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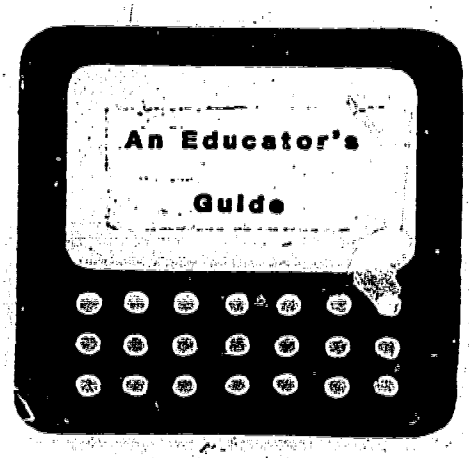
ABSTRACT

Intended for use by teachers, administrators, and boards of education in Tennessee as they make decisions about the instructional and managerial uses of microcomputers in education, this handbook is structured around several main topics: (1) basic microcomputer information, including microcomputer components and peripheral equipment, computer literacy, and major computer languages; (2) instructional applications, including advantages, computer-assisted instruction, computer-managed instruction, curriculum considerations, further applications, and misapplications; (3) administrative uses, including database management systems, word processing, electronic spreadsheets, and communications; (4) microcomputer hardware selection, including needs and objectives, and criteria for selection; and (5) microcomputer software, including systems and applications, sources of software, software selection and evaluation, and software/hardware consideration criteria. A software evaluation form is provided, and appended materials include a glossary; lists of microcomputer periodicals; software evaluation sources and software user groups; and a checklist for software selection and evaluation. (LMM)

MICROCOMPUTERS IN THE SCHOOLS



STATE OF TENNESSEE
DEPARTMENT OF EDUCATION

Printing Authorization # 1940

Robert L. McElrath
COMMISSIONER

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October 27, 1982

Dear Tennessee Educators:

The decade of the 1980s is an exciting time to be involved in education. Part of the reason for this excitement is the technological advances which are occurring at an unprecedented rate. School systems across the country are involved in decisions on how to utilize the new technology--particularly microcomputers--for the instructional program and for administrative applications.

As with any innovation, there are numerous questions and uncertainty due to lack of adequate information on the subject. The State Department of Education is receiving daily requests for assistance in the selection and use of microcomputers in the schools. This handbook has been developed by our Division of Research and Development as an initial venture in providing relevant information on microcomputers. The title, "Microcomputers in the Schools: An Educator's Guide," indicates that the information is written for school personnel. It is not a comprehensive information source, but it provides a guide for school systems to reference as they begin to make decisions about the instructional and managerial use of computers in education.

It is hoped that this handbook will assist teachers, administrators, and boards of education in Tennessee as they address the current issues of computers in the schools. The state's recent membership in the Minnesota Educational Computing Consortium and the development of management software for the BASIC SKILLS FIRST program are the first steps at the state level for assistance in microcomputer technology to local school systems. We at the State Department of Education hope that this handbook and our recent activities can begin a cooperative venture as we face the challenge of learning and using technology in the schools of Tennessee.

Sincerely,

Robert L. McElrath

Robert L. McElrath
Commissioner

RLM/cft

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Introduction

The decade of the 1980s is creating massive changes in our economy, social structure, and use of technology. The educational systems in our country must respond to these changes, and local school systems are scrutinizing their programs, staffing patterns, and budgets. While it appears that financial resources are becoming more difficult to secure due to economic and social changes, technological advances are providing an unique opportunity for education to become part of the information revolution.

The computer has been in use in education since the early 1960s. Its use in the classroom has been limited due to the original space needed for the hardware and the cost involved in "on-line" mainframe time. The introduction of the microcomputer, with its declining price and expanding capabilities, is making computerization of instruction and administrative records a reality for local school systems.

Experts in the field of computer science are urging schools to take the leadership in providing educational programs which equip students to live in the twenty-first century. Arthur Luehrmann, Director of Computer Research at the University of California in Berkeley, refers to computer literacy as a national crisis. He states:

> *The ability to use computers is as basic and necessary to a person's formal education as reading, writing, and arithmetic. As jobs become increasingly oriented toward the use of information, society demands and rewards individuals who know how to use information systems.1*

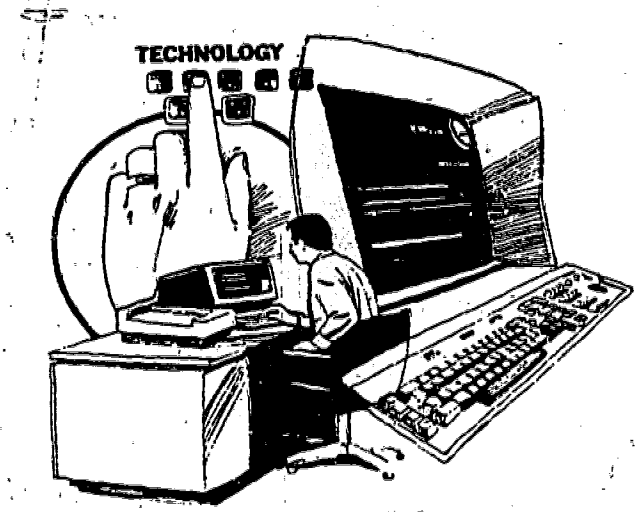
Another leading expert in the field of computers, Dr. Andrew Molnar, a project director for the National Science Foundation, agrees with the need for computer literacy. He states, "In the future a lack of knowledge of computers will make people as functionally illiterate as the inability to read, write or do arithmetic is today."2

As is true of most societal problems, part of the solution will rest with the schools. The need for good decision-making concerning computers and instruction is imperative in today's world. This handbook on microcomputers has been developed by the Tennessee State Department of Education's Division of Research and Development as an initial source of information on microcomputers. It is by no means a comprehensive information source, but it is a guide for school systems to reference as they begin to make decisions about the instructional and managerial uses of microcomputers in education.

This handbook is structured around several main themes related to microcomputers. Chapter II addresses basic information concerning computers, their components, and peripheral equipment. Computer literacy is discussed and major computer languages are identified.

Chapter III discusses the uses of microcomputers in instruction. A distinction is made between computer assisted instruction and computer managed instruction. Misuses of computers are identified, and future computer applications are discussed. Equity of access and the general relationship of computers to the curriculum are presented.

Chapter IV presents administrative uses of computers, and Chapter V presents criteria for selection of microcomputer hardware. Chapter VI discusses criteria for the selection of microcomputer software. The Appendices contain a comprehensive glossary of terms, a listing of selected computer periodicals and other information related to software evaluation and users' groups.



Basic Microcomputer Information

In today's educational world it is nearly impossible to avoid "computer jargon". Educators have been accused of having a special vocabulary and jargon of their own, which eliminates noneducators from understanding conversations. It now appears that the award for the most "jargon" might be given to the computer world for examples such as "bits", "bytes", "peripheral devices", and all sorts of acronyms--"ROM", "RAM", "CPU", "K", "COBOL".

In attempting to understand the world of computers, one must first decipher the vocabulary and understand the functions and components of a computer. Other terms such as "peripheral devices" and the meaning of computer literacy need to be understood. Computers have languages that they understand, but they aren't the typical academic languages of Spanish, French, Latin, and German!

What is a Computer?

Computers are electronic devices which store, organize, and process information. This information can be alphanumeric characters--which means either letters of the alphabet (A-Z), or numbers (0-9), or special symbols (#$@).

Main Units of a Computer

A computer system consists of: the input and output devices, the central processing unit (CPU), main (or primary) memory, and secondary memory (or storage). Figure 1 reveals these major components. Input devices can be a typewriter keyboard, a cassette recorder, a card reader, or various other devices such as light pens and joysticks. Computers usually have a video monitor which is referred to as a CRT (cathode ray tube).

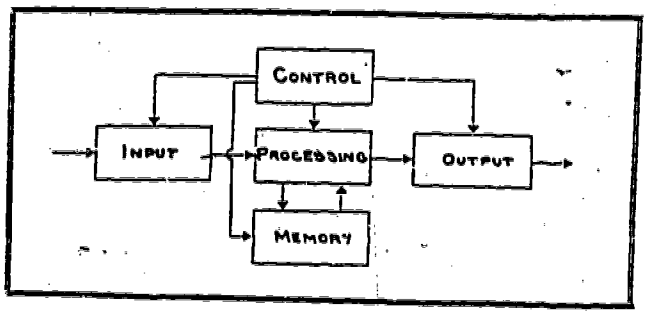


Figure 1: Main Units of a Computer

CPU

The central processing unit consists of three parts: the storage section, the control section, and the arithmetic/logic section. It is called the central processing unit since all information in a computer must pass through the CPU at least one time. The main memory (or storage) section of a computer is located in the CPU. Secondary memory (or storage) is located on magnetic tape or magnetic disks. Main memory is fast and expensive while secondary memory operates more slowly and is less expensive. Figure 2 shows the three parts of the CPU.

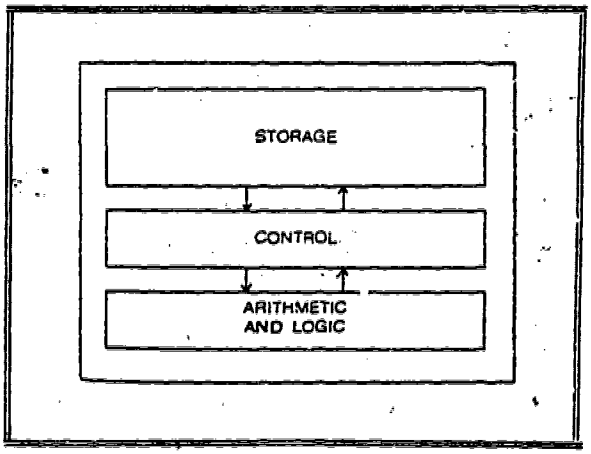


Figure 2: Central Processing Unit

RAM/ROM

Computers have two types of main memory. Random access memory (RAM) is memory where a user can temporarily store instructions in a computer. Any information stored by the computer in RAM is lost when the machine is turned off. Read only memory (ROM) contains the operating system for the microcomputer and is an integral part of the machine. The computer can read instructions from ROM, but information cannot be stored there by the user. Information or instructions located in the ROM memory still remain in the machine after it is turned off. Memory in computers is referred to in kilobytes (K), such as 48K, which means the computer can store approximately 48,000 characters of information.

The CPU's control section directs the flow of information and is comparable to a telephone exchange. The arithmetic/logic section carries out mathematical operations and other logical operations such as sorting. The CPU can obtain instructions from memory and perform mathematical operations. The CPU in a microcomputer is called the microprocessor. A microprocessor is a silicon chip with an integrated circuit which acts as the brain of the computer. It is smaller than a postage stamp.

Mainframes, Minis, and Micros

Computers have been divided into three major classifications depending on the central processing unit, the amount of primary and secondary storage, and the price. Mainframes are the largest and most expensive computers. Mainframes have a large processing and storage unit. The speed of processing information in mainframe computers is faster than other computers. For instance, one large mainframe can carry out five million addition operations in a second. Mainframes are used for large data bases or for school systems which have many users. Often large computers share their CPU and storage areas with other terminals. This is referred to as "time-sharing" or "on-line" time.

Minicomputers are more compact in size than mainframes and are lower in price. As shown in Figure 3, they are in the middle between the mainframe and microcomputer in relation to size, price, storage, and speed of operation.

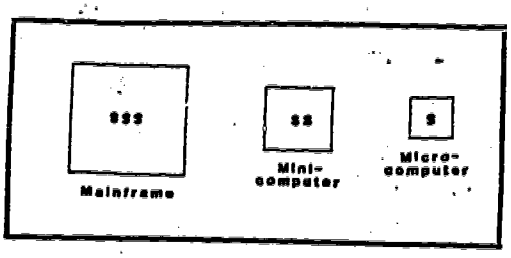


Figure 3: Mainframe, Minicomputer, Microcomputer

However, minicomputers recently have been perfected to work at the speed and capacity of medium size mainframes. The Digital Equipment Company (DEC) estimates that one million students a year learn on minicomputers.[3] This is possible because a minicomputer's capability can be shared with terminals located in different areas. An entire class can work at terminals which are receiving their power from the CPU in the minicomputer.

A microcomputer is smaller in physical size and is a stand-alone unit. A stand-alone unit means that the system is self-sufficient, with the input/output terminal and microprocessor in the same location. A microcomputer is often referred to as a personal computer (PC) because the owner has complete control over its operation, and its size permits it to be portable.

Microcomputers received their name because their CPU and storage capacity (memory) were originally limited, making them a "micro" of the "macro" mainframe. Recent developments in technology have increased the capacity of the microprocessors, and microcomputer memory and processing capabilities are being increased. Price is beginning to be the determining factor in distinguishing a microcomputer and a minicomputer. A recent article on microcomputers states:

> *However, the current micros are really only first generation devices, which will become outmoded in a few years. Already available improvements, such as touch-sensitive screens, light pens, "bubble" memory systems, videodisc interfaces, random access audio devices, etc., will enhance greatly the performance capabilities of micros, but quite likely with attendant cost increases.*[4]

While this article hints at increases in costs for increases in the capabilities of the microcomputer, at the present time, it appears that prices are declining as capacity increases.

Microcomputers are popular in schools because of lower cost and portability. Microcomputers can be moved from classroom to classroom or school to school. Teachers can take them home at night, much like a typewriter, to do their work.

Peripheral Devices

Most persons are familiar with the term "periphery", which means the outermost part or region with a precise boundary. Computer terminology uses a form of this word--peripheral--to mean a component which is added to the central processing unit to extend its operational capabilities. A peripheral device is on the outer boundary of the CPU.

Because peripheral devices are not part of the CPU itself, they must be connected, or interfaced, with the computer's brain. Just as our brain

acts as an interface to tell our arms and legs to carry out certain functions--"swing at the ball," "run to catch the bus,"--an interface on the computer also receives commands to work the peripheral devices. In general, all devices not a part of the CPU must be connected by interfaces. Some interfaces, such as the interface of the keyboard, are built directly into the machine. Interfaces for other peripheral equipment often require special cables or interface cards to make the connecting device operate on the computer. This special connecting equipment varies from machine to machine and often purchasers of peripheral equipment find that they have a new "toy without a battery" to operate it. This special interface equipment can add considerably to the cost of the machine, and it is wise to determine at the time of purchase which options can be added and the additional cost for them to be operational. Four common peripheral devices for a computer are an audio-cassette recorder, a disk drive, a printer and a MODEM.

Audio-Cassette Recorder

A basic cassette tape recorder is a common input and data storage device for a microcomputer. Although a cassette tape recorder is one of the least expensive methods for loading and storing computer programs, it has some distinct disadvantages. Loading a program from a cassette is a slow procedure which can take from 3 to 20 minutes depending on the length of the program. In a classroom setting, this waiting period is lost instructional time and a consideration if buying a microcomputer for instructional purposes. Information is stored sequentially on a tape which means that one must go through the preceding data to find a particular item, again a distinct disadvantage if time is a factor.

