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ABSTRACT

The purpose of this book is to help teachers feel at ease with microcomputers so that they will begin to think of computers as tools that they themselves might use. There are four chapters. The first chapter provides basic information to help a user understand the computer. Discussed are how the computer is put together and how it works. To help teachers generate ideas about how this new educational aid might be useful in terms of their own teaching objectives, the second chapter describes why and how other educators are using the computer. Chapter 3 is an introduction to software evaluation, i.e., how computer programs that are available for use in the classroom can be judged. Criteria are presented. It is suggested that teachers using computer-assisted instruction should have a feel for some of the broader issues related to computers in education, as well as practical knowledge. The purpose of the fourth chapter, which deals with social and educational issues and directions, is to provide a perspective about these broader issues and a context into which teachers might place their own activities. Most of the book's readings provide a bibliography of references and further resources. In addition, a list of resources available through the ERIC system is provided. (RM)

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USING MICROCOMPUTERS IN THE SOCIAL STUDIES CLASSROOM

Edited by Robert B. Abelson

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CONTENTS

FOREWORD

The major functions of the Educational Resources Information Center (ERIC) are gathering, selecting, and rapidly disseminating information about current resources useful to persons in all phases and levels of education. Having gathered and disseminated such information, ERIC also serves as a permanent archive for it.

An important additional task of the ERIC system is to select, integrate, and publish information, from the ERIC data base and elsewhere, about particular topics of special current interest to educators. Each year the ERIC system publishes about 100 such "information analysis products."

We believe that the publication of such products provides a useful service to educators, supplementing and going beyond the access provided to the broad ERIC data base. We are also aware of the hazard involved in providing comprehensive and well-thought-out information about a topic of great current interest: under the best circumstances, such a publication may be outdated by the time it sees the light of day.

This hazard is particularly acute in the case of this publication on the use of computers in education. As editor Abelson and some of the authors represented in the volume argue, the topic itself is very unlikely to become outmoded; educational use of computers is more probably in its infancy. But some information provided in any treatise on this topic is likely to be rapidly outdated. Still, certain computer basics will remain relevant, as will careful examination of the many possible uses of computers in education, considerations in evaluating courseware, and both short-term and long-term social implications of the uses of computers in education. This volume covers these four aspects of the topic well, without presuming to be exhaustive.

Irving Morrissett
Executive Director, Social Science Education Consortium
Director, ERIC Clearinghouse for Social Studies/Social Science Education

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FEELING COMFORTABLE WITH MICROCOMPUTERS

"Feeling comfortable with microcomputers"--in a nutshell the raison d'etre for this book.

Microcomputers in the classroom are here to stay; in fact computers in society in general have become a fact of life. It is difficult to imagine how deeply computers will affect our lives in the coming years and how thorough-going will be the transformation of lifestyles resulting from the "information age" explosion that is just beginning now. Many have speculated, but one thing is certain: the impact of computers on our lives will be no less remarkable than the impact of the automobile or the television has been. Because of computers, our world will look, feel, and act very different than it does today. At this point we can only guess at specific implications, but whatever they are, we cannot hide from them; they will find us.

Microcomputers are really not mysterious or overly esoteric. In many ways they are simpler than modern cars and television sets, but while we have grown up with cars and television and become used to them, to many adults computers are new and strange. (Children don't find them strange, though; they perceive computers as a very natural part of their world.) Many adults are afraid of computers, some feel inadequate and unprepared to deal with them, and many just plain don't know that much about them. The purpose of this book, then, is to remedy these feelings and hesitations, whatever their source.

For educators, microcomputers offer the potential of a uniquely effective teaching tool. This is not to say that this potential has already been actualized. On the contrary: we are still in the "fumbling around" stage in computer-assisted instruction. Nonetheless, CAI is a current educational phenomenon and will no doubt become more important as its present problems and inadequacies are worked through. Thus, you as a teacher may someday (if not already) want to try using computers to assist you in meeting the educational objectives you have set for your classes. In this book, we hope to provide you with the knowledge you need to begin thinking of computers as tools that you, yourself, might use.

So both knowledge and comfort are our goals. But this is not exactly a "how to" book. It is designed to provide an atmosphere--an internal "set"--for your initial foray into using microcomputers in the classroom. If you have tried and become frustrated, we hope the book will rectify the problem and make you better prepared to try again.

In the first chapter, we introduce you to the microcomputer itself. This is not a technical discussion designed for beginning engineering students. Rather, it provides the down-to-earth information that you need to understand the computer from a user's point of view. We try to make the seemingly obscure and technical understandable, and to demystify the entire matter. We take the position that the computer is a tool for your use--you are the master--and we show you how the tool is put together and how it works.

The second chapter describes why and how microcomputers are being used in schools. It provides an overview of uses and some specific examples. The purpose of this chapter is to tell you something about what other people are thinking and doing, in the hope that this knowledge will help you generate ideas about how this new educational aid might be useful in terms of your own teaching objectives.

Chapter 3 introduces you to courseware evaluation; i.e., how you can judge the value of the many computer programs that are available for use in the classroom. You are far more likely to use programs written by others than you are to write your own. Therefore, it is important for you to have some criteria for identifying the programs that are right for your needs.

It is probably best for a teacher using computer-assisted instruction to have a feel for some of the broader issues related to computers in education, as well as practical knowledge. The purpose of the fourth chapter, which concerns social and educational issues and directions, is to provide a perspective about these broader issues and a context into which you might place your own activities.

Most of the readings provide a bibliography of references and further resources. In addition, a list of some resources available through the ERIC system is provided at the end of the book.

We hope that you will find this book useful and that if you are considering using microcomputers to further your educational goals, the book will provide you with the proper background for your endeavors.

Obviously, the information and views contained in the book are only a beginning; hopefully they will excite your curiosity and give you enough confidence to further investigate the intriguing possibilities computers hold for the educator. If there is one thought for you to keep--both while reading the book and afterward as well--it is this: The computer is a tool, no more, no less; it is your objectives that are important. Like any skilled professional, your success in reaching those objectives will be largely determined by how effectively you use the tools of your trade. New tools and methods can be strange and even sometimes frightening, but skill and knowledge overcome strangeness and fear. We hope, that after reading this book, you will "feel comfortable with microcomputers"!

1. INTRODUCTION TO MICROCOMPUTERS

by Robert B. Abelson

When learning about a new field, it is hard to know where to start. Since the purpose of this book is to make you knowledgeable and comfortable enough about computers to use them in the classroom, we might as well start with the computer itself.

A microcomputer is not really a single "thing," but a <u>system</u> of things; i.e., interrelated components. Some of these components are actually "things" in the sense that if you got hit over the head with one, it would hurt. These include keyboards, TV-like screens, disk drives, and plastic boards containing electronic devices; taken together, these components are known as hardware. They are interrelated and form a functional system in the same way that electronic components (such as FM tuner, record player, amplifier, and speakers) form a hi-fi system.

There is another type of "thing" that is also part of the whole system; it is called software. Software is simply another name for computer programs, or the instructions written in a special language that tell the hardware what to do and when to do it. Strictly speaking, therefore, a program is not a physical "thing" in the same way that a piece of hardware is, but rather a <u>method</u> for solving a problem or performing a task.

Do not confuse software with the medium on which it is stored; a song is not the same thing as the phonograph record or tape cassette on which it is stored. We will discuss various ways of storing programs and other information later (e.g., floppy disks, computer memory modules, etc.).

One last definition: "courseware" is simply software that has teaching as its purpose. Computer-assisted instruction (CAI), therefore, is based on computer programs (i.e., courseware) designed with educational objectives in mind.

In this chapter, we first cover hardware, then software, and finally how the entire system works together. The purpose of the discussion is to make seemingly obscure and technical terms and processes understandable to the novice--to demystify computers.

Hopefully, you will then be comfortable enough with computers to begin considering how you might be able to use them in the classroom to further your own educational goals.

Hardware

The Central Processing Unit

The heart--or perhaps more literally, the brain--of the computing system is the "central processing unit" or CPU. This electronic wonder is a product of modern high-technology, in which thousands of electronic components (such as transistors) are miniaturized and etched into a small piece of specially prepared semiconductor material to form what is called an integrated circuit. The basic material used is often silicon; hence the name, "Silicon Valley," referring to the area in California where many of these integrated circuits or "chips" are manufactured. A typical CPU chip is physically a very thin wafer, measuring about one-quarter inch square, and is mounted in a package suitable for attachment to a board containing other types of integrated circuits and components. Many of these CPUs cost less than ten dollars.

Just as there are different brands and models of cars, each performing much the same function but varying in design, there are different brands and models of CPUs. But instead of being called "Starfire" or "Supergalactic Special" like cars, they have been given more mundane names, such as 8080, Z80A, 6502, and 68000. The manufacturer of each brand and model of computer selects the chip to be incorporated into its system from the limited number available today on the basis of the CPU's specific performance characteristics.

Basically, any CPU has the following general functions: (1) it interprets the program instructions and executes them at the right time and in the right order; (2) it controls the actions of the other parts of the system, such as causing data to be moved from one of the various components to another; and (3) it performs the arithmetic and logical operations such as adding, subtracting, and "making decisions."

Memory

A second major component in a computing system is its internal information storage capability, called memory. It is easiest to conceive of memory as a large cabinet with a great many pigeonholes in which things can be put, similar to the post office boxes you can rent at the post office. The number of these electronic pigeonholes in today's microcomputers is usually approximately 64,000 or "64K," although you can buy computers with memory sizes of 32K, 48K, 128K, etc. (One "K" equals 1,024, which is two raised to the tenth power; for certain technical reasons computer engineers tend to count in binary, rather than in our normal decimal number system.)

If you were to look inside one of these pigeonholes (or memory cells), you would find eight on-off switches, each conceptually similar to a wall switch that turns an overhead light on and off. The main thing to realize is that each of these eight switches can have only two states: on or off. (In binary terminology, the number "1" refers to the "on" state, and "0" refers to "off.") Therefore, if you work out all the permutations and combinations, you will find that there are exactly 256 ways you can arrange these eight switches (for example, the first two on and the other six off; the second, fourth, and fifth on and the other five off; etc.). The implication is that each cell can hold any piece of information that can be coded in up to 256 ways. Each such unit of information, or of information storage capacity, is called one byte.

Let's take an example. Each letter of the alphabet can be assigned an eight-digit binary code (i.e., using only 1's and 0's); for example, upper case "A" could be coded as 01000001 (i.e., arrange the eight switches from left to right as off-on-off-off-off-off-off-on). As a matter of fact, a system of coding all the letters of the alphabet, as well as the numbers and special characters like asterisks, is in common use today. This system uses one byte of memory for each letter, number, or other character. Thus, storing the word "FROG" in memory takes four of the 64,000 bytes in the memory of a typical microcomputer. Storing a typical double-spaced typewritten page of information requires approximately 2,000 bytes of memory (one byte for every typed character on the page).

Each byte or cell of memory has an "address"--a number or some other code referring to its location, much like post office boxes are assigned box numbers. When the CPU needs data from memory to carry out an instruction, it specifies an address and asks for the <u>contents</u> of that cell to be sent to one of its own internal registers. Similarly, to store information, it sends the contents of one of its internal registers to a specified memory address. Programs are therefore written in terms of addresses rather than in terms of specific information. For example, to add two numbers, you tell the CPU to retrieve the contents of, say, address "A," then of address "B," add, then store the answer in address "C." You then instruct the CPU to display the contents of address "C" on the TV screen monitor. This type of programming allows great flexibility: whatever numbers you have previously stored in cells "A" and "B" will be added by this little program.

One final point about memory must be made. Two common types of memory are in use--RAM (random access memory) and ROM (read only memory). There are two major differences between RAM and ROM: (1) ROM is permanently "burned in," so that the CPU can retrieve information from it but cannot send new information to be stored there, whereas RAM can be both "read" from and "written" to; and (2) when you turn off the power to the machine, RAM totally loses all the information stored, whereas ROM retains it. ROM is therefore used by manufacturers to store certain very basic information that must be available to the CPU at all times, regardless of whatever else is going on inside the computer. RAM, on the other hand, is more like a scratch pad that can be used for any transient purpose; if you want to save what you have stored there, however, you must copy it onto a permanent medium, such as a disk, before turning off the machine.

Peripheral Storage Devices

Because of the way in which memory is electronically connected to the CPU, memory is generally thought of as being an "internal" or "central" component of the computing system. "Peripheral" devices that can also be connected to the system have much the same general functions as memory--with a few significant differences. These devices simply provide a means for storing much larger quantities of information than central memory can hold, and the information can usually be stored in a permanent form. However, before the information can be used by the CPU, it must first be placed in memory; therefore, it takes longer to access peripheral information.

The most common peripheral storage method used in microcomputers is the "floppy disk." The disk itself is a round plastic platter that looks a little like a flexible version of a 45 rpm phonograph record. It is coated with a substance that can be magnetized in such a way that it can store a great many binary numbers (1's and 0's). These binary numbers are organized into bytes just as they are in central memory. Thus, the information on the disk can be "read into" memory, at which time it becomes directly available to the CPU. Similarly, any number of bytes in memory can be "written" on the disk for permanent storage; obviously, once on the disk, the information can be read back into memory at a later time. The physical device that does the reading and writing is called a disk drive.

Other common peripheral storage devices include tape drives and hard disk drives. Tape drives for microcomputers use tape cassettes and function similar to audiotape recorders. Although cheaper, they are much slower in operation than disk drives and have an important additional limitation: to find any desired piece of information, you have to read all or part of the tape sequentially from beginning to end. Disks, on the other hand, are "random access," meaning that you can immediately access any information no matter where it is on the disk without searching for it sequentially from the beginning.

Hard disks are common in business, but rare in the smaller systems that are used in schools. Basically, a hard disk functions in the same way as a floppy disk, except it has a much larger capacity and is much faster in operation. You cannot ordinarily remove the actual medium, however. The hard disk system is like a jukebox in which the records are more or less permanently in place, while the floppy disk is more like a single-record phonograph in which the user selects and mounts the record he or she wants at that moment.

