controller), acoustic coupler/direct line, product code scanners, speech synthesizers, voice recognition units and music synthesizers. This is not an exhaustive list, but will give the reader an idea of what is available in computer hardware. Noonan (1983) and Covvey and McAlister (1980) provide additional information for the interested reader.

However, one other peripheral device deserves some attention. It is the terminal. Most terminals use typewriter-like keyboards as their input component and output information via a Cathode Ray Tube (CRT) or hardcopy printer. Video terminals can output information faster and provide a more flexible medium for graphics (Coburn et al., 1982), but a hardcopy printer is usually required to record a session on the terminal.

There are two types of terminals - "dumb" and "intelligent". An intelligent terminal has a microprocessor inside it, while a dumb terminal leaves it to the "host" computer to handle the terminal's functions and communications.

A terminal may be located in another room, another building or another country. Terminals are usually connected to the host computer by telephone lines.

3. Computer Software

Generally, software is divided into two types: applications software and systems software. Systems software is comprised of programs put in by the manufacturer. It insulates the user against obscure and trivial operations of the CPU. It makes the computer do the tasks we want it to do. Systems software is essentially applications software for programmers, making it much easier for them to write programs. It controls the flow of data to the peripherals and makes it possible for several users to share one computer-timesharing system. Examples of systems software include operating systems, language interpreters or utility programs.

Applications software consists of programs that instruct the computer to perform such tasks as writing cheques, playing chess or testing students. Both systems and applications software are invisible. On an audio cassette tape or floppy disk, the instructions that make up a program are as invisible and intangible as the lyrics of a song recorded on tape or 45 rpm record. The software is necessary to bring the hardware to life and allows the user to interact with the computer.

4. Educational Software

Educational software consists of programs written specifically for use in education to aid in learning a particular subject or topic. The program may be designed to reinforce what has already been taught through drill and practice or to create a broader understanding of the topic through simulation models. More will be said about educational software (courseware) in the chapter on computer applications in education. Computer Assisted Instruction (CAI) and Computer Assisted Learning (CAL) make extensive use of courseware.

Chapter IV

Computer Languages

1. Binary Numbers/Machine Language

At the risk of being redundant, I would like to point out that the number system we have used all our lives is known as the decimal system. We use ten digits (0-9), probably because we have ten fingers. In binary code there are only two digits, 0 and 1. Combinations of 0's and 1's are used to represent all numbers and letters. The computer reads 1's and 0's by the presence or absence of an electronic pulse. A pattern of pulse and no pulse signals result in a combination of 0's and 1's to represent a character. The American Standard Code for Information Interchange (ASCII) is a binary code using 8 bits to represent 128 text and control characters. It has become the standard code for storing and transferring data. For example in ASCII 00000001 is A while B is 00000010. To change A to B in machine code a different bit is turned on. There are 256 different ways of arranging the 0's and 1's in an eight-bit byte. This is enough to represent all the symbols on the keyboard, with some combinations left over for things like colors and sounds and special characters.

If the binary system only uses two digits, 1's and 0's, how can you use it to count or perform mathematical operations? Remember that binary means 2. Values increase by factors of 2; the second column is twice the value of the first column. In our decimal system, numbers increase by factors of ten, i.e. decimal numbers are written in columns of ones, tens, hundreds, thousands, etc. Binary numbers are written in columns of ones, twos, fours, eights, etc. The decimal number for 13 is three ones and one ten. The binary number for 13 is

8 + 4 + 0 + 1

00001101 or simply 1101 or (1x8) + (1x4) + (0x2) + (1x1) = 13.

Another term used for binary code when it is used to program a computer is machine code or machine language. Writing a program in machine code would be a tedious and time consuming task. It can also lead to many errors. A simpler method was developed, Mnemonic Code, which uses machine code and English short forms. LD can be used to represent Load, D for Divide, RD for Read and so on. Since the part of the computer that translates mnemonics into machine language is called an assembler, the term assembly language was coined. Assembly language, because of all the codes and mnemonic symbols that are used, is still a difficult language to use. The big advantage of using it is that it uses memory space efficiently and a program written in assembly language runs very fast.

2. High Level Languages

Computers remained in the domain of the expert programmer until high level programming languages were developed. Machine code is a low level language using only numbers while the high level languages are more like the English we speak to each other. They use an interpreter or compiler to translate the language into machine code. Hundreds of high level languages have been developed, many of them designed to do one particular kind of work. Some examples of high level languages that use an interpreter are Beginners All-purpose Symbolic Instruction Code (BASIC), ADA, and PASCAL. Most microcomputers contain a BASIC interpreter chip. The advantage of the interpreter languages is that the user can interact with the program, modify, add, or delete parts of the program as often as needed and then run it.

Compiler languages are non-interactive and therefore have the disadvantage of not being easily debugged. The whole program has to be recompiled in order to make changes in it. Compiler languages are suitable for batch processing. Some examples are FORTRAN, COBOL, ALGOL and PL/1. The interactive languages such as BASIC are best suited for education because they allow the user to communicate interactively with the computer. Using compiler languages has been compared to letter writing. All the information is translated into 0's and 1's by the compiler before it is sent to the CPU to be executed. Interpreter languages are more like a telephone conversation allowing the user to make decisions based upon previous responses of the computer. It is similar to reading an instruction, executing it, reading a second instruction and executing it before going on to the third instruction. Lieberman, McFadden and Steeves (1981) used the chart shown on p. 29.1 to illustrate language relationships (Fig. 4-1).

A table on p. 30 lists some of the many computer languages that have been developed since the 1950's.

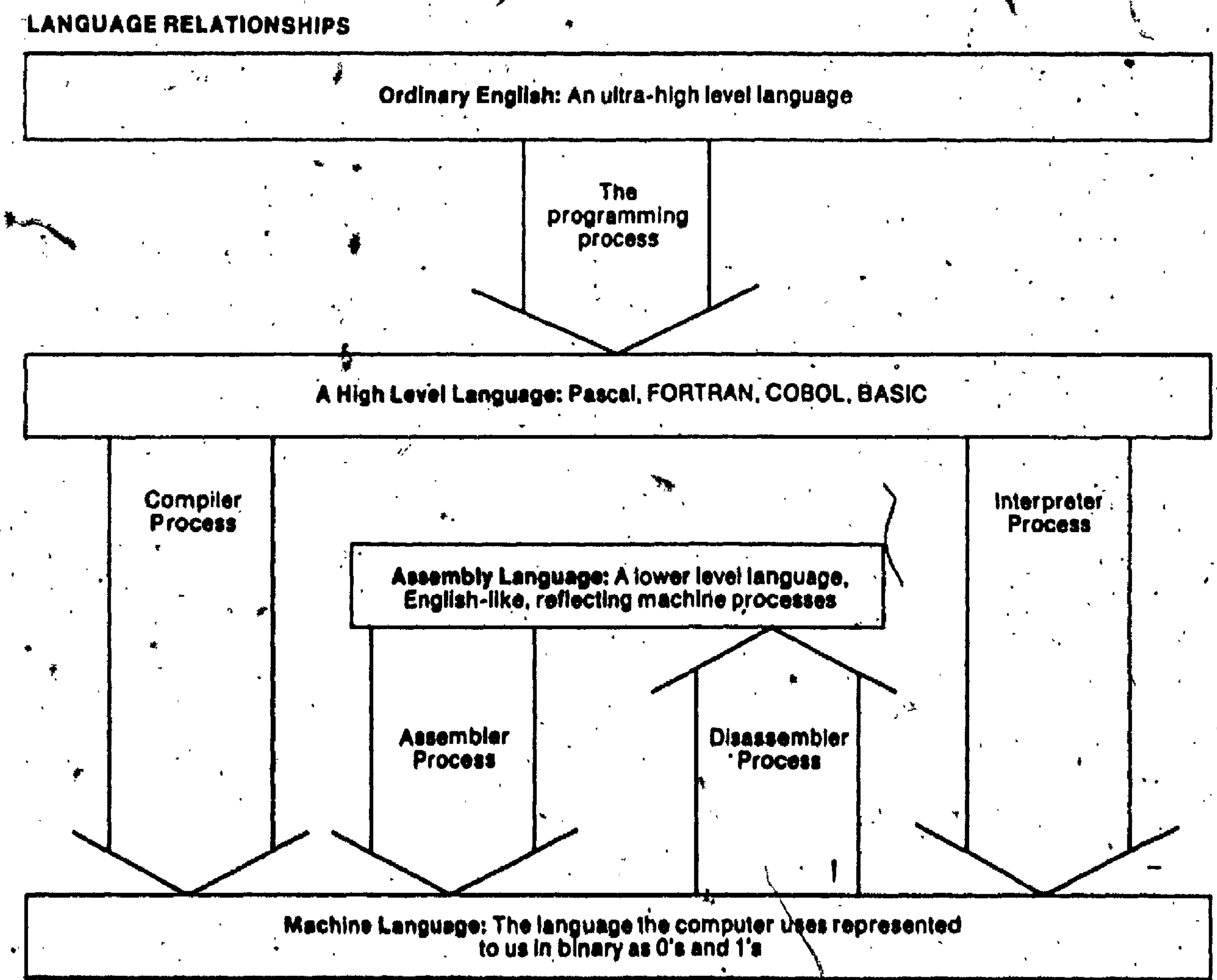

LANGUAGE RELATIONSHIPS
Ordinary English: An ultra-high level language
The programming process
A High Level Language: Pascal, FORTRAN, COBOL, BASIC
Compiler Process
Interpreter Process
Assembly Language: A lower level language, English-like, reflecting machine processes
Assembler Process
Disassembler Process
Machine Language: The language the computer uses represented to us in binary as 0's and 1's

Figure 4.1

COMPUTER LANGUAGES

Name	Initial Use	Application
FORTRAN (Form Translation)	1958	Scientific Language; Engineering and problem solving.
COBOL (Common Business Oriented Language)	1960	Business language, processing files, payrolls, lists, etc.
ALGOL (ALGOrithmic Language)	1957	Similar to FORTRAN: better suited for scientific calculations.
APL (A Programming Language)	1962	Interactive Application like BASIC.
BASIC (Beginners All-Purpose Symbolic Instruction Code).	1963-1965	Education to teach novices programming skills. Recreation.
PL/1 Programming Language	1966	Combination of FORTRAN, and COBOL: batch processing; interactive.
RPG II (Reports Progress Generator)	1969	Reports; payroll
PASCAL (Named for the French Mathematician Blaise Pascal)	1973	Designed for teaching programming as a systematic discipline.
ADA (Lady Lovelace's middle name-1st programmer)	1975	To provide a standard universal programming language - "The Language".
LOGO (Developed by Seymout Pappert at MIT)	1970	Education; very high level language. Interactive; facilitates teaching of math and programming to young children?

3. Ultra High Languages

As the power of microcomputers increase, so does their ability to interpret words of a spoken language. The ultimate would be to create a computer that could understand commands given by the human voice. LOGO and SMALLTALK while falling short of this goal, offer users the opportunity to program computers using a language closer to the one they speak. It is necessary to give the computer only a few commands to create a design that would require a very long complicated program to produce using BASIC. The commands produce concrete results that are immediately visible on the screen.

LOGO is a language which is presently available for some microcomputers, but its use is still not widespread. Commodore have developed a computer which has the capacity to interpret a version of LOGO (kidstuff). At present APPLE LOGO is much more sophisticated than Commodore or Texas Instruments Logo. Commodore hopes to be able to refine its version in the near future for the Commodore 64.

Another very high level language is being developed by the Xerox Palo Alto Research Center. The language is known as SMALLTALK. According to Kay (1977) "if the computer is to be truly "personal", adult and child users must be able to get it to perform useful activities without resorting to the services of an expert". (p.231).

SMALLTALK requires the use of a very powerful microcomputer because of its highly interactive nature. Everything in a SMALLTALK program is an object; each object can communicate with other objects and can be manipulated independently of each other. This type of manipulation requires a lot of memory space. The microcomputer that is being developed to handle such high level software is called Dynabook. Kay (1977) predicts the Dynabook will be the size of a notebook and be available by the mid 1980's. But he cautions that "communication with computers based on symbols as they occur in natural language" is difficult because "it is not yet understood how human beings do what they do".(p.236). However, SMALLTALK's use of parallel processing, allowing it to control and manipulate many objects at once, brings it a step closer to the way the human brain operates. It removes the user from the step-by-step tedium of program construction. It is important for a student to get a "good" first experience in programming because it can leave an impression that will last for years (Kay, 1977).