Disk Drive

A disk drive is a data entry and storage device which utilizes a disk similar to a "45" RPM record. The disk is called a floppy disk because it is thinner and slightly more flexible than a "45" record. Disk drives are more expensive than cassette tape recorders and can range from approximately $350 to several thousand dollars. However, disk drives, with their floppy, circular, five and one-fourth inch or eight inch disks operate with greater speed. Typical program loading time is from 5 to 30 seconds. Floppy disks come in various qualities which means good ones last longer than less enpensive ones. "DOS" is an acronym which stands for disk operating system, and is the system which includes the capability of controlling and coordinating the functions of a disk drive within a computer system. Each model of microcomputer has a DOS, and each system has unique features.

A recent innovation is the development of a hard disk. Hard disk drives are expensive, presently in the $2,500 to $5,000 range. A hard disk is a rigid platter which is put in a sealed chamber to prevent dust particles from becoming lodged between the head reader and the disk when the drive is in operation. With a floppy disk drive, the head actually touches the disk as it reads it, while with a hard drive, a miniscule space exists between the head and the diskette. It reads the diskette by creation of a magnetic field, and in order that it be read correctly, it is imperative that no dust enter the small space. Therefore, hard disks are in sealed chambers. Hard disk drives can store information in "megabytes" or millions of bytes, compared to floppy disks' "K-bytes" or thousands of bytes. Hard disk drives are appropriate when large data bases must be maintained and manipulated.

Printers

A printer is a common output device for a microcomputer. Printers can be expensive, ranging in price from several hundred dollars to printers that can cost ten thousand dollars. Printers can cost more than the computer itself. Therefore, it is important to assess needs carefully before purchasing a printer.

Determining the type of printer to purchase is not an easy decision as the terminology becomes complex, and there are many variables to consider. For instance, this quotation from a recent computer magazine says it all!

> *There are basically two types of printers--impact and non-impact. But there are, in addition, two other basic types of printers--letter quality and dot-matrix. And just to confuse matters more, there are letter quality impact and non-impact printers, and there are dot-matrix impact and non-impact printers.*[5]

Printers are often defined by the manner in which they form characters, (letters and numbers) as they operate. Three main types of character formation are:

- Dot-Matrix
- Thermal
- Letter Quality

Dot-Matrix: Dot-matrix printers are usually less expensive than letter quality printers. These printers use a series of dots to generate characters, and the most common way is by impacting (or striking) a ribbon with a series of fine wires to form a letter. The fine wires actually form a series of dots which produce a letter. Hence, the name dot-matrix.

Thermal: Another method of forming characters is through heat, and this device is called a thermal printer. Thermal printers are fast and quieter than

impact printers, but the paper used is of poor quality and must be stored under special conditions.

Letter Quality: In order to have material look as if it has been typed on an electric typewriter, one needs a letter quality printer. One common type of letter quality printer uses a daisywheel--a print head which is shaped like a daisy and rotates at a rapid rate of speed to print letters. Daisywheel printers create a great deal of noise when in operation, and a sound cover is recommended to reduce the noise level.

Other considerations when buying a printer are:

- Speed
- Number of characters per line
- Paper feed mechanism

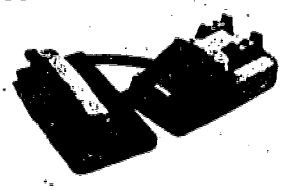
Speed: A daisywheel usually prints an average of 30 to 50 characters per second (cps). Some dot-matrix printers can operate at 400 cps.

Characters Per Line: The normal range for printers is 80 to 132 characters per line. If one is using an electronic spreadsheet such as Visicalc, or the BASIC SKILLS FIRST management system, it is beneficial to have a 132 character per line printer.

Paper Feed Mechanism: Typewriters generally use a friction feed mechanism for loading paper, but this is not the best method to use with a high speed printer. Daisywheel printers often use a friction feed method in combination with a tractor feed device. The tractor feed allows for the use of continuous paper feed. Many dot-matrix printers use a pin-feed method. However, unlike the tractor feed device, a pin feed method may not allow for varied paper size.

Modem

One of the most exciting applications of a microcomputer is for communication. In order to communicate over telephone lines with a computer, a modem is a required peripheral device. Modem is a word which stands for modulator/demodulator, and this refers to the function of the modem. The modem translates digital data into a sound frequency which can be sent over telephone lines. When the message reaches its destination, another modem changes the audio signal back to a digital signal which can be understood by the computer. Figure 4 displays this process.



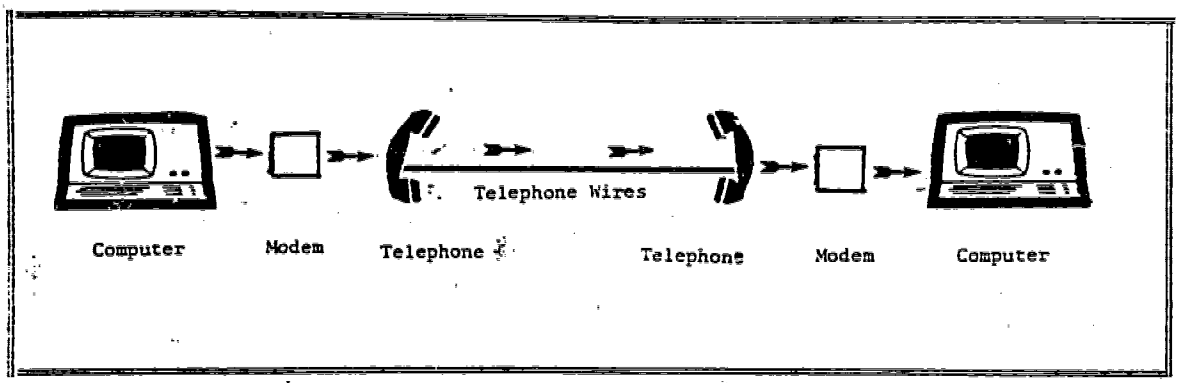


Figure 4: Communication using a Modem

A description of the meaning of modem appeared in a recent computer journal. The authors stated:

> *Every modem has two sets of circuits: a modulator, or square wave to audio section for transmitting data through the network; and a demodulator, or audio to square wave section, for receiving data from the telephone network.*[6]

There are two methods for connecting modems to telephone lines--a direct wire connection or an acoustic coupler. To use a direct connect communications method an electrical connection is made between the modem and the telephone line. This method is generally more reliable, with less static and interference.

If communication occurs infrequently, an acoustic coupler is often utilized. An acoustic modem has two suction cups in which the headset of the telephone is placed when a number is dialed and information is transmitted. This method is less expensive and easy to operate, but interference on the line is greater than with a direct connect modem.

Two methods can be used for a communicating system installation--a dial up network or a dedicated line. A dial up network, often referred to as Direct Distance Dialing (DDD), is best for occasional communications. A dedicated line is used for only one purpose and is applicable when the computer is in use most of the day for communications. Banks use a dedicated line for electronic teller stations.

Microcomputers, due to their ability to process data before and after communication, are often called "intelligent terminals". This means they can perform more sophisticated operations rather than being limited to receiving and sending information. For instance, a microcomputer can store information which it receives through communication with another computer and can manipulate that data in various ways.

In order to maintain compatibility among communication networks, a

standard has been developed which is referred to as "RS-232." When one refers to a "RS-232" port, it means that the computer has the capability of utilizing a modem for communications purposes.

Computer Literacy

Once one has a basic understanding of what a computer is and its main units and peripheral equipment, then this information needs to be applied to our field of interest--education. Computer literacy is a term which is in vogue at the present time. This section defines the meaning of computer literacy as it relates to our knowledge about computers.

Computer literacy is similar to any other term applied to basic skills in which literacy is based upon a continuum of skills and knowledge. This knowledge is identifiable by developmental stages, with each stage emphasizing, reinforcing, and elaborating upon skills from previous learning while, at the same time, introducing new concepts. All basic skills, particularly those in mathematics and language arts, are based upon proficiencies which increase in sophistication and difficulty as one progresses through the curriculum. Not every student needs or is capable of performing mathematical computations in calculus, yet one expects a "literate" person to be able to perform addition, subtraction, multiplication, and division operations. In computer education, not every student needs to know how to do advanced programming, yet one should be able to understand the elementary concepts in computer programming.

Computer literacy can be based upon a continuum of skill development which begins at an awareness level at which one understands what a computer is and continues to a proficiency level at which one understands advanced programming techniques in one or several languages. At the awareness level concepts are introduced which explore what a computer is, and, in simple terms, how its "brain" works, and how the computer affects us in our daily life.

At the literacy level one has a working knowledge of how a computer functions and is able to perform simple programming operations. Inferences can be made about the impact of computers on the individual and society and when use of computer applications is appropriate. Career opportunities are explored, and positions in computer operations are identified.

At the proficiency level one learns the complexities involved in computer operations. Advanced knowledge of one programming language is acquired, and complex sociological impacts of computers (both positive and negative) are understood.

Figure 5 represents the continuum of computer literacy. This appears as a one-dimensional model, but each step overlaps and builds upon the other.

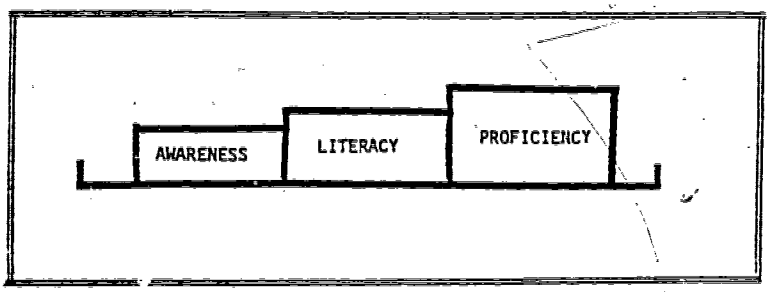


Figure 5: Computer Literacy Continuum

One may be proficient in programming at the literacy stage, but not knowledgeable of computer operations in general.

Another method of expressing this concept is shown in Figure 6. This model overlaps each stage, and information from one stage is necessary to expand the next stage.

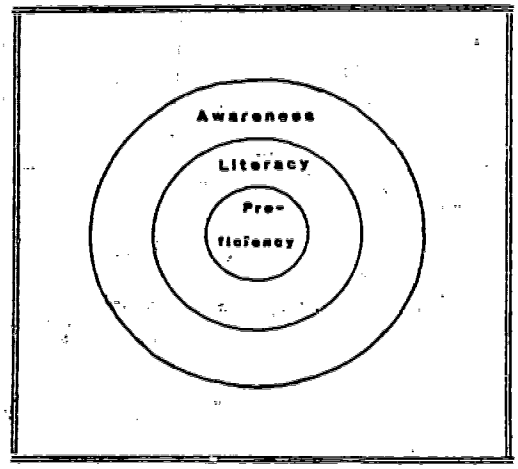


Figure 6: Computer Literacy Venn Diagram

Languages

In order to operate a computer, a program must be coded into the machine in a form the machine can understand. The ways the programs are coded are called languages. There are two general types of languages that computers use in their operation--source programs (high-level languages) and object programs (low-level machine languages).

Source programs are called "high-level" languages because they resemble the English spoken language more closely than object programs. Object programs use "low-level" machine language based on binary digits.

Once a source program is entered into a computer, it must be translated into machine language. Two tools which perform this translation function are called interpreters and compilers. An interpreter uses directions stored in the computer to execute each line of a program written in a "high-level," or person oriented language, into machine language. An interpreter executes one line at a time before going to the next line in a program. A compiler translates an entire program into numeric codes for machine language.

A diagram of the progression from a high-level language, to a translation to a lower level language, to final formatting in machine language is shown in Figure 7:

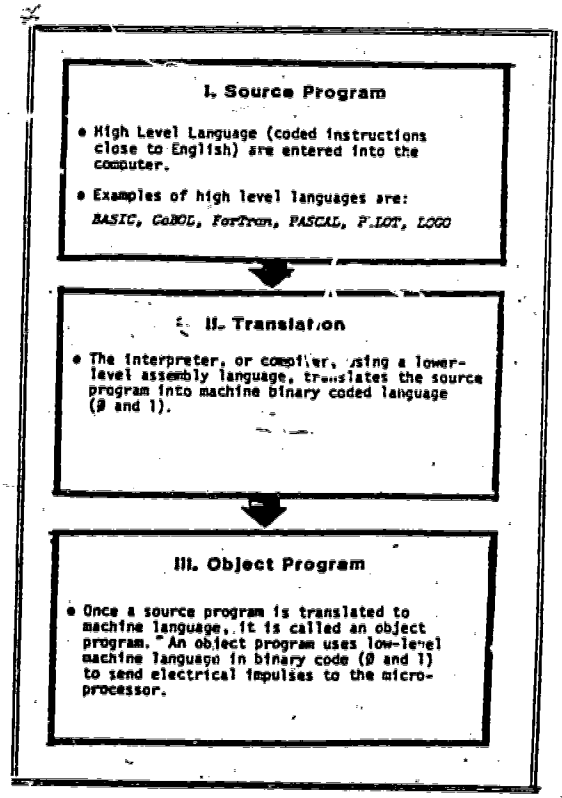


Figure 7: Source Program to Object Program

Many computer languages are expressed as acronyms. Examples of high-level languages and some of their uses are:

- APL — (A Programming Language). This is a mathematically oriented language and is used by scientists, financial managers, and others who work with large arrays of numbers.
- BASIC — (Beginner's All purpose Symbolic Instruction Code). This is the language common to microcomputers and one of the easiest to understand.
- CoBOL — (Common Business Oriented Language). This is a business language which is easy to read but lengthy to write.
- FORTRAN — (Formula Translation). This language was introduced in 1957 and was one of the earliest languages. It is used primarily by scientists, engineers, and mathematicians.
- LOGO — LOGO is a language developed by Seymour Papert which utilizes graphics to teach programming to young children. It is an interactive language which is learned at the computer.
- PASCAL — This is a language named after the originator of the earliest calculating machine, Blaise Pascal (1623 - 1662). The advantage of Pascal is that it is adaptable to the structured approach to programming. (BASIC is not adaptable to structured programming). Pascal also allows for data names of any length.
- PILOT — Pilot was developed in the 1970's to assist teachers in the development of curriculum materials. It is as powerful as BASIC, but Pilot programs are easier to read and comprehend. It is often referred to as an "authoring" language as it allows teachers to create and write their own CAI programs.