Recall that the typical microcomputer memory can hold 64K bytes (which is theoretically about 30 double-spaced typewritten pages). In comparison, a typical floppy disk can hold from 100K to 500K bytes, depending on the system. Hard disks can hold many millions of bytes.

Even though these devices are random access, this does not mean the information is placed helter-skelter on the disk. In fact, there is

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always a rather structured organization, and it takes some complicated software to keep track of where each piece of information resides. Without examining the technicalities of how this is done, it is important to know that, from the user's point of view, the information is organized into files. A file is simply a body of information about some particular thing. It could be a file of data, for example, or it could be a file of computer instructions (i.e., a program). Each file is given a name; when the user wants to access the information on the file, he or she refers to it by its name, rather than by its location on the disk.

Input/Output Devices

In order to get these marvelous electronic systems to help us in our work, we obviously need a way to communicate with them; and because they are our tools, not we theirs, we must be able to communicate in language or other means that is comfortable for us. The devices which allow such communication are called input/output (I/O) devices.

The most common input device is the familiar keyboard. Basically, it looks like (and is used like) a typewriter. We type in our commands and information, and the device (along with its associated software) translates each keystroke into a pattern of 1's and 0's that the computer can "understand." Often, the characters we type in are translated into their binary codes and directly stored in the computer's memory, one byte per character, for later use. Alternatively, the software already residing in the computer recognizes the pattern of characters we type in as a command to do something, in which case the command is directly executed by the CPU.

The opposite side of the coin is the printer. This output device translates bytes of binary code sent by the computer into electro-mechanical signals that control the printing mechanism. Similarly, a TV monitor (also called a video display) prints characters on the screen or draws pictures in response to the binary signals sent by the computer.

In addition to these common and familiar I/O devices, a large group of other devices can be used to accept input or produce output. There are input devices that translate various kinds of human responses into a set of binary numbers; that is the only way a computer can work with the information. "Joy sticks," for example, accept mechanical movement and code it so that the computer "knows" which way you have moved the stick. There are also environmental sensors (such as those found in microprocessor-based ignition and fuel systems in cars) that translate temperature, pressure, etc. into binary codes.

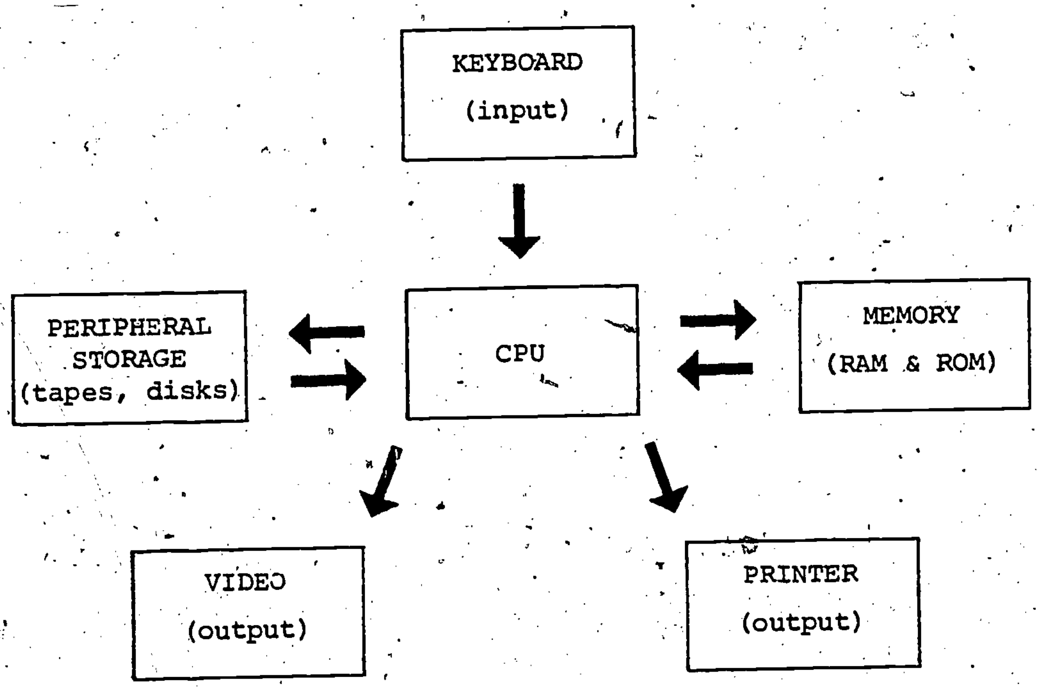
Various types of output devices do the reverse: they translate binary signals sent by the computer into some form that can be understood by people (or by other machines). For example, a plotter translates these signals into pen movements to cause a graph or diagram to be drawn on a piece of paper. There are even speech synthesizers that allow the computer to "understand" the spoken word and to produce "speech" that we can understand.

In general, an intermediary device is placed between the computer and the I/O component. This device, called an interface, involves both hardware and software necessary to make the translations described above. These translations between human language and computer language are made automatically by the I/O devices and their interfaces, so that the user finds it very natural to communicate with the machine.

Putting the Components Together

We have now described the most important hardware components of a typical microcomputer system: the central processing unit (CPU), memory, peripheral storage devices, and input/output devices. Many manufacturers of small computers package all or some of these components in one unit, so that from the user's point of view, it is simply one machine. Other manufacturers supply the components separately, so that the user plugs the various parts together. Advantages of the first method include compactness and the assurance that the parts are all compatible. An advantage of the second method is flexibility--you can pick and choose the components that best fit your needs and you can easily add new products when they become available.

Regardless of how the computing system is packaged, from a logical (but not necessarily electronic) point of view, you can think of the parts as fitting together as shown in the diagram below. As the diagram shows, the CPU can communicate with all the other devices, which makes sense because it is the CPU that controls the functioning of the entire system.



Software

Computer hardware, no matter how fancy, basically sits there and does nothing until it is told to act. What tells it? The answer, of course, is that computer programs--strings of instructions and related information--provide the intelligence. It is the programs that tell the CPU what operations to perform and in what sequence. Another name for computer programs is software.

Programs must somehow first be stored in the memory of the computer, and in the computer's own language (bytes of binary code), before the CPU can access and understand their instructions. Normally, the act of placing the instructions in memory is initiated by a command to read a file of program instructions into memory from a peripheral device, such as a disk, or by directly typing the commands in on the keyboard. Later, we will discuss a little more about how these programs work, but first let us look at the various types of programs that exist.

Operating Systems

When you realize that even the seemingly simple command to read a program from a disk into memory requires that the CPU recognize your command, and that the hardware really cannot do anything by itself (including recognizing the simple command to "READ"), it becomes clear that there must be some level of software always residing in the computer's memory. This is where ROM comes in. Recall that ROM is memory which is "burned in"--i.e., the information it holds is never changed and is not lost when power to the machine is turned off.

ROM holds a small master program which, among other things, tells the CPU the first thing to do each time the power is turned on. Generally, it tells the CPU to read a specific program file on a specific disk drive into memory. (Of course, it is the user's responsibility to first insert the correct disk into the disk drive.) This program is part of a large, complicated set of software known as the operating system, which is generally supplied by the manufacturer when you buy the hardware.

Each brand and model of computer has its own operating system, but all operating systems consist of a set of master programs that handle the everyday, always-used operations such as decoding keyboard characters and recognizing certain very basic commands (such as "read a disk file"). Since virtually all other programs use at least some of these very basic operations, no other program will run without the operating system.

One of the most important functions of an operating system in a computer that uses disk drives is to handle the disk operations. The operating system allows you to refer to files by names, rather than worrying about where they reside on the actual disk. It also keeps track of what parts of the disk already contain information; thus, when you want to store something else on the disk, it will not over-write the old information unless you tell it to.

Computer users usually need not concern themselves with the internal mechanics of operating system software. A manual that comes with the computer tells you what commands to type in to make the computer do various things; the system programs will automatically interpret these commands and instruct the CPU to perform the required functions.

<u>Language Translators</u>

Another common type of software available today consists of programs that translate <u>other</u> programs into the computer's own language. These translators allow you to write your programs in a natural, English-like language, which is much easier to do than writing in the computer's own

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peculiar language using only codes comprised of 1's and 0's. The translator program reads <u>your</u> program as input and translates your instructions into the appropriate machine code.

Some of the more common languages for which translators exist are BASIC (a general-purpose beginner's language), FORTRAN (a scientific and mathematically-oriented language), and COBOL (a business-oriented language). A wide variety of other, special-purpose languages also exist.

There are several methods for handling language translation. A "compiler" is a program that translates your entire program into a machine language program which is then stored on a disk. The resulting machine language program can be read into memory and run at any future time without retranslating, resulting in very rapid execution.

An "interpreter," on the other hand, translates each individual instruction in your program and then immediately executes it. It does not create an entire machine language program first, just a series of machine instructions corresponding to a single statement in your program. Programs run under interpreters are much slower than compiled programs, but interpreters make modifying programs and debugging them (removing errors) easier.

There are other types of translators, each with specific advantages and disadvantages, but as a group, this special type of software makes programming much easier than it would be if you could only communicate with the computer in its own language.

Applications Programs

Do not get the idea that you must write your own programs in order to use a computer. In fact, there are probably more people using computers today who haven't the slightest idea of how to program them than there are professional (or amateur) programmers.

Available on the market is an enormous array of so-called "applications programs"--programs written for a specific use or application. CAI courseware represents one type of applications program. Generally, you buy disks for your machine with the programs you want already stored on them. You simply insert the disk in the disk drive and command the computer to read the disk and execute the program. Later in this book we will look at various types of courseware that are commercially available.

Some Perspective on Software

As we have seen, hardware does essentially nothing--except look pretty and cost money--without software. Furthermore, although there are some differences in the quality and capacity of comparably priced components today, the hardware in most computers in a given price range performs pretty much the same. It should therefore be becoming clear that most of the value of a computer to you, your students, or your school is contained in the software.

While hardware has been getting dramatically less expensive over the years, good software is still extremely costly to produce because writing good programs is so labor-intensive and requires a great deal of skill and experience. And there is a great deal of difference between good and bad software; as with so many things in this world, good things do not often come cheap or easy. Later in this book, we will look at some ways you can evaluate the quality and usefulness of CAI courseware.

How It Works

Remember that our goal in this discussion is to make you knowledgeable enough to feel comfortable about using computers to further your teaching objectives. We have so far discussed hardware and software, so that you now know about the various essential elements that make up a computing system. The final section of this introductory chapter attempts to provide some insights about how the system actually works in running a program. You do not absolutely need this information in order to successfully use courseware in your classes, but knowing it will give you a greater understanding of how the programs work and will assist in demystifying the entire field.

Internal Program Storage

Three basic concepts are important in understanding how a computer runs a program. The first is the idea of the internally stored program. This simple idea was one of the biggest breakthroughs in the development of computing theory, which allowed the creation of modern computers. We have actually already made reference to it: All the instructions that comprise the computer program are stored in the memory of the computer, just as if they were data. In other words, the method, or "algorithm" for solving a problem or performing a task, is stored in its entirety in the memory of the computer before the computer begins its work.

This also means that electronically and physically, there is absolutely no difference between data and program. In fact, if you were to look at the contents of a cell in memory, you could not tell whether the cell held data or a program instruction. All you would see would be eight binary numbers, 1's and 0's. The entire program, with all its loops, branches, decision criteria, and so forth, is stored in the computer's memory before any execution occurs.

Making Decisions and Conditional Branching

Having the entire program stored in memory allows decisions to be made by the computer on the basis of some condition which exists, without intervention by the user. Thus, the CPU can be executing a series of instructions, come to a decision point, and branch to one or another series of instructions depending on the outcome of the decision. Here is how this is accomplished:

The CPU has an internal register known as the "program counter." The program counter register holds the address of the cell in memory that contains the next instruction to be executed. (In this way, the CPU "knows" which cells in memory hold instructions rather than data.) Normally, after each instruction is executed, the CPU automatically increases the number in its program counter by one. It then fetches the instruction in that memory cell for its next cycle.

There are instructions that allow you to change the program counter to anything you want, however. These instructions can be combined with other instructions to allow "conditional branching." For example, in your program you can instruct the CPU to compare two numbers, say A and B. If A is larger than B, the program instructs the CPU to reset the program counter to, say, memory cell 1000. Then on the next cycle, the CPU will execute the instruction found in cell 1000. If A is not larger than B, the CPU simply increases the program counter by one, in the normal way, and executes that instruction next. Therefore, a different instruction is executed if A is larger than B than if A is not.

Symbolic Addressing and Coding

The third important concept to understand is that of "symbolic addressing and coding." Originally, programming computers was extremely tedious and very error-prone because all data and instructions had to be coded as 1's and 0's and then entered that way into the computer. As you know from our discussion of software, language translators were eventually developed so that you could program in English-like commands (like "ADD" and "READ"); the translator program then codes these commands into the appropriate binary patterns.

In addition, the so-called higher-level languages, like BASIC, allow a programmer to refer to memory addresses by symbolic names. The programmer can assign a symbolic code name to any address and then refer to the contents of that cell by its symbolic name. Thus, programming became a much more feasible, and natural, task. One can now, for example, write programs with commands such as "ADD COST TO OVERHEAD" or "TOTAL = ITEM1 + ITEM2" instead of "0010110101001010001111010100101101 00."

A Simple Program

Now we are ready to look at a simple example that illustrates the logic of a program. This example will help you understand how a computer "thinks." You may be surprised at how little a computer can actually do in each step and at how simple the operations really are. From these simple operations, however, some pretty complex programs can be built to perform some very complex tasks. (The following discussion is a bit technical, and it certainly is not necessary for a teacher to master in order to effectively use CAI; it is nonetheless included for those readers who are interested in increasing their knowledge of how computers really work.)