4. Implications For Education

These new interactive languages (LOGO and SMALLTALK), according to their developers, offer new and exciting opportunities for education. Kay (1977) believes that "children should have an active learning tool that gives them ready access to large stores of knowledge in ways that are not possible with mediums such as books". (p.231). SMALLTALK is still in the developmental stage and it is too early to tell if it will become the "active learning tool" that Kay (1977) talks about. It is enough to say that if microcomputers such as Dynabook become available in notebook sizes, they will probably infiltrate the schools in the late 1980's in much the same way that calculators did in the 1970's.

The proponents of LOGO, most notably Seymout Papert himself, are not shy in pointing out the impact that LOGO could have on instruction in the schools. According to Papert (1980) it will lead to a new "style" of thinking. LOGO creates a microworld in which children can explore and experiment with complex mathematical concepts. The experience of being able to design various geometric shapes by directing a cybernetic turtle on a computer screen can result in a new degree of intellectual sophistication. Papert (1980) argues that through teaching the turtle mathematical concepts they lose their fear of mathematics and this will lead to an improvement in other subject areas. LOGO offers the opportunity for children to learn mathematics in a computer based microworld where learning new mathematical concepts is as simple as learning French in France.

If Papert's thesis is correct, then the role of the teacher will have to change. Much more emphasis will be placed on "learning by doing". The classroom will be less teacher oriented and more child activity centered. The computer will be transformed from "tutor" to "tutee".

However, in spite of all the claims made in support of LOGO, there is very little data to support such positive assumptions. In the words of Ragsdale (1982) "the claims that programming instruction helps develop logical thinking, problem solving skills, and creative writing ability, need further investigation". (p.20). There is certainly a need for caution. Conservatism still has its place in education.

Nonetheless, it is reasonable to assume that programming does help a child to think more logically and precisely about a subject. Teachers learn a great deal from explaining a topic to others. The use of LOGO will provide an opportunity for even a very young child to teach a computer. But more study is needed to substantiate claims that programming a computer allows a child to grasp concepts more quickly than he would without a computer. As the use of high level languages increases, there will no doubt be documentation to substantiate or dismiss the assumptions of the LOGO group.

Chapter V

Computer Programming

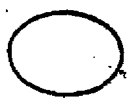
Just how much programming skill is required in order to be considered computer literate is a matter of controversy among the proponents of computer literacy. It is very difficult to consider a person literate if he has mastered none of the skills of reading or writing. A computer literate person needs to be familiar with computer languages so that he can write short programs; be able to modify existing programs to perform the operations required for a specific task; and have enough knowledge about programs so that he can evaluate commercially prepared programs or programs that are available in the public domain.

1. Algorithms and Flowcharts

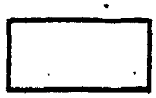
A program is a list of instructions or a series of steps for solving a problem written in some programming language such as BASIC. To write a program for a computer you must first study the problem very carefully and work out the main steps needed to achieve the result you want. The instructions for each stage will have to be broken down into even smaller steps which can be translated into a language that the computer can understand. Algorithms - a step by step procedure for performing some function - are useful in writing programs for a computer.

In order for the computer to perform the task that you want it to do, each instruction must be clear and have only one meaning. If there are any errors or "bugs" in the program, it will not run or will give you the wrong results.

Flowcharts, diagrams drawn to illustrate the algorithm, are useful for a programmer (not all programmers agree that flowcharts are necessary or helpful). A series of geometric shapes connected by arrows are used to represent a variety of functions. Each geometric figure has its own function in the chart:

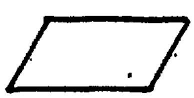


An ellipse is used to start or end the procedure.

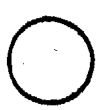


A rectangle is a processing box. It indicates the operations to be performed by the computer.

Decision diamond. It indicates the program branches in different directions, depending on the decision made.



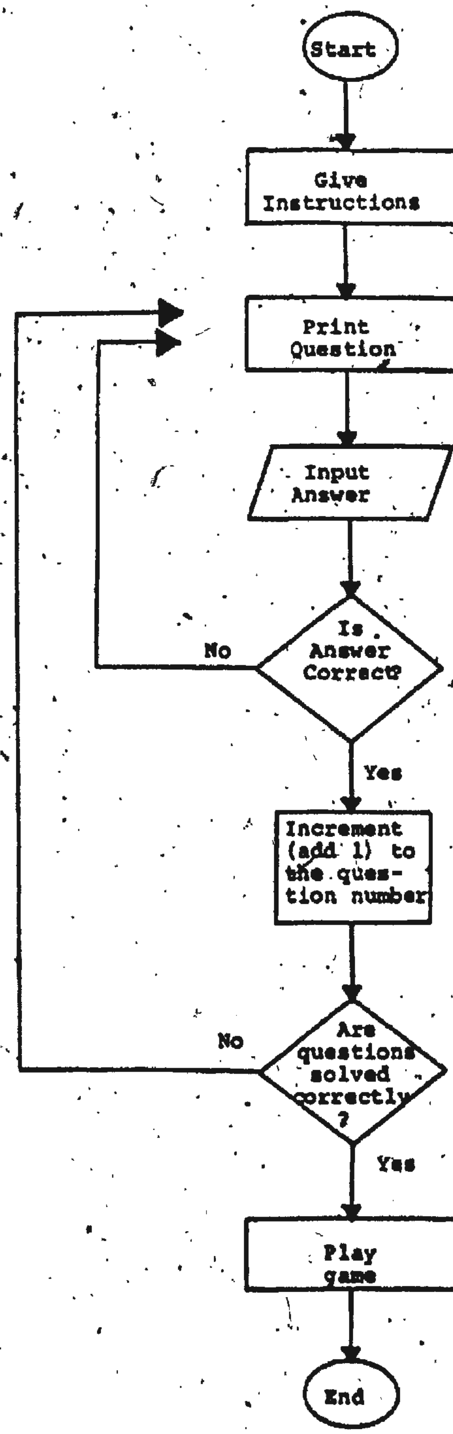
Input/output parallellogram. Indicates input from the keyboard, diskette or tape or output to the screen, tape, diskette or printer.



Continuation - indicates the program continues on another page. The page number is written in the circle.

The following is an example of a flow chart designed to drill students in mathematics (Noonan, 1983). (See page 38).

Fig. 5-1: Flowchart designed to drill students in Mathematics.



2. Programming in BASIC

The program is now ready to be translated into BASIC and debugged on the computer. It would be unusual for the program to work the first time it is tested on the computer because there may be errors of logic or mistakes made when the program is typed into the computer.

There are many words in BASIC that are the same as in English and are, therefore, easily understood. The following is a list of such words and their meanings:

PRINT	- to display on the screen
INPUT	- requires the user to give the computer information. It allows the user to input information while the computer is running the program.
RUN	- asks the computer to execute the program.
LET, DATA and READ	- commands are used to input information into the computer. For example:

LET A=6; READ A, B; DATA 6, 231.

A one line statement may be entered by the LET command.[1] Larger amounts of data may be stored via the DATA command while the READ command translates these numbers into variables.

The order of arithmetic operations on a computer are:

Function	Operator	Example
Parenthesis	( )	(5+3)
Exponentiation	↑	3↑2*
Multiplication	*	2*3
Division	/	4/2
Addition	+	2+5
Subtraction	-	6-3

* Same as 3^2

The computer, if given the PRINT command, would execute the following statement in the order of precedence illustrated below:

$$(9^{3}+[\overset{1}{(6+5)}*^{2}3]^{4}-7]$$

The computer may be used in the immediate mode, or the programming mode. In the immediate mode it can be used as a calculator or to display messages using the PRINT command. The information may be spaced using the semi-colon; or comma,. The TAB command and Spc are also useful for organizing information on the screen. TAB (20) will place the data in the centre of a forty character screen, while Spc (2) 4 and Spc (6) 7 will place the 4 two spaces from the left of the screen and the 7 six spaces from the 4. A sample operation in the immediate mode looks like this:

```
PRINT "RUBBISH" (Press RETURN)
     RUBBISH
```

In the programming mode each line must start with a number. This first line can be assigned 10, the second

20, the third 30 and so on. The RETURN button must be pressed before you start a new line. After the program is typed in and the program is checked for errors, type RUN and press RETURN. The computer will execute the program if it is error free. If the computer tells you there is an error, type LIST and the program will be displayed on the screen. The error can then be corrected by retyping or editing the line in which the error occurs.

Before the computer can become something other than a calculator or display machine, it requires information or data.

When data is entered into the computer, either through the LET or READ...DATA, or INPUT commands, you have to give it a label so that you can find it again. Usually letters of the alphabet are used to label a memory space. A labelled memory space is called a variable because the contents of variables can change during the program. A variable containing a number is called a numbered variable - real numbers are represented by A, while A% represents an integer variable. One which contains letters and symbols, A$, is called a string variable. The DATA items must be separated by commas so that the computer can identify each item listed.

For numbers, a letter may be used such as 10 INPUT A, and for words a line such as 20 INPUT A$ is entered. When the computer processes the command INPUT in a program, it puts a label on a memory space and prints a question mark to ask for the data. After you type in the data, the computer stores it and goes on with the rest of the program.

One of the greatest differences between a calculator and a computer is the computer's ability to compare data and then do different things according to the results. It can test to see if two pieces of data are equal, or greater or less than the other. To do this you use the IF...THEN commands. Words, numbers and variables can be compared. You can give the computer one of a few instructions after the word IF: GOTO, THEN, THEN...GOTO. A useful instruction is to instruct it to go to another line by typing GOTO. GOTO on its own can be used to create a loop or continuous loop. Another way to repeat the same loop a number of times is to use the commands FOR..NEXT.

Programmers also use subroutines. They are sort of a mini-program within a program. They carry out particular tasks and you can direct processing to one whenever you want that task carried out. The subroutine saves writing out the lines each time and makes the main program shorter. It is useful for carrying out any task which you want to repeat several times at different stages in the program. It is entered into the program by typing 50 GOSUB 100. The subroutine must have a RETURN line to direct processing back to the instruction after the GOSUB line.

Smith (1982) provides the following checklist for typing in programs:

> 1. Before typing in a new program, type NEW. This clears any old programs out of the computer's memory.
>
> 2. When you are typing in the program, remember to press RETURN...at the end of each line.
>
> 3. After typing in the program, check all the lines on the screen to see if there are typing mistakes. Make sure none of the lines are missing.
>
> 4. Next type CLS (or your computer's word) to clear the screen. Then type RUN to start the program.
>
> 5. Type LIST to get the program back again to check it or alter a line. To display one particular line, type LIST and the line number, but check this command as it varies slightly on different computers.
>
> 6. To stop the program while it is running type BREAK or ESCAPE.... To start the program again, type RUN.
>
> (p.15)

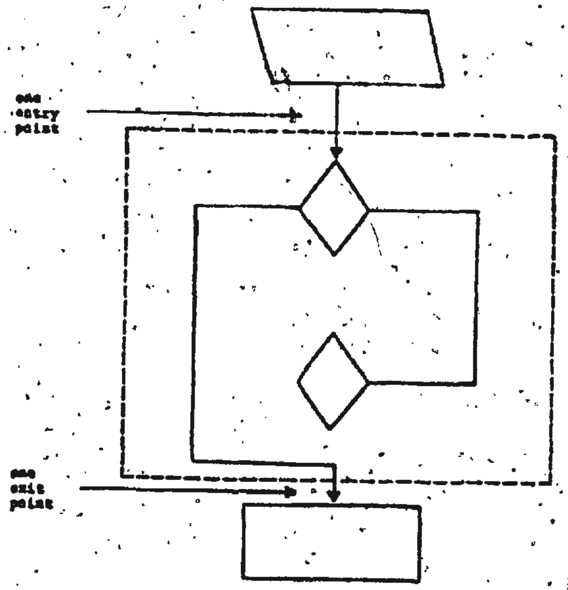
To assess a program stored on cassette tape, Noonan (1983) gives the following sequence of steps to follow: plug in the computer and turn it on; rewind the tape; type LOAD on the computer and press the RETURN key; press the play button on the cassette recorder and wait for the word READY and a flashing cursor; type RUN on the keyboard and press the RETURN key. (p.12).