Examples of low-level languages are:

- ASSEMBLER — This language works directly with the internal design of the machine during the translation function. The language varies from machine to machine.
- MACHINE — Machine language is the language which communicates directly with the electronic circuitry by use of binary code. It is a low-level language because its binary character makes it burdensome and difficult to use.

Use of Computers

This chapter has provided basic information on the microcomputer--its mode of operation and its major peripheral devices. Computer literacy is defined, and common computer languages are discussed. The next issue to address is how to use microcomputers in education.

There are two general classroom uses of microcomputers. One is for computer-assisted instruction (CAI) and the other is for computer-managed instruction (CMI). In addition, the microcomputer can be used for administrative functions. The next chapters of this booklet focus upon uses of computers. Terms are defined and examples of applications are discussed.

The Microcomputer in Instruction

As a brief introduction to this chapter let's first look at what this section is not about. Notice the title is not, "Should We Have Microcomputers in Instruction?" That question is no longer the central one for educators. The focus has changed to how microcomputers can be used in instruction to shape a new world for teachers and their students. The flexibility of a modern computer, small or large, is infinite. The range of tasks it can perform is limited only by the range of programs which can be written for it. However, one task that a computer cannot perform is the replacement of the teacher. This section views the microcomputer as an aid to enhance a teacher's repertoire of teaching tools. The microcomputer is a new tool for instruction and that is the central focus of this section.

Advantages

Why use the microcomputer? This is a frequently asked question that can be answered from several perspectives. Perhaps the most important one deals with the reality of our modern world. Joseph Bourque, Montana State University, states:

> *Most (parents, teachers and school administrators) realize that today's school children will grow up in an increasingly computerized world and that computer literacy tomorrow will be almost as important as reading skills are today.*

Stated another way . . . if we hope to prepare today's students for tomorrow's world we cannot ignore computer technology.

But beyond our obligation to a dynamic -- not stagnant--education, are there any advantages of this new tool? Again, the answer is yes. Three basic advantages are:

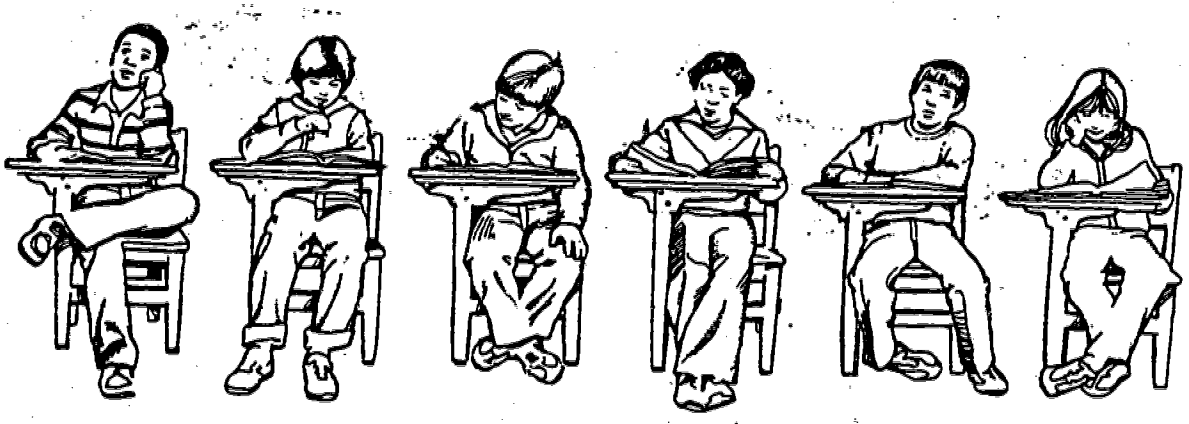
- Computers are flexible
- Computers are motivational
- Computers save time

Flexibility shows up in three separate areas. 1) The same or nearly the same equipment can be utilized in most subject areas--a real boon in the self-contained classroom. 2) A wide variety of instructional programs

are available. (See Computer Assisted Instruction for a listing of the types of programs.) 3) The pace of most programs can be varied to fit the individual student.

The second advantage, increased motivation, is perhaps debatable. Some see the excitment created by computers in the classroom as a temporary phenomenon. Should computers be ignored because some "think" students eventually will be bored with them? Skeptics like to cite Educational Television as an example of an earlier passing fancy which seemed initially to excite students but later to bore them. This example loses some of its credibility when one stops to think that students never became bored with television itself but merely with the ETV programming and usage in the classroom. One must also remember that TV was perceived first as entertainment and no relationships were established between TV and the "real" world of work. This is not the case with computers.

When it is said that computers save time, first thoughts are of teacher time, which is certainly important. However, one cannot overlook the advantage of saving student time. Absent students do not have to wait for the teacher to give them a missed assignment. Computers don't "lose their place" or "forget" an assignment. Also, the very important feature of immediate feedback allows students to continue to the next level or to receive extra practice in problem areas rather than wait for papers to be marked by the teacher. All of these features combine to give students more productive time on task. Please note that productive time should be distinguished from simply more time. One study estimated that utilization of computers in instruction could produce a 20 to 40 percent savings in time required for learning as compared with "conventional" instruction.[8] Couple that finding with research that recognizes that increasing productive time on task has a positive correlation with increased student achievement, [9] and some very strong reasons emerge for incorporating computer technology into the classroom.



Other advantages of utilizing microcomputer technology in the classroom are listed below. One should keep in mind that this list is by no means an exhaustive one; as computer technology is utilized by more educators this list is sure to grow:

- Teachers will have more time to work with individuals and small groups.
- Text-editors, or word processors, can improve writing productivity.
- Drill time responses can be controlled.
- Motivational graphics can be included.
- Computer-assisted music instruction can include music synthesizers.
- Good educational programs are fun to use.
- Quality teaching is uniformly upgraded.
- Students can be faced with real situations and data, simulations otherwise not possible.
- Learning can be self-adjusted by the student to meet his/her own profile.
- Graphics can display an object in real-time and then be slowed down for careful study.

Computer Assisted Instruction (CAI)

Now that the advantages of computers in instruction have been established, let's look at the ways in which computers can support and supplement instruction at all grade levels and in any subject area. Instructional programs usually fall into six Computer Assisted Instruction (CAI) classifications:

Drill and Practice: The computer can provide endless practice in any chosen area. It can randomly select items from a list such as a spelling list or it randomly can generate addition, subtraction, multiplication, and division problems at many levels. Given exercises can be timed as well as a summary given. These are probably the easiest computer programs to write and therefore the most plentiful. Controversy abounds as to

whether drill and practice programs constitute a worthwhile use of computer technology. It is probably safe to say that teachers who intend to use relatively expensive computer equipment for only drill and practices should be advised instead to use the money to purchase flash cards and workbooks.

Simulation/Gaming: This type of program has been called the best use of CAI. Simulation programs attempt to duplicate some real situations. One very popular program is called "The Oregon Trail", which simulates a trip to Oregon in the year 1847. The computer randomly generates various situations that could occur (bandits, hunting for food, etc.). The student then must make a decision based upon the information given. Immediate feedback is given as a result of the student's decision. Simulations have great value in improving problem solving and decision making skills. One can bring to the classroom situations which otherwise would not be possible.

Gaming is probably the most familiar computer application. Learner oriented games develop logical thinking, sequencing skills, manual dexterity, factual knowledge, and problem solving techniques. The students will build skills in acquiring knowledge, analyzing a task, and transferring problem solving strategies to other problem situations.

Inquiry and Dialogue: In the interactive inquiry and dialogue, the user indicates a specific area of knowledge and the microcomputer provides a routine which will upgrade the user's knowledge in that specific area. The programming is written in small, specific segments of instruction as compared to a full course of study.

Problem Solving: Problem solving is referred to as a higher level task because it requires some programming skill. Problem solving techniques are well utilized in secondary mathematics classes because they can enable students to explore various methods for solving the same problem and thus gain a broader understanding of underlying mathematical concepts. At this level students use the power of the computer to generate solutions rapidly that would require lengthy hand calculations.

Information Retrieval: Information retrieval systems make use of a bank of data (information) which serves as a resource for users. This reference source is faster to access than using reference books. Examples are a thesaurus of synonyms and antonyms, scientific data, and subject oriented central information files.

Tutorial: Tutorial computer teaching is closely related to the traditional lecture method. Information is presented in an organized fashion, including frequent one-to-one reinforcement, as the learner responds. A summary of key concepts and information learned as well as how these relate to the real world may be found at the end of each unit.

Computer Managed Instruction (CMI)

CMI programs reduce paperwork and increase teacher time available to students by performing the following functions:

- Organizing curricula and student data
- Monitoring student progress
- Diagnosing, prescribing, testing, and evaluating learning outcomes
- Providing planning information

A typical CMI system, such as Tennessee's Basic Skills First Management Program, is one in which students take tests on machine-readable sheets and the sheets are scored through key entry or a "scanner". The results are then processed and summarized by the computer. Some CMI summaries may include a diagnosis of problems and prescriptions for further study. The focus of CMI systems is relieving teachers of much of the paperwork and recordkeeping tasks which accompany individualized instruction. It is important to remember that CMI, no matter how sophisticated, is not a substitute for decision making by a teacher. A CMI system can form logical conclusions based on information fed into the computer, but controlling this information is still the primary responsibility of sensitive and capable teachers.10

Curriculum Considerations

Computer literacy, as defined in Chapter II, is promoted in the classroom in two general ways. The computer is used primarily as a tool to enhance the existing curriculum. The computer is a technical device, like a filmstrip projector, a television, or a book, that helps provide instruction and releases the teacher for more personal interaction with the students.[11] (This aspect is discussed more thoroughly in the CAI and CMI section of this chapter.)

The computer is also used as an object of instruction. In such courses students learn about the computer, programming, and literacy. People who work with computers in the classroom are saying that computer literacy courses should include:

- How computers are used
- What a computer can and cannot do
- How computers work
- The impact of computers on society
- How computers can develop the skills of decision making and coping with change
- An introduction to, or an awareness of, programming[12]

The Tennessee Statewide Microcomputer Advisory Committee has identified the following major strands for a computer literacy program:

- Applications
- History
- Logic and Problem Solving
- Operations
- Social Impact
- Terminology

Because the issue of computer literacy and integrating computer technology into the school curriculum will have such a great impact on education in the next decade, many local school systems around the country have formed their own computer committees to examine proposed solutions and to assure quality decision making.

Further Applications

Microcomputers in the classroom should serve to extend the mental powers of students, challenging their intellects in a manner not seen before. With appropriate software microcomputers can or soon will be able to:

- Perform calculations quickly, allowing students to rapidly determine the results of a change in a single factor in a complex formula. If these calculations had to be done by hand, students would likely lose interest long before they reached insight into the phenomenon under study.
- Draw diagrams of any object, real or unreal, that can be described mathematically. Once drawn, these diagrams can be viewed from any angle and perspective. In no other way can some concepts be adequately presented and understood.
- Rearrange textual information quickly, allowing students to experiment with their own written work in order to produce more expressively powerful compositions.
- Act as a learner instead of a teacher, allowing students to expand their understanding of a concept by teaching it to the computer.[13]

Extending the mental powers of students is not limited to the average or gifted students. One of the most challenging and exciting uses of microcomputer technology in the schools is in the area of education for the handicapped. Some microcomputer "gadgetry" that was recently displayed for the National Association of State Directors of Special Education included:

- An electronic plate that, when slipped into certain microcomputers, allows students who cannot speak to type what they want to say and let the computerized voice do the talking.
- A computer that allows students without use of their hands to speak into a microphone and see the words appear on a monitor screen.
- A "paperless Brailler" that lets blind students type Braille electronically, rather than by pressing the symbols onto paper, and prints in regular type for a sighted teacher, or, conversely, lets a sighted teacher enter type and have it read by the blind student through Braille dots that pop up and down electronically.
- Drill programs in math or spelling that provide visual and auditory stimuli such as fire-breathing dragons and shooting rockets, which are intended to help learning disabled students learn.[14]

It really does not matter whether the student is gifted or handicapped, or whether the microcomputer is used to deliver the instructional program (computer assisted instruction), to augment student learning (a problem solving tool) or as an object of instruction (computer literacy). In any case two variables that enhance learning should be stressed. First, learners should play an active role when using the computer. Research has shown that active learners tend to have higher levels of achievement than passive learners.[15] It may sound silly to say that someone could "use" a computer passively, but when the student is always a "receiver" and never a "commander" the result is passive interaction. The second variable to consider is learner independence. According to John Richards, Massachusetts Institute of Technology:

> *One should view the computer as a tool in the hand of the learner; ...making the learner independent, using the computer as a tool, is a shifting of control from the computer to the learner...I have a very simple-minded notion that if one of the purposes of education is to get students to become adults who assume responsibility for their own continuing education, then the best way to do this is with practice.* [16]

Opportunities to become familiar with all aspects of computer use and operation should be provided to all students. Educators should be aware of the danger of limiting students' access to the computer according to intellectual ability, social class, or wealth of the school system. If some students interact with the computers only to receive instruction from them while other students learn to program them, the result will be the creation of two separate classes of students: one which controls computers, and one which is controlled by them. Therefore, equity of access should always be a priority to educators.

Misapplications

The most glaring misapplication of the microcomputer in schools would be the under-application, or under utilization, of it. This misapplication can take many forms:

Locking into one mode or one instructional package--there are ways to incorporate computers into almost any teaching area. Look at areas that have not been considered traditional ones for computer use;

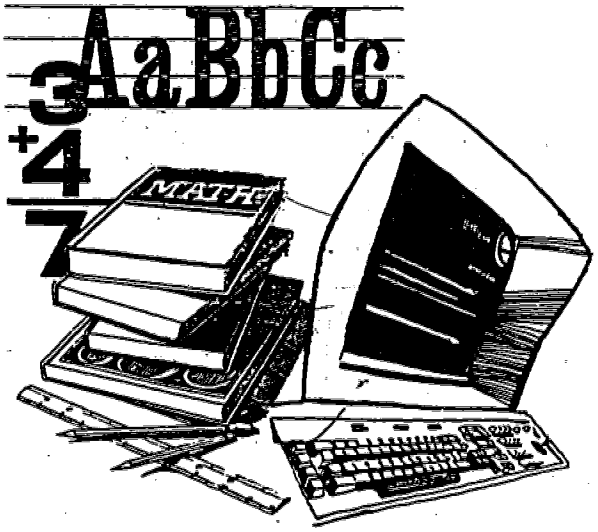
Limiting student access to the machines--interest may wane if students do not have an opportunity to practice and reinforce their new skills;

Using computers solely for CMI--to use computers primarily as a testing device would be to lose the benefit of the enormous range of educationally motivating materials that are available and to render the microcomputer merely an animated and self-correcting form of multiple choice test;

Using computers only for individualized instruction--failure to explore the possibility of using the computer as a tool for whole group instruction serves to limit the opportunities for an inportant aspect of human interaction as teachers and students explore a new field together.