Let us take as our example the task of adding two numbers, which are typed in on the keyboard, and displaying the answer on the screen. Before proceeding, you need three additional facts: First, the keyboard has a register called a "buffer," which holds the binary representation of the character you just typed; second, when you type a character, the keyboard sets a "status switch," which indicates that there is a code residing in its buffer; and third, the CPU has a register that we shall call the "accumulator," which holds numbers (or codes) that are to be operated upon.

Now let's list the major steps through which the computer must go to perform our simple task:

1. Look at the keyboard status signal. Does it indicate that a number is waiting in the keyboard buffer indicating the operator has typed in a number? If not, keep looking. If so, proceed to step 2.

2. Move the number in the buffer to the CPU accumulator register.

3. Move the number in the accumulator to a memory cell that we will refer to by the symbolic name "A." (Memory cell "A" will now contain our first number.)

4. Repeat step 1 (this time we are looking for the second number which is to be typed in).

5. Repeat step 2 (after the operator has typed in the second number).

6. Move the number in the accumulator to a memory cell that we will refer to by the symbolic name "B."

7. Move the contents of memory cell "A" (which holds the first number to be added) to the accumulator.

8. Add the contents of memory cell "B" to the contents of the accumulator.

9. Store the contents of the accumulator (which now holds the sum of the two numbers) in a memory cell that we will refer to by the symbolic name "C."

10. Move the contents of memory cell "C" to the video device.

Shown below is a program, written in the BASIC language, to accomplish the above steps. Note that in this language, each instruction must be assigned a number.

```
1    INPUT A
2    INPUT B
3    LET C = A + B
4    PRINT C
```

Let us now modify our program to illustrate conditional branching. This time, assume we want the computer to stop if the second number we enter is zero; otherwise, the computer does the addition, displays the answer, and then repeats the whole program with a new set of two numbers to be added. You can also see in this program the function of the instruction numbers; they tell the CPU what to set the program counter to when you want it set to something other than the next instruction.

```
1    INPUT A
2    INPUT B
3    IF B = 0 THEN GOTO 7
4    LET C = A + B
5    PRINT C
6    GOTO 1
7    STOP
```

With the information presented in this chapter, you now know most of what you need to begin considering computer-assisted instruction for your classes. In the following chapter, we turn our attention to why and how microcomputers are being used as educational aids.

2. WHY AND HOW MICROCOMPUTERS ARE BEING USED IN SCHOOLS

Now that we have discussed what microcomputer systems are and a little about how they work, it is time to turn our attention to why and how they are being used in schools. Since this book is targeted primarily at social studies teachers, our emphasis wherever possible is on using the computer in social studies. However, most of what is said here applies to all subjects.

The reason the computer is such an exciting new educational tool is that it is so well suited to certain types of instructional strategies. In fact, it may provide the <u>best</u> way of implementing some of these strategies. This is not to say that computers are currently being used to their full potential in this regard. In fact, as we have seen, the potential of the computer does not reside in the hardware itself, but rather in the software that is written to actualize this potential. Later in this book we will consider some ways of evaluating courseware, but for now, let us look at why such great potential exists. The following discussion illustrates some of the uses for which computers are particularly well suited.

We can (perhaps arbitrarily) classify these uses into three groups: (1) to provide conditions known to facilitate learning, (2) to provide conditions favorable to motivation, and (3) to provide efficient management of learning.

First, good courseware can provide a variety of conditions known to facilitate learning. For example, good courseware can provide immediate feedback (learning is generally inversely proportional to the length of time between response and reinforcement or other feedback). The computer can be used to require active motor and/or cognitive participation on the part of the student, as opposed to passive listening or reading (involvement of motor and multiple associative pathways strengthens learning); it can also be used to break down complex tasks or material into easily mastered steps (shaping or successive approximation can be a very effective teaching strategy). Courseware can perceptually organize complex phenomena or information through dynamic graphics and other techniques (learning can be facilitated through creative use of new and different perceptual organizations). It can also, of course, provide lots of practice (strength of learning is proportional to number of trials or time on task).

Second, good courseware can provide conditions favorable to motivation. It can provide a highly motivating background in which practice or new learning occurs; using computers has been found to be inherently highly motivating and fun for students, especially when graphics and interactive techniques are used creatively. Furthermore, CAI can be used to give students more control over their own learning experience by creating a learning situation in which students have more responsibility (this applies to those computer-based activities that are more sophisticated than simple drill-and-practice programs). Also motivationally advantageous is the fact that the computer can provide totally objective feedback not confounded by the teacher's mood or attitudes and expectations toward the student or by the student's interpersonal patterns. A good program can also continuously and automatically adjust the difficulty of a lesson so that every student has a predominantly successful experience, regardless of ability or stage in learning.

Finally, computer-assisted instruction can be used to provide efficient management of learning. It can provide drill and practice with a minimum of wasted teacher and student time, it can continuously and automatically present tasks or information that depend on the student's performance on prior tasks, and it can automatically provide the teacher with a record and analysis of students' successes, failures, strengths, weaknesses, and response patterns. Moreover, CAI has the potential of permitting the teacher to personalize each student's learning activities by setting parameters in the computer programs, as well as by selecting different types of programs depending on the student's best learning style; for example, highly structured programs such as drill and practice for students who need structured direction, programs emphasizing graphics for students who learn best through visualization, and programs allowing free use of data bases for students who learn best through exploration, discovery, and insight. Lastly, computers can be used to provide activities that investigate or use highly complex situations or material that would be difficult or impossible to use without a computer; for example, computer programs can simulate phenomena the student would otherwise not be able to experience, they can explore data bases not otherwise readily available to the student, and they can quickly perform calculations that allow the student to examine very complex relationships.

The readings in this chapter examine in some detail ways in which microcomputers can be and are being used in schools. The first reading, by Denyse Forman, lists a wide variety of computer applications in education. Computer-assisted instruction is only one of twelve applications described. We include this reading first to provide an overview of all the likely contributions a computer can make in a school; the readings that follow generally concentrate on CAI.

In the second reading, James E. Davis and John D. Haas describe in more detail seven categories of instructional courseware: drill and practice, tutorials, demonstrations, simulations, information retrieval and analysis, instructional games, and computer literacy skills programs. Although examples are drawn from elementary social studies, the descriptions apply equally to other levels.

The next three articles provide more specific discussions of the uses of educational software in schools. The first, "The Computer in The School: A Case Study," by Andrew Zucker, provides many examples of the ways in which computers are actually being used in schools. Although he describes applications beyond social studies, Zucker provides many ideas about how the computer can be beneficially employed and includes some examples related to the social studies. One, for instance, involves a high school history student who used the computer to correlate U.S. senators' voting records on civil rights with a number of other variables.

The second article, "Social Studies Education in the Information Society," by Beverly Hunter, focuses on simulations and data bases as examples of computer-based tools that can be used in social studies instruction. The examples also suggest ways in which these tools can be used to help analyze the impact of computers in society.

The third paper, "Using Microcomputers in the Social Studies," by Thomas D. Weible and Jacqueline McMahon, describes a typical type of simulation program. It is presented here to provide a more detailed description than the previous articles of how such simulations operate. It shows how this type of activity can be used to involve students in the events of a time period, in this case the late 1920s and early 1930s. The authors report that students asked to comment on the experience gave responses such as "I feel the game was a great challenge and helped me better understand the Great Depression."

One of the most exciting uses of a computer for instructional purposes is in conjunction with a videodisc. So far precious little software is available for this function, but the technology, which already exists, has tremendous promise as an educational method. Therefore, no anthology on our topic would be complete without inclusion of the "intelligent videodisc." The article by Jeff Kemph, "Videodisc Comes to School," describes the technology and the ways it can be used interactively with a microcomputer in an educational context.

POTENTIAL, ACTUAL, AND PROJECTED USES OF THE COMPUTER IN EDUCATION

by Denyse Forman

A search of the literature reveals that there are various applications which have been identified as being reasonable and effective uses of the computer in education. These applications include the following:

1. Administrative applications, which include such activities as keeping track of accounting, payroll, inventory, and employee records and of attendance, grades, and student records. The computer has also been used in administration in class timetabling and in simulating models to forecast the implications of decisions and changes in the educational environment.

2. Curriculum planning applications such as the resource information file which was developed and is being used in Alaska to provide teachers with information on available educational resources.

3. Professional development applications, which not only provide teachers with new skills and an understanding of the uses of computers in education, but could also provide highly informative and imaginative professional development courses in other areas of education.

4. Library applications, which involve the computer in maintaining records of holdings, managing intra- and inter-library loans, and enabling users to search files for relevant titles and information.

5. Research applications, which enable a school or district to analyze data collected on a regular basis or for special purposes.

6. Guidance and special services applications, which include computer administration and scoring of selected standardized tests; provision of guidance and career information using a computer; and the administration of tests and the analysis of data to assist special education personnel with the diagnosis and remediation of learning problems.

Excerpted from "Search of the Literature," in The Computing Teacher 9, no. 5 (January 1982), pp. 43-44. Used by permission of the International Council on Computers in Education.

7. Testing applications, which include computer assistance in the construction, administration, scoring, and evaluation and analysis of test results.

8. Instructional aid applications, which involve the use of the computer in the same manner that any audiovisual device or piece of laboratory equipment may be used to demonstrate or illustrate concepts or to allow students to manipulate parameters without having to duplicate a real world situation.

9. Instructional management applications, which assist the teacher in providing individualized or small-group instruction by using the computer to manage the student's learning experiences and to monitor and assess progress.

10. Computer-assisted instruction applications, which involve the computer in taking over a central part of the instruction of the student and which can include a number of different modes of interaction with the student.

a. Drill-and-practice programs take advantage of the computer's tireless patience and ability to provide immediate feedback and reinforcement to prescribe, provide, and monitor potentially very complex drill-and-practice activities which can be tailored to a student's individual needs.

b. Tutorial programs, depending on the capabilities and the storage capacity of the computer system, are dialogues between the learner and the designer of the educational program. The computer acts as a "tutor" to teach the student concepts and skills. The worst of such programs are simply page-turners which present passages of text and then ask the student to answer a question on what they have just read. The best type of tutorial, called "dialog," leads the active learner through a series of carefully planned questions to some new understanding or knowledge of the topic at hand.

c. Simulations or controllable worlds are programs in which the computer can be used to simulate or generate environments for the learner so that he or she can change variables and explore situations in a manner that might have been too expensive, too restricted by time limitations, too dangerous, or too impossible to allow the student to explore in the real world.

11. Computer awareness and literacy applications, which involve the computer in preparing students to understand and to be able to use computers in our future computer-oriented society.

12. Computer science applications, which include teaching students about computer architecture, operations, programming, and applications.

MICROCOMPUTERS IN THE SOCIAL STUDIES

by James E. Davis and John D. Haas

There are at least two categories of classroom use of microcomputers: (1) management and record-keeping tasks and (2) instruction. Many routine classroom chores can be completely handled by an in-class computer or can be simplified with the help of a computer. Teachers do quite a bit of record-keeping that could become less burdensome with the aid of a microcomputer: maintaining class rosters; checking textbooks out to and back from individual students; recording and reporting student attendance; recording completion and grading of homework assignments; recording results of quizzes, tests, and examinations; analysis of scores in determining letter grades; creating and producing ditto masters; and other information processing required by district and school policies.

There are seven general uses of microcomputers as aids to teaching and learning: (1) drill and practice, (2) tutorial, (3) demonstration, (4) simulation, (5) information retrieval and analysis, (6) instructional games, and (7) computer literacy skills.

Drill and practice is the simplest, most mundane type of microcomputer use and also the easiest type of program to create (for professional program designers and for teachers who write their own software). For social studies at the elementary school level, most programs fall in this category, focusing on such topics as: capitals of states, geographical location of nations and continents, relational geography (e.g., Colorado is north of New Mexico and west of Kansas), capitals of nations, library research skills, and reading and summarizing tables of information presented in graphics.

Tutorials instruct the student in a sequence of <u>question</u>(computer)-<u>response</u>(student)-<u>feedback</u>-(computer), in the well-known programmed instruction linear or branching formats. Elementary social studies programs of this type are: how to read a map, how to handle money, how a bill becomes a law, colonies in the New World, and natural resources of a nation. This use is clearly almost as limiting as drill and practice.

Excerpted from a longer paper by Davis and Haas. Used by permission of the authors.

Demonstration is a traditional teaching technique most commonly used in teaching science and mathematics. Using the microcomputer for demonstrations assures that the demonstration will work as planned and that all students can see what is happening--one or two at a time at the console. Further, this use often incorporates many special capabilities of the microcomputer, such as high-resolution graphics, multi-colored diagrams, sound effects, and moving figures. Although the computer is particularly well-suited to demonstrating such processes as planetary motion or fruitfly genetics, it can also be used to demonstrate such system interactions in the social sciences as the circular flow diagram of a market economy, the evolution of geological strata (as in the Grand Canyon), the time flow of underlying and immediate causes of an historical event, the public transportation systems of a large urban complex, and the dynamics of a social system (e.g., a family or an elementary school). One elementary social studies program ("Historic Scroll") prints up to 40 separate time lines of key events from B.C. to the present. Another ("You Can Bank on It") demonstrates how a bank operates as an interactive system. Demonstration programs for social studies are relatively rare.

Non-computer simulations have been popular with social studies teachers for the past 15 years. Now they are available for the microcomputer, but with one somewhat severe limitation. Since social interaction (i.e., student-to-student and small group) is a valued aspect of in-class social simulations, the machine-student interactions of microcomputer simulations tend to restrict if not preclude interaction among students. [Ed. note: Many computer simulations <u>can</u> be set up in the classroom in such a way as to foster group interaction and group decision-making.]

Simulations model real-life or fantasy situations in simplified forms. They allow students to understand the essential factors involved and to change or manipulate key variables to yield diverse outcomes. Unlike games, simulations do not result in winners or losers; they tend to emphasize the process, the interaction of variables, and the effects of human decisions. There are quite a few commercially produced simulations for elementary social studies, simulating such contexts as: an overland journey on the Oregon Trail in the 19th century, the fur trade in the 1770s, ruling the ancient kingdom of Sumer, transporting furs by canoe from Minnesota to Ontario, Canada, small business practices in selling apples, bicycles, or lemonade, problems faced by a forest fire dispatcher, and Presidential election campaigns.