3. Structured and Unstructured Programming

Structured programming involves writing an algorithm, rewriting each step over and over until the words from a high level language such as BASIC can be written for each step. PASCAL, ALGOL, PL/1 and Waterloo BASIC are considered structured programming languages. Lieberman et.al. (1981) states:

> "Structured programming languages provide greater readability and clarity to a program by using modular constructs in the language. They greatly reduce errors in logic and also decrease the time and cost in writing programs." (p.59).

A structured program is built from smaller parts called modules. Each module is connected to the part before it by an entry module and followed by one exit module. These modules may be used independent of the main program or transferred to another program. The following diagram illustrates a structured programming module.



The simplest way to explain unstructured programming languages is to compare them with structured ones. Unlike structured languages, they are more difficult to read and may not always reflect the logical divisions of the problem. Two popular unstructured languages are BASIC and FORTRAN. A novice programmer is likely to write unstructured programs.

4. Programming in LOGO

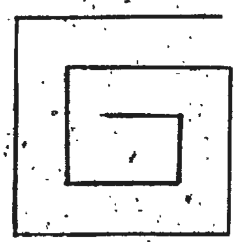
Using the commands listed below, the very young child can program the computer in LOGO:

FD - FORWARD	: (identifies input values required)
BK - BACK	TO
RT - RIGHT	DRAW (immediate mode)
LT - LEFT	SAVE (Saves program to tape, disk, etc.)
REPEAT	LOAD (Inputs programs into computer)
PENUP	PENCOLOR = (Selects color of pen)
PENDOWN	BKCOLOR
RANDOM	
IF	
PRINT	
STOP	

FORWARD (FD), BACK (BK), RIGHT (RT), and LEFT (LT) commands give directions to a "turtle" on the computer video screen. For example, FD100 instructs the turtle to go forward 100 "turtle steps"; PENDOWN instructs the turtle to begin drawing on the screen; REPEAT commands the turtle to continue drawing the design over and over again; the PENCOLOR= command instructs the turtle to draw the design in a color selected by the user while BKCOLOR allows the user to select a different background color. A command such as RT 90 FD100 would direct the turtle to turn right 90° and move forward 100 turtle steps. By repeating this instruction four times, the turtle can be directed to draw a square. The student labels the figure (whatever name the student wants to give it) and the computer remembers how to draw it. Each time the student types "To SQUARE" on the keyboard, the computer will produce a square. Once the computer has been taught to SQUARE, SQUARE can be used to draw more elaborate designs.

More elaborate designs can be created by using command SQUARE E:Dist. (x) (this variable allows the programmer to insert any number for the variable x). Another command is To STEP:Dist. It is useful in creating a spiral effect.

```
ToSTEP:Dist.
FD Dist.:300 stop
STEP Dist. +5
```



By experimenting with LOGO, children can produce some very elaborate designs on the computer.

Chapter VI

Societal Issues

1. Differential Access to Computers

Access to computers, in the home or in school, is bound to create new problems or reinforce existing social problems. The preliminary information indicates that students from higher socioeconomic levels are more involved with computers, in and out of school, than those from less advantaged backgrounds (Coburn et al. 1982). It is generally accepted that students enter schools with a wide range of abilities and skills. If computers become an integral part of a child's education from kindergarten to university, what effect will it have on the socially disadvantaged children who have no access to a computer at home and not as much involvement with computers in their schools? Will the gap between the level of achievement of the affluent students and the lower class students widen? Already more affluent school districts are making greater use of computers in their schools. Even if all school districts implemented the use of computers in instruction in the same manner, the problem would not necessarily disappear. Try to imagine the difference between the attitude toward computers of a child who hasn't used a computer before entering school and one who has spent months at computer summer camps. Computer summer camps are combining with schools to give the upper class child every possible advantage. The social implications of computer use in the schools need to be studied and recommendations made to overcome them.

Another social problem that computer use in education may exacerbate is the reinforcement of sex-role stereotyping. In many schools it has been observed that boys have a tendency to use computers more frequently and for longer periods of time than girls. The computer room is occupied before and after school by boys only. Very few girls show interest in computer clubs or enroll in computer programming courses. Coburn et al. (1982) wonder how much attention schools are paying to these kinds of side effects in their planning.

2. Security of Information/Privacy

Information was first passed by word of mouth; later it was transmitted by words written on paper; but today's communications systems transmit information in the form of electronic pulses, radio waves or sparks of amplified light. The modern computer has made possible the transmission of thousands of bits of information per second to any part of the world. The transfer of information and storage of data in computer files has created a problem of security. The technology that has made the computer very efficient has also made it very vulnerable to the information burglar. Much of the information stored on computer is personal and/or private. It is important that it not be accessible to a third party.

The weak link in a computer network is its dependence on telephone lines. For educators, a real concern is privacy. Who will have access to student and/or teacher records? How difficult it is for someone to "break into" the computer files and change the content of the records? Security of information is a major concern for network users.

Closely related to security of information is the privacy question. How much information should a business or government agency be permitted to collect on a person? Information is often collected and stored without the individual being aware of it. Only recently has the law changed requiring credit bureaus to reveal the information in a person's file. Until recently loan applicants could be refused credit without explanation and could not read what was in their file at the credit bureau. The question of how agencies use the information may be more important than the fact that they have it.

Much of the information is important and when used properly can be beneficial to us. However, there is a very real possibility that this information could be misused. If it is being misused, or even if it isn't, should we be permitted access to all information about us that is stored in data banks? This is a difficult question. Noonan (1983) identifies two major problems associated with the collection of information in data banks: "the misuse of personal information"... and "accidental errors in the data about us" ..." (p.297). As the home computers are brought into use for banking, and storage of all personal and financial records, privacy will become an even greater concern.

3. Computer Crime

In the past decade, legislators have become increasingly concerned about a new type of criminal. He is a programmer who has access to the computer system, or else is technologically sophisticated enough to crack computer "locks". Computer crimes range from university students stealing time on a computer network to cracking the security system of a bank's computers, and then ordering them to place funds into an account that the criminal has taken out under a fictitious name. A recent CBC report on computer crime claimed that the average computer criminal "earns" an average of $450,000 for each crime. The availability of microcomputers and modems make the big computers accessible to the ingenious criminal. The same method could be used to sabotage or erase government files or company records. D'Ignazio (1981) raises the spectre of a nation being held to ransom by a terrorist group threatening to destroy national computer networks. There would be no easy way to track them down; it might take months and cost billions of dollars. The highly computerized nations would be most vulnerable to this type of attack.

Fortunately, most computer crime is more trivial. Manipulation of interest by the programmer or a person with access to a bank's computer has been documented. It occurs when interest is rounded off to the nearest cent. The fraction of a cent was diverted into the criminal's account, netting him between $17,000 and $70,000 before his actions were discovered. (Noonan, 1982).

The inability of the courts to successfully prosecute computer crime, even when it is discovered, was demonstrated in a case involving University of Alberta students who were using the university computer for their own part-time business. The authorities didn't know what charge to lay against them. Eventually they were charged with "fraudulent use of a telecommunication facility". The Supreme Court of Canada ruled that a computer was not a telecommunication facility, and the charges were dropped. The law has not kept pace with the technology. (Noonan, 1983).

In another case in Nova Scotia, information was stolen from a large university computer. Thieves used university paper to print out the information. Since nothing had been physically removed from the computer, they were charged with theft of the paper and found guilty of that offence only. (Noonan, 1983).

The use of magnetic ink to print branch, bank and account numbers on cheques so that they can be read by computerized machines has provided an opportunity for cheque fraud to occur. Noonan (1983) reports that one American criminal netted over $100,000 before the crime was discovered.

Noonan (1983) cites a number of reasons why computer crime is such a problem. The number of computers in use is increasing rapidly and the number of people with expertise to break into computers is increasing each year. The number of assets, both monetary and otherwise, protected or controlled or recorded by computers is very high. Computer crime is very profitable and the chances of being convicted are low. Lawmakers have not been able to create new laws for the authorities to prosecute computer criminals successfully. The legislators, as well as members of the general public, must become more computer literate to successfully combat computer crime. Judges and juries need to know a great deal about computers in order to hold a proper trial. Perhaps in time, computer experts will be permitted to testify as to the contents of tapes, diskettes or cards in the same way ballistics experts testify as to the identification of murder weapons.

Throughout the history of computing, there has been more emphasis on the development of new technology than on security. Recently more emphasis is being placed on better security systems. Using teams of programmers reduces the chances of a programmer making a part of the program work for him, since neither of the team members is involved at every stage of program development. Regardless of what precautions are taken, computer crime will continue, but hopefully a more secure system will emerge.

4. <u>Employment/Unemployment</u>

Throughout our history, technology has reduced the dull, trivial, tedious and dangerous tasks that man was required to perform. It has been a common practice in the history of mankind for new inventions to change our lives and the way we live. The printing press, the steam engine, electricity, the automobile, the transistor and the integrated circuit have combined with other inventions to create a lifestyle that we have come to accept. Each new invention brings positive results to many, but it has also brought suffering to the workers who are supplanted by it. Jacquard's loom, considered so significant in the history of computers, led to a reduction in employment for weavers. The Industrial Revolution led to the destruction of cottage industries, but later provided employment in the cities that sprang up around the factories.

It is common for writers to say that we are no longer living in an industrial society. We are living in a new age: a post industrial society has emerged in which the main ingredient is information. LaConte (1982) states that information is the energy that fuels the new age. He points out that fify per cent of all jobs in the United States are related to storage, analysis, processing and transfer of information. LaConte (1982) talks in terms of an Information Revolution which will transform our society just as surely as the Industrial Revolution did in the last century. The big question is "how".

Just as the Industrial Revolution spawned new jobs, the "high tech" industries of the Information Age will create alternate employment. New industries are developing to produce the tools for using, accessing, storing, processing and retrieving the massive amounts of information. The manufacture of computers and related hardware has already created many new jobs. High tech companies are being courted by governments who recognize their future potential for providing employment. The high tech industries, however, only require a small number of manufacturing plants, reducing the possibility of employment in many areas. Added to this problem is the practice of exporting components to third world countries for assembly by low cost labour. Still there is increased demand for people in computer related occupations: keypunch operator, computer designer, computer programmer, computer operator, computer analyst, computer teacher, computer technician and computer consultant.

During the period of transition from an industrial society to an information society, there will be increased unemployment. It is perhaps ironic that Japan, a country devastated by bombing during World War II, should emerge as the world's industrial leader in the 1960's and

1970's, One of the reasons they were able to do so was because they didn't have any industrial dinosaurs to dispose of. They were able to start "fresh", while Britain continued to produce in outdated factories. New technology, combined with dedicated workers, gave the Japanese a competitive edge over most of the western world. The problem for Canada is to use the high technology to increase its productivity, without creating more unemployment.

The period of transition will be painful. Men and women, secure in their trades, will find that their job skills are no longer marketable. The assumption that a people can be trained for jobs in their youth which will last a lifetime is no longer valid. The problem then is not simply to produce a new computer literate generation, but to create a system that will make all of society computer literate. Who will educate the adults? Persons trained in traditional trades are very vulnerable. Many have identified the schools as being the most vulnerable in this computer age. Some have predicted that formal schools will disappear completely, while others believe they will survive in a modified form (Thowaldson, 1980). Some foresee a radical shift to a home-and-job-based education. People who are working in relatively unskilled jobs will probably be affected the least (waitresses, truck drivers, janitors). Of course those fortunate enough to have already acquired computer related skills are in an enviable position.

In the post-industrial society, the big powerful unions of the 1970's have already become less powerful as their membership declines due to increased unemployment. As the power of unions declines in a competitive job market, manufacturers will increase their efforts to automate their plants. It is probably not accidental that Japan, the most automated nation in the world, has no unions. With the decrease in the power of the third party and its ability to protect its membership, there is an increased responsibility for governments to ease us into the information age with as little pain as possible.

5. Computers and Young Children: A Developmental Issue

There is no questioning the allure and popularity of computer simulation video games. Evans (1979) attributes their strong appeal to the challenge of overcoming a competitor, but more importantly, it offers "an exciting simulation of one's fantasy life". (p.97). No one knows what the long term effects of this new preoccupation will be. Evans (1979) voices concern that we have not even begun to formulate the right questions. This is perhaps not surprising when one considers that the phenomenon is so new. It will probably not be until the present generation of school children have become adults that the first effects will be felt.