* * *

There are two ways that microcomputer technology can have an impact on the classrooms of this state and this nation. Schools which utilize microcomputer technology to its fullest extent will allow education to keep pace with societal changes. On the other hand, schools which ignore this tool will become obsolete. If education is to keep pace with the work place, careful planning must become a part of the system. Rushing to incorporate technology without an action plan can result in wasted time, money, and effort. The following sections of this guide discuss the administrative uses of microcomputers and issues to consider when making hardware and software selections.



Administrative Uses

As computers become more powerful in the ability to store and manipulate data, an increase occurs in administrative applications. Microcomputers, however, are not intended to replace applications which require large amounts of data entry and data storage. These types of uses are best left to the larger computers which have been prevalent during the past few decades. Thus, the administrator must decide which type of computer is best suited for a particular task. For example, a microcomputer may be suitable for a small payroll while a larger computer would be appropriate for a larger payroll. Some administrators may find it appropriate to use a terminal connected to a large computer or "mainframe" for certain system-wide tasks, while using a microcomputer for general central office operational tasks.

One of the first steps an administrator must take in deciding whether to use a microcomputer for administrative purposes is that of assessing the management needs of the school system. The second step is to identify which of the needs are best met through computerization. The third step is to determine which type of computer is best suited for the application. Considerations in the second and third steps include items such as: available software, amount of data storage, ease of operation, overall costs of operation, staff availability, staff training, accessibility to the data, location of equipment, and portability of equipment.

An administrator may find that both the microcomputer and the mainframe are partners in addressing the needs of a school system. The final step is to develop a plan of action. This plan would not only include implementation strategies, but would also include a method for reviewing the products of both hardware and software vendors. This review would be similar to those mentioned in the hardware and software selection procedures in this guide.

The microcomputer has several applications appropriate to both a school building central office and the central administrative office. Since the central administrative office requires information from the school level office, it is imperative that one be consistent across the school system with the types of microcomputers purchased for administrative uses. Software programs which work on one brand of computer generally will not work on another brand of computer. Thus, all school administrators should be involved in the planning process for purchasing computers.

Four identified uses of computers for administrative functions are:

- Data Base Management Systems
- Word Processing
- Electronic Spreadsheets (fiscal records)
- Communications

Data Base Management Systems

Data base management systems provide a method for reducing paperwork and for organizing and managing information in a manner that makes it easily retrievable. Data base management systems are often referred to as "filing systems" and include any type of software that allows the organization of information and records and the generation of reports. The advantage to using a data base management system, as opposed to more conventional filing cabinet/filing card records, is that information can be retrieved in more than one way. For example, if all student records are in a filing cabinet by the students' last names, then the only available method of retrieving information is by last name. A data base management system allows information to be filed and to be retrieved by several methods, such as by which students belong to certain clubs, which students have received immunization, and which students are on the honor roll.

One typical filing software package allows a person to design a form right on the computer screen, determining the categories and spaces to allow for each item of information. This program allows for the storage of files on numerous diskettes, each capable of storing approximately 1000 one-page forms. Therefore, files can be established for personnel records, student records, PTA groups, student extra-curricular organizations, inventory records, discipline referrals, student transcript information,and other necessary categories.

There are specialized programs in data base formats for keeping school records Examples are programs for class scheduling, student attendance records, and recording of student grades. In purchasing a scheduling package, it is wise to be sure that the software allows for period by period scheduling for each student. Combined packages are available which allow keeping of attendance and grade records in one management system. If central office records require greater storage, or if a large school is involved, consideration may be given to the purchase of a hard disk. Hard disks have been discussed in Chapter II. If more than 1600 records are involved, a hard disk is recommended. Cost of a hard disk drive adds considerably to the cost of the computer system ($2500 - $5,000 for five megabytes of storage). A hard disk can handle 20,000 records with greater speed and more reliability than a floppy disk drive.

Basic questions that need to be answered when purchasing data base management software are:

- How many records will the system maintain and is the available computer hardware compatible with the program?
- What specific functions will the program accomplish? Will the program do multiple functions?
- What is the cost of the program?
- Can the manufacturer recommend other schools currently using the program?
- Are the directions (documentation) clear and easy to follow?
- Are back-up diskettes provided or are additional copies available if the program is accidentally destroyed during operation?
- Is information easy to enter and is clerical/secretarial staff willing to adapt to new methods of performing tasks?

Word Processing

One of the most popular uses of computers in the office environment is for word processing. Word processing is a method of electronic text editing. Any secretary that has enjoyed the self-correcting typewriter will think that a computer with word processing is from the twenty-first century! Word processing allows the typist to create and correct text on the screen and to manipulate and store text for later use.

In order to do word processing on a computer, software needs to be purchased which allows the computer to perform the aforementioned functions. Word processing automatically formats text. It can left and right justify margins (typewriters left justify only), automatically center text (no more counting spaces from the center), allow for insertion and deletion of text anywhere in the document, and move sentences, words, or paragraphs within the document itself. Corrections are made by typing over text, and the computer automatically realigns the text if space requirements need to be adjusted. In addition, word processing software sometimes has the ability to merge text with mailing lists. This means a letter is written and sent to a list of persons whose names appear in a separate file. Each letter is individually addressed and has the appearance of being typed for each person. Some word processing software contains spelling programs which automatically check the text for spelling errors. Spelling programs contain dictionaries with 10,000 to 50,000 words and allow the user to type in a limited number of words that are frequently used in the work environment.

Typical uses of word processing in a school environment include:

- writing form letters
- creating mailing lists and merging files
- developing contracts and other forms
- writing professional papers
- publishing manuals and brochures
- developing student tests
- preparing classroom materials
- publishing student or PTA newsletters

If word processing is to be used for professional documents and official correspondence, a letter quality printer (see Chapter II) is recommended.

Questions to ask concerning word processing software include:

- Is mailing list capability available?
- Does the cursor have the versatility to move anywhere on the screen?
- What capabilities are available for inserting text, deleting text, and using only parts of the text, as needed?
- Is merging of text from other files possible?
- Is a spelling dictionary part of the program?
- Is assistance (a help menu) available in the program?
- Are keys defined to use for particular functions such as to insert standard paragraphs?
- How does the program handle hyphenation at the end of the line?
- Can the text be easily scrolled (moved up/down, side-to-side) on the screen?
- Is it possible to underline words in the text?
- Is a split screen capability (looking at two parts of the document at once) available?

Electronic Spreadsheets

Electronic spreadsheet is a new term which is applied to one of the most popular computer programs for business managers and planners. It is estimated that at least twelve commercial packages are on the market for this term under variations of the brand name "Visicalc." A recent comment in a computer magazine stated, ". . . the spreadsheet programs fit a virtually limitless number of applications . . . budgets, annual reports, fiscal projections, sales records, and a bottomless list of others."[7]

Electronic spreadsheets create a grid of rows and columns on the computer screen that can contain thousands of entry positions. It resembles a computerized ledger sheet. Each position accepts a value or relationship which is defined by the user. The user can change one value, and the computer will adjust all other values affected by the change. This ability to recalculate any item in any row or column and to automatically see the impact it has on the other variables and total amounts, is one of the strongest (and most time saving) aspects of the program. The program has the capability of determining in minutes what the cost of salary increases for personnel would do to the total school budget. If a tax increase is needed, a percentage value can be written into a formula and added to the spreadsheet. The computer determines the amount needed to balance the budget.

Questions to consider when examining an electronic spreadsheet program include:

- How much machine memory is required?
- What is the size of the spreadsheet?
- How easy is it to change values and formulas?
- How does the program format to the printer?
- Does the program have split-screen capability?

Communications

Chapter II of this booklet discusses the use of a MODEM for communication purposes. Although there are other methods for communicating with other computers, this section discusses electronic communication through the use of a microcomputer and a telephone MODEM. The ability to communicate rapidly, and often at a cost savings, is an innovation which is becoming more widespread.

Electronic communication can be divided into three major areas:

- Electronic Mail Networks
- Data Base Information Retrieval
- Electronic Transfer of Data

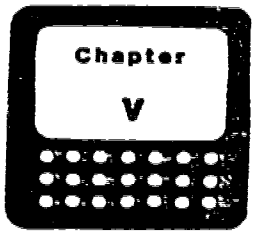
Electronic mail is the sending and receiving of messages by a computer or communications terminal for purposes of sharing information with other individuals. Messages are stored on a computer in one location according to specified addresses of individuals. To send messages, one merely types in the text with the address of the individual to whom the message is to be sent. The same message can be sent at once to all individuals on the network or to any other number of individuals. Whenever an individual accesses the network, the computer will indicate that messages are ready to be read. Most electronic mail networks also have bulletin boards, or special interest sections which are accessible to the users. For example, SpecialNet--a network for special education and of which the State of Tennessee Department of Education and some local school systems are members--has bulletin boards dealing with such topics as federal legislation, bibliographies, meetings and conferences, and computers. Any member of the network can access these bulletin boards to receive current information. Tennessee also participates in a network of other state departments of education for the purpose of improving basic skills through technology. Rather than manually typing and sending fifty letters, one can use the electronic mail network to request information more cheaply from all the other states through sending one copy of the letter through the network. Although electronic mail produces cost savings in many instances, not all messages are cost effective. One must still assess the most cost efficient and effective means among the postal service, telephone conversations, and electronic mail for a particular information need.

In order to utilize electronic mail, one must have either a communications terminal or a microcomputer that has an RS-232C interface, a telephone MODEM, and a communications software package. A printer is convenient for maintaining hard copy of information. Cost varies by the length of time it takes to transmit and receive information and the cost of the particular data base. Costs for electronic mail networks generally range from $5 to $30 an hour.

Electronic data base retrieval is the accessioning of information by a computer or communications terminal through the use of key words. Data bases are maintained on a large computer and cover a wide variety of topics. A popular data base maintained by various companies for educators and which is accessed by the Tennessee State Department of Education is the Educational Resource Information Center (ERIC) collection. The user, by communicating with the computer on which the data base is stored, searches for particular articles in the ERIC collection by typing key words describing the information needed. The computer then lists the articles by author and title or in abstract form as requested by the user. Computerized searches of the

ERIC base eliminate hours and days of manual searching. Other data bases provide not only information but also software package access. Thus, the user can operate a microcomputer as if it were a larger computer. Schools located in areas where local phone calls can be made to computers, such as in a university town, generally can access software programs provided on the mainframe computers for a nominal cost. These programs range from statistical analysis to word processing. The same equipment necessary for electronic mail can be used for electronic data base retrieval. Costs for this service generally range from $20 an hour to over $100 an hour.

Electronic transfer of data is the sending and receiving of data from one computer to another. Using this method, school building files or records could be sent to the administrative central office. Paperwork reduction can occur using the electronic transfer of data.



Selecting Microcomputer Hardware

Purchasing the right computer hardware (the physical components which comprise a computer system) becomes a frustrating task when one considers the large variety of manufacturers and models of computers. The diversity of computers in the schools suggests that there is no single microcomputer which is considered best by educators. Determining how a microcomputer system will assist in meeting curricular, instructional, and administrative needs is a major task in the decisionmaking process of acquiring computer hardware. In selecting a microcomputer, educators should find a system that will not only meet immediate needs but will also meet future applications.

The purpose of this section is to provide educational decisionmakers with procedural suggestions for selecting microcomputers. These procedures are:

- Identify school needs
- List the needs which may be met through computer applications
- Establish microcomputer objectives
- Understand criteria for selecting a microcomputer
- Rate the importance of each characteristic
- Review various brands of microcomputers
- Rate each brand of microcomputer according to how well it meets each characteristic

Appropriately selected and properly utilized computers can enhance the instructional program while providing assistance to teachers and administrators.

Needs and Objectives

The first step in selecting a microcomputer is to identify curricular, instructional, and administrative needs of the school. These needs can be identified through group interaction techniques or through individual survey-type methods. The needs should be stated without consideration to microcomputer applications. They should be stated in narrative terms such as "The mathematics curriculum should include resources for motivational drill and practice," or "Students need to improve their understanding of verb and subject agreement," or "Teachers should have assistance in grading tests."

It is also important to determine whether teachers and administrators are willing to spend the time in using microcomputers. Without some commitments, the probability of failure will be increased. Commitments should also include the funding of hardware, software, maintenance, and teacher training.

Some needs may not be met through the use of a microcomputer. Thus, one should list those needs which can be addressed through the use of a microcomputer. This listing can then be developed into microcomputer objectives. The establishing of objectives should be as specific as possible to identify the features needed for the microcomputer system. For example, objectives for a school may be: "Students who have difficulty applying principles in mathematics will increase their abilities through the use of motivational drill and practice computer games," or "Students will increase their knowledge of subject and verb agreement through tutorial computer programs." or "Teachers will be able to save time through computer scoring of tests." These objectives can be classified according to the instructional, managerial, and administrative uses of computers discussed in other sections of this guide. Cross-referencing the objectives with subject area or types of students will also help in identifying the number of microcomputers needed and how they should be placed within the school setting.

Characteristics for Selection

After the needs and objectives are determined, a method of comparison should be applied to all microcomputer equipment being considered for purchase. Purchasing microcomputers that do not serve an identified need will be wasting resources. The characteristics and methods may be modified to suit local needs.

1. Keyboard Layout: Most microcomputers have three styles of keyboards, A mylar, or membrane type of keyboard, is a flat surface board. Since nothing can become lodged between the keys, it is suited for young children. However, a mylar keyboard, due to its unique touch sensitive design, is not conducive to fast typing. Another type of keyboard uses keys similar to the shape of those found on a calculator. The third and more common style of keyboard is that similar to a standard typewriter. The typewriter style keyboard is important for word processing or for applications requiring typing. Some computers come with an additional numeric keypad or allow these pads to be attached as a separate unit. Data entry is expedited through the use of this keypad.

2. Video Display: Computers generally display output to a video monitor or a television set. Video displays may be built into the computer unit or may be attached as a separate unit. A computer video monitor cannot receive signals over the air as can a television. Video monitor displays can be color, or as a less expensive alternative, black and white or green-phosphorus. If a color or black and white television set is used, a radio frequency (RF) modulator is required as an interface. Monitors produce a sharper picture than do television sets. A computer screen displays output anywhere from 22 to 80 characters per line by 16 to 32 lines. This display size becomes an important factor in word processing or where large amounts of information need to be shown at one time. Some computers may also display both upper and lower case letters, while others will display only upper case letters with the smaller case being produced as an inverse video.