The most common use of the computer is for information storage and retrieval. The microcomputer is ideally suited to store information that can be used for analysis by students. At the simplest level, there can be storage of factual information such as dates, people, and places. Information about states, regions, or countries can be stored, and students can retrieve information that would enable them to compare and contrast. At a more sophisticated level, voting patterns, results of attitude surveys, economic data, etc. can be stored and retrieved by students doing research or being asked to respond to questions requiring analysis. For the social studies, information retrieval and analysis may be the most promising use of the microcomputer for educational purposes. A few available programs have limited data stored for student retrieval, such as place names or dates. However, programs that require more sophisticated use by students do not yet exist.

Instructional games usually simulate a situation in which the goal is to beat an opponent--another student or the computer. Here also there are many programs available for elementary social studies, but as is the case with simulations, there is considerable variation in quality and appropriate applicability. Topics of some instructional games are: getting from point A to B by the shortest and quickest route (map-reading skills), solving a murder mystery (logic and problem-solving), and war games (Napoleon/Wellington at Waterloo or North/South in Civil War).

Finally, teachers can use microcomputers to teach computer literacy skills. Becoming literate with computers generally means being able:

--to run commercially produced programs on a variety of subjects and topics

--to program; that is, to create programs for personal, vocational, and academic applications

--to modify or debug an existing program

--to use computers to retrieve information, to make decisions, and to solve problems

--to evaluate the usefulness of a program for a particular purpose

--to understand computer technology as a source of social issues (e.g., invasion of privacy).

Presently a few programs available for microcomputers teach various facets of computer literacy skills such as: computer capabilities (e.g., word processing, graphics, sound effects), history of computers, writing programs in BASIC or LOGO, using the typewriter keyboard and special control keys, and how a computer works (including rudimentary electronics).

THE COMPUTER IN THE SCHOOL: A CASE STUDY

by Andrew A. Zucker

Versatility is a key reason for putting computers into schools. Teachers, students, and administrators will continually find new way: use computer technology. The applications I am about to describe il: trate only a few of the countless possibilities, but perhaps it is u: to examine one school's experience in some detail--if only to realize how much an institution can accomplish with a new computer over a th: year period.

Instructional programs came from a number of sources. We wrote some, begged and borrowed others, and occasionally purchased one. I: had it to do over, I would budget more money for the purchase of programs.

We used the computer at our school in three ways: in courses, i extracurricular activities, and in carrying out administrative tasks.

Typically, people think first of mathematics and science courses when they consider the role of a computer in the curriculum. Our exp ence demonstrated a variety of other possibilities as well. For exan the health teacher used a program called DIET. Students entered thei typical daily diets and such personal information as their weights ar activity levels. The computer then produced an analysis of each student's diet and, when appropriate, recommendations for improving it.

Social science simulations were available from several sources, including the Huntington II programs, funded by the National Science Foundation. Several teachers used these for group or individual projects. In a public affairs course, for example, the teacher assigned program titled "Limits to Growth."

A history teacher used a student-developed program to produce hidden-word puzzles. In her case, of course, the hidden words were related to European history.

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One of the Huntington II programs is designed to analyze survey data, and we modified it to take advantage of the capabilities of our computer. On several occasions, students conducted surveys that brought thousands of responses to questionnaires on such topics as teenagers' use of alcohol and tobacco. The program made it easy to type in (and correct) data from respondents. Students then carried out fairly sophisticated data analyses, including crosstabs and correlations, and the student newspaper published their findings.

Reading teachers in grades 3 through 6 happened on a program called MAZE, which produces one-of-a-kind paper-and-pencil mazes. They found these useful as spatial-relations exercises for students with certain kinds of learning disabilities.

The mathematics teacher for grades 3 through 6 used an individualized approach. Each child had a notebook containing personalized assignments, e.g., worksheets, games, calculator problems. When this teacher had a computer terminal installed in her room, computer programs became one more type of assignment. Eventually, we produced a catalogue of more than three dozen programs for use in the lower school. Many students developed a strong interest and used the computer before or after school, as well as in class. A few of the children even learned to program in BASIC.

More than two dozen programs were listed in our "Mathematics Program Library" catalogue. These included drill-and-practice programs, a 100-place precision calculator, curve-fitting routines (used occasionally by the science department), calculus demonstrations (e.g., comparing methods of integration), and general-purpose graphic and square root finding routines. Occasionally, math teachers used the computer for class demonstrations--to teach the basics of sampling techniques for polls and surveys, for example, or to demonstrate to a pre-calculus section some uses of the computer for problem solving. However, math teachers used the computer less than we had anticipated, in part because terminals were so scarce.

The physics teacher used a simulation of the Millikan oil drop experiment, which determines the unit charge of an electron, in lieu of the actual experiment. The computer, under a student's control, generates data as would an actual (but exacting and time-consuming) experiment. Students were responsible, however, for data analysis and interpretation.

Courses on programming were the most regular instructional application of the terminals. Introductory and advanced courses were offered, each meeting twice weekly for a full year and yielding a half-credit for participants. Assignments in both courses regularly called for hands-on work with the computer.

Students who wished to have personal "accounts" on the computer, if they had not taken a programming course, were required to pass a test demonstrating knowledge of basic computer skills and of applicable rules and regulations. I entered a large data base of test questions, and the computer generated and printed tests containing randomly selected items. Since each test was unique, cheating was difficult; it was also simple to give students another chance if they failed the test.

Near the end of the year, students in the advanced programming course designed and implemented a computer contest for students in the introductory course. The introductory class was divided into four groups, and each group used one of the terminals for a three-hour period. The group that solved each programming problem in the least number of trials gained the most points for that problem.

Individual student projects in the programming courses ranged from game programs to experiments in animation, which had the computer producing one paper "frame" at a time. A junior in an American history course correlated U.S. senators' voting records on civil rights with other variables; his techniques attracted the attention of faculty members at a nearby college.

Many students who had their own computer accounts worked independently. Some developed game programs. One talented student wrote an excellent drill-and-practice program for lower-school students on converting Roman numerals to Arabic numerals, and vice versa. Another student wrote a program called PROOF, which solves simple equations in the manner of a geometry proof. This program, about 30 single-spaced pages in length, won first prize in a national programming contest for students. Two other youngsters, with my assistance and the approval of the administration, analyzed grades and Scholastic Aptitude Test scores during the preceding decade. We were able, as a result, to compare our school's grading and testing patterns to national norms.

We also discovered a variety of uses for the computer in extracurricular activities. The usual array of games made their way into the computer, of course, and this posed some problems. In fact, we terminated access to the all-school computer account after 4 p.m. to discourage students from foregoing other activities to entertain themselves in this fashion.

Entertaining computer programs have certain advantages, however. For example, those secretaries who were trained to use the computer for administrative purposes were first shown how to use the "biorhythm" program, because they tended to find this interesting. Creating or modifying game programs also proved highly motivating and instructive for many students.

Our computers could produce strings of large block letters in a variety of sizes. Teachers in the lower school found these useful for posters and other classroom displays.

One student created a program that kept hockey statistics; this was later imitated for another sport. After each game, a student entered the data. The computer then produced one table of statistics (e.g., goals and assists for each player) for that game and a second table of statistics for the season to date.

Reporters for the student newspaper experimented for several issues with entering stories directly into the computer. The editors could then edit under program control. But the chief advantage was using a utility program (modified by a student for our computer) to produce typed copy of any specified column width, justified at both margins. A major disadvantage was that the terminals had dot-matrix printers, producing lower-quality print. Several students used the RUNOFF program for their term papers, however, and all the manuals for administrative software were prepared on the computer.

The student newspaper kept its subscription list on the computer, which could produce sticky labels quickly and cheaply. One teacher used the computer to maintain a membership list for a non-profit association of which he was an officer.

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Several of the math teachers used the computer as a problem-solving aid. They studied the behavior of certain expressions or equations over a range of numbers or used the computer to help verify hunches about difficult problems. One or two of the most talented math students used the computer in the same manner.

One teacher decided to establish several extracurricular clubs. To determine the interests of students, he listed 50 activities--from cooking to rock-climbing--and asked each student to check those that interested him or her. A special program allowed students to type in this data quickly. Another program produced a list of the 50 activities, each one followed by the names and ages of every student who professed an interest in it. The teacher used this information to establish formal clubs and to help students find peers with similar interests.

Nearly 100 computer programs were written to do administrative tasks. Most of these used the same basic data, organized in three sets: data on teachers and students, on graduates, and on students applying for admission.

The essential jobs for the computer were producing report cards, grade lists, class lists, and student and teacher schedules. We ordered pre-printed, triplicate report card forms, designed so that the original could be slipped into a window envelope. Continuous, pin-fed ditto master forms reproduced the grade lists. Pin-fed address labels were the only other special materials we needed for report cards.

A woman--gifted with a better capacity for scheduling than the computer--carried out that task. But we learned to use the computer to speed her work greatly, by having it print myriad interim lists and schedules and check for errors.

A recent survey by the U.S. Department of Education (ED) found that about one school in four now has a computer available for student use, and there is good reason to expect this number to increase rapidly. But other ED-sponsored research, examining the experiences of three urban school systems with microcomputers, demonstrates the difficulties of implementing large-scale computer use.

As school use of computers increases, there are a number of things to bear in mind. Computers in schools are not panaceas, and they are not without problems. One of the most serious may be attracting and

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keeping qualified staff members, when the computer industry pays better than education and has thousands of available jobs. Moreover, school administrators must be willing to devote resources to staff development and to the purchase or development of software. A low-cost microcomputer is not the only expense. Finally, common sense should prevail when school computer specialists explain their hopes and goals. If we keep these cautions in mind, this versatile tool will yield many benefits for education.

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SOCIAL STUDIES EDUCATION IN THE INFORMATION SOCIETY

by Beverly Hunter

The rock song lament "too much information" (Police 1981) is voiced not only by teachers and students, but by business people, industrial workers, bureaucrats, and researchers throughout modern society. Many of the changes in our society are rooted in new ways of generating, storing, communicating, and using increasing amounts of information.

To more and more of us, the ability to survive and thrive in modern society requires that we become better information handlers. "Information handling" is used here to mean such activities as collecting, organizing, storing, classifying, analyzing, interpreting, retrieving, or communicating data and information.

Most information-handling activities are carried out with the aid of papers, pencils, reference books, and other traditional tools and media. Increasingly, however, it is important also to be able to use computer-based tools to aid us in our information-handling tasks.

By "computer-based tools" we mean various kinds of computer programs that aid in information-handling and problem-solving, such as those used to:

--Store and retrieve information.

--Perform statistical analyses of data.

--Simulate situations or systems.

--Help graph or plot information displays.

--Help compose, edit, and format compositions.

--Communicate with other computers and information utilities such as <u>The Source</u>.

This article describes two examples of computer-based tools that students and teachers can use to both bolster social studies instruction and to analyze the computer's impact on our society. The examples include tools for building and using simulations as well as social studies data bases.

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Building and Using Simulations

The increasing complexity and interdependence of societies and problems on a global scale make it increasingly difficult to understand and interpret individual social, historical, political, and economic events. Simulations are often used in the social studies to analyze problems by using a representation or model of a situation and then exercising the model to see how it behaves under different circumstances.

As a simplified representation of a system, the model aids one in understanding how the system operates. Simulations are often used by social studies teachers and students. A simulation model may be a physical model, a mental concept, a mathematical model, or a computer program model.

The decreasing cost and increasing capability of computers enables more people to experiment with computer programs which simulate the behavior and interaction among variables in complex systems. For example, many attempts are being made by researchers to develop global simulations to help understand the interdependence of world-wide systems. Since The Limits to Growth (Meadows et al. 1972) was published about ten years ago, seven other widely recognized "global" models have been completed, with at least 20 more under development. Global models have been made in many parts of the world, using many different techniques, to answer quite different questions.

More and more computer simulations useful for the social studies classroom are becoming commercially available. One of the best known is "Lemonade," in which students try to maximize profits from running a lemonade stand. Susan Friel (1983) provides a detailed description of using "Lemonade" to help students learn about both business economics and about the simulation itself (e.g., variables the simulation takes into account and the limits of the model).

Both the computer tools and the intellectual skills needed to build and use computer simulations were until very recently accessible only to a few. The computer programming required specialized technical skill, and the math prerequisites for actually developing, understanding, and modifying simulations seemed to preclude introduction of these subjects into precollege curricula. Three significant developments promise to bring the intellectual and technological tools of modeling and simulation into the hands of just about everyone. These developments are:

1. A textbook, written at a junior-senior high school level, called Introduction to Computer Simulation (Roberts et al. 1982). This book introduces basic concepts of system simulation, structure of feedback systems, graphing and analyzing the behavior of feedback systems, formulating and analyzing simulation models, and implementing simulation models on a computer. The same author (Roberts 1981) has demonstrated that fifth- and sixth-graders can learn dynamic feedback systems thinking, and that these skills can be taught at this grade level by a teacher with no previous background in the field.

2. The development of Micro-DYNAMO, a computer simulation language for microcomputers (Pugh-Roberts Assoc. 1982). Using Micro-DYNAMO, students can express their models in easily understood algebraic relationships without worrying about technical details of a general-purpose computer programming language. Micro-DYNAMO takes advantage of the high resolution color graphics available on inexpensive microcomputers.

3. Increasing accessibility of low-cost computers to teachers and students.

How might educators and publishers take advantage of the opportunities presented by these developments? The following steps might be taken:

1. Develop and publish a variety of simulations written in Micro-DYNAMO and documented in a manner that will assist classroom teachers and students to understand the models, modify them, and conduct experiments using the simulations.