It is not only games which have led to children spending a great amount of time interacting with a machine. Parents are encouraging, and sometimes pressuring, schools to involve their children in some form of computerized instruction. If they feel their children are not given enough exposure to computers in school, they purchase their own computer. An increasingly more common alternative is to send their children (including pre-schoolers) to computer summer camp. Canoes go unused as the children stay inside to work with computers.

Barnes and Hill (1983) ask the question: Should young children work with microcomputers? They concluded that "... a preoperational child would not be harmed by contact with a microcomputer. However, experiences with a microcomputer should never replace their experiences with real events and objects". (p.11). Preoperational children (those below 7 or 8) are active, and need to be active physically. The computer engages them mentally and emotionally, but allows no opportunity for mobility, no chance to manipulate three dimensional objects. The child learns problem solving skills by stacking building blocks or by fitting pots and pans into each other and by interacting with people. Real life situations offer the opportunity for open ended experimentation. Without concrete experiences, the child will not posses the foundation to formulate the abstractions the computer requires of the user. Such concepts as "above" and "below" are learned very naturally in the real world, probably much more so than on a computer screen.

A major area of learning for young children is language acquisition and it is learned through interacting with other children and adults. Social interaction is also essential to developing attitudes and feelings of concern for others. These requisites for good interpersonal relationships can only be fostered through social interaction. Barnes and Hill (1983) state that "children at micros are not getting the opportunity to actively manipulate three dimensional objects in the physical world; discover cause and effect relationships through experiences (kick and be kicked); or develop concepts and language through involvement with others." (p.12).

LOGO, a language considered by many to hold great promise for introducing primary students to computers, offers children an opportunity to experiment and explore in a microworld. However, LOGO requires the user to learn a set of commands before the experiment is possible. These commands (RIGHT, LEFT, FORWARD, etc.) are abstractions that the child cannot understand without concrete experiences in the real world. Papert himself credits his fascination with gears and wheels as a child for his success in being able to concretize abstract mathematical concepts. He hypothesizes that the "turtle" in the LOGO microworld offers children the same opportunity to "externalize" their thinking.

Despite all the optimism of Papert and his supporters, there is a paucity of documentation to back up their claims. Barnes and Hill (1983) advise caution and urge parents to allow their children to play with "Lego" before LOGO. The effect of computers on children is unknown. At present, it may be impossible to measure the full impact but a beginning must be made, even if it is only to determine what types of questions should be asked.

6. Limitations of Computers/Artifical Intelligence

Because computers can perform calculations, answer questions, store information and process it at high speeds, some people have come to regard them as intelligent. A more common label applied to the abilities of computers is "artificial intelligence". One of the difficulties in determining whether or not a machine is intelligent is the difficulty of formulating a precise definition of intelligence. The Oxford English Dictionary's definition demonstrates the ambiguity and circularity involved in most attempts to come to grips with a clear explanation. It defines intelligence as "the faculty of understanding; intellect". But what do understanding and intellect mean? The Oxford English Dictionary offers the following: "to understand" is defined as being "to apprehend the meaning or impact of; to judge with knowledge; or to comprehend and reason". Intellect is defined as "the faculty of mind or soul by which one knows and reasons; power of thought; understanding; rarely used in reference to lower animals".

Evans (1979) identifies "the ability to perceive relationships between objects and patterns, to solve problems of varying complexity and to see fresh ways out of mental puzzles" as intellectual ~~activities.~~ (p.156). He states that many animals are capable of performing these tasks. How about lower life forms? Is it possible to accept machines as being intelligent? The answer to the latter question is often "no". "Computers can only do what you tell them to" is a frequent remark. The other side of the question is: doesn't a young child with little experience have to be told how to behave? Humans have been programmed by their environment for millions of years.

Evans (1979) gives a basic and fundamental definition of intelligence. "Intelligence is the ability of a system to adjust appropriately to a changing world, and the more capable of adjusting - the more versatile its adjusting power - the more intelligent it is". (p.157). He then illustrates or expands on his definition by identifying six principal factors that make a creature flexible or versatile in the way it adapts to its environment.

The first factor is "sensation" or "data capture". An entity is intelligent to the extent that it can extract information from its environment through sensory perception. The better its sensory abilities are, the more intelligent it is.

The second principal factor is "data storage capability". The intelligence of an entity can be measured by the amount of information it can store and how well it can use the data collected to improve its ability to adjust.

The third factor is processing speed. Processing speed refers to the switching speeds of neurones in animals and microtransistors in computers. The computer brain can operate a billion times faster than the human brain according to D'Ignazio (1981), but the human brain is able to process large numbers of commands at the same time. The computer, on the other hand, processes information one instruction at a time.

There are some similarities between the human and the computer brain. They both use electrical impulses organized into a binary code (1's and 0's) to store and transmit information. In the human brain, neurones act as switches; the computer uses micro-transistors. The speed with which the "brain" can process information is usually considered an indicator of intelligence.

A fourth factor is software flexibility. An entity is intelligent to the extent that its programs can be easily changed and modified. This would be crucial to the creation of an intelligent machine. Any intelligent entity must be able to change its programs or create new ones if necessary. All biological entities have the ability to do this internally, while a computer's program must be modified or rewritten externally by a human. Until machines reach a level where they can self-program, they cannot be regarded as intelligent. However, computers have been taught to play chess, checkers and tic-tac-toe and to improve their playing skill with each game played by remembering the errors it made in the previous game. Chess playing robots have now improved their skills so much that they can beat top-ranking amateurs.

A fifth factor identified by Evans (1979) is software efficiency. Unless programs are written in very precise language, a lot of processing power is wasted and the program runs very slowly. Human software has become efficient over the millions of years that man has been dealing with a harsh environment. Inefficient programs led to death so there was strong motivation to create very efficient programs. Computer software remains inefficient because it is new and doesn't carry the same potential for disaster that human programs do. D'Ignazio (1981) points out that the U.S. military are already conducting research into the possibility of connecting the human brain to a computer. Depending on your point of view, this could lead to a more intelligent human or more intelligent machines as the person will be able to "think up a command and send it directly to the computer's brain". (p.92).

The final factor that makes a creature versatile and flexible is software range. The "brain" must be equipped with a wide range of software with which it can cope. The greater the variety and number of programs that are available for the central processor, the more intelligent the machine will be considered.

A test designed by Alan Turing, known as the Turing Test, was supposed to determine a computer's ability to think. The test requires two persons and a computer. The computer and one person are positioned on one side of an opaque screen while the person testing the computer sits on the other side. All three can communicate with each other by means of a keyboard and video screen. The person sitting alone asks questions via the keyboard, but is unable to see which one responds. The purpose is to see if the questioner is able to tell if the human or the computer is responding. On such subjects as chess, bridge and mental health, the computer has passed the test. However, the computer has consistently failed tests when it was questioned on a wide range of subjects.

Perhaps it may never be possible to create a truly intelligent machine. The problems range from our difficulty to create a precise definition of what intelligence and thinking is, to developing a self-programmable machine. Many feel that until a computer can experience emotions and write poetry and music, it cannot be considered intelligent. It is unfair to compare the ability of computers to the human creative geniuses because not all humans, even those who are highly intelligent, could create such masterpieces as Bach or Michaelangelo.

Chapter VII

Computers in the Information Age

1. Information Retrieval Systems/Telidon

A computer was important in the 1940's for performing calculations that would require the human brain a long period of time to complete or solving problems which humans could not otherwise solve. More recently systems have been developed to store information in computer data banks so that it can be recalled for later use. A great deal of data from printed material such as books, journals, and papers can be stored in relatively small areas by the use of computers. In an information society knowing a great deal of information is not as important as being able to get this information when needed. Furthermore, the computer can make the information available much more quickly than conventional means of retrieval. Many countries have developed their own information retrieval system.

One of the most advanced information retrieval systems has been developed in Canada, Telidon. The Federal Department of Communications describes Telidon as "an advanced and easy-to-use videotex system that uses the newest developments in graphics, telecommunications and computer technologies". Videotex is a two way communication system that links a television set to computers and data banks. Videotex adapters can be attached to or built into home TV sets, turning them into computer terminals which can draw information from the memory of other computers. Telidon also allows users to send information back, a form of electronic mail.

The broadcast version of videotex is teletext. In this system the information is broadcast over the spare or unused lines of a TV signal or over a cable TV channel. It is transmitted in high-speed bursts every few seconds. The information is accessed via a keypad or keyboard. The user simply pushes a button(s) to select the information from the menu.

A Telidon System consists of three components:

- data bases connected to a central computer;
- a modified TV set with a push button unit like a pocket calculator or a keyboard like a typewriter, for getting or sending information;
- a transmission link, such as telephone lines, cable, optical fibres, television broadcast, satellites or even laser.

(Telidon, Dept. of Communications pamphlet).

The adapter, once installed in your TV set, decodes the information sent to the TV by the central computer. The computer signals show up on the screen as printed words, graphs or pictures. The information is available instantly when you want it. Telidon and other systems for information retrieval can provide many different kinds of information and services. Noonan (1982) lists these examples:

> . banking
> . ordering goods from stores
> . tourist information
> . obtaining and confirming bus, rail, airline and hotel reservations
> . mail orders
> . bibliographic data
> . comparison shopping
> . weather forecasts
> . stock market updates
> . job openings
> . apartments for rent
> . real estate information and prices
> . displaying white and yellow pages of the phone book
> . traffic reports
> . education, business and commercial research
> . electronic mail
> . educational instruction
> . television listings
> . local live theatre and movie theatre listings
> . taking surveys of public opinion
> . interactive games
> . displaying books on the monitor from a library, page by page, for the user to read
> . telemonitoring for fire and other alarms
>
> (p.240)

Readers interested in Telidon may visit the Arts and Culture Centre Library where a Telidon terminal is set up for use by the general public. Terminals have been set up in cities across Canada to acquaint Canadians with this new technology.

2. Implications for Education

> "Telidon has the capacity to be an electronic school, a library, a newspaper, a bank, a supermarket, a post office, a travel agent and much more".
>
> (Telidon Dept. of Communications Pamphlet).

A submission of the Ontario Teacher's Federation (OTF/FEO) to the Ontario Cabinet identified several uses for instruction (Thowaldson, 1980). One such area would be courses offered through correspondence. Electronic mailing of assignments to an on-campus computer would greatly facilitate the grading and turn around time. Having a library as close as your TV set would certainly be an asset in completing assignments regardless of whether a student was in full time attendance at an educational institute or studying through correspondence.

Drill and similar exercises could be provided easily by Telidon. Practice exercises could be created using the excellent graphics and color capabilities of the Telidon system. Ease of input by keyboard or graphics tablet makes it very attractive for this type of use.

The OTF/FEO also recognized that Telidon could serve as a means of tutoring by terminal and telephone line. Students are given immediate feedback along with solutions to problem areas in their work (Thowaldson, 1980).

The advantages of using Telidon for computer assisted instruction (CAI) are obvious. Telidon can be used to transmit CAI material from a central computer to a micro or minicomputer in offices, resource centers, classroom or homes. As Telidon becomes available, a new industry - an electronic publishing industry - will use this equipment to make available a whole range of information services. Educators must be aware of these new developments so that computers, and information networks using computers, will not enter the schools in a haphazard way. The need for in-service to keep teachers abreast of new developments in technology is immense. Failure to make teachers a part of the decision-making process at the school and school board level could prove to be wasteful, inefficient, and lead to less effective use of the new learning tools (Thowaldson, 1980). Planning and coordination between governments, schools, school boards is essential if the new means of communication is to be used successfully and efficiently in the schools.

Chapter VIII

Applications of Computers in Education

The educator may find it useful to see the computer being used in two ways in this chapter. First of all, there is a role for the computer in administration at the classroom, school, and school board level. The distinction between the use of the computer for administration and computer managed instruction (CMI) is by no means a clear one. There are many aspects of CMI which are administrative in nature. In the second application, the teacher teaches through and with computers. This mode involves the use of computer assisted instruction - drill and practice, tutorial and simulations. The computer is a tool used for instruction in the same way that a 16mm or overhead projector is used and the software performs the same function as a filmstrip or transparency.