3. Graphics: Computers capable of producing graphics generally are of two modes - low resolution and high resolution. High resolution graphics utilize more dots on the video screen and produce a more vivid and detailed picture than low resolution graphics. Art classes may require a high resolution graphic mode, whereas administrative applications may need only a low resolution. Programs calling for illustrations may also require a higher resolution capability. Some computers produce graphics more easily than others and require fewer keystrokes and memory utilization. Other graphic considerations include the capability of accepting peripherals such as graphic tablets, plotters, or light pens. Graphic tablets allow the user to draw figures for direct input into the computer rather than programming a figure. Light pens will allow drawing or movement of figures on the screen.

4. Color Capability: Not all computers are capable of generating color. The number of color or intensities of colors vary among machines. Generally, the range is from eight to sixteen different colors. Some applications, such as management uses, do not require color monitors (or TVs) while other uses, such as art classes, require color capability. If the computer will be used mostly for generating text, such as in word processing, a color monitor or color television is not recommended since the clarity will not be as good.

5. Sound or Music Capability: Not all computers can generate sound or music. Variety exists in the quality of sound and music produced by computers. Some computers have separate synthesizers for producing sounds which are of higher quality. Other optional items for computers are internal/external speaker systems. Computers use sound to focus a user's attention to the video display or alert the user to a particular operation. Other uses of sound are for

simulation or motivational purposes. Considerations may be given to the capability of voice synthesizers as a feature. If a microcomputer is to be used in music classes, then tone and pitch quality becomes an important factor.

6. Language Capability: In most microcomputers, BASIC is the inherent language. Variations exist in different versions of BASIC and some can utilize more sophisticated programming techniques. If programming is a priority, then these levels, or dialects, of BASIC need to be considered as well as multi-language capability such as COBOL, FORTRAN, LOGO, PASCAL, or PILOT.

7. Memory Capability: Memory is expressed in kilobytes (K) meaning a thousand bytes (or characters). A 4k machine has a 4000 byte (character) memory while a 64k machine has a 64,000 byte (character) memory. The amount of memory varies from machine to machine. Most computers are constructed to accommodate additional memory for an additional cost. Most CAI and sophisticated programs have greater memory requirements than other programs for operation. One needs to consider the minimum requirements of the type of software to be used on the computer. If used strictly for computer literacy, without prepared software, then less memory is sufficient. Word processing, data base management systems, financial packages, and computer managed instruction require a large memory. Various types of peripheral devices, such as disk drives, use some of the system's RAM for their operation. Some programs, generally on lower price machines, come in ROM cartridges to save utilizing RAM.

8. System Expansion Capability: Along with the current rate of technological advances, comes the ability for items to be added to microcomputers for system expansion. One needs to consider what peripherals currently are available and how well the system may adapt to new innovation. Consideration should be given to memory expansion capability. The manufacturer's plans for updating the existing system is also a consideration.

9. Interfacing Capability: The ability to connect, or interface, to other devices is essential for a complete microcomputer system. Some microcomputers have built-in ports, or plugs, which allow connecting the computer to equipment such as printers, game paddles, and MODEMS. Other computers may require additional devices to allow connections. Consideration should be given to the location, accessibility, and convenience of these ports, as well as to whether they are electrically wired in a serial or parallel manner.

10. Peripheral Devices: The most common peripheral devices were discussed in Chapter II. Most computers offer options for peripherals. Consideration should be given to the devices that are purchased with the computer and to the availability of other equipment. An important peripheral device is a printer which is used whenever a hard copy of information is needed such as in word processing or computer managed instructional activities. It is important to ascertain the type of printer compatible with the microcomputer, and the interface requirements. Disk drives are important when there is a need for speed in loading and saving programs or when there is a need for a large storage of information. Most commerical software requires at least one disk drive. One needs to ask how many disk drives can be accessed by the computer, whether the drives are built into the machine, and whether hard disk drives can be added. If communications is planned, then a MODEM, or an acoustical coupler, is needed. Most communication devices require an RS-232C communications port or interface card. Scanning devices can also be added for scoring of tests or for data entry such as attendance reporting. Other peripherals for consideration include game paddles or joy sticks, graphic tablets, light pens, synthesizers or plotters.

11. Execution Time: The time it takes to operate, load, or save a program varies with the specific hardware and software. Time differences are considered when large volumes of data are to be processed. Likewise, student attention spans need to be considered in the loading of programs and the speed of screen displays.

12. Communications Capability: Some computer systems will allow for classroom networking through connecting less expensive computers to a larger microcomputer. Consideration should be given to the necessity of communicating with other computers in the school system. Discussions within Tennessee are occurring concerning future networking with all school systems in the State. With emphasis on electronic mail and information sharing, one may wish to consider joining national networks such as SpecialNet a special education network. The Source and CompuServe are commercial networks which have become popular.

13. Flexibility: An advantage of a microcomputer is its portability. Dependent upon needs, one may find it necessary to move the microcomputer. One should consider the computer's sturdiness, weight, durability, ease of disconnecting components, and reliability under frequent movement conditions. One should also determine the type of room environment the computer system needs. Consideration should be given to the special cords, humidity, temperature controls, and the protection needed by the system. Cost of office furniture to accommodate the computer is an additional consideration.

14. User Training Support: Unless one is knowledgeable in the use and assembly of a particular microcomputer system, schools will need support from the microcomputer vendor on the operation and physical configuration of the system. Some companies ship microcomputers without providing technical assistance to the users. Important factors in training are whether the dealer provides training, the amount of training that will be provided, and the number of personnel that can be trained in each session.

15. Service Support: Although most microcomputers require little maintenance, service and repair of equipment should be a major concern. Disk drives and printers have a higher incidence of repair than the microprocessor. One should ascertain the available warranties or service contracts, and how well the servicing organization supports the equipment. Determination should be made as to the items included in the content of the warranties such as parts, labor, and shipping. Some school systems have technical staff capable of servicing equipment, but, in many cases, a system which has been repaired by school system personnel will void the warranty. If equipment is to be serviced outside a school system, one should ask about the possibility of loan programs, the cost of shipping, and the average repair turnaround time. Equipment in for repairs over 25 hours or more will greatly limit the use in the school. Consideration should be given to the support for updating equipment as new developments are made.

16. Software Availablity: Careful consideration should be given to software support. A microcomputer with limited software will not be sufficiently utilized. Documentation from the manufacturer or dealer is also an important factor in making a selection. Questions to be asked include: Are there sufficient manuals, reference and program materials available? Is there sufficient software to support needs? Have outside vendors supported the machine? Have software programs been field tested? What is the cost for updating software as new developments are made? Are back-up copies of software available? What technical assistance is provided for operating various software?

17. Cost: Costs generally range from $300 to $4000 to establish a microcomputer system. The list price advertised generally includes the keyboard, a microprocessor, and minimum memory. This price does not include a complete system. Figure the necessary peripherals with the total cost as well as the cost of needed software to operate the system. Adding a large number of peripherals to a low priced machine may eventually equal the cost of higher priced units. When comparing costs among machines, be sure to include the same configuration in the comparison.

Selecting the Microcomputer

After understanding the characteristics necessary for a particular use, one should rate the importance of each characteristic as to its relationship to the needs. The hardware consideration sheet on page 40 suggests a scale from 1 to 7 for rating the importance of each characteristic. A number "1" indicates the item to be "unimportant," while a number "7" indicates that the item is "extremely important." For example, if one plans on using a microcomputer for management purposes, then color capability may not be as important and a "1" may be given as a rating. On the other hand, if one wishes to use a computer extensively for art classes, then a higher rating would be given. Importance of the same characteristic will vary as needs vary. This step of determining the importance factors is best done in a committee representing all staff members who will be users of the system. One may need to use a separate hardware consideration sheet for each of the major categories of uses such as CAI, CMI, administrative uses, and computer literacy. If money is available and a high utilization of equipment will occur, a separate sheet may be necessary for uses within categories.

After deciding on the importance of each characteristic, the next step is to review the various microcomputers. Initially, one should visit a school that owns a microcomputer to probe for advantages and disadvantages. Demonstrations from the various vendors are essential as well as becoming familiar with available literature on microcomputers. It is recommended that notes be taken as to the positive and negative aspects of each machine for each characteristic.

The last step is to rate each machine on how well it meets each characteristic. A suggested rating would be to use a scale from 1 to 5 where "5" indicates the best match with the particular characteristic. For example, a machine with a small amount of memory, with no possible memory upgrading, may receive a "1" for how well it meets the memory characteristic. If a machine is low priced, then the rating may be high. If a characteristic is an absolute necessity, then a machine which does not meet this characteristic should be eliminated without consideration of the total score. To illustrate, a machine whcih will be used for word processing and has a mylar keyboard should be eliminated prior to considering the remaining characteristics.

For each brand of microcomputer, multiply each characteristic importance rating by the corresponding machine rating to obtain a score for each characteristic. Totaling these products will give a grand total for comparing each brand of microcomputer.

The same brand of microcomputer may not be selected for all categories of uses. For example, a computer used extensively for computer managed instruction may be a different brand than one used extensively for computer assisted instruction. It is not recommended, however, to mix brands of computers among the same category of use. That is, if computer assisted instruction is a high priority requiring extensive software, then one should buy the same brand of computer for all computer assisted instruction. This way software can be shared.

Tennessee Department of Education
Hardware Consideration Sheet

Manufacturer _____ **Model** _____

Directions

At the top of the page, fill in the microcomputer MANUFACTURER and the MODEL NUMBER.

Before examining any particular machine, fill in SECTION I - WEIGHTED FACTOR. This is the importance of each characteristic according to the needs and objectives of your system. For example: If used in typing classes, keyboards would receive a weighting factor in Section I of 7 = EXTREMELY IMPORTANT.

After examining a machine, fill in SECTION II - RATING. Rating indicates how well the machine meets each characteristic. For example: A machine with a limited memory and no ability to upgrade would receive a rating in section II of 1 = POOR (Item 7 - Memory).

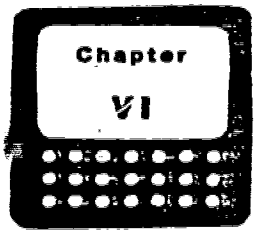
After completing Sections I and II, MULTIPLY each weighted factor by each corresponding machine rating to obtain the score. The SUM of the TOTAL column gives a score which can be used for comparisons among various manufacturers. Generally the higher the total score, the more likely the machine meets the indicated needs. Discretion must be used in interpreting the scores. If a machine does not meet a necessary objective, it may be eliminated without consideration of the total score. For example: A machine to be used for typing instruction which does not have a standard keyboard, may be eliminated, regardless of the score.

Characteristics	Section I Weighted Factor Scale: 1=Unimportant 2=Somewhat Important 3=Mildly Important 4=Important 5=Moderately Important 6=Very Important 7=Extremely Important	X	Section II Rating SCALE: 1=Poor 2=Below Average 3=Average 4=Above Average 5=Excellent	=	Section III Score
1. Keyboard Layout					
2. Video Display					
3. Graphics					
4. Color Capability					
5. Sound/Music Capability					
6. Language Capability					
7. Memory Capability					
8. System Expansion Capability					
9. Interfacing Cabpability					
10. Peripheral Devices					
11. Execution Time					
12. Communications Capability					
13. Flexibility					
14. User Training Support					
15. Service Support					
16. Software Availability					
17. Cost					
Total					

Systemwide Considerations

A school system should strive for consistency in purchasing microcomputers for a particular use. Software which will run on one brand of microcomputer generally will not run on another brand. Thus, if a particular microcomputer is purchased for computer managed instruction by one school, then that brand of machine should be purchased by all schools in the system for computer managed instruction. This consistency will hold the cost of software purchasing and machine training to a minimum as sharing across the school system can occur.

The establishment of a systemwide planning committee will facilitate purchasing the same brand of microcomputer for an identified use as well as identifying training needs and strategies. This committee should be composed of those who know the needs of a particular school for all areas of use. After a particular school has identified the brand(s) of microcomputers they wish to purchase, the school representative can work with others on the committee in determining the brands of microcomputers to be purchased and the standards to follow. It is also recommended that one person in the school system be given the responsibility for training and facilities management.



Microcomputer Software

Microcomputers must be instructed to perform any given task by means of a software program--the set of instructions that tell a computer what to do and how to do it. These instructions are either already in the computer, or are fed into it from a tape cassette, a diskette, cartridge or a communications mode.

Another term, "courseware", is sometimes used to refer to software. This term describes software which is designed to support instruction in a course of study and includes teacher and student support material. In this publication the term software is used as a broad generic term and includes instructional courseware. This chapter discusses the classification of software, sources of software, software selection, and evaluation.

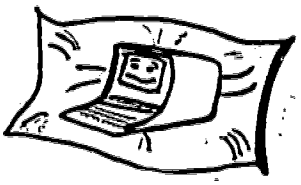
Systems and Applications

Software is often classified as systems software and applications software. Systems software refers to the instructions that cause the microcomputer to interact with its component parts. This software determines how a computer will operate. Each brand of computer has its own unique operating system which supports the languages which the microcomputer understands, the way it performs mathematical computations, and the way it stores and retrieves information. As a result, most software programs written for one brand of microcomputer will not operate on a different brand.

Applications software is designed to solve a specific problem or to accomplish specific tasks not inherent to the operation of the microcomputer. Instructional software for Computer Assisted Instruction (CAI), direct instruction by use of the computer, and Computer Managed Instruction (CMI), classroom management activities such as testing, scoring, and analyzing test data, are applications software which are discussed in depth in this publication.

In addition to direct classroom applications there are many other uses in the field of education. Administrative uses include word processing and finance. These applications
booklet.

Sources of Software



There are four methods of obtaining software:

- writing/developing software
- modifying existing software
- sharing software through user groups
- purchasing software from commercial vendors

Each of the methods should be explored by local school systems for appropriateness.

There are several reasons why teachers might want to develop their own software. One reason is that the teacher has control over the style and content of material. Another reason for creating software is that appropriate software may be unavailable or the cost may be prohibitive. The disadvantage of teacher generated software is the amount of time and technical expertise required to write a good software program. A working knowledge of BASIC, or one of the other programming languages, is necessary in order to write good software programs.

Adapting an existing software program requires less programming skill than is needed to write an original. Some programming skill is necessary, however, due to the slight differences in languages from one brand of computer to another. Software protected by the copyright law cannot be copied, or adapted, unless permission is granted by the producer.

Since many teachers do not have either the time or the expertise to write or adapt software programs, they may want to share software programs through educator-user networks. Usually a small fee is assessed each member of a user group. For this fee a member can copy programs free of charge or for the cost of a blank diskette. A partial list of user groups is included in Appendix C of this publication.

The final method for obtaining software is through the purchase of commercially developed programs. An enormous amount of software is currently on the market. Educators have the difficult task of selecting software that is affordable, creative, and educationally sound. It is essential that teacher-developed software, adapted software, user group material, and commercially developed programs all be subjected to the same thorough selection and evaluation procedures in order to develop and maintain a quality software collection.