2. Incorporate systems thinking into social studies classes. For example, in the simulation textbook, students are provided with examples of narrative prose that purports to describe or explain some social phenomenon, such as the growth and decline of a city, heroin addiction in an inner-city environment, the international politics of the oil crisis, the tragedy of the Sahel. The students analyze the narrative prose and draw diagrams showing the cause-and-effect relationships implied or stated in the prose (Roberts 1983). This is an excellent activity for improving comprehension of the subject matter as well as practicing critical thinking skills.

3. Provide courses devoted to system dynamics and other modeling techniques. By learning and applying techniques and discipline of system dynamics modeling, and by using software such as DYNAMO, students not only study more complex phenomena. They also gain information-handling skills they can apply to many different problem areas.

Building and Using Social Studies Data Bases

A file of information can be stored on a floppy disk, using a computer program called "Personal Filing System" (PFS) on an Apple II computer. Similar programs are available for any microcomputer with a disk drive. Programs such as PFS are technically very easy to use, allowing the student to concentrate on content-related information and problems which are the important focus of the social studies class.

Students may create and use such a computerized data base for states, countries, regions, kings, wars, cities, mountain ranges, presidents, early civilizations--any content relevant to their course of study.

Students can explore their data base by formulating hypotheses and questions, and developing strategies for retrieving selected information. For example, a data base with information on the 50 states would allow us to pose such questions as:

Which five states experienced the greatest percentage population growth between 1970 and 1980? What similarities are there among them? How do they differ from the states that experienced the least population growth?

I'd like to visit a state that has a high altitude and a large amount of state forest and park land. Suggest five states to me.

I'd like to live in a state that has a high per capita income and low population density. Can you suggest five candidates?

Questions such as those posed above can be answered by interrogating the states data base.

As the students are developing skills in handling information, they may develop a greater appreciation for the importance of content knowledge. For example, in order to ask PFS about states with the highest altitude, it helps to have some content knowledge. If I already know that, say, Utah is mountainous, I can use this procedure to make my inquiry:

--Retrieve the record for Utah.

--Find the mean altitude of Utah.

--Ask PFS to print a list of all states having a higher mean altitude than Utah's.

If I don't have such content knowledge, I can ask PFS to print a list of all the states, sequenced by mean altitude. Such a "brute force" strategy will work for some fairly simple inquiries, but becomes cumbersome and time-consuming as the questions become more complex. The more familiar I am with my content, and with the format of my data base, the more efficient I can be in making my inquiries.

Activities such as those discussed above can be approached at several different levels of complexity. At the first level, students use a data base that has already been prepared (e.g., by the teacher) to make inquiries and prepare reports related to the subject of the course.

At a second level, students create the data base, by entering data through the computer keyboard into a format already designed by the teacher. They extract their data from available reference sources such as textbooks, almanacs, and encyclopedias.

At a more advanced level, students decide what information they will need for their projects. They then design the format and content of the data base themselves before they enter the data and use it.

Programs such as PFS are technically so easy to use that students and teachers can concentrate on the content and format of their data without being distracted by technical details of a computer programming language. Creating a data base format in PFS technically involves nothing more than typing the headings of the data items (e.g., STATE ABBREV:) where you want them on the page (the "page" being a blank screen on the computer's display).

The "advanced" aspect of designing the data base is that the learner needs to understand his or her data and how he or she will want to use it.

Analyzing the Impact of Computers in Society

After students have acquired personal experience in using computer-based systems in the social context of the classroom, they are in a much stronger position to understand and analyze issues related to computers in the larger society.

For example, imagine a class project in which ten groups of three students have each entered the data for five states into a computerized states data base. The states data base becomes a shared resource which all members of the class depend upon in order to make their inquiries and accomplish assigned projects.

Suppose one of the groups, through carelessness or mischief, enters erroneous data for its states into the data base. This results in "garbage" retrievals and reports for everyone.

This is a good opportunity to introduce social issues related to computerized data bases. Students can collect information on the kinds of data bases used, for example, in government, law enforcement, and business. They can investigate techniques, such as identification codes and passwords, that are used to restrict and control access to computer systems and data bases. Controlled access to systems is necessary in order to prevent crime, protect personal privacy, keep a data base free of errors, or to protect authors' copyrights.

Having developed and used a computerized data base for their own work, students have an experiential base upon which to analyze advantages and disadvantages of information retrieval applications.

In this example, they may decide that the advantages of their computerized data base are that they can retrieve information more quickly than they could from printed sources and that they can organize the information and display it easily in the form of various printouts.

They may also observe disadvantages of this particular information retrieval application, such as:

1. Individuals have no control over the accuracy of the total data base.

2. Not enough flexibility in the choice of output format, using PFS.

3. Information they need for a particular project may not all be included in the data base.

4. The system is too restrictive in terms of the amount or kinds of information they can put into a record.

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Conclusion

Computers are having, and will continue to have, more powerful effects on society and individuals than any of us yet know how to imagine or predict. Our only hope for making wise and beneficial uses of the technology and avoiding some of the potential disasters is to have an educated citizenry with an attitude of responsibility and a sense of control.

Learning materials and activities are needed to reach these goals. Some of these objectives are addressed in Computer Literacy Instructional Modules developed by the Minnesota Educational Computing Consortium. Sample lesson plans addressing these topics are also found in My Students Use Computers (Hunter 1983).

To survive and thrive in an information-based society will require that students learn skills and techniques for handling information. Computer programs such as data bases and simulations are tools students can use to learn, manage information, and solve problems in the social studies. Students' ability to analyze issues related to the impact of computers in society is enhanced through personal experience in using computer-based systems in a social context, such as the classroom.

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USING MICROCOMPUTERS IN THE SOCIAL STUDIES

by Thomas D. Weible and Jacqueline McMahon

Introduction

Imagine using a microcomputer to simulate a segment of history and to make decisions based upon events and information from that time period. Complete with a cast of characters, financial situations and chances, the simulation "The Great Depression" provided high school students with the unique opportunity of "reliving" the era of the late 1920s and early 1930s.

Recent years have witnessed tremendous interest in microcomputers as an educational medium; however, a review of available software for the social studies indicated a need for more materials in this area. This need prompted University of Missouri personnel to undertake a study at the David H. Hickman High School to find out if microcomputer simulations could be used as an effective teaching strategy in a social studies classroom. It was believed that the varied capabilities of the microcomputer could add an exciting instructional feature to simulation gaming.

The school's American Cultures course was selected to pilot this project. Classes had just concluded a unit on the "Roaring 20's" and were beginning a study of the Great Depression. University personnel working with teachers at Hickman High developed an instructional unit on this topic; the unit included a microcomputer simulation designed to extend student understandings about this period. The remainder of this article describes the various game components and student response to this form of instruction.

Description of Game

The simulation began with an orientation appearing in printed text on the monitor. The text informed students that they were participants in a project designed to help them gain a better understanding of the economic and social events affecting people's lives during the early

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years of the Great Depression. This introduction included an explanation of game rules and procedures for hardware use. These were kept as simple as possible to eliminate any unnecessary confusion or apprehension. Following the orientation, students were encouraged to ask questions they might have.

The simulation then continued with a description of the cast of characters. Fictional characters were created to add interest, humor, and a personalizing element to the game format. Students were required to assume the role of the main character, Maynard Megamillion III, as he made decisions affecting his financial empire. Maynard was cast as a financier who wheeled and dealed his way through a variety of business ventures.

Throughout the game, Maynard was posed with investment situations which involved family, friends, and business associates. These characters constantly tried to influence his investment decisions. Some of the students' favorite characters included: Florence, Maynard's wife, who served as his financial advisor and confidant and did her best to keep him out of serious trouble; "Salty" Crittle, a retired sea captain who knew the in's and out's of the shipping business and superbly managed Maynard's fleet ("Salty" loved to imbibe, smoke Cuban cigars, and tell of his experiences as a young man on a "five-master"); and Cousin Clarence, who had frittered away his money on foolish business dealings and was forever hitting Maynard up for funds. Maynard was forced to relent to these monetary demands because Clarence knew a lot about his past and present "shady" business escapades.

Once introduced to the characters, students then proceeded to the decision-making components of the game. Working in groups of three, they were posed with numerous investment situations, starting in the year 1929 and progressing through 1932. All groups were given a predetermined amount of assets. Acting as Maynard, their objective was to manipulate successfully their finances through the early years of the Great Depression. The group with the greatest amount of total wealth when the game ended was the winner. Investment situations were based on ventures in stocks, real estate, commerce, and agriculture. A list of possible options accompanied each situation, and groups had to decide which option would be financially most advantageous. The following is an example:

"Salty" Crittle is really concerned about the drop in world trade resulting from the depression. He has confidence, however, that your shipping company will survive the worst of times. He believes the best way to solve the shipping problem is to concentrate on domestic rather than foreign trade. "Salty" tells you that expenses such as fuel, repairs, and labor will be cheaper if you limit your overseas ventures. Your business manager, Teddy Bowen, disagrees with "Salty." Teddy fears you will damage the overseas relations that took you years to develop. In order to gear your fleet for domestic trade, you must invest $50,000. If you wish to continue the shipping company's emphasis on foreign trade, you will need to invest $100,000 for long range shipping and labor. You see merit in the words of wisdom given by each of these men. Since you are the owner of the shipping operation, the ultimate decision must be yours. You must decide to:

1. Invest $50,000 in domestic trade.
2. Invest $100,000 in foreign trade.

Once an option was selected, a response immediately appeared on the monitor indicating the results of the decision. The following consequences accompanied the above investment situation:

Response to Option 1:

1. "Salty" was absolutely correct in his predictions for 1930! By June of 1931, domestic trade increased 6%. Add this increase to your shipping company assets.

Response to Option 2:

2. Teddy's advice was not the best. His predictions for shipping caused your company to lose money. By June 1931, foreign trade decreased by 11%. This amount will be deducted from your company's total assets.

Decisions had to be reached within a predetermined time limit controlled by the microcomputer. A digital readout of time remaining was always visible on the monitor. If a decision was not reached within the allocated time period, the opportunity to make a possible monetary gain was lost. The microcomputer quickly performed all mathematical calculations and kept a record of each group's financial status. A summary of assets was available at all times to help groups make their decisions.

Students not only had to act upon investment situations, they also were able to transfer their stocks and real estate holdings into cash during timed selling sessions. Selling sessions appeared throughout the

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game, but students did not know when these would occur. Again, group decisions had to be made as to which holding, if any, would be sold.

To assist groups when making investment or selling decisions, the microcomputer randomly generated economic information statements. These consisted of financial reports and business indicators reported by respected trade journals of the time as well as quotes and predictions from financiers and government officials related to the nation's economy. A wide array of economic information statements were available, and time was provided for discussing the financial implications of each statement. The following quote is representative:

Information Statement-1931

I see nothing . . . in the present situation that is either menacing or warrants pessimism. During the winter months there may be some slackness of unemployment . . . but I have every confidence that there will be a revival . . . in the spring and that during the coming year the country will make steady progress.

Andrew Mellon, Secretary of the Treasury, in a New Year's Day radio broadcast to the nation.

Realizing that life is filled with many unforeseen events, an element of chance was also included as a game component. Chances were encountered by all groups as they proceeded through the simulation. Incidents such as inheritance, payoffs from wagers, the need to purchase and repair equipment, and the costs of social functions added to and diminished each group's wealth. Chances like the one below were randomly generated by the microcomputer:

Chance 1931

You are stunned to hear that your good friend Knute Rockne was killed in Kansas during the crash of a Transcontinental and Western Air Express plane. The Notre Dame gridiron has lost a great coach. You send $2,000 to his family to help them through this tragic time and make them promise to notify you if they need any further assistance.

The versatility of the microcomputer made it easy to manage all of the previously discussed components of "The Great Depression." The microcomputer's ability to execute rapidly the complex functions required for this simulation added an exciting element that would have been missing otherwise.

Student Responses

An important aspect of this project was to evaluate student perceptions of microcomputer instruction in the social studies. Researchers used documented observations and administered a questionnaire to assess students' reactions. Preliminary findings indicate responses were overwhelmingly positive. Observations revealed that students worked intensely and enthusiastically throughout the project. Teams worked independently, interacting and making decisions with minimal supervision. It was also noted that there was little apprehension in using the microcomputer, even though the questionnaire indicated that only a few individuals had prior experience with the hardware.

The following comments from participants may more accurately represent their thoughts. One wrote, "I feel the game was a great challenge and helped me better understand the Great Depression. I think we should have more group activities of this kind." Another commented, "I really loved it. I think it is important to find more ways to make learning productive." Perhaps this final statement best summarizes the thoughts of many: "I enjoyed working with the microcomputer because it was a change of pace. But it also was interesting and helped me better understand this era of history."

Conclusion

The success of this project leads us to believe that microcomputers have a tremendous instructional potential for the entire social studies curriculum. This technology makes it possible to add a new dimension to all social studies disciplines through the use of computer graphics, sound, and the rapid calculation of mathematical functions. The increasing availability of microcomputer hardware and software will soon make it possible for all social studies teachers to take advantage of this unique medium.

VIDEODISC COMES TO SCHOOL

by Jeff Kemph

A new audiovisual technology, the videodisc, is beginning to make its presence felt in education. Because it has a radial surface like a phonograph record, rather than a ribbon surface like a film or videotape, the disc makes information more accessible and thus usable. Film and videotape present programs in a linear fashion; they play from start to finish without interruption. The videodisc is a nonlinear medium; the user may view any of the material in any order. Thus, depending on the needs of the user, a program can have many beginnings, middles, and ends.

Four major videodisc formats are currently available or scheduled for introduction before the end of 1981. They use different techniques to record and read the information on the disc and, consequently, are noncompatible. We will concentrate on the capabilities of one format--the reflective optical videodisc system--introduced in 1978. In terms of program design and production, research has concentrated on this format.