1. Administrative uses of computers

(a) School Level

In recent years there has been "a back to the basics" movement which has led to greater emphasis being placed on accountability. In order for a teacher to demonstrate how well the objectives of a unit or instruction are achieved, records must be kept. In addition, efforts have to be made to individualize instruction. CMI is designed specifically to help teachers with the considerable number of clerical and record keeping tasks involved when instruction is individualized. All CMI systems perform the basic tasks of storing student records and profiles and use the information to analyze student progress and help the student select the next learning sequence. The teacher is freed from the barrage of paper work that is counterproductive to the primary task of teaching. The simplest type of CMI can be accommodated on a microcomputer system. It uses the computer as an electronic grade book; the teacher writes the test, administers it, scores it and enters the results into the computer.

At a more sophisticated level, CMI programs for microcomputers developed by the major producers have included controlling and accounting for the interactions of students, computer and the curriculum. There are, however, few programs available outside the subjects of elementary school mathematics and language arts. Kepner (1982) argues that hardware capability is not a problem. The limitations perceived in CMI systems "..., are the result of poor curriculum design, poor choice of instructional strategies, or unclear definition of objectives". (p.23).

Wherever individualization of instruction is attempted, the computer can be a very valuable asset for the teacher. A summary of the advantages of CMI is provided by Lieberman et.al. (1981):

> - frees teachers from tedious record keeping;
> - individualized prescriptions promote efficient use of computer time;
> - provides immediate feedback;
> - statistical feedback can be used to identify ineffective curricular units requiring improvement;
>
> (p.6).

With the proliferation of microcomputers and availability of CMI packages in more subject areas, CMI will likely become more prominent in the future.

Another administrative use of computers is computer based testing. In its simplest form, it provides checking of correct and incorrect answers and tallying of student and class scores. More sophisticated CMI systems may include a listing of correct and incorrect responses, a raw score, a percentage score, a class mark etc. for the student. For the test, it may generate mean, median and standard deviation scores, as well as an analysis of test items. Such feedback will help the teacher create more valid and reliable tests.

Computer test item banking is a scheme in which the computer is used to store thousands of test items that have been randomly sampled and tested for reliability and validity over a wide geographical area. The computer stores each item along with information about it such as the objective it tests and level of difficulty in the item bank. The teacher can then use the computer to produce a test by drawing items from the bank.

In order for item banking to be efficient, teams of teachers must pool their test items. Lieberman et.al. (1981) identify the Ontario Assessment Instrument Pool (OAIP) as an example of such an approach. Teams of teachers have listed thousands of items and tested them for validity and reliability. However, the project is still incomplete. For optimal use of computer assisted testing, teachers will require a knowledge "about computers and about testing and item construction, and some knowledge of computer software". (Kepner, 1982, p.20).

At the school "office" level, the computer is a very valuable tool for the administrator. Timetabling and scheduling without the assistance of a computer has become an increasingly tedious and time-consuming task. Scheduling students into classes at the secondary level has become more difficult with the adoption of a credit system. The necessity for schools to keep an accurate account of the number of credits each student has acquired as well as scheduling him/her into other courses that he/she needs to graduate, has created an enormous headache for administrators. The advantages of a computer are obvious because these are the tasks that a computer can perform very well.

Computers are also capable of producing report cards to the specification of the program. Some may simply have the grades for each subject printed on them with spaces left for the teacher's comments to be added later . Others may already have the comments of the teachers printed on them when they are printed by the computer. Of course all grades and comments must be input into the computer by the teacher and/or secretary.

Word processors, a computer with a word-processing package, can be a very efficient "administrative assistant". Some of the uses that teachers and administrators are finding for word processors are: mail outs to parents, etc.; for storing and easily revising items, such as school handbooks; for printing daily notices, etc. But Coburn et. al. (1982) caution that such use of computer resources "requires a tremendous amount of computer time and space on peripheral storage devices". (p.39). This and other factors must be considered and weighed against increased efficiency.

At the school level, the computer offers the opportunity to free teachers and principals from the time/consuming tasks of testing and record keeping. The effect of computerization can be improved instruction because it gives educators an opportunity to prepare their instructional strategies as well as provide immediate feedback to evaluate them. With computer support, teachers can teach more effectively, and principals, freed from the trivial details of administration, will be able to give more attention to educational issues.

School site administrators must become computer literate and lead by example. This doesn't mean that they must be expert in computer use but understand how it works, be familiar with the jargon and be aware of both administrative and instructional use of microcomputers (Latta, Dunn, and Stevenson, 1982). Leadership by example is effective leadership.

(b) <u>School Board Level</u>

At the school board level, computerizing administration can have two meanings. First, it could simply mean the board office or secondly, the board and all its schools. With the proliferation of microcomputers for instructional applications, school boards need to provide "an intensive and supportive environment for implementation of technological innovations" (Tracz and Cousins, 1983, p.17). Tracz and Cousins (1983) report that the main areas of concern for educational administrators "relate to needs assessment, hardware configuration, software applications and development, and personal issues" (p.17).

Both short-term and long-term objectives and goals of the board must be considered in the needs assessment. Tracz and Cousins (1983) suggest these points be given consideration:

> - turn around time - the time that elapses between input and output, including allowances for the elimination of errors or "debugging".;
> - board independence - the reduction of dependence on external computing facilities or service bureaus;
> - data security - control over access to the data and preventions of tampering, abuse and break-in;
> - tailored reporting - geared to the specialized output requirements of the users; and
> - networking - within the board (among schools) and other external data bases.
>
> (p.17).

Once the needs have been assessed, then it is time to consider the type of hardware that would best meet the immediate and long range objectives and goals of the board. A careful selection of hardware is a must because a computer with a large memory size having networking capability is very expensive and it will not be feasible to change the system after it is in place. The Educational Computing Network of Ontario (ECNO), which is now patronized by more than 20 Ontario school boards, uses the VAX-based systems produced by Digital Equipment of Canada. Most Ontario boards with between 750 to 1000 teachers are using the intermediate sized VAX-11/750 computer system. (Tracz and Cousins, 1983).

One of the advantages of networks, such as ECNO, is in the area of software development. "Any member board may have the option of developing software internally for local use, developing software internally for network use, or acquiring software packages produced outside the network". (p.18). The members of the EGNO are essentially members of a cooperative organized to share information.

On the question of personnel, Tracz and Cousins (1983) recommend retraining staff rather than hiring new personnel. It is important that persons who are already familiar with the operation of the board have substantial input into system development. All board personnel, from clerical workers to the superintendent, should be involved in the acquisition of new knowledge and skills. Network computer systems can reduce duplication in hiring of external expertise and provide support services during the retraining period. A good approach would be to set up a committee from within the board to act as liaison between the board and external expertise. When the system is set up, the administrators will then be able to use it themselves.

2. Teaching Through Computers

(a) Computer Assisted Instruction (CAI)

Thowaldson (1980) describes CAI as "an attempt to achieve interactive teaching in an automated fashion". (p.8). The skill of the designers is crucial to the success of the instructional experience the student receives. There are many "bad" programs in circulation that have resulted in boredom for the user, as well as causing many teachers to question the usefulness of the computer in instruction. The absence of proven documented software has been a major drawback to the use of computers to assist instruction. Most CAI materials are very elementary drill and practice routines. However, the software shortage is slowly being overcome. (Diem, 1981).

(i) Drill and Practice

In this mode the computer does not teach; it is a strategy for practicing what the teacher has taught. Coburn, et.al. (1982) write: "Drill and practice programs are probably the most common, best known, and most disparaged application of computers in education". (p.21). Better designed programs would make them more beneficial. Graphics are included in more sophisticated programs to enhance learning and make them more appealing to the user. Regardless of the level of skill used to design the program, they all follow the same basic format. The computer presents the problem, the student responds, and the response is compared to an expected response. If the answer is incorrect, the student is asked to try again. Usually after three tries, the computer will give the user the correct answer. If the student meets with failure, he may be directed to another branch in the program. The student who experiences success may be rewarded with a message such as "VERY GOOD, JOHN", and be directed to go on to a new set of exercises. Programs which use graphics and sound should be constructed so that the user isn't given a greater reward for an incorrect answer than for a correct one. There is a possibility the student could be motivated to deliberately give an incorrect response to see the graphics display and hear the sound effects.

Drill and practice programs, as long as they are never used in place of primary instruction by the teacher, have a number of advantages. They are easily produced or modified by a teacher with some programming skills. The student is informed immediately as to the correctness or incorrectness of his response. It offers the student an opportunity to practice skills without fear of penalty or embarrassment. Practice programs should not be condemned without considering these advantages.

(ii) Tutorial

In order to function effectively as tutor, the computer must be programmed by someone who is expert in programming and the subject the user is learning. There is a need for greater interaction than in drill and practice programs. The computer presents some information about the subject, the student responds, the computer evaluates the response and determines what to present next. Taylor, (1980) writes:

> "At its best the computer tutor keeps complete records on each student being tutored; it has at its disposal a wide range of subject detail it can present; and has an extensive and flexible way to test and then lead the student through the material". (p.3).

According to Coburn et al. (1982), it is possible to construct a sophisticated tutorial containing moving graphics and recognizing responses as tentative as "I think so". The pedagogy and the technology exist to do it. But along with this, one must realize that many hours of expert programming are required to produce one hour of good tutoring. A big advantage of the computer as tutor, however, is that it includes the strategic details needed to individualize the lesson. The human teacher is more flexible and requires less time to prepare a lesson, but doesn't always account for individual differences. It would, nonetheless, be a mistake to regard the computer as an ideal teacher. It must be given appropriate use to be effective. Used to introduce students to new material, the computer can increase student motivation. It is also an ideal way for students to catch up on work they missed due to absenteeism. Another advantage for a shy student is the comfort of knowing that the computer will not embarrass him if he is wrong. With a tutorial, students enjoy a one-to-one student "teacher" ratio. In order for a student to enjoy the full benefit of the tutorial session, the lesson must anticipate all answers, even those that are correct but not exact. This is very difficult for the instructional designer to do.

(iii) Demonstration

Demonstrations have been used for many years in the teaching of science and mathematics. Using a computer they can now be done cheaply and accurately in a fail proof way. Demonstration packages utilizing sound, color and graphics are available. The teacher doesn't have to intervene except to hit a few keys. The variables are easily manipulated and the effects are instantaneous.

Demonstration packages can probably best be used as an aid to the teacher during the introduction of new material and as an aid to students in their review. With programming experience, teachers and/or students can create their own programs, but it requires many hours of work.

(iv) Simulations and Games

The terms simulation, model and game are often taken as synonymous. All three are representations of reality by means of some sort of algorithm. In a simulation, the user needs no knowledge of the internal workings of the computer. Edwards, (1978) defines simulations as "operating models of physical or social situations". (p.60). The word model means a framework in which reality is reduced in size to manageable proportions. It is a framework in which reality is simplified so that it may be better understood or controlled. The element of competition added to a simulation makes it a game. There are competitive interactions between players to achieve specified goals.

Reiser (1980) effectively summarizes the features of a simulation. As an instructional strategy, a simulation will: provide active learner participation, provide a set of precise rules, specify precise goals and represent some aspect of the real world. An examination of an example will give a feeling for the nature of simulations and their uses.

Ennals (1979) describes a social studies simulation from the history and computer studies departments of Sweyne

School, Essex. In their Russian Revolution program, several students adopt the role of different characters in the revolution. Each inputs decisions based on their judgement of the information presented by the computer. The computer then produces new output based on a combination of the effects of the students' input, existing conditions and the probability of certain outcomes. This new output is again used by the students to make their next decision.

Computer simulations can be used for mastery of skills, learning of content, concept development, to promote inquiry or motivate student interest. Coburn et.al. (1982, p. 31) warns that simulations must not be used to replace other important learning experiences.

Computerized instructional games also may be simulations (simulation games) but are classed as games principally because they operate on a clear set of rules and have winners and losers at the end. Their explicit goal is learning. Games are highly motivational and provide a student with a rich and complex learning environment. A concern of some educators is that many games portray violence. There is a lack of games which teach skills and concepts in a sophisticated way. And teachers lack the sophisticated programming skills to produce their own. As in all other areas of computer use in instruction, good software is in short supply. Nonthe-less, one should not overlook the use of non-educational games as rewards to motivate students.