Software Selection and Evaluation

At the present time no single set of manufacturing standards exist for microcomputers. As a result, a program developed for one brand and model of computer will not run on another brand. This variety of hardware dictates an equal variety in software and establishes the first selection criteria for software - the software must be compatible with the microcomputer. If hardware has not yet been purchased, hardware and software selection decisions can be coordinated. The kind and amount of software available for a specific brand and model of microcomputer is a very important consideration in hardware selection.

When selecting software, it is necessary to determine whether one or more of the following peripherals may be required:

- mass storage devices (external memory)
- scanner
- printer
- joy sticks
- MODEM
- plotter
- speech and music synthesizer

Due to the rapidly changing technology other peripheral devices not mentioned here may be necessary to run specific software. The hardware/software interface criteria on pages 48 and 49 will assist users of this publication in determining hardware/software compatibility.

After the hardware and software is found to be compatible, a program should be further evaluated to determine which program best meets needs within a particular school system. Educators already possess many of the skills essential to the selection and evaluation of microcomputer software. They recognize important curriculum concepts, and they realize the importance of clear instructions and positive responses. They understand developmental issues and bring to software selection years of experience in classroom instruction.[18]

The following general instructional criteria for selecting microcomputer software is similar to criteria for selecting other instructional media:

- Are the instructional objectives stated?
- Does the program fit into the curriculum?
- Is the material accurate?
- Is the presentation clear?
- Is the target population and grade level specified?
- Are teacher guides and documentation available?
- Does it incorporate sound learning theories?

A review of the software may be necessary to answer some of these selection questions. Some producers will not allow preview of their software prior to purchase due to the ease with which a program can be copied. Ideally, a program should be previewed by the user. If not possible, evaluations by MICROSIFT or one of the other clearinghouses listed in Appendix C of this publication should be considered in the decision-making process. Another alternative is to ask the producer for a list of users in the state and contact them for their recommendation.

In addition to the educational content one must also consider the program itself:

- Is it "user friendly?" ("user friendly" means that the program instructions are clear and simple to follow and guide users through the program easily).
- Is it free of technical errors?
- Does it offer positive reinforcement?
- Does it give direct feedback?
- Does it utilize a computer's distinctive capabilities?
- Does it use graphic modes appropriately?

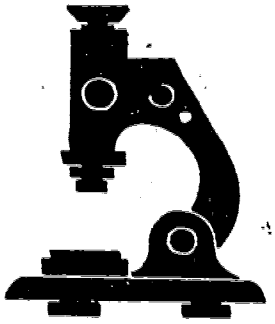
A personal review of software may be essential to answer the specific questions listed above.

Instructional strategies used by the computer must also be considered. It is necessary that the strategy be compatible with curriculum goals and be interesting and motivating to students.[19] The most frequently used instructional strategies, as defined in Chapter III, are:

- Simulation/Gaming
- Drill and Practice
- Inquiry and Dialogue
- Information and Retrieval
- Tutorial
- Problem Solving

Each type of instructional strategy should be explored in order to find the best mode for incorporating the microcomputer into a particular subject area of the curriculum.

In addition to the software selection criteria already discussed, a more extensive list is provided in Appendix D. There may not be a program that does everything a user wants, but, by applying as many criteria as possible one can select the best available software program.



Software Evaluation Form

Evaluating microcomputer software is like evaluating other instructional materials, but it important to combine the educator's skill and educational expertise with a new understanding of the microcomputer and its specific capabilities. The evaluation form which follows on page was developed by Research and Development Staff members and includes questions about educational merit as well as the special capabilities of a computer. The form is designed to assist local school systems in evaluating software obtained from the Minnesota Educational Computing Consortium (MECC) as well as other instructional software.

Some of the items on the evaluation form are especially important when evaluating a MECC program. For instance, in Section I the number of the diskette is important since MECC evaluation forms may later be stored in a data bank for retrieval by diskette number. Section II, which contains information about the number of times a software program is used and the number of students involved, is important for validation purposes. It is also important to be able to determine whether the entire diskette was evaluated as opposed to only a portion of the diskette.

The third section of the form is especially useful for classroom teachers in determining how a particular program can be used in the classroom setting.

A general evaluation of each of the four remaining sections can be given by drawing a circle around the appropriate number which ranges from 1 (low) to 5 (high). In addition, specific items under each of the four areas can be checked to pinpoint particular strengths and weaknesses.

The overall evaluation of the program, which is the last item on the evaluation form, should reflect the evaluator's opinion of how well the program functions as a whole. A program may have some weaknesses but will function well as a whole, or parts of a program may do quite well while it will not function well as a whole.

It is apparent that evaluating is a complex, time-consuming task which is best done by teachers or educators who will be users of the software. "In the end the most crucial question they can ask may be whether the computer is the most suitable way to teach a particular instructional objective."[20]

Tennessee State Department of Education

MECC Software Evaluation Form

I. No. of Diskette_____ Evaluator's Name_____ Position_____

Title_____ School System_____ School_____

II. Evaluation of Total Diskette: ___Yes ___No
If no, list specific programs being evaluated:
_____

No. of times diskette was used:_____

No. of students involved: _____

III. RECOMMENDED USE: (check all that apply)

___Individual
___Small Group
___Large Group

INDICATE:

___Ability Level
___Grade Level
___Subject Areas
_____

INSTRUCTIONAL TECHNIQUES UTILIZED: (check all that apply)

___Drill & Practice
___Learning Management
___Information Retrieval
___Problem Solving
___Game
___Tutorial
___Simulation
___Other

Ease of Use (circle no.) 1 2 3 4 5 (low ... high)

Check Yes or No:

Can students easily operate program?	___Yes	___No
Is it easy to start and to end the program?	___Yes	___No
Were there any technical problems?	___Yes	___No

Educational Value (circle no.) 1 2 3 4 5 (low ... high)

Check Yes or No:

Was material accurate?	___Yes	___No
Was it educationally valuable?	___Yes	___No
Was it appropriate to the audience?	___Yes	___No
Was quality of instruction good?	___Yes	___No
Were instructional objectives stated?	___Yes	___No
Were instructional obj. met?	___Yes	___No
Were there unintentional learnings?	___Yes	___No

Support Documentation (circle no.) 1 2 3 4 5 (low ... high)

(Teacher and Student Support Material)
Check Yes or No:

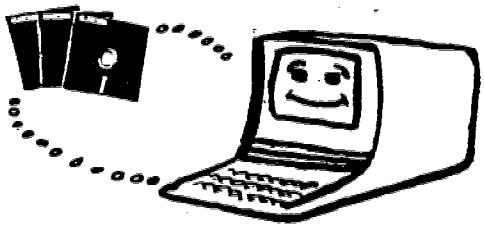
Were instructions clear?	___Yes	___No
Complete?	___Yes	___No.
Did it identify prerequisite learning(s)?	___Yes	___No

Utilization of Micro-computer Capabilities (circle no.) 1 2 3 4 5 (low ... high)

Check Yes or No:

Was feedback relevant & timely?	___Yes	___no
Can student control rate and level of presentation?	___Yes	___No
Was student addressed by name?	___Yes	___No
Was reinforcement positive?	___Yes	___No
Was it "user friendly?"	___Yes	___No
Did it use color, graphics and sound effectively?	___Yes	___No

Overall Evaluation: ___Excellent ___Good ___Fair ___Unacceptable



Software/Hardware Interface Criteria

A confusing task for many persons is how to determine whether a specific program will operate on available hardware or whether hardware under consideration for purchase will be applicable for available programs. Certain criteria--the microcomputer and the peripheral equipment, including the CRT--need to be examined to determine whether compatibility exists between the software and hardware.

Ideally, software that meets the needs of the school is identified and then hardware is purchased which will operate the selected software. However, in some cases, hardware is already available for use and decisions must be made on the purchase of software.

A sample Software/Hardware Interface Criteria Form on the next page allows the user to either complete the form using existing software or to complete the form using existing hardware. If neither hardware nor software is identified, it is recommended that schools first select the software that meet their needs and then purchase hardware which is compatible with software requirements.

The following instructions can assist in completing the Software/Hardware Interface Form.

Complete Section A first if applicable software is identified and the consideration is the type of hardware to be purchased. The information should be available from advertisements, specifications, or operational sheets accompanying the program. Then complete Section B to determine which hardware meets the requirements of the software.

Complete Section B first if hardware is available and the consideration is the type of software to be purchased. Then complete Section A, listing the requirements of selected software. The comparison of the two columns indicates whether compatibility exists between hardware and software.

TENNESSEE STATE DEPARTMENT OF EDUCATION

SOFTWARE/HARDWARE INTERFACE ANALYSIS SHEET

A. Software Program Title Program Producer		B. Hardware
	Microcomputer	
	Brand	
	Model	
	Language(s)	
Bytes	Memory Size	
	Peripherals	
	Cassette Recorder	
	No. available/required	
	Disk Drive(s)	
	No. available/required	
	Solid State Input	
	Printer	
	Joy Sticks	
	Graphics Tablet	
	Speech Synthesizer	
	Music Board	
	Special Sound Amplifier	
	Other (Specify	
	CRT/Monitors	
	High Resolution	
	Low Resolution	
	Black and White	
	Color	

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[1]Arthur Luehrmann, "Computer Illiteracy--A National Crisis and Solution for It," Byte (July, 1980), p. 98.

[2]Andrew Molnar, "The Challenge of the 1980s: Computer Literacy," Educational Computer (February, 1981), p. 10.

[3]Susan D. Price, "The Mini or Micro: Which One is Right For You?," Electronic Learning (November/December, 1981), pp. 44, 45.

[4]Gerald T. Gleason, "Microcomputers in Education: The State of the Art," Educational Technology (March, 1981), p. 9.

[5]David Gabel, "If Its Worth Its Weight in Paper . . .," Personal Computing (July, 1982), p. 66.

[6]Robert Owen and Eugene Doronuik, "Computer Communications Using the Telephone Network," Interface Age (July, 1982), pp. 71, 72.

[7]Bourque, Joseph, "An Apple for the Teacher: Classroom Computers," Popular Computing

[8]Gleason, Gerald T. "Microcomputers in Education: The State of the Art," Educational Technology (March, 1981), p.16.

[9]Bozema, William J. and David B. Thomas, "Computers Can Manage and Assist With Instruction," The Executive Educator, (March, 1980), p. 1.

[10]Bozema, p. 2.

[11]Gawronski, J. D. and Charlene E. West, "Computer Literacy," ASCD Curriculum Update (October, 1982), p. 1.

[12]Garronski, p. 2.

[13]"Selecting Microcomputer Hardware and Software for Instruction," Iowa Department of Public Instruction, (1981)

[14]"Computers Create New Worlds for Handicapped Youngsters," Education Daily, (October 15, 1982), p. 5.

[15]Richards, John, "Who's in Charge Here?", Classroom Computer News, (March/April, 1982), p. 19.

[16]Richards, p. 20.

[17]Myron Berger, "Scenarios for Success: The Vision of Spreadsheeting," Personal Computing, (April, 1982), p. 58.

[18]Molly Watt, "Making a Case for Software Evaluation," The Computing Teacher, (May, 1982), p. 2.

[19]Shirley Douglas and Gary Neights, A Guide to Instructional Microcomputer Software, (Harrisburg: Pennsylvania Department of Education, 1982), p. 5.

[20]Jay W. Dean, "What's Holding Up the Show?" Today's Education, (April-May, 1982), p. 22.

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The Tennessee State Department of Education wishes to express appreciation to the other organizations who, by sharing their information with us, have assisted in making this publication possible. We particularly wish to thank the Appalachia Educational Laboratory, the Iowa Division of Public Instruction, and the Pennsylvania State Department of Education.

APPENDIX A

Glossary

ACCESS TIME
The period of time between the calling of information from memory and the delivery of that information. Disk storage generally has faster access than tape storage.

ACOUSTIC COUPLER
A device attached to a computer terminal to transmit and receive audio tones via telephone lines. A type of modem.

ADDRESS
Designates where information is stored within a memory device

ALGORITHM
An orderly step-by-step procedure, like a recipe, that consists of a list of instructions for accomplishing a desired result, or for solving a problem. Usually expressed in mathematical terms. In computer programming, an algorithm is expressed as a flowchart.

ALPHANUMERIC
The computer symbols, letters (A-Z) and/or numerals (0-9), and/or special punctuation, mathematical, or graphic symbols.

ARCHITECTURE
The internal, preset arrangement or organization of a computer that determines how the computer operates.

ASCII
American National Standard Code for Information Interchange. This is a standard code using a character set of 7-bit characters for information interchange among data processing systems.

ASSEMBLER
The program that coverts English in machine language (binary format).

ASSEMBLY LANGUAGE
The computer language that uses mnemonic names to stand for one or more machine language instructions. Assembly language is similar to "shorthand," used to avoid the tedious use of long strings of zeros and ones found in machine language. The advantage of using assembly language instead of a high-level language, such as BASIC, is speed of execution, but a high-level language, is usually easier for a human being to understand.

AUTO START
A feature of many micros which automatically boots up the operating system and, often, begins execution of a program as soon as the system is turned on.

AUXILIARY MEMORY (STORAGE)
Storage available in a computer, in addition to its own memory banks; it can be either disc or tape.

BASIC
An acronym for beginners all purpose symbolic instruction code. A high level conversational, interpretative programming language in wide use. Always written in capital letters, BASIC was invented by Kemmeny and Curtz at Darmouth College in 1963. It permits the use of simple English words and common mathematical symbols to perform the necessary arithmetic and logical operations needed in programming microcomputers.

BATCH PROCESSING
The method of processing information in logical groups.

BAUD
Rate with which a device transfers information in one second. 1500 Baud is equivalent to about 150 characters per second. It is stated as bits per second (bps). Common baud rates are 110, 150, 300, 600, and 1,200 bps.

BINARY DIGIT
Best known as a bit. Representation of the binary numbering system in a computer. All information in computers is stored as combinations of bits.

BINARY CODE
Code using only zero and one to represent data.

BIT
Binary Digit. The smallest unit of digital information thought of as representing; a yes/no choice or whether a circuit is on or off, stated as a one or zero.

BOOTSTRAP
A term for the loading of certain portions of the computer's operating system from ROM as soon as the machine is powered up. The procedure is often called "booting."

BRANCH
An instruction which, when met in a program, causes a move to another part of the program, deviating from the normal sequencing of the program. Branch statements are one of two types: conditional statement command (IF ... THEN); or unconditional statement comment (GO TO).

BRANCHING PROGRAMS

An instructional program designed in such a way that the student's progress through the program is determined by the specific answers given. If remedical work is required, the microcomputer will take the students into a remedial branch and provide the work necessary before continuing through the main portion of the program. The path a student uses is determined by that student's response.

BPS

Bits per second.