The basic vodeodisc system consists of three elements: the player, a television set, and the disc itself. About the size of a phonograph record, the videodisc contains all the information necessary to reproduce 30 minutes of color video with two channels of audio. The information is contained in a series of micropits of various lengths and spacings encoded onto a reflective surface. Because the micropits are very delicate, the reflective layer is encased in plastic to protect the program information from damage due to fingerprints, dust, scratches--even peanut butter.

The disc surface can be wiped clean with a soft cloth and can be played thousands of times without losing the quality of picture or audio. Commercially available discs retail for $5.95 for short subjects to $29.95 for feature-length films such as <u>Coal Miner's Daughter</u>.

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The Player

There are two categories of players available: The Consumer and the Educational/Industrial (E/I). Pioneer and Magnavox currently market consumer players which sell for approximately $750. E/I players are presently being sold by DiscoVision Associates (DVA) and Sony. The prices range from $1,725 to $2,800 with price affected by the quantity ordered. The E/I player is more rugged than the Consumer player and because of its programmable microprocessor it is also more flexible. The microprocessor enables the user to more easily access the contents on the disc and makes the player easier to interface to an external computer, vastly expanding the system capabilities.

The output of the disc player can be displayed on a standard television receiver, either color or black-and-white, but since the videodisc plays color television pictures, a color television is recommended.

Capabilities

Unlike the video recorder, the videodisc is a "play only" medium. While it cannot be used to make a recording, it has other features useful to students and teachers: (1) the disc is read by a noncontact, low-powered laser; (2) each frame, or picture, on the disc has a unique address or frame number; and (3) the information is contained on a radial surface.

In a 30-minute television program there are 54,000 frames of information. Each frame on the disc is contained on a separate spiral track and given a frame number from 1 to 54,000. Since the information is read by a noncontact laser, a variety of display modes are possible, including still visuals such as text and slides or motion. The rate of speed can be selected by the user from slow motion to fast scan forward or reverse. Any time the disc plays at "normal" speed (30 frames per second) two channels of high quality audio are available. These can be used for stereo music, bilingual audio tracks, or to present commentary at two different levels of comprehension. With the disc the user can monitor either or both audio channels.

Because any program segment on the disc can be randomly accessed in a matter of seconds, the contents of a videodisc can be arranged much like the contents of a book. The information can be organzed into discrete chapters, indexed by a table of contents (using the frame numbers), and supported by optional appendix material such as tests, teacher's aids, or a visual data base that can be used as a reference library.

Levels of Interaction

Depending on the capability of the videodisc system and ability of disc producers to organize programs in non-linear fashion, four distinct styles or levels of programs can be presented. The four levels refer to player/disc "intelligence" or the ability of the videodisc system to process information input by the user. A higher level of player "intelligence" results in more interaction between the program and user and better adaptation to individual needs.

At its most basic level, Level Zero, the videodisc is used to present material linearly--in real time. For example, a movie plays from the beginning to the end with no user interaction.

At Level One, unique features of the videodisc can be used. The program can consist of a mixture of still and motion sequences, using whichever medium is most appropriate. The user selects the portion of the program to be viewed and controls the pace of the presentation. Single frame material can include simple quizzes, for example. If the student gets the answer wrong, he/she can immediately review the portion containing the correct information.

The second level of interaction uses the programmability of the E/I player's microprocessor. Following a programmed sequence, the player presents a section of the program, halts at a decision frame, and allows the user to select where the program will go from the choices presented. The user can redirect the path of the program with the press of one or two digits on a hand-held keypad. For example, a typical program might begin with a table of contents. The student selects and views a content segment, then answers several multiple choice questions. If he/she gives the correct answer, the program continues. If the answer is wrong, the player automatically replays the segment of the program containing the answer, then branches back to the original question for a re-test. Some simple forms of scorekeeping are also possible with a Level Two program.

The highest level of program interaction is a Level Three program. Here, the E/I player is connected to an external microcomputer. Disc content can be designed to be given at several levels of comprehension. The computer then evaluates the user's response to decision frames and guides the user through the program at the appropriate level. The computer can be used to generate graphics and text information which can be overlaid on the picture from the disc. Questions and answers contained in the computer are easily edited without changing the disc, and the computer keeps a detailed record of the student's progress, if desirable.

As an audiovisual aid the videodisc technology has a lot to offer. The players are simple to use, and as one teacher reported, relatively "grunch proof." The software (program) is durable and inexpensive when compared to film or videotape, and the disc is more capable of responding to the needs of the classroom teacher or student than conventional media. The technology has been developed to allow the user to easily customize a prepackaged audiovisual program to respond to a specific classroom need.

The only thing currently missing is the development of a large base of quality interactive software for the players. Although there are many research and development projects studying the videodisc, available software is limited. And since the videodisc is a play only medium, the worth of the technology to education will be ultimately defined by the quantity and quality of interactive software available in the marketplace.

3. EVALUATING COURSEWARE

However great may be the computer's potential for assisting teachers in reaching their educational objectives, this potential does not reside in the computer hardware itself. Rather, it is in the software that is written for use with the hardware. Being able to find courseware of the highest quality is therefore critical for the teacher.

A good deal of the courseware available today is not generally regarded as being of very high quality or useful in meeting educational objectives. Many available programs reflect little knowledge of how children learn best. Others lack clear educational objectives or fail to take sufficient advantage of the interactive and other capabilities of the computer, simply providing text material in another form.

One of the key reasons for the problems with available programs is the development process that has typically been used. Much of the courseware available today has been developed by programmers who do not understand educational objectives and techniques and have limited background in learning theory or discipline content. Other programs have been created by curriculum developers who are not thoroughly familiar with the logic, structure, and capabilities of computer processes.

In any case, the teacher who desires to use computers needs some way to evaluate the quality and usefulness of the programs being considered; teachers need to be able to separate the good from the bad. The readings in this chapter are designed to help meet that need. In our first reading, "Evaluating Computer Courseware: Even Old Dogs Need Only a Few New Tricks," Don Rawitsch points out that a teacher does not have to be a computer expert to effectively evaluate courseware. He explains how teachers can apply the same evaluative criteria to instructional software as they do to other types of instructional materials. Rawitsch presents a simple and practical approach to evaluation.

Roger Berg, in our second reading, provides insights and guidance in evaluating microcomputer-based social studies simulations/games, based on a review of the literature. It is included in the anthology for those who wish to delve more deeply into the subject, including its underlying theoretical considerations, and for the general good advice Berg provides.

Finally, for those who wish to examine a very detailed and comprehensive method of evaluation, we present excerpts from a document entitled Evaluator's Guide for Microcomputer-Based Instructional Packages. This guide, produced by the Northwest Regional Educational Laboratory as part of a National Institute of Education funded project known as "MicroSIFT," is designed to aid teachers and other educators in evaluating courseware themselves.

Teachers may also be interested in knowing that there is a computerized data base that focuses exclusively on computer education. Developed as another part of the MicroSIFT project and known as RICE (Resources in Computer Education), the file describes 2,000 pieces of software in terms of cost, producer, subject area, grade/ability level, ERIC descriptors, instructional purpose, required hardware and software, instructional techniques, documentation available, and evaluation information. It also contains information about more than 150 producers of software: address, hardware brands and types for which software is produced, subject or application area for which software is produced, age levels, and modes of instruction. For more information about RICE, contact the Northwest Regional Educational Laboratory, 300 S.W. Sixth Avenue, Portland, OR 97204.

Microcomputer Index is a quarterly publication that can now be accessed by computer. It is a subject index covering more than 2,000 articles regarding microcomputers, many related to education. Microcomputer Index is published by Microcomputer Information Services, 2464 El Camino Real, Suite 247, Santa Clara, CA 95051. Both RICE and Microcomputer Index can be searched by ERIC/ChESS User Services.

EVALUATING COMPUTER COURSEWARE:
EVEN OLD DOGS NEED ONLY A FEW NEW TRICKS

by Don Rawitsch

Computer use in schools is growing rapidly, and the social studies classroom can be an important part of a school's overall instructional computing program. Very often a lot of effort goes into purchasing the computer equipment itself. But educators are becoming aware that obtaining quality courseware for those computers is every bit as important.

Courseware, referring to a complete instructional product which includes both software for the computer and written support material for the teacher, is not the only way to use the computer for social studies activities. For example, word processing, a generalized utility, could be used by students to write research papers. But the use of courseware to teach material in the current social studies curriculum will for some time remain the predominant method of using computers in the classroom.

The first problem is to find the courseware. Of greater importance is the need to evaluate what is found. Computers should not be used because courseware exists. It is tempting to believe that one must have computer expertise to evaluate computer courseware. But the most important word in the term "instructional computing" is the first one, and many of the factors that go into evaluating courseware are the same ones educators were applying to all instructional materials long before computers entered the classroom.

Locating Courseware

As many social studies educators have come to lament, there is not currently a wide selection of courseware available for the social studies. (See "Educational Software: A Taste of What's Available for Social Studies," by Millie L. Cohen, in The Computing Teacher, December 1982, for a survey of the market.) More is undoubtedly in the offing, but it will not come as fast as in more popular "basic skills" areas.

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Some effective ways to find new courseware would include the following:

--Watch the catalogs of major publishers and query publisher representatives whom you meet.

--Visit computer dealers.

--Read magazines devoted to instructional computing.

--Attend instructional computing conferences.

--Utilize local services such as computing support organizations and colleges and universities.

Matching Your Machine

A preliminary hurdle for determining whether a courseware product will meet one's needs is verifying that it will run on the computers available. Not all courseware works on all computers. Thus, the following computer considerations must be kept in mind when reading product descriptions:

1. Is the product designed for the brand of computer to be used? (Courseware for Atari computers won't work on Apple computers.)

2. Is the product designed for the model of computer to be used? (Courseware for the Atari 800 might not work on the Atari 400.)

3. Is the product designed for the storage device of the computer to be used? (A product on a diskette won't work on a computer that uses a cassette recorder.)

4. Is the product designed for the memory capacity of the computer to be used? (A product that requires "48K" of memory space won't work on a computer that has only "32K" of memory space.)

5. Is the product designed for a computer language available on the computer to be used? (A product written in the Pascal language won't work on a computer that uses only the BASIC language.)

Instruction-Related Evaluation Factors

The factors important in evaluating a courseware product include several items that would apply to judging <u>any</u> instructional product. These items as a group are the most critical to the evaluation process. Moreover, they are not unique to social studies material. Write down your own list of important instructional factors before studying the list below (which is not meant to be exhaustive).

1. The subject matter of the courseware must fit the teacher's plan.

2. The subject matter must be accurate.

3. The reading level of the materials must be appropriate for the students.

4. The activities must be of appropriate length.

5. The activities must be sequenced for effective learning.

6. Instructions must be clear and concise.

7. Correct grammar must be used.

8. The materials must motivate students.

9. The materials must be socially acceptable (e.g., avoiding objectionable stereotypes).

10. Student materials must be attractively designed.

11. Teacher support materials must be complete.

Only if many of the above criteria were met would cost become a factor. Inexpensive materials are not desirable if their instructional qualities are substandard.

Computer-Related Evaluation Factors

Certainly the computer as a delivery device for instructional activities has some unique characteristics. The total list of courseware evaluation factors should include some of this nature.

If activities are worth implementing on a computer, they should be taking advantage of computer capabilities which are not available through other methods. These would include the ability to produce random events and responses in an activity, and specialized graphics and sound techniques that enhance the presentation of the material.

Any particular courseware product will be used in a variety of situations by a variety of teachers and students. Thus, its design ought to offer user control over its operation. For example, the movement from one screen of information to the next can be user controlled by pressing a key to accommodate differences in reading rate. Also, the product could offer options in terms of how much activity will be presented in one student session and the difficulty of the material or skills to be covered.

No product will ever be used in all situations as it was intended. Often students, either intentionally or not, will respond to questions asked or choices offered in a way contrary to instructions. The courseware should be designed to handle such cases smoothly. For example, if the instructions say, "Type a number from 1 to 4," and the student types 5, the computer should repeat the instructions and give another chance to respond.

If, given a choice, a student asks for 100,000 state capital questions, the computer should determine that this response is unreasonable and request a new choice. Student input considerations such as these should be incorporated into courseware design. In testing a courseware product, teachers should deliberately type in inappropriate responses to check this design aspect.

This set of computer factors, use of computer capabilities, user control options, and input handling, is not exhaustive but suggests some key considerations. In any case, technical factors related to courseware design should not overshadow the importance of instructional concerns.

The Evaluation Process in Perspective

Several authors have attempted to create universally complete lists of courseware evaluation criteria. This may be a useful intellectual exercise but at the same time it might blow the evaluation process out of proportion. The amount of effort put into evaluating a product should be related to the value of the result received.

For example, consider the amount of choice available. If a teacher seeks a courseware product that covers concepts related to the exploration of new geographic territory, and finds there is only one on the market at a reasonable price, the evaluation process will be quite brief. One either chooses that product or none at all. If the product is of reasonable quality, one might be inclined to buy it without extensive analysis so that students can obtain some computer experience. On the other hand, if five products are available, a more detailed evaluation would be needed to differentiate among them.

Consider how much evaluation data will actually be helpful in making a decision. Can a person really digest all of the information generated by a 50-question evaluation form? If not, the form is too lengthy to be

ERIC

useful. In some cases, one question might be enough to make a final decision on a product. Courseware that has excellent quality on all criteria except that it includes sexist stereotypes will be unacceptable to teachers for whom such stereotypes are offensive.

Consider the amount of money at stake. It makes more sense to spend more evaluation effort on a $500 courseware product than on one that costs $50.

Summary

The use of computers in the classroom is new to many educators. Thus, they conclude that the evaluation of computer courseware is also a new endeavor that requires special skills and training. This view is, for the most part, unfounded. It would be helpful to learn some new information about factors related to effective design of computer materials. However, many of the factors important to social studies teachers are those which they have been using for some time to evaluate other types of learning materials.

One could easily design a workable evaluation form based on this knowledge. A variety of published instruments also exists. No matter what method is used, the effort expended should be scaled to the extensiveness of product choice available or the importance of the decision to be made.