3. Teaching with Computers - Computer as Tool

(a) Word Processing

Recently manufacturers have developed text editing software packages that can convert even the smallest microcomputer into a word processor. As a result, students and teachers with access to a computer equipped with text editing software, can now organize, enter, edit, format and print out anything they might write. All revisions and editing are done on the computer's video screen before it is committed to print. All errors can be corrected and words inserted or deleted. More advanced word processors make it possible to rearrange the text by moving a paragraph from the end to the beginning of the essay or letter.

Through using the computer as a word processor, the student learns that the computer can store information and that utility programs can be applied to that information to produce useful results. McClean (1981) states that "the use of word processing programs in English classes changes the emphasis from 90 percent erasing and recopying compositions and 10 percent thinking about what is being said, to 20 percent technical details and 80 percent thought about the composition" (p.15). In addition to improved expression, use of word processors is also likely to lead to students writing longer essays or assignments. An interesting side effect is that the student is introduced to computer as a tool.

Kleiman and Humphrey (1982) state that children in elementary school "show more enthusiasm for writing ...write more, edit more and produce better compositions" (p.97). Teachers at the East York Schools in Ontario report that the length of the average essay has doubled, the essays are more error free and the children are more aware of the presentation of ideas (Kleiman and Humphrey, 1982).

In order to get started in word processing, you need a micro-computer with a videoscreen, a dot matrix printer and a word processing program (not necessarily an expensive one).

Beyond the applications discussed previously in this section, there are exciting and innovative word processing programs available for unique educational purposes. In addition to offering benefits such as ease of editing and printing, these programs signal the student when a spelling error is made. SMART-WRITER is a program that would be particularly useful for students who are discouraged from writing because of their inability to spell words. Other software packages have been designed to help the learning disabled children. Such programs will enable many heretofore handicapped children to lead more normal lives.

(b) Numerical Analysis

Perhaps the best known use of computers is for storing and processing vast amounts of numerical information in a number of different ways. There are a number of sophisticated statistical packages available for even the least powerful microcomputer.

The numerical analysis capabilities of computers have almost infinite applications for instructional and administrative purposes:

- Use in the social studies classes to analyze demographic and other population statistics;
- Use in biology and chemistry labs to analyze the results of experiments, particularly those requiring extrapolating, interpolation, and/or error analysis;

- Use in mathematics classes to compute numerical results of solved problems and to study probability, statistics and number theory;

- Use by the athletic department to store and analyze individual and team statistics; and

- Use by the administration to project pupil attendance, to analyze reading scores, grades, basic competency testing results and to keep track of inventory, individual school budgets, purchasing or other aspects of school finances.

(Coburn et.al. 1982, p.40)

As with word processing, a number of new educational adaptations have been made. The first of these emerging packages "piggybacks" CAI onto a numerical analysis tool known as VisiCalc. VisiCalc is an electronic worksheet used by businessmen and scientists to solve problems in their fields or by individuals to manage their financial affairs. The piggy backing feature involves building a tutorial program, so that students may be instructed by the computer as to how to use the program and practice using VisiCalc at the same time. The real benefit of this exercise is to offer the student an opportunity to be instructed in a way that the teacher cannot.

A second uniquely educational numerical analysis tool, Semantic Calculator (SemCalc) was designed to help students with "word" or "story" problems.

There are statistical analysis packages available which require no more knowledge of the user than to know what types of questions to ask. The computer becomes a super calculator. In education, the computer is used as a calculator in mathematics, science, business and statistics courses.

Through the use of the computer as a "number cruncher", students acquire knowledge of the functions of computers in the "real world". The students are not just the subjects of computer administered instruction, but are learning skills that will make them masters of the new technology.

(c) Data Processing

Data processing is the most common use of computers in business and government. Remember, it was the need to process massive amounts of census data that gave impetus to development of calculating machines. Massive "databases" exist on almost any topic. These databases may be the electronic library of the future and offer educators and students the opportunity to selectively retrieve large amounts of quantitative and qualitative data. Or students can be encouraged to set up their own databases on a modest scale in order to gain experience in the way data (knowledge) is structured.

(d) <u>Instrument Monitoring Devices</u>

Instrument monitoring and control devices were originally designed for large computer systems but more recently engineers have developed ways to control thermostats, electrical appliances, etc. by connecting them to microcomputers. Computerized measuring devices first found their way into science labs where they are used to measure temperature, light and sound frequency, or electric voltage etc., and then into the classroom where the data collected continuously by heat and light measuring instruments can create a lab in the classroom. The effort to provide unique educational applications for instrument monitoring devices is just beginning (Coburn, 1982).

(e) <u>High Resolution Graphics and Sound Synthesizers</u>

Sharp, clear, complex designs can be created by computers and printers and can produce hard copies of the drawings. Computer graphic designs, widely used in the media, have not yet been used extensively in the schools. However, the use of the home computer for creative arts is growing in popularity. Eventually the art and music department will be able to take advantage of these computer applications.

4. Teaching the Disabled

Children who are slow learners or those who are exceptionally bright can be helped or motivated by traditional CAI materials such as drill and practice or simulation programs. But there are others such as the blind or deaf who will benefit from more innovative uses of the computer. With the improvement of voice synthesizers, the computer is becoming a communication aid for the blind. Major improvements in optical scanners have eliminated the need for a typist to type the words of a book into a computer; the scanners pick up the letters directly from the page. Using the scanner and voice synthesizer, under computer control, a blind person can read any typed information.

Children with Cerebral Palsy (CP) can be helped through special applications of the computer. A computer with special touch controls allows the CP child [illegible] communicate using Blissymbolics, a graphic, meaning-based communication system. Blissymbolics have also been adapted for use on the computer to help non-speaking persons communicate. According to Noonan (1983), program options include the ability to activate a printer or voice output. However, there is a need for more applications software to make computers even more useful in educating the physically handicapped.

5. <u>Evaluating the Impact of Computers on Education</u>

It is nearly impossible to get a true reading of the impact of computers in instruction. "There is very little that we know about the relative value of different techniques, including using computers versus not using computers". (Ragsdale, 1982 p. 77). Evaluating use of computers also presents some extra difficulties. There is no way to conceal the fact that a study or testing procedure is ongoing if the treatment involves the use of computers. Knowing that they are being given special treatment, the Hawthorne effect comes into play, i.e., knowing that they are being tested the group's performance will automatically improve, even if the treatment is deliberately counterproductive.

Another difficulty in assessing computer impact arises because the technology is so new. Students will be using the latest in high technology and the novelty effect comes into play. How much of the increase in student motivation is the result of the novelty effect? According to Ragsdale (1982), this question cannot be answered until computers have been in use in schools for several years.

A further problem has resulted from the way people view computers; very few people are neutral about the use of computers in society or in education. Computers are an emotional issue. Persons involved in the study may be influenced by people who feel that computers are the great hope for humanity or by views that computers are "evil". Preconceived opinions about computers will no doubt affect the outcome of the treatments.

Ragsdale (1982) stresses that "formative" evaluation, evaluation that is conducted during the developmental stages, is most important because it is often the only evaluation information that gets used. He proposes supplying a small school district with computers and two teams of evaluators to supplement the local staff. The first team would train the teachers in the use of computers and develop new applications. The second team would collect information on teachers and students involved in the study. They would attempt to determine the side effects of the treatments (goal free evaluation). The positive side effects are just as important as the negative ones, but it is the negative factor that holds the greatest potential for harm. One of the positive side effects might be an improvement in a student's self-esteem because he is working with high technology. Ragsdale (1982) warns that to embrace the technology in a way that Canadians have embraced the automobile could lead to an acceptance of harmful side effects. Just as auto owners have accepted pollution as a side effect of automobiles, a wholesale love affair with computers could cause us to ignore the possible health hazards of video terminals. There is certainly a need to broaden our evaluation studies to include the unintended outcomes, as well as the intended (cognitive) outcomes of computer use.

6. <u>Selection and Evaluation of Educational Software</u>

Many school districts have proceeded with the purchase of hardware without any consideration being given to instructional software (courseware). More recently, educators are beginning to realize that a computer must have good courseware to be effective as an instructional tool. It is not the scarcity, but the abundance of courseware that makes the selection process so difficult. Coburn et.al. (1982) says that "what makes the selection of educational software so difficult is the limited choice to be found among the vast quantity of software offered by a bewildering number of sources". (p. 110).

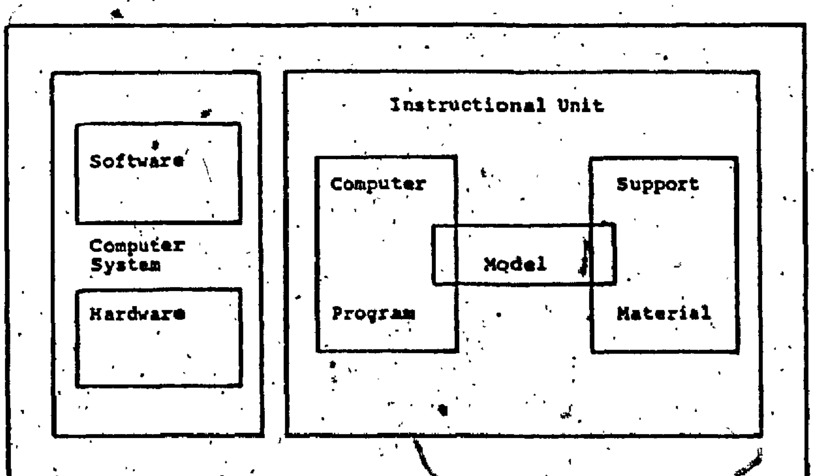
Many of the principles that apply in the evaluation of audio visual materials also apply to educational computer software. As pointed out earlier, formative evaluation is the most useful. Ragsdale (1982) points out that authors of courseware are not interested in modifying completed programs. Providing feedback to the authors at each stage of development can be effective and lead to changes being made to improve the lesson.

Summative evaluation occurs after the courseware package is completed. It is used to test whether it really meets its stated objectives. The evaluator may find that the lesson is valid when used with one age group but when used with an older or younger group, it just doesn't work. Ragsdale (1982) questions any assumption on the part of the author that the lesson is useful with a variety of audiences in different settings.

Ragsdale (1982) cautions that there must be a balance between objective and subjective information in an evaluation of courseware. Overemphasizing the subjective could lead to a collection of unsupported opinions. Nor should one rely on summary scores or ratings because they often reflect the biases of the reviewer. It is also difficult to classify multi-dimensional software in one dimension. Coburn et.al. (1982) looks forward to the day when on line data bases will provide teachers with descriptions of available software.

> Each software listing would include descriptions such as subject area, application, grade level, instructional model, program style and publisher ...
> (p.110)

Edwards (1978) uses the model shown in Figure 8-2 to conceptualize the elements of a computer based learning experience:



ELEMENTS OF A COMPUTER-BASED LEARNING EXPERIENCE (Fig. 8-2).

A model is the idea around which a unit of instruction is organized. The model overlaps the program and the support materials. It is formulated independently of both, but is contained in the program and explained in the support materials. All the elements - software, hardware, program, model and support materials must be evaluated.

Edwards (1978) divides the process for selecting computer-based instructional units into two categories - initial decisions and final decisions. Many of the questions used by Edwards (1978) also appear in Coburn's (1982) guidelines for educational software evaluation. However, the latter is more detailed and therefore better suited to formal (summative) evaluation and selection. The following is a summary of evaluation procedures suggested by Coburn et.al. (1982):

1. The best way to buy software is "on approval". It permits you to preview the package. Avoid companies that demand pre-payment.

2. After the materials arrive, study the documentation. The documentation tells you if it can operate on the computer system you have. Gives all the information necessary for running the program as well as the educational objectives.

3. Run the program three ways: as a bright student; as a difficult student and as a teacher. When you run it as a bright student, make note of any difficulties. As a difficult student, make deliberate errors to see how the program handles them. Finally, as a teacher, search for possible flaws, review the documentation and ancillary materials.

4. Write up your assessment using these guidelines:

   (a) Program Content:-

   - Is it suitable for your students?
   - Does it fit with your curricular goals?
   - Is the content accurate?
   - Are the objectives for the program stated clearly?
   - What values are conveyed by the content?

   (b) Pedagogy:-

   - What type of feedback is provided to students and how immediate is it?
   - What assumptions are made about learning and how children learn?
   - Does the program permit modification?
   - Can it be used with individuals, large groups, small groups?
   - Are there any side effects or unintended outcomes?

   (c) Program Operation:-

   - Is it free of bugs or errors?
   - How does it handle user errors?
   - To what degree does the student have control over the program operation?