BUFFER

A space in a computer system where information is temporarily stored. Usually used to store small sections of data during a transfer process. For example, data may be read from a tape cassette in small units, placed in a buffer, then transferred to main memory when the computer is ready to process the data.

BUG

An error in programming which causes faulty outputs. may also mean a hardware malfunction or design error either in the computer or in its peripherals.

BUS

A physical connection of parallel wires providing a communication line along which data can be sent. Usually shared by several parts of the computer. An S-100 Bus has 100 lines. In a unidirectional bus system lets signals go either way on the bus, again activated only one at a time. Most microprocessor data buses are bidirection.

BYTE

A group of binary bits. Eight bits is commonly equal to one byte. It takes 8 bits to form one character; so one byte is generally equal to one letter, number, or graphic symbol.

CASSETTE RECORDER

A device by which information is stored. The information is put onto a cassette as audio signals. The cassette information is stored sequentially and is therefore a slower format for storage of information.

CHARACTER

Single items that can be arranged in groups to stand for information. There are two forms; (1) numbers, letters, graphic symbols, etc., that can be understood by human beings, and (2) groups of binary digits that can be understood by the computer. A character is usually represented by one byte.

CHARACTER SET

Refers to the characters available to a computer, printer, or terminal. Some devices have only upper case letters plus numbers and a few special characters such as punctuation, #,], etc. Others have upper and lower case letters, numbers, and many special characters which may be combined to form designs.

CHIP

The heart of a microcomputer, on which thousands of electronic elements are implanted. This piece of silicon, a microprocessor, contains all the circuitry to carry out the many computer operations. It is created through a photographic etching process.

CLASSROOM MANAGEMENT SYSTEMS

A program that maintains the class records for a teacher. It may include grades, test scores, attendance, as well as other student information.

COMMAND

An instruction given to the computer from a input device.

COMPATIBILITY

There are two types of compatibility: software and hardware. Software compatibility refers to the ability to run programs on a variety of computers. Hardware compatibility means that various components (printers, disks, keyboards, etc.) may be connected directly.

COMPILER

A program inside the computer that translates machine language into symbols that can be understood by humans and vice versa.

COMPILER LANGUAGE

A computer language more easily understood by a human being than an assembly language. Compiler language instructs a compiler to translate a source language into a machine language.

COMPUTER

A device that receives and then follows instructions to manipulate information. The set of instructions and the information on which the instructions operate are usually varied from one moment to another. If the instructions cannot be changed, the device is not a computer. The difference between a computer and a programmable calculator is that the computer can manipulate text and numbers; the calculator can manipulate only numbers.

ER ASSISTED INSTRUCTION -- CAI
irect instruction conducted by the computer. Examples of this
ype of instruction are: drill and practice, tutorial, simulation
nd gaming, inquiry and dialogue, information retrieval, and problem
olving.

ER BASED INSTRUCTION -- CBI
he overall term used to describe the use of computers in the
nstructional process. Usually divided into two areas: computer
ssisted instruction and computer managed instruction.

ER LANGUAGE
language used to communicate with a computer. All computer
anguage instructions must be translated by a program within the
omputer into the machine's internal language in order for the
structions to be implemented.

R LITERACY
understanding of computers and their application in the every-
y world. To be computer literate, a person should have a cursory
derstanding of: computer programming, problem solving, applicat-
ns of computers in various fields, the impact of computers on
ciety, computer system components and computer capabilities and
mitations.

R MANAGED INSTRUCTION -- CMI
structional support functions conducted by the computer. Examples
the support functions are: testing, prescribing, record keeping,
hedule monitoring, and time and resource management.

e operating portion of a unit.
e: Hardware

UNIT
rtion of the computer which directs the operation of the computer,
terprets computer instructions, and initiates the proper signals
the other computer circuits to execute instructions.

TION
e matching of the content of instructional software with text-
oks, reference materials and/or instructional media.

RE
ombination of content, instructional design, and the physical
grams, software, which causes a computer to complete instructions.

les per second

CPU
The Central Processing Unit controls what the computer does. The arithmetic, control and logic units do computations and direct functions for the computer.

CROSS-ASSEMBLER
Program run on the computer to "translate" instructions into a form suitable for running on another computer.

CRT
The Cathode Ray Tube is similar to a television screen, the CRT terminal usually is accompanied by a keyboard from which information is entered into the computer.

CURSOR
Usually a blinking indicator on the CRT that shows the user where the next character to be typed will appear.

DAISY WHEEL PRINTER
A printer which has a wheel mechanism, with characters on the perimeter of the wheel. The wheel rotates to place the appropriate character in print position. A "hammer" strikes the character, forcing it against a ribbon, thereby forming an impression on the paper. The daisy wheel printer has the reputation of great reliability, is relatively inexpensive, and forms a solid character on the paper.

DATA
The information given to or received from a computer.

DEBUG
Process of finding, location, and correcting mistakes or errors in a program that might create problems or provide inaccurate information.

DIRECT MEMORY ACCESS (DMA)
A technique to move data rapidly from the microprocessor to a storage device (i.e. disk).

DISK (DISC) -- DISKETTE
Magnetic coated material in a 5" or 8" record-like shape on which information and programs are started. The information is stored randomly and therefore faster than cassette storage. Sometimes called diskettes or floppy disks.

DISK DRIVE
A mechanical unit that may be built into the microcomputer case or may be an add-on peripheral which reads and records on a round magnetic surface. See also "Disk" and "Floppy disk."

NT
written description of a piece of software or hardware. It can lso be used as a verb which is the process of producing such a escription.

isk Operating System. A set of programs and instructions that ermit interaction between the diskettes and the microcomputer.

TRIX
method to generate graphic characters by using dot patterns. A X 7" dot matrix is a common example.

program that controls the peripheral devices and how they interact th the CPU.

RMINAL
terminal that acts as an input/output device only.

ading what's in memory (or part of it) in the CPU or into another orage medium.

ocess of establishing two-way communication simultaneously between mponents of a computer.

MEMORY
type of programmable memory which requires that the information tiny capacitors inside integrated circuits be refreshed every often to prevent the data from being lost. Generally uses less wer and is cheaper and faster than static memory.

program which allows changing, modification, or movement of ogramming statements. It allows the programmer to write and dify instructions using the microprocessor and a terminal as a ry sophisticated typewriter.

ectrically Programmable ROM. A read-only memory which can be ased either by an electrical signal or by ultraviolet light.

running of a computer program.

EXTERNAL STORAGE
Peripheral device for storage (i.e. tape or disk).

FILE
Collection of related data.

FILENAME
Number or letter characters to identify a file or collection of data.

FLOPPY DISC (DISK) DRIVE
A device for storing masses of information on a rotating, flexible, metallic-coated plastic disc which is similar to a 45 rpm record. Information can be stored and retrieved.

FLOWCHARTING
A programming technique using shaped blocks indicating the direction and sequence of operations in a program.

FORTRAN
Science-oriented program language. The acronym stands for Formula Translator.

GRAPHICS
Characters that can be used to form figures, shapes, and forms on the CRT or printer. In addition to letters and numbers, a computer may have a graphics character set that can be used to create graphics by writing them into a traditional computer program, by using a graphics tablet, or by using a light pen on the CRT surface; depending upon the capability of the particular microcomputer.

GRAPHICS TABLET
A flat device which, when drawn upon, will transmit the drawing to the output device, to a microcomputer's memory, and/or to its storage device.

HARDCOPY
Data or information printed on paper. Used to distinguish between printed information and the temporary image found on the CRT.

HARDWARE
Mechanical, magnetic, electrical, and electronic devices which make up a computer. The physical equipment that goes into a computer system, consisting of the central processing unit plus all peripherals.

HARDWIRED
Physcially interconnected and usually intended for a specific purpose. Hardwired logic is essentially unalterable; a microprocessor, on the other hand, is programmable and may be adapted to accommodate various requirements.

EVEL LANGUAGE
computer programming language using English words, decimal arith-etic, and common algebraic expressions. Each instruction represents large number of computer operations.

ESOLUTION
ne capability of producing and reading at least 256 lines or columns f dot pattern or a CRT. High resolution graphics produce an image nat has the detail approximating a photograph.

ntegrated Circuit. A plastic or ceramic body with numerous leads xtending from it. The body protects the silicon chip inside. The eads permit electrical connection of the chip to other components.

nformation going into the computer or into a peripheral. The same ta may be output from one part of the computer and input to some her part of the computer. When using this word, specify what the ta are input to or output from.

TION SET
st of commands to which a given computer responds. Instruction ts may vary among computers, even though those computers use the ne programming language.

GENT AUTHORING SYSTEMS (IAS)
prepared program that guides an author through the process of veloping an instructional program. It usually requires little no computer skill to produce a program with one of these systems.

GENT TERMINAL
rminal with built-in programmable intelligence enabling it to e-process information and/or instructions without the aid of a).

CE
electronic circuit used to connect one electrical device to ther electrical or mechanical device to allow the flow of data tween units. The matching or interconnecting of systems or devices ing different functions.

STORAGE
ory system inside of the computer, rather than disk or tape rage.

TER
rogram used to translate various computer languages.

I/O
Input and Output of data and information in a computer system, as through a keyboard, floppy disk drive, printer, cassette, recorder, modem, graphics tablet, etc.

JOY STICKS
Small control devices which allow the computer operator to control actions or graphics on the CRT. Most commonly associated with their use in computer games.

KEYBOARD
Similar to a typewriter keyboard, this is where information is put into the computer. Computer function keys are here such as reset, run, clear, etc.

K (short for KILO)
Equals 1000 -- With the microcomputer it is speaking of the RAM or ROM memory capability, i.e., 16K is 16,000 bytes of information.

LANGUAGE
A format that allows a programmer to communicate more efficiently with a computer, where commands will give requested actions. BASIC is one of the most popular languages.

LIBRARY ROUTINES
Collection of standard routines that can be used in programs.

LINEAR PROGRAM
A program written in such a way that all students must proceed through each step of the program in the same sequence.

LINE FEED
The command to a teleprinter that advances the paper one line at a time.

LOAD
Putting information into the computer's memory from mass storage such as tape or a diskette.

LOW RESOLUTION
Video monitor or microcomputer capability that produces graphics as a series of square blocks. Usually, there can be up to 64 blocks in each row.

MACHINE LANGUAGE
A computer programming language that has its instructions in binary, octal or hexadecimal format. Computers understand their own machine language without translation, but not all computers use the same machine language.

MEMORY
The memory which is directly accessible to the computer. In a microcomputer, main memory is referred to as RAM or ROM.

STORAGE
Devices such as discs or tapes are used to store large quantities of data. These devices are not directly accessible for processing by the computer, therefore, the data which are stored must be read into main memory before the computer can use it.

X PRINTER
The matrix printer is so-called because it forms characters from a matrix of dots. Usually the matrix consists of five dots across and seven dots down or seven dots across and nine dots down. The 5 X 7 matrix is suitable for upper case letters and numbers; however, for lower case letters and other characters, the resolution provided by the 7 X 9 matrix is better. Matrix printers have the advantage of being lower in cost than other types but are also slower in print rate.

he integrated circuits of a computer which store information. In icrocomputers, they are referred to as RAM and ROM.

CHIP
chip on which data is stored as electrical charges.

ROCESSOR
n integrated circuit that executes instructions inside the microomputer. It is the "brain" of the computer.

ROCESSOR BOARD
board (Actually made of plastic) to which are attached integrated ircuits, including microprocessor chips, which form the microprocessor.

ECOND
ne microsecond equals one millionth of a second. This is the speed t which some computers get and execute instructions.

device that makes possible the transfer of information between mputers over phone lines. It translates digital information into nes which are translated back into digital information by another odem at the other end of the line. MODEM stands for Modulator-emodulator.

TOR
device called an RF modulator, which premits a standard television act as a video display unit.

MONITOR
A video display unit which uses a CRT tube to generate characters. It looks much like a normal television set and may be either black and white or color, as well as high or low resolution.

MOS CHIP
MOS is an acronym for metal oxide semiconductor. A MOS chip is a chip or integrated circuit (IC) which can perform a vast number of electrical operations. A MOS chip one-quarter of an inch square can perform operations equivalent to 6,000 discrete electronic devices. A chip this size has the power and ability of a room-sized computer of a few years ago.

MOTHERBOARD
The central circuit board (or boards) inside the microcomputer which interconnects the various chips, and forms the interface between memory and peripheral devices.

MULTI-PROCESSING
Refers to more than one microprocessor executing different programs simultaneously. A computer system may contain more than one microprocessor, thus multi-processing may occur within that system.

MULTI-PROGRAMMING
A microcomputer can be multi-programmed if two or more programs are present in main memory. Because the microprocessor operates so rapidly, it appears that each program is run simultaneously.

NANOSECOND
One nanosecond equals one thousandth of one millionth of one second or 1 X 10^{-9} seconds. This is the speed at which many computers get and execute instructions.

NOISE
Inaccurate data transmission.

NONVOLATILE MEMORY
Memory that holds data even after the power has been shut off. ROM is sometimes nonvolatile. Disk and tape storage is nonvolatile. Nonvolatile ROM is also called static ROM or static memory.

OBJECT PROGRAM
The form of a program which can be understood by a computer. The object program results from the translation of a human readable program, called source program, into a machine language program. An object program appears as a series of numbers when printed or displayed.

fers to data which are stored on devices not immediately access-
le to the computer. Data stored on magnetic tape, punched cards,
paper tape must be loaded into on-line storage to be available
the computer.

fers to the location of data on storage devices which are immedi-
ly accessible to the computer. Usually on-line data are stored
discs, in RAM, or in ROM. Data which is off-line must be loaded
o on-line storage for use.

G SYSTEM SOFTWARE
et of programs that are resident in a computer and facilitate
ng the attributes of the computer. An operating system typically
trols the I/O functions such as managing the keyboard, and deter-
es to a great extent the application software that can be used.

ormation coming from the microcomputer to a display unit such as
ideo display unit or a printer.

CONNECTION
electronic connector which allows the microcomputer to commun-
te with peripheral devices (printers, keyboards, etc.) A parallel
nection transmits data in parallel mode, that is all bits of in-
nation are sent simultaneously. If the microcomputer is sending
parallel mode then the peripheral device must receive in parallel
, and vice versa.

DATA TRANSMISSION
rocomputers handle data in groups of eight or sometimes 16 bits.
e groups are called words. Parallel transmission refers to pass-
words from one component to another as an intact group. An
t-bit word would be transmitted as eight simultaneous bits along
t parallel wires.

L DEVICE
vice, such as a printer, mass storage unit, or keyboard, which
n accessory to a microprocessor and which transfers information
nd from the microprocessor.

vice that draw two-dimensional shapes and designs on paper.

location on the microcomputer where input and output devices
be connected. The most common type is an RS 232 port.