Courseware evaluation will become more important as the number of products grows. Having to put more effort into evaluation will be a reasonable price to pay in return for increased opportunities to use the computer's potential in social studies instruction.

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ANALYTICAL CRITERIA FOR MICROCOMPUTER-BASED SIMULATION/GAMES

By Roger Berg

Professionals in education can have more than one role. Their roles are characterized as practitioner, researcher, and developer. Practitioners are expected to operate in a variable and real world and try to control those events which would promote skills, knowledge, and attitudes. Researchers have uncertain theory to guide them as they try to advance understanding. Developers have tasks to perform which are not constrained by the real world of students and schools nor the necessity of adding to present understanding. Developers attempt to provide instructional materials and activities for use by practitioners and, it is hoped, reflecting the accomplishments of researchers (Schwen 1977). There is a knowledge-production-to-use continuum implied by these roles. These roles and the different products of educational inquiry that they imply have been suggested as appropriate ways to define the possible missions of teacher educators by the American Association of Colleges of Teacher Education (Howsam et al. 1976).

Having all three roles to satisfy leads to diverse perspectives. In the past few years, I began to use microcomputers and was struck by the different experience they provided from the simulation/games I had used with students. As I read available reviews, I was often disappointed because I found them not very helpful to my understanding of the programs they reviewed. Their checklist approaches were usually not appropriate. I found the reviews neglected either social studies/social science or simulation/gaming or, in some cases, computer-based education criteria. Furthermore, the audiences for whom these reviews were written seemed to be relatively unsophisticated practitioners who were looking for materials beyond drill and practice in an area, social studies, which had little of even that mode. As someone who sees himself as a sophisticated practitioner of simulation/gaming, a developer of some simulation/

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games, and a sometime consumer and retailer of research about simulation/games in my classes, I decided to find some ways to improve the analysis of microcomputer-based social studies simulation/games.

In this paper I try to identify analytical criteria gleaned from reading, practice, and reflection.. These criteria may help practitioners make better decisions. They may help developers clarify their tasks in the development of microcomputer-based social studies simulation/games. And finally, since one discipline's assumptions are another discipline's objects of inquiry, the suggested criteria may lead to some research questions.

There are several sources from which criteria might be derived. This paper focuses upon those aspects of simulation/games which might best illuminate ways to make decisions about microcomputer-based social studies simulation/games. Nevo (1983) notes that "known standards set by experts or other relevant groups or the quality of alternative objects" can be bases for evaluative criteria. Thus, only areas which might supply criteria for analysis of microcomputer-based social studies simulation/games will be explored. These areas include research and evaluative literature about simulation/games, instructional design, and instructional psychology, as well as the literature of the social studies.

The following questions will serve to focus this inquiry into microcomputer-based social studies simulation/games:

1. What are microcomputer-based social studies simulation/games?
2. How effective are simulation/games?
3. How effective is computer-based education?
4. How are simulation/games reviewed?
5. How is microcomputer courseware reviewed?
6. What can be learned from instructional theory about microcomputer-based education and simulation/games?
7. How might microcomputer-based social studies simulation/games be reviewed?

The answers to these questions may help practitioners, developers, and researchers in their uses of microcomputer-based social studies simulation/games.

[Ed. note: We have omitted several of the above sections due to space limitations; we have included only those that are most directly related to evaluation.]

How Are Simulation/Games Reviewed?

There are few large sets of criteria for the analysis of simulation/games. Horn and Cleaves (1980), the most complete single source of analytic criteria, contains formats suggested by the editors and other formats proposed by the individual essayists and reviewers. The criteria, although common to all simulations reviewed in evaluative essays, are applied differently and selectively by each of the authors.

However, it can be concluded that the following skills and activities are appropriate categories from which criteria for most simulation/games might be formed:

Information Processing--analysis, planning, gathering information

Proposals and Lawmaking--opposing proposals, voting on proposals, writing proposals

Group Activities--debate, discussion, problem-solving

Human Relations--competition, interviewing, forming coalitions, persuading

Role Playing--as an individual, a group role, a work function, switching roles

Resource Management--survival, maximizing resources, managing resources, trading resources

Evaluation (exclusive of debriefing)--self, by peers

Other criteria include simple continua dealing with model validity, flexibility, clarity of rules, depth of content, and quality of accompanying materials.

Individual evaluative essays also suggest some particular criteria for analysis. A review of ecology simulation/games rates these simulation/games on the extent to which content awareness and social skills might be learned (Schaefer et al. 1980). An economics evaluation essay classifies simulation/games by how much they promote competition, compromise, and cooperation (Pascale and Ehrman 1980). The "percentage of time allocated to affective considerations" was used to classify simulation/games about energy and environmental quality (Bottinelli 1980).

Futures simulation/games were rated by which values were promoted (Plummer 1980). A review of simulation/games on the topic of international relations suggests that there is an inverse relationship between flexibility and abstraction (Suransky 1980). Finally, the theoretical schools represented (values clarification, reality therapy) became the basis for classifying self-development simulation/games (Farra 1980).

How Is Microcomputer Courseware Reviewed?

There are as many systems for reviewing software as there are for reviewing simulation/games. Most of these software review systems can be categorized as consumer information systems and/or general review systems to be applied by the consumer. A second level of review systems are those designed to be applied by review teams but which use a common format for all courseware. A third level would use specialized formats for different instructional models applied by review teams.

There appears to be an anomaly in the conventional wisdom about currently available courseware. On the one hand, many would agree with the assertion that "95 percent of all the programs carried should never have been offered for sale" (Grayson 1982). On the other hand, "children in the Computer-Assisted Tutoring System at Teachers College have worked eagerly on a software program that adult educators said was quite awful" (White 1983). Similar successes were reported by early users of person/ascendant and machine/ascendant simulation/games.

Consumer information and general review systems can be found everywhere. The consumer information systems are filled with shibboleths about not purchasing any hardware until one has decided which software meets one's needs and the importance of purchasing enough memory. Educational consumer information review systems are a little more helpful. These include information about the availability of previews, money-back guarantees, easy backup of diskettes, and field-test data ("How to Find Good Software" 1982). General review systems are also widely found. They seem to be based upon rather simple, descriptive, and general models of instruction. Some general review systems criteria are those which might be used to select any curricular materials. Other criteria which are based upon the particular capabilities of the microcomputer can be helpful but are likely to be applied rather haphazardly ("The Software

Line-up" 1982). Review systems, both consumer and general curricular or simple instructional design, are necessary and helpful but probably should not be the only guides to a decision.

The second type of review system is more useful, since teams of experienced professionals can apply more sophisticated criteria to courseware. These systems may report their findings on one or more pages, but these reports are usually based upon the application of an evaluator's guide by a team of professionals. The Northwest Regional Education Laboratory system attends to the potential of the microcomputer more than other review systems. This review system is based upon a large and well-documented guide (MicroSIFT) which was nationally field-tested (Marler 1981). Similarly, EPIE and the Microcomputer Resource Center at Columbia University sponsored a study to develop a similar instrument. This instrument seems to lean more heavily than others upon ideas from instructional design and instructional psychology. Some aspects of this study (Cohen 1982) can be seen in the EPIE and Consumers Union Micro-Courseware PRO/file and Evaluation review system. A third system, the CONDUIT review system, tends to be used to describe materials for the college level. The CONDUIT system attends to the concerns of the scholar, the author as communicator, the teacher, the student, and the computer specialist (Anderson 1980). Although these three systems are the most complete review systems, they provide few explicit criteria for analyzing microcomputer-based social studies simulation/games.

What Can Be Learned from Instructional Theory About Microcomputer-Based Education and Simulation/Games?

Instructional design and instructional psychology both can make contributions to understanding the microcomputer-based social studies simulation/game. Martorella (1982) delineated the contribution they can make to text design. As Bunderson and Faust (1976) have noted, "whenever emphasis is placed on hardware technology or its design and development, the artistic approach is easily adopted. This has been true of the field of CAI. Institutions or organizations that have focused on the develop-ment of interactive graphics, simulations, and gaming have tended to ignore principles of systematic instructional development and to focus

69

on the affective and aesthetic qualities of their product." The following discussion of possible contributions is meant to be indicative and cannot claim to be more than a sample of possible analtyical criteria.

Although it has roots in educational psychology, instructional psychology is a relatively new and changing field. Over the past 15 years it has moved from postulating hierarchical structures of learning to using artificial intelligence models to understand learning (Menges and Girard 1983). Instructional design has been on the scene for many years in various guises, but the Journal of Instructional Design was only begun in 1977. Together these disciplines can be characterized as the sources for instructional theory. In turn, instructional theory has been the single most important source for conceptual developments in courseware for microcomputers. From this literature, some further criteria for practitioners, developers, and researchers may be gained.

Roblyer (1981) has observed that although "selecting optimal sequences of learning events has by no means reached the state of scientific procedure, knowledge of learning theory does play an important part. This knowledge is lacking in most programmer-designers working in the field today, although the knowledge is readily available." When Roblyer is noting the lack of learning theory, he is particularly concerned with its application in instructional design. Although recent theories proposed by instructional psychologists have not yet had the effect of those instructional psychologists writing in that field for several years (Braden and Sachs 1983), instructional designers have sought to integrate instructional psychology into their decisions for the design of instructional systems, as demonstrated by Wildman and Burton (1981). Consequently, much of instructional design attends more rigorously to instructional psychology than social studies text materials, as noted by Martorella (1982).

Gagne is the most used instructional theorist within the field of instructional design (Braden and Sachs 1983). Wager (1982) uses Gagne's events of instruction to suggest an algorithm for simulations. He applies this and other algorithms to the design of computer software. As Gagne and Briggs (1979) and Wager (1978) note, not all nine events are necessary in any lesson; Wager therefore uses those he judges most relevant to simulations. Wager says that "this type of program is often used to teach the relationships between variables by the 'discovery' method" (Wager 1982). Typically, according to Wager, a stimulus is presented, a response is elicited, and feedback is presented to the learner according to an unknown algorithm. The algorithm modifies the stimulus as well as provides other feedback which the learner must ultimately use to solve the simulation.

Graphics are lauded as having great potential for computer-based instruction. Merrill and Bunderson (1981) apply Gagne's domains of learning as organizing theory to provide guidelines for the use of graphics in instruction. Dwyer (1978) treats the same topic in a textbook which cites over 650 studies from a variety of nearly as many researchers. These sources are representative of those applications of instructional theory available to enrich the ubiquitous software criterion which typically asks whether or not graphics are used well.

Learning theorists with various perspectives can illuminate issues in the design and use of microcomputer-based social studies simulation/games. Davis (1980) postulates frames (an idea similar to Piaget's schema), which are structures representing information. These structures can be built up and retrieved from memory as needed. He states that their existence can best be demonstrated in mathematics as students make mistakes and reveal idiosyncratic structures. Allen (1975) eclectically combines theories and aptitude-treatment interaction studies to develop prescriptions in instructional design for students with higher or lower mental abilities. Jay (1983) presents some specific and sensible prescriptions for courseware design and evaluation based upon human information processing abilities. Tennyson (1981), while noting that cognitive psychology has presented a minimum of information-processing theory for instructional designers, asserts that principles rather than intuition should guide the design of computer-assisted instruction programs. For example, several review systems ask whether learner control of a program is part of a software package. Tennyson points out that studies have demonstrated that learners frequently terminate the program before they have attained the program's stated objective. Tennyson shows how a learner self-assessment component can remedy this situation.

Gagne classifies simulations as intellectual skills since he sees them as the higher order rule-learning component of that domain. Critics of his theory (Strike and Posner 1977) have suggested that the learning hierarchy approach may not reflect the conceptual structure of content or individual objectives. It may be suggested that simulation/games, either person/ascendant or machine/ascendant, might be classified as part of Gagne's cognitive strategy domain of learning (Gagne 1972). Although he seems to reserve this domain for the production of novel solutions, the processes described seem to correspond to what might occur during the reflective debriefing of a simulation/game. Since Gagne's domains of learning and events of instruction remain important instructional design principles, this classification may be important for both developers and researchers.

Alternative theories about problem-solving behaviors have tended to use cybernetic or artifical intelligence theories to suggest models. Newell (1982) compares paleontology to computer science by noting that paleontology's "major conceptual advances occurred by stumbling across the bones of immense beasties" rather than through theoretical prediction. He believes that some advances in artifical intelligence may also result from practice rather than theory. The foregoing is not intended to suggest that artificial intelligence does not supply useful notions. A tutorial (Stefik et al. 1982) on techniques of expert problem-solving systems collates several notions useful for developers and researchers. Greeno (1978) applies concepts and methods of cognitive psychology and artifical intelligence to the analysis of problem solving. Thus, artificial intelligence finds many models for problem solving or inquiry. Traditionally, at least for pedagogical purposes, the social studies has posited a method of inquiry or problem solving. Strike and Posner (1977) discuss the epistemological position that the above approaches demonstrate and contrast it with the traditional position that the social studies has espoused.

How Might Microcomputer-Based Social Studies Simulation/Games Be Analyzed and Reviewed?

Coombs (1978) predicted that microcomputers would lead to greater use of simulation/games. A Delphi study of trends in the production of instructional materials confidently predicts that simulation/games will increase in popularity with the proliferation of microcomputers (Dayton

ERIC

1981). Both predictions imply that all three professional role groups will need better analytical criteria.

There are three issues yet to be discussed. First, the idea that special criteria can be used is explored. Second, the use of social science models is identified. Third, some examples that justify the use of microcomputer-based social studies simulation/games are discussed. In conclusion, some questions which might provide a framework for the development of criteria are offered.

Several writers have suggested ways to improve the review of courseware. Cohen (1983) has suggested that a distinction be made between general instructional attributes and those specific to the design of microcomputer courseware. She supplies some generalizations to be considered in the design of courseware. Roblyer (1981) compares the PLATO and Standford/CCC models for courseware design. Besides noting some essential criteria, he suggests that differential criteria are also useful. It is suggested that besides the local program criteria that practitioners often use, special criteria be developed to reflect the particular design requirements of simulation/games.