- Is there good clear documentation for the student and teacher?
- Are the directions in the program itself clear and acceptable?
- How well does the program use the color, sound and graphics capabilities of the computer?
- Is the screen display effective?

(d) Student Outcomes:-

- How easy is the program for the student to use?
- Is the program interesting for students?
- Does it make appropriate use of limited computer resources?
- How effective is it compared with non-computer instruction in the same subject area?

Even if teachers follow the best evaluation procedures available for selecting software, there are immense problems created by machine incompatibility. Not only will a program designed for a PET not run on an APPLE, but a program designed for an earlier version of APPLE may not run on the newest model. A recently formed computer company (ORANGE) in Ontario has started production of a computer called ORANGE which allows the user to interchange microprocessors and other hardware to make it compatible with various brands of computers available. The APPLE company already has a version of LOGO which can be loaded into their machines.

7. Hardware Selection and Evaluation

The first step in purchasing a computer system-computer and keyboard, monitor and cassette or disk drive - is to analyze your needs. What specific functions do you wish the system to perform. Determine what each system will do and how much that will cost. Present as well as future needs must be considered. For Coburn et. al. (1982) "the formulation of a catalog of desired computer applications is perhaps the single most important process ... in evaluating and acquiring a computer system (p.87). An appendix to Coburn et.al. (1982) provides computer comparison charts that would be very helpful for deciding what system to purchase.

Selecting an appropriate computer system, if done properly, can be a time-consuming task. You need to discover the limitations of computers which may require you to do a lot of reading and comparison shopping. Visit the dealers and ask about their competitor's product, as well as the dealer's own brand. Learn as much as you can about the "state of the art" by reading the literature and talking to those who already have knowledge and experience. Computer dealers usually have the equipment set up for demonstrations so "mess about" with it. Ask to borrow the instructional manuals (documentation). If the documentation is good, it may be a strong indication that it is a good system.

Coburn et.al. (1982) makes the following suggestions for evaluation of hardware:

1. Look for local sales and service.
2. Beware of new products.
3. Look for durable construction and engineering.
4. Allow for expansion.
5. Look for good and well documented software.
6. Choose a system with more than one language available.
7. Look for systems with a lot of available applications software.
8. Talk to owners and users of the systems you are considering.
9. Don't rush anything.
10. Remember that all rules have been exceptions.

(pp. 92-94)

Remember that regardless of how much time you take or how much you read, you won't know everything about computers; however, you are more likely to make a better choice if you follow the suggested guidelines.

Chapter IX

Integrating Computers into the School

This chapter is designed to help give teachers or principals answers to some of the questions that should be answered, preferably before the computers arrive. Some key questions are: where are the computers to be located in the school?, who will have access to them?, and who will coordinate their use? Consideration must be given to these questions long before the computers arrive. The location of computers and decisions about access may determine how much the computers are used by the school staff. (Coburn et al. 1982). In addition to the decisions concerning management of computers in the school, there is a question of in-service training for teachers so that the teachers will be able to acquire the skills necessary to help them utilize computers in their teaching. Who will provide this in-service? How much do teachers need to know about computers in order to make use of them for instruction? The extent to which teachers are in-serviced will influence the way they use computers in the schools.

1. Location of and Access to Computers

Since ease of access will be an important factor in the decision, the most obvious place would be some central location such as the school library or resource center. The school library works well because it is usually open before and after school, is usually under adult supervision, and has been traditionally used for storing and retrieving information and materials. These are factors to consider when storing hardware, as well as software. The school library/resource centre has functioned very well in the past for storing, scheduling and retrieval of AV equipment and affiliated software. There is no evidence that computers couldn't be managed in the same way. It is unlikely, and perhaps unnecessary, that a school would be able to purchase a computer for each classroom, therefore, access to software and hardware will determine teacher's willingness to use the computer. Failure to make projectors available when needed has discouraged the use of AV equipment in the past and accessibility will certainly be a factor in determining how computers are used in the future.

To make the computer mobile, place it on an AV cart so that it can be easily moved from the storage location to the classroom. Since it is realistic to expect that there will only be one computer for the entire class, it would also be helpful if the teacher could hook it up to a large television for total class instruction.

Ease of access to the computer and educational software is a must if CAI is to become an important part of a teacher's instructional strategy. The software purchased by the school should be catalogued and stored in the library with other instructional materials where teachers and students can check out programs as easily as they can check out books. In a school where computers are accessible only before or after classes, because they are used for teaching a computer science course during the day, the majority of students will be denied access to the computers and teachers will not have the opportunity to use them for CAI or any other computerized activity.

2. <u>Who will coordinate their use?</u>

The most logical person to coordinate computer use is the school librarian, particularly if a decision is made to store the computer in the school library. The advantages of this central location have already been discussed.

It is unlikely that the principal or classroom teacher would be able to devote appropriate attention to managing the computer. The school librarian already has a scheduling procedure for other types of hardware and software and there seems to be no justification for treating the computer any differently than other instructional equipment or materials.

3. <u>In-Service Education</u>

Intensive in-service training by the school board must be provided because most teachers have not had computer studies courses included in their pre-service education. As many teachers as possible should be included in the workshops. Kepner (1982) warns that in-service education should not cease when the computers arrive in the school. Failure to provide continuous support could mean the teachers will not keep abreast of new developments in educational computing.

Ragsdale (1982) identifies three stages in the development of in-service programs. The first stage involves experts giving half day sessions aimed at giving a maximum number of teachers a minimum amount of exposure to the uses of computers in education. The second stage of the process involves several days of instruction over a number of weeks, with the opportunity for each participant to use a computer for the duration of the course. The third stage consists of a series of courses covering a number of topics. Each course would be about ten weeks in length.

The school library can also play a role in the computer awareness process. Magazines such as <u>Creative Computing</u>, <u>Byte</u>, <u>Pupular Computing</u>, and the <u>Computing Teacher</u> can be very helpful in keeping teachers, and students, current with developments in computing. Teachers within the schools who have a keen interest in, and knowledge of computers, should be utilized to educate other staff members. Use of internal personnel as opposed to external experts, has at least one advantage. The school can easily use their services for additional training as the need arises. This approach may be a more successful one than bringing in elitist hobbyists or experts.

Chapter X

Conclusion

During the 1960's computer advocates were confident that the computer would become a teaching tool that would provide traditional instruction more efficiently and offer students new opportunities for learning which otherwise would be very difficult to create. Some, with the benefit of hindsight, argue that they were too early; maybe innovators always are. Remember Babbage? He was ahead of his time, but look at the results of his ideas. When his genius was combined with twentieth century technology, the result was the birth of a new era - the Information Age. It is still too early to determine whether the work of Patrick Suppes, Arthur Leuhrman and Seymour Papert will lead to a revolution in education in the 1980's or 1990's. The technology of the 1960's consisted of large computers that were only available to the schools through expensive timesharing networks. The microcomputer is cheap, powerful and readily available to schools. It is light and portable and when combined with peripheral devices, can be used in the classroom to provide instruction in a number of modes.

Not only has the computer become smaller since the 1960's, the microcomputer of the 1980's has a wide range of features: voice synthesis and recognition, music, linkage with a great variety of peripheral devices, not to mention the possibility of connecting it with the vast stores of information of large computer networks. These add new and exciting possibilities for the use of computers in the schools.

Schools not only have a responsibility to teach programming skills, but to incorporate uses of computers into instruction in all subject areas so that students will be aware of all the possibilities for computer use. Students, exposed to a computer as a data processor, word processor, or for numerical analysis or simulation will develop an understanding of the role of computers in society.

The expanding use of computers in society, combined with increased public awareness of their importance, is creating pressure on the schools to teach computer literacy as part of the school curriculum. It is becoming increasingly important for students to be aware of the uses of computers as well as training them to program computers. Coupled with this outside demand for greater use of computers in schools is the interest of administrators and individual teachers within the schools. In the

1960's the computer advocates were the intellectual elite; in the 1980's individual teacher enthusiastists are playing a role in the introduction of computers. Since the development of the microcomputer, a whole new publishing industry has grown up based on computers. Numerous periodicals and magazines, curriculum publishers, universities and teacher organizations have begun promoting educational uses of computers very heavily. These and other factors may create a bandwagon effect with no school wanting to be the last to acquire microcomputers.

To buy a computer system may be a first step to their introduction into the school, but the physical presence of a computer is not enough. Remember the 8mm film loop projector which showed such promise for student and teacher use but now remains idle in the schools that purchased them. One of the reasons why it failed was the unavailability of good quality software. Will the computer suffer the same fate and for the same reason? Where will the high quality educational software for computers come from? Such programs are going to be expensive to produce and will require extensive field testing. It would therefore seem inevitable that a large number of low quality programs will be rushed onto the market hoping to cash in on the bandwagon effect. Over a period of time, as teachers become more selective and discriminating in their software purchasing, the quality of educational programs may improve.

Just as with all other educational innovations, the teacher is the key to the success or failure of computers in education. However teachers are human with all the weaknesses, shortcomings, biases and strengths of the species. A teacher, just as any other person, will not acquire knowledge of computers automatically. There are some who do not feel the need to know and others who feel that such knowledge is beyond their grasp. It also gives teachers an uneasy feeling to know that their students may know more about computers than they do. The answer to these concerns is retraining. But where will they get it? Will the school boards recognize this critical need and budget for teacher education as well as purchase of hardware? Or will they leave it up to the individual teacher to attend university courses, or look to the private sector to do the job? The latter has some inherent dangers.

The teachers who want to introduce computer literacy courses into their classrooms have another problem.

There is no agreement among the advocates of computer literacy as to what that term should mean. Should a computer literacy course teach only about computers and their uses in society? Some say yes. But a great number believe that programming, at least at an introductory level, should be included. Others argue that students cannot be considered literate in the true sense unless they can read and write with reasonable skill. If you apply this analogy to computer literacy, then to have studied the history and uses of computers and to have touched them is not enough to make students computer literate. They need to learn to use them as well as learn about them.

The success of computers in education will only be possible if all decisions are not "top-down" decisions. There must be room for input at the grass roots level. Failure to involve teachers in the planning warns the OTF (Thowaldson, 1980) could lead to inefficiency and waste of resources.

The computer is a very versatile and powerful tool when it is teamed with sophisticated, well-designed software. There seems little doubt that computers will have an impact on education, regardless of how they are used in schools. They will invade society in the 1980's in much the same way calculators entered the home and then the schools in the 1970's. Educators are already reacting to public pressure to use computers. Computer companies have already identified the schools as a market with great potential for profit. Parents are sending their children to computer camp at pre-school age to give them an edge in the job market when they become adults. The pressure is on for schools to use computers. Papert (1980) sees the future this way:

> "For me to phrase "computer as pencil" evokes the kind of uses I imagine children of the future making of computers. Pencils are used for scribbling, as well as writing, doodling as well as drawing, for illicit notes as well as for official assignments". (p. 210)

Teachers must become knowledgeable about computers so that they can judge their capabilities and limitations, as well as allocate limited resources to efficient use. Teachers will need to be knowledgeable about the educational value of computer applications, or else they will find they have surrendered control of education to the technocrats.

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GLOSSARY OF COMPUTER TERMS

ACOUSTIC COUPLER	See also MODEM. A device which allows you to send and receive information over a telephone line.
ADA	A new computer language developed by the U.S. Department of Defense. It is a structured language similar to Pascal. It was named after Ada Lovelace, Lord Byron's daughter who was a major intellectual inspiration and patron of Charles Babbage's Analytical Engine.
ADDRESS	Memory locations are systematically numbered. These numbers are the addresses or names of each memory location.
ALGOL	(ALGORITHMIC LANGUAGE). A computer language developed in the late 50's and early 60's. It is primarily used today as a standard for developing more modern languages.
ALGORITHM	A step by step procedure for performing some function. A program is an algorithm.
ANALOG COMPUTER	Represents numbers in continuously variable states such as voltage as opposed to digital computers which represent numbers in discrete form. See also digital computers.
APL	(A PROGRAMMING LANGUAGE). A programming language invented by I.B.M.'s Ken Iverson. Array manipulation is very easily performed with APL. It is also a very symbolic language. It is primarily used in education and science.
ASCII	(AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE). A standard code for storing and transmitting data.