PRINTER
A peripheral device that collects output data from the microcomputer and prints it on paper. Printers are defined as impact or non-impact. Impact printers strike the paper by a ribbon-like a typewriter. Non-impact printers form characters by electrical charges, or by spraying ink.

PROGRAM
A series of instructions to a computer which cause the computer to solve a problem or perform a task.

PROGRAMMED INSTRUCTION
A technique of organizing instruction into a series of very small segments which by their design lead the learner through the program with a minimum of incorrect responses.

PROM
An acronym for Programmable Read Only Memory. A type of permanent or static memory made of an integrated circuit which can be programmed after it has been manufactured. Programming a PROM consists of permanently recording data or instruction on the chips which make up the PROM.

RAM
Ramdom Access Memory. Any memory which can be written on or read from, in which the memory locations can be accessed in random sequence. RAM can be erased and reprogrammed by the programmer as frequently as necessary. RAM size is expressed as a quantity of bytes such as 4K (4,000 bytes). RAM may be expanded by adding memory chips or memory boards.

READ
The act of retrieving information or instructions from memory or from an input/output device.

REFRESH
The process whereby volatile memory is constantly charged with electrical current. This keeps the bit pattern of the memory in proper order thereby maintaining the data which are stored. Without refresh, the memory would lose electrical charge, consequently losing the stored data.

REGISTER
A temporary storage device located in the microprocessor which holds information the computer is currently using.

RESPONSE TIME
The time interval required for the microprocessor to respond to an instruction or input device.

DISPLAY
ribute of a CRT which permits characters to be displayed either white on black background or black on white background.

acronym for Read Only Memory. It is an integrated circuit on ch data or instructions are programmed at the time of manufact- . It cannot be erased or reprogrammed by normal computer operat- s. The size of ROM is expressed as the quantity of bytes, for mple, 12K (12,000 bytes).

eries of instruction within a program which performs a specific task of the program. A routine is usually performed only once ing the execution of a program.

name of a type of port which permits serial transmission of to a peripheral device. The RS232 Interface has been standard- by the Electronics Industry Association and is found on many rocomputers.

on for "execute."

mmand which causes information in the computer to be "written" off-line or mass storage.

chnique of displaying data on a CRT screen. Each line of data ars first at the bottom and moves upward as new lines are dis- ed. Eventually the line disappears off the top of the screen.

NNECTION
nput/output port which allows serial transmission of data. In serial transmission mode, each bit of information is sent vidually. If a peripheral device receives in serial mode, then microcomputer must send in serial mode, and vice versa.

TA TRANSMISSION
ans for transmitting computer words by sending bits individually equence. Whereas in parallel data transmission, the bits are ied along parallel wires, in serial transmission only one wire sed; therefore, bits are sent and received singly.

SMART TERMINAL
A terminal that has the ability to process data and function as a computer in addition to being an input/output device for a main frame computer.

SOFTWARE
The programs and accompanying documentation. Software is stored on tape cassettes, disks, and solid state cartridges. These are permanent methods of storage and are not erased when the computer is turned off. The computer reads the software into its temporary memory (RAM) in order to manipulate the data in its functioning. See also courseware.

SOLID STATE CARTRIDGES
Storage devices that are composed of microprocessor chips which allow for playback but not recording. This produces the fastest type of loading. This method of recording is very hard to copy.

SOURCE PROGRAM
A program written in a language such as BASIC, FORTRAN, or COBOL. The source program must be translated via a compiler, interpreter, or assembler into a machine language object program. The language of a source program is symbolic, that is, the instructions are represented by words or mnemonic devices which are readily understood by humans.

SPEECH SYNTHESIZER
A device which allows the computer to produce words and phrases as audible sounds.

STATIC MEMORY
A type of programmable memory which changes only when a electrical charge is applied. It is often found in a MOS chip. It does not require refresh operations as does dynamic memory.

STORAGE CAPACITY
The quality of bytes a storage unit can hold. A diskette is said to store 48K (48,000 bytes), approximately 48,000 characters, letters, numbers, spaces, or symbols.

STORAGE DEVICE
A peripheral device that stores information, i.e., tape or disk.

STORE
Placing information in a storage device.

NE
ortion of a program which performs a specific subtask. A sub-
tine is usually called upon several times during the execution
the program of which it is a member.

most common microcomputer tape is magnetic, such as cassette tape.
netic tape is stored in electrical charge patterns that are
ivalent to what we know as letters, numbers, symbols, etc.

eripheral device which facilitates human communication with a
puter. Usually it consists of a keyboard with alphabetic and
eric characters coupled with a printing mechanism or a CRT.
enters information via the keyboard; the computer responds
the printer or CRT.

TOR
ystem of programs which facilitate editing. The functions avail-
e usually consists of adding text, deleting text, searching for
cified text, paragraphing, and page layout. SEE: Editor

area where magnetic impulses are stored on diskettes. Some
kettes have up to 70 or more tracks.

nym for Universal Asynchronous Receiver Transmitter. This device
erts parallel data transmission to serial data transmission, and
versa.

N
testing of an instructional program on a representative sample
he intended users, then revising the program and/or content,
retesting. This procedure should be repeated until the pro-
is guaranteed to produce the results attributed to it without
ure.

SCROLLING
thod of displaying text on a video display unit (VDU). In the
where more text is stored than can be displayed on a screen,
text is "scrolled," that is, moved up or down on the screen.
scrolled up, the text disappears off the top of the screen;
scrolled downward, the text rolls off the bottom.

PLAY UNIT
rt of a microcomputer similar to a television where information
laced on a screen.

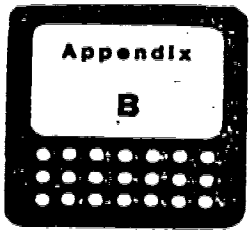
VOLATILE MEMORY
A type of memory device which does not retain information when the electricity is turned off. RAM memory is volatile.

WINDOW
Refers to partitioning a computer display into independent segments. A CRT screen may be divided into segments, one of which may contain explanatory text, another pictures or other graphic symbols, and the third segment representing questions pertaining to the text and pictures. The fourth segment could present responses to the student's answers to the questions. The contents of each segment or window could be varied independently of any other window.

WORD
A grouping of bits. Words may consist of eight bits of 16 bits. Computers read, store, and manipulate data in words rather than as individual bits.

WORD LENGTH
The number of bits in a word. Most microcomputers have a word length of eight bits, through a 16-bit word length is also available from some manufacturers.

WRITE
The act of delivering information to a memory device or a storage medium.



Selected Periodicals*

For Classroom Teachers

Classroom Computer News (bimonthly) International Education, 51 Spring St., Watertown, MA 02172. Aimed at all educators who use microcomputers in their instruction. Articles describe experiences and applications of microcomputers in the classroom. In addition, reports on current developments regarding computer instruction. Includes many valuable features helpful to both beginning and advanced classroom computer users.

The Computing Teacher (monthly September through May) Department of Computer and Information Science, University of Oregon, Eugene, OR 97403. Geared to elementary and secondary school educators using computers in instruction. News, stories, columns, and articles discuss the educational applications of computers. A variety of features include class application techniques, software reviews, sample programs, and information regarding professional organization activities for computer teachers. A very valuable resource for educators involved with microcomputers.

Creative Computing (monthly) Box 789-M, Morristown, NJ 07960. Aimed at users of microprocessors for educational, personal, and recreational purposes. Includes a wide variety of features and columns with an emphasis on how-to articles for all types of microcomputers. One of the best "non-educational" microprocessor journals available. Offers articles and features for all users regardless of interest and experience.

Educational Technology (monthly) 140 Sylvan Ave., Englewood Cliffs, NJ 07632. Designed for educators and administrators involved with changing classroom technology. Has extensive coverage of theory and applications with regard to educational hardware and software. Computers are only one of the technologies featured. Regular columns include computer news, media news, product reviews, and professional literature reviews related to educational technology. A well-written journal with over 50 back issues available covering various aspects of instructional media.

Electronic Learning (bimonthly September through May) Scholastic, Inc., 50 West 44th Street, New York, NY 10036. Very appropriate periodical for educators who use microcomputers, video recorders, and other electronic technology for instructional purposes. Includes a variety of news items and features regarding products, educational applications, and current technological developments in education. Most articles are practical with regard to the selection and basic uses of various electronic equipment. A good resource for technology-minded educators.

For General Interest

BYTE (monthly) Box 590, Martinsville, NJ 08836. Designed for business oriented users of microprocessors and other small information systems. Of value to instructors teaching advanced computer courses and those who desire more sophisticated applications for microcomputers.

Educational Computer Magazine (bimonthly) Box 535, Cupertino, CA 95015 A helpful supplement for computer-oriented instructors, media personnel, and administrators at all educational levels. Presentations cover a wide range of educational microcomputer uses. Also featured are book reviews, software evaluations, and news of microprocessor conferences.

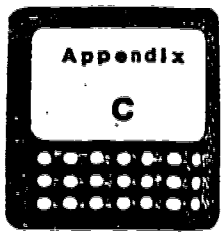
Infoworld (weekly) Popular Computing, Inc., Box 880, Framingham, MA 01701. Aimed at all users of microcomputers. Includes extensive software and hardware reviews combined with current news and information of interest to microprocessor users. Should have special value to introductory data processing instructors who need to keep informed about the computer industry.

Personal Computing (monthly) 4 Disk Drive, Box 13917, Philadelphia, PA 19101. Designed for small business and home microcomputer users, with some applications for educators. Presents a wide variety of articles regarding microprocessors in business and home settings, with emphasis on financial applications and home management/kitchen uses. Includes sample programs which may be adapted for classroom use.

Popular Computing (monthly) 70 Main St., St. Peterborough, NH 03458. Valuable to all users of microcomputers. Includes many articles on software systems, product evaluations, and social implications of automated information processing. A very good supplement for educational and home computer users.

T.H.E. Journal (Technological Horizons in Education) (Free to selected individuals in education and training) Box 992 Acton, MA 01720. Designed for individuals involved in technological education and training. Articles feature current developments related to the use of technology in the classroom and for other administrative purposes. Reviews of new products, publications, and software are also included.

** The selected items listed under periodicals are only a portion of a listing from the article written by Les R. Dlabay, entitled, "The Educator's Guide to Computer Periodicals," Curriculum Review (May, 1982, pp. 144-46. Reprinted from the May, 1982 issue of CURRICULUM REVIEW, published by Curriculum Advisory Service, Chicago, Illinois*



Software Evaluation Sources

1. Microsift News, Northwest Regional Laboratory, 300 S. W. Sixth Avenue, Portland, Oregon 97204. Evaluations will be published four times a year.

2. The Journal of Courseware Review, Foundation for the Advancement of Computer-aided Education, 20863 Stevens Creek Blvd., Building B-2, Suite A-1, Cupertino, California a 95014.

3. California Library Consortium for Classroom Evaluation of Microcomputer Courseware. 54 library media specialists from 23 counties in California. Will publish a document in Fall, 1982, containing 200 microcomputer programs reviewed by educators and based on classroom use. (address - SOFTSWAP)

4. CONDUIT - A source for computer-based instructional materials at the secondary level that are reviewed, documented and programmed for ease of transfer and continually updated. Materials are available in biology, chemistry, physics, mathematics and statistics, Spanish, psychology and sociology for use on the Apple II, TRS-80 and Pet 2001.

5. THE SOFTWARE EXCHANGE, TERC (Technical Education Research Centers), 8 Eliot Street, Cambridge, Massachusetts 02138.

   This microcomputer information service is in the planning stage at this time. Among the many services envisioned are the semi-annual publication of 50 in-depth reviews of educational software and the provision of an on-line electronic software database which would contain evaluations and purchasing information. These services and others such as technical reports, seminars, a current awareness service, and a newsletter would be available to users for a fee.

6. EPIE Institute, Educational Products Information Exchange, (in collaboration with Columbia Teachers College Microcomputer Resource Center), P. O. Box 620, Stony Brook, NY 11790.

Software User Groups

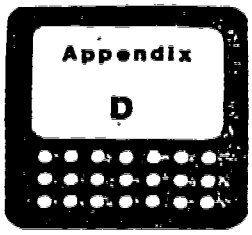
1. SOFTSWAP - Probably the most widely known of the educational software clearinghouses. It is operated by the San Mateo Office of Education and Computer Using Educators. Contact them at:

   333 Main Street
   Redwood City, California 94063

   Their disks sell at $10.00 each or you may go to their center and copy them free of charge. You may also receive a free disk for each disk of original material. TRS—80, APPLE, ATARI, COMMODORE PET, and COMPUCOLOR.

2. Georgia MICROSWAP. Operated by the Department of Mathematics Education, University of Georgia, Athens, Georgia 30602. To receive programs you must contribute programs. A $15.00 membership fee is charged.

3. Apple Avocation Alliance, 721 Pike Street, Cheyenne, Wyoming 82001. An apple club. For $1.00 per disk fee he will copy programs from his library to your disk. Some programs are educational.



Software Selection and Evaluation

1. Does the software match your predetermined instructional objectives?
2. Is the specific strategy (i.e., problem solving, drill and practice, tutorial) compatible with the needs of students?
3. Does the software require prerequisite or entry level skills?
4. Has the software previously been evaluated in terms of its effectiveness in improving learner outcomes?
5. Does the vendor provide software updates and error correction? What is the cost of this service?
6. Is the software pedagogically sound and is there a diversity of instructional approaches?
   - o What is the reading level used in the software and is it appropriate for the intended student users?
   - o What is the overall visual effect of the material?
   - o Are the pictorial simulations used where appropriate?
   - o Do the content strands contain a sequence of lessons ranging from easy to difficult?
   - o Does the teacher manual and/or student manual complement the software?
   - o Is adequate documentation (at the appropriate reading level) provided with the software?
   - o Does the program provide clear instructions to the student while interacting with the computer?
7. Is the software user-controlled?
   - o Can there be random selection of software content?
   - o Can the user branch to various parts of the lesson for help, glossary, etc. and get back again?
   - o Are the next steps clear?
   - o Does the user control the reading rate and pace?
   - o Can the student decide to revise work previously completed during a session?

8. How is feedback to students provided?

   o Are explanations provided on why incorrect response was unacceptable?

   o Are incorrectly spelled answers accepted? Is the spelling error corrected in feedback to the students?

   o What happens when the student input is not recognizable by the computer?

   o Are wrong answers treated appropriately--not demeaningly?

9. Does the software provide for permanent management and scoring or is it lost when the machine is turned off?

10. Is the software easily and quickly loaded into the computer?

11. Is the name and address of the software developer/vendor provided if a user has questions, recommendations, or problems?

12. Will teacher training be required to use the software and who will provide the training?

13. Are "backup" disks, cartridges or tapes provided with the program?

Adapted from: Guide for Selecting a Computer-Based Instructional System. Texas Education Agency