ASSEMBLER — A program which takes assembly language and translates it into the computer's machine language consisting of numbers. It is in a sense a special compiler.

ASSEMBLY LANGUAGE — A low level language which represents very closely the computer's machine language. It uses English-like short forms which make it somewhat easier to read.

AUXILIARY MEMORY — Refers to disc or tape storage as opposed to main memory storage.

BASIC — (BEGINNER'S ALL-PURPOSE SYMBOLIC INSTRUCTION CODE). A computer language most commonly used in educational settings.

BATCH — A Batch System allows for the processing of many programs one after the other without any operator assistance. It is often found in systems where card input is used.

BAUD — The number of bits transmitted per second, thus it is the rate at which information is transmitted. The average typist types at about 100 BAUD. Computer terminals transmit at rates ranging from 15 BAUD to 20,000 BAUD.

BINARY — Pertaining to two. Binary numbers use only digits 0 and 1.

BIT — Contraction of Binary digit. The smallest unit of information in a computer, having only two states and usually represented by either 0 or 1.

BUG — An error in a computer program.

BUS — An electrical connector used to transmit signals from several devices to several devices within a computer.

BYTE	A group of 8 Binary digits. One Byte stores one character of information.
CHIP	A thin piece of silicon about 1 square centimetre in size. It contains up to thousands of electrical circuit elements. Chips are located in an IC and have made miniaturization of the computer possible.
COBOL	(COMMON BUSINESS ORIENTED LANGUAGE) A computer language which has been used in business since the early 1960's. It is a system designed to handle large volumes of data.
COMPILER	A sophisticated program which translates a program written in "English-like" words into machine words, i.e. code that a computer can understand. The code produced by the compiler is called object code.
CORE	Refers to the main memory of a computer. In the 1960's and 70's computer memory was made out of thousands of little do-nut shaped cores each of which stored one bit of information.
COURSEWARE	Programs written specifically to be used by students to aid in learning and understanding some course or subject being studied.
CPU	Central Processing Unit or the guts of the computer. It contains the arithmetic unit and logic units which perform the computing functions.
CRASH	A crash occurs when a computer malfunctions and stops running. Computer operators and programmers appear very flushed after a crash and invariably deny any responsibility.

CRT	(CATHODE RAY TUBE): the T.V. terminal by which the computer displays information.
CURSOR	A symbol placed on the screen to indicate where the next character you type will appear.
DATA	The material a computer uses to calculate with. Usually consists of collections of numbers i.e. student marks or words, student names.
DEBUG	To correct errors (BUGS) in a program. The process of debugging a program often consists of replacing incorrect code with other code which is not as obviously incorrect until the user tells you.
DIGITAL COMPUTER	A computer which processes data stored in discrete form such as binary digits. In contrast with an analog computer which processes data in continuous form such as fluctuating voltage. This difference is best illustrated by contrasting the digital clock to the traditional wind-up clock.
DISC (DISK)	Similar in shape to a musical record but without grooves, used for storing information. The metallic oxide coating allows information to be stored magnetically.
DISKETTE	(Also FLOPPY DISC). A small 8 inch or 5¼ flexible disc normally used with microcomputers.
DISK DRIVE	Hardware which rotates the disc while reading information from or writing information onto the disc.
DOS	(DISC OPERATING SYSTEM). A collection of programs stored on disc which when executed allow the computer to access the disc.

DOWN	Opposite of Up. The state of a computer when it is not functioning. Computer Science students will confirm that computers go down only on the day assignments are due.
EPROM	(ERASIBLE PROGRAMMABLE READ-ONLY MEMORY). A memory chip which may be reprogrammed after erasing the memory with ultra-violet radiation.
EXECUTE	To make computer carry out the instructions indicated in the program.
FILE	The organizational unit by which information is stored on a disc or tape. Information may be accessed from any part of a random access file. A sequentially accessed file allows for access only sequentially starting at the beginning and processing to the end similar to a cassette tape.
FORTRAN	(FORMULA TRANSLATOR). A computer language originally designed for scientific use, but has many other areas of application now.
GATE	An electronic device which has only two states i.e. it is either open (allowing current to flow), or it is closed depending on input to the gate.
HARD COPY	Information printed on paper.
HARDWARE	The physical equipment such as electronic, electrical and mechanical devices which make up the computer (see SOFTWARE).
I/O	(INPUT-OUTPUT DEVICES OR DATA). A device which is strictly input would be a card reader. A line printer is solely output. A video display unit could be both input and output device. As

I/O (Cont'd)	data: Information going into or out of the computer.
INITIALIZE	1) In programming, to give a variable a first value. 2) To initialize a disc: to set up a disc so that information may be stored and found on it.
INSTRUCTION	A syntactical unit in machine language programming. It specifies an operation to be performed. It contains an operator or command and one or more operands or objects to be worked on.
INSTRUCTION SET	All those machine language commands which a computer is capable of executing.
INTEGRATED CIRCUIT	(IC). A very small 2 to 3 cm. black plastic or ceramic device which contains a chip. Many metal connectors extend from the IC and they allow the chip to be connected electrically to other devices. See also CHIP.
INTERACTIVE	A computer system which responds immediately to the user's keyboard input. Microcomputers are interactive. Contrast to Batch process.
INTERFACE	A shared boundary. As a verb: To join together in order to work as one unit. As a noun: a device which allows a computer to communicate with some external device.
INTERPRETER	A computer program that translates and executes each source language instruction before going on to the next instruction, i.e. BASIC is usually an interpreted language.
K	Is a symbol for 1000. It actually stands for $2^{10} = 1024$. It is most often used to measure units (usually bytes) of memory as in

K (Cont'd)	"This is a 16K memory board". This means that the memory board has 16384 storage locations.
KEYBOARD	The typewriter-like keys on a computer terminal.
LOAD	Usually means to copy a program into main memory in order for it to be executed.
MACHINE CODE	The language written in binary numbers which a computer understands. All programs written in high level language must be translated into machine code to be executed.
MACHINE LANGUAGE	See MACHINE CODE.
MAINFRAME	Usually refers to the central processing unit and central memory of a large computer.
MEMORY	A device which stores information. memory is broken up into a number of locations each capable of storing one unit of information. These locations have numbers associated with them called addresses which allow a computer to locate a particular unit of information.
MENU	A list of options usually given at the beginning of a program.
MICROCOMPUTER	A computer which is not significantly larger than a bread box. An innovation of the mid 1970's made possible by the miniaturization of the chip.
MICROPROCESSOR	The chip found in a microprocessor which contains the CPU, i.e. Z80 processor, 6502 processor.
MINICOMPUTER	A computer whose word length is between 8 and 16 bits and at the

MINICOMPUTER (Cont'd) — same time is larger than a bread box but smaller than a telephone booth.

MODEM — (MODULATOR-DEMODULATOR). A device which allows you to send and receive computer information over a telephone line.

MONITOR —
1) A program which supervises and verifies the execution of a program. An operating system may be referred to as a Monitor.
2) A television set specially designed to be connected to computer (no channel selector).

OPERATOR — Somewhat like the verb in an English sentence, i.e. in adding 2 and 3, the operator is addition, the operands are 2 and 3.

OPERATING SYSTEM OS — Sometimes referred to as a monitor in small computers. An operating system is a collection of programs which allow a person to use the computer.

OUTPUT — See I/O.

PARALLEL — (As opposed to serial). Two or more things happening at the same time. For example, a parallel interface handles several electrical signals simultaneously.

PASCAL — A structured programming language developed in the early 1970's. It is available on most microcomputers.

PERIPHERAL — Devices connected to a computer for storage or communication, i.e. line printer, card reader, disc drive,

PIXEL — Short for picture element. This is the elementary dot displayed on a T.V. screen. Letters when displayed are made up of a combination (matrix) of pixels.

PL/1	(PROGRAMMING LANGUAGE L1. A structured programming language developed and supported by IBM.
PORT	The part of a computer to which a peripheral device may be connected.
PRINTER	A device which prints characters on paper. A line printer prints an entire line of characters at once. A serial printer prints one character at a time. Printers may be tractor fed (paper with holes along the sides) or friction fed (unpunched paper).
PROGRAM	A series of steps solving a problem written in some programming language. See also ALGORITHM.
PROGRAMMER	A person who writes computer programs which work.
PROM	Once the instructions are programmed into this chip, they may not be changed. It is then used only to read instructions from. Data may not be stored in PROM.
RAM	(RANDOM ACCESS MEMORY). One may read and also store information in this memory.
REGISTER	A special memory location set aside for particular operations such as holding the memory address of the next instruction to be executed.
RF MODULATOR	(RADIO FREQUENCY). A device which allows you to use an ordinary TV set as a display terminal for a computer.
ROM	(READ-ONLY-MEMORY). Instructions are permanently imbedded in the chip. One cannot write or store other information on the chip.

RUN	To execute a program.
SAVE	To copy a program from memory, and store it on disc or cassette tape.
SERIAL	One after the other. A serial interface handles one bit of information at a time. (See also PARALLEL).
SOFTWARE	Any Program or set of programs which run on a computer. (See also COURSEWARE).
STRING	A sequence of symbols consisting of either characters, letters or numbers.
SUBROUTINE	A subprogram or procedure. Programs are often made up of sets of previously prepared routines. These subprograms may be called upon many times to be executed thus providing efficiency in programming.
SYNTAX	The rules of grammar of a language. If the rules are not followed, then get you a syntax error.
TELIDON	The brand name of a Canadian video-text system.
TERMINAL	A typewriter-like device usually with a TV screen attached. It allows you to communicate with the computer. A computer may have more than one terminal. A "dumb" terminal has no internal memory; it is simply an input-output device. An "intelligent" terminal has an internal memory; it may be a micro-computer capable of performing functions of its own while still being attached to a larger computer.
TEXT	Data other than numeric.
TIMESHARING	In a large computer system where many programs are competing for

TIMESHARING (Cont'd)	computer resources each program is moved in and out of memory for a short time in order to be executed. Thus many users can use one computer simultaneously.
UP	Opposite of Down. The state a computer is in when everything is working properly. When a computer has gone from down to up, some programmers have been known to smile.
VARIABLE	A name for some quantity which might change in value during program execution.
VIDEOTEXT	A videotext system transmits and displays textual and graphical information to and from central computer and a TV in the home.
WORD	A sequence or group of bits treated as a unit and capable of being stored in one memory location.

(Lieberman, et al. 1981 p.75-81)

APPENDIX "B"

INFORMAL AND FORMAL QUESTIONNAIRE

INFORMAL AND FORMAL QUESTIONNAIRE

SECTION A: General Information

1. Are you presently involved with the use of computers?

   Yes ____ No ____

2. Have you completed any education courses at university relating to the use of computers in education?

   Yes ____ No ____

3. How many years have you taught in schools? ____

4. What teaching certificate do you presently have? ____

SECTION B: Rating of handbook objectives

To what degree do you feel the objectives of the handbook have been met? Rate each objective on a "five-point" scale as follows: Poor (1); Fair (2); Good (3); Very Good (4); Excellent (5). Please indicate rating by circling your choice.

This handbook has been designed to help the reader:

(a) develop an understanding of the concept of computer literacy and an appreciation of the need for it;

(1, 2, 3, 4, 5)

(b) appreciate the historical antecendents and evolutionary trends of the computer;

(1, 2, 3, 4, 5)

(c) develop a "functional" understanding of the computer hardware, software and systems operation.

(1, 2, 3, 4, 5)

(d) develop an awareness of a number of computer languages and an understanding of how high-level languages make programming a computer possible for the non-expert;

(1, 2, 3, 4, 5)

(e) identify some of the social concerns created by the widespread use of computers;

(1, 2, 3, 4, 5)

(f) understand that a program is a series of instructions that must be presented to the computer in an ordered and logical sequence;

(1, 2, 3, 4, 5)

(g) foster an understanding of videotex through an examination of Telidon and develop a realization of their implications for education;

(1, 2, 3, 4, 5)

(h) develop an awareness of ways in which computers can assist without administrative tasks in education;

(1, 2, 3, 4, 5)

(i) differentiate among the major classes of instructional/learning educational computer applications;

(1, 2, 3, 4, 5)

(j) participate in efforts to introduce and integrate computers into a school;

(1, 2, 3, 4, 5)

(k) identify in-service education as a necessary strategy for integrating computers into a school.

(1, 2, 3, 4, 5)

SECTION C: Comments: ____________________

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