The literature of simulation/gaming demonstrates that social science models can be used for instruction (Greenblat and Uretsky 1977; Greenblat and Duke 1975; Inbar and Stoll 1972). Outside of social studies, social science, and simulation/gaming literature, there is little acknowledgement of these models. Lave and March (1975) provide four basic social science models: choice, exchange, adaptation, and diffusion. These might serve as bases for practitioner decisions and developer planning.

My experience has been that many in education consider simulation/games as games and therefore frivolous and unnecessary activities. However, there are several justifications that developers and practitioners might use for microcomputer-based social studies simulation/games. Simulation/games can be among the most easily managed forms of action learning (Mehaffy et al. 1981). Klassen and Rawitsch (1981) point out that microcomputer-based social studies simulation/games can provide the laboratory experiences that the social studies has usually lacked. Cohen and Bradley (1977) used a simulation/game as the third cognitive task, problem solving, in Taba's instructional strategy. The incorporation of such perspectives into software and the reviews analyzing software may help establish the educational relevance of the activities themselves rather than the content and concepts included.

The following lists of questions can be used to develop criteria for the analysis of a microcomputer-based social studies simulation/game. The practitioner would want to know:

1. Where does it fit in the curriculum?

2. Are there enough support materials so that other students are occupied profitably?

3. Can all students use this software with understanding?

4. How much content does it carry?

5. Which classroom organizational changes must be made in the use of this program?

6. How well do students learn when this software is used?

7. What extra work for the teacher is involved in the use of this software?

8. Besides information from student use, what information is available from teacher use of this software?

The above concerns are generic to new users of microcomputers in the classroom.

In addition to answering new user concerns, reviews should, on the descriptive level, inform consumer concerns about matters such as the availability of previews and copying policies. Beyond these two levels, there is the general level of instructional and courseware criteria. This level assumes sophistication on the part of practitioners. The questions that address instructional and courseware criteria might include:

9. How does this program compare in learning efficiency with instructional alternatives?

10. How does this package affect attitude toward a subject?

11. Can groups of students or a whole class efficiently use this software? With what results? Under what conditions?

12. With which instructional strategies might this software package be coordinated?

13. What record keeping is supplied by the program?

14. Is there an instructional design theory for this package? If so, what are its assumptions and what does it predict as a result of using these materials?

15. What use is made of the graphic capabilities?

16. What use is made of interactive capabilities?

17. Are other instructional materials available for teacher as well as student use?

The above list suggests questions to be asked of all microware. Sources cited would indicate specifics.

A third list focuses upon criteria more appropriately applied to microcomputer-based social studies simulation/games:

18. What is the model this simulation/game teaches?

19. Which social science concepts and generalizations might be taught by using this program?

20. How many and which variables are managed in this simulation/game?

21. How is the algorithm flowcharted?

22. How much role flexibility or adaptation is possible?

23. What kind of information processing or thinking skills are used by learners?

24. What provision is made for evaluation of the learner by the program, the learner by peers, or the learner by him- or herself?

25. What kinds of group skills might be promoted by the use of this package?

26. Which special criteria might be applied to a class or category of simulation/games?

This third level should supply enough analysis to satisfy most practitioners.

Developers and researchers need information from a different perspective. Researchers and developers need to find ways to answer these questions about microcomputer-based social studies simulation/games as an instructional strategy:

1. Which are most effective to teach particular objectives?
2. How can graphics theory best be applied?
3. Which interactive techniques are most useful for this strategy?
4. How many and which variables can be managed by which learners?

5. Is there a model for adapting board games to this strategy?

6. Is there a model for adapting person/ascendant, whole class simulation/games?

7. How effective would a branched dialogue be for debriefing?

8. Given that diskettes can be used to store student responses in an uncoded (albeit limited) and coded form and these responses could be transmitted, what might be learned from these data?

9. Since this strategy, at present, seems to lack the affective risks of people/ascendant simulation/games, what effect is there upon cognitive and affective outcomes?

10. Do current prescriptions from research about graphics need to be revised in this medium and/or strategy?

11. Current social studies texts use more than 50 percent graphics up to age nine. What mix of graphics to text is most appropriate for different ages using this strategy?

12. Can artificial intelligence expert problem-solving systems serve as models for this strategy?

13. How might videodiscs be integrated with this strategy?

14. What effects might students using personal or school micro hardware and software at home have?

15. There are several frame games now in the person/ascendant mode. These are simulation/games that can be used with a variety of concepts and topics. Can similar frame games be developed for this strategy?

16. Simulations have been played internationally but microcomputer technology now makes this option available to all. What effects might this development have?

17. What changes in school organization might this strategy and its accompanying technology cause?

As researchers, developers, and practitioners begin to address these questions, more analytical criteria will emerge.

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EVALUATOR'S GUIDE FOR MICROCOMPUTER-BASED INSTRUCTIONAL PACKAGES

The complete guide developed by MicroSIFT, a clearinghouse for microcomputer-based educational software and courseware, provides background information and forms to aid teachers and other educators in evaluating available microcomputer courseware. The evaluation process comprises four stages: (1) sifting, which screens out those programs that are not instructional in nature and determines a package's operational readiness and hardware compatibility; (2) package description, including program format, instructional purpose and technique, type of package, available documentation, and the hardware configuration necessary for operation; (3) assessment of the content, instructional quality, and technical quality of the package; and (4) in-depth evaluation, which is not described in the guide. This excerpt explains the kinds of information needed in the second and third phases and discusses some of the factors to be considered in completing a courseware evaluation.

Introduction

Purpose

Except in instructional situations where student programming is the primary activity, microcomputers can be used to assist the instructional process effectively only to the extent that quality software is available.

This Evaluator's Guide has been developed to provide background information and forms to aid teachers and other educators in evaluating educational software and courseware. Two forms, "Courseware Description" and "Courseware Evaluation," are described.

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The forms were based on those developed and used by the CONDUIT Project for evaluating computer-based instructional packages for post-secondary institutions, with additional concepts adopted from forms developed by other organizations and individuals.

The Evaluator's Guide was originally designed to be used by school personnel participating in the courseware evaluation process of MicroSIFT. It has been found useful by individual teachers or others wishing to evaluate courseware before purchasing, and as a supplement to pre-service and inservice courses concerned with the development or use of computer-based applications.

Process

In December 1979, under a contract with the National Institute of Education, the Computer Technology Program of the Northwest Regional Educational Laboratory began designing a clearinghouse for microcomputer-based educational software and courseware. The clearinghouse, called MicroSIFT (Microcomputer Software and Information for Teachers), has as one of its goals the development and implementation of an evaluation process and related instruments for such courseware.

The design of MicroSIFT includes a selected network (SIFTnet) of significant centers of instructional computing activities at the K-12 level. The centers are large school districts or regional consortia or other education agencies where full-time instructional computing staff exist, and which have a history of development, evaluation, and implementation of instructional applications of computers. This network forms the basis for the evaluation process.

The four stages of the evaluation process include:

1. Phase 1--Sifting. Sifting is the first look at a package. At this time, those programs that are not instructional in nature are screened out. In addition to a program's instructional value, the sifting phase determines a package's "operational readiness" and its "hardware compatibility" status. The MicroSIFT staff completes this stage. If the software fails to meet the MicroSIFT standards for this phase, the evaluation terminates.

2. Phase II--Description. In Phase II, one briefly describes the package, specifying the program format, instructional purpose and tech-

nique(s), type of package, available documentation, and the hardware configuration necessary for operation. The MicroSIFT staff completes most of this stage, using the "Courseware Description" form.

3. Phase III--Peer Review. At least two teachers with experience in the subject and grade/ability level of the material are selected from schools served by the network site to evaluate courseware according to the content, instructional quality, and technical quality criteria identified in the "Courseware Evaluation" form. The courseware is also evaluated by a network site expert who then completes a summary review. The summary review becomes the MicroSIFT evaluation of the package.

Completion of Phases I through III takes approximately two months. The evaluations may or may not include observation of student use of the package.

4. Phase IV--In-Depth Evaluation. Some materials, because of complexity or amount of curriculum covered, warrant more extensive evaluation. Activities in this category would be pre- and post-testing or detailed observation of student use of the package. This phase is not being implemented by MicroSIFT at this time.

Courseware Description

Before a package can be evaluated, some factual information is needed. For example, does it have all the components necessary to make it an instructionally useful package? Indeed, determining the existence of needed components is itself an evaluation.

The "Courseware Description" form identifies the information necessary for evaluation and use of a package. In some cases, a list of components is included. In a complete package, all the information should be readily available in the program and support materials. If some information is not provided in the package, you may be able to infer some of it by a trial use of the package.

Some sections of the "Courseware Description" form are discussed below.

1. Version Evaluated. A version number, a date, or hardware identifier that distinguishes the specific package on which the evaluation is based.

2. Producer. The original source (developer, publisher, author, individual) who produced the package.

3. Subject Area. A general area such as mathematics, reading, or history.

4. Specific Topic. A subset of subject area such as multiplication, phonics, or World War I.

5. Grade/Ability Level. The grade level, grade range, or other ability-level indicator for which the package is intended.

6. Required Hardware. Identify the minimum hardware required for package use.

a. Computer (brand, version)

b. RAM amount

c. Mass Storage Devices (disk drive, cassette)

d. Output Devices (color or black-and-white monitor or TV, printer)

e. Other Peripherals (joystick, paddles, voice synthesizer)

f. Special Electronics (circuit cards, interfaces)

7. Available for Hard Disk. Indicate whether the software can be copied onto a central disk system for a cluster of computers, thus making it available for more than one computer at a time.

8. Required Software. Identify the language, operating system, and utility software required to install and use the application software in the package. Include any drivers, subroutines, or special software requirements not in the package or standard in the hardware specified.

9. Software Protected. Indicate whether the software is protected from casual copying through software or hardware means.

10. Medium of Transfer. Check the medium the software is stored on.

11. Back Up Policy. Note the policy of the producer in providing back-up copies of programs in a package, whether through providing it with the package, sending it free or at low cost by request of purchaser, no policy, or other appropriate note.

12. Field Test Data. Indicate whether or not the producer has conducted a field test and makes the data available.

13. Instructional Purposes and Techniques. Indicate the techniques employed in the package (e.g., remediation, standard instruction, enrichment, assessment, instructional management, authoring, drill and practice, tutorial, information retrieval, game, simulation, problem solving).

14. Documentation Available. For the items in the package, indicate whether the documentation is in printed supplementary materials or is contained in the program.

15. Objectives. List the purposes, goals, or objectives that the package is intended to achieve.

16. Prerequisites. Describe the experiences, skills, concepts, understandings, maturity, and ability levels which the intended user should possess for successful use of the package.

17. Package Content and Structure.

a. Abstract of Content. This information should be available in the material provided by the producer of the package. However, you may wish to add comments if the description is incomplete or inaccurate.

b. General Content. Describe the general content domain of the package.

c. User's Role. Describe the dimension of user control over rate, sequence, amount, type, and content of problem examples, if applicable. For example, "The user determines how much time will be allowed for solving each problem." "The user defines the number of hospitals, the amount of medicine available, and the quantity of pesticides used for mosquito control."

d. Instructional Strategy. Describe the instructional strategy used in the courseware. For example, "This is a drill and practice program designed to increase student proficiency and speed in solving quadradic equations." "This courseware simulates a malaria control situation by determining cost-effectiveness and impact of the variables selected by the user."

e. Instructional Integration. Describe the degree to which the package is or can be an integral part of instruction. For example, it may be intended as a random or casual supplement, chosen by teacher or student, one of several options. On the other hand, it may be the only way an important topic can be addressed with a student activity.

f. Program Structure. Describe the flow or sequence of activity in the program. For example, "The program contains three major sections: a presentation of an example, a section of controlled user activity, and a section of uncontrolled user exploration."

Courseware Evaluation

The "Courseware Evaluation" form is designed to be used after the information in the "Courseware Description" form is available. The rating of the 21 items on the form is to be the starting point of the evaluation. The sections of the form are described in the sequence they are to be completed.

Judgments should be based on thorough investigation of the program and support materials in the package. It is intended that where the term "package" is used, all components are to be taken into account in making the evaluation.

NOTE: The descriptions of each of the items on the following pages are intended to be suggestions for consideration in arriving at a judgment on the item. They are not necessarily checklists, are not in order of importance, and are not exhaustive of possible considerations. The alphabetic identifiers are merely for reference purposes.

Student Use

It is not expected that student use of a package will be observed in this evaluation process. You, as a professional, are making a judgment based on your teaching experience in the grade level and subjects intended for the package. However, if it is convenient to observe student use of the package, the evaluation may be even more valuable. If students take part, indicate this on your evaluation form.

Content Characteristics

1. The content is accurate. Possible problems in content accuracy include:

   a. Outdated information or instructional approach.

   b. Factual errors.

   c. Invalid model used in a simulation.

d. Oversimplified model or example.

e. Improper use of statistics.

f. Inaccurate graphs or displays.

2. The content has educational value. Any decision on this item will be highly subjective. Some considerations leading to a positive judgment might include:

a. The content and objectives are addressed in common school curricula.

b. The knowledge and skills involved have utility in some aspect of life.

c. An instructional situation can be envisioned in which the package would be useful.

d. Use of the package enables you to learn something about the nature or needs of the student using it.

e. The content of the package is central to the subject field.

3. The content is free of race, ethnic, sex, and other stereotypes.

a. Certain racial, ethnic, or sex groups may be overrepresented at the expense of limiting others.

b. Some racial, ethnic, or sex groups may be portrayed in terms that are indicative of false generalizations about the characteristics of that group.

Instructional Characteristics

4. The purpose of the package is well defined. Purposes, goals, and objectives may be in the program or in user support materials. The identification of instructional objectives is important to the transferability and use of an instructional package.

a. Objectives should be explicit, rather than implied.

b. Objective statements should be clear, i.e., unambiguous and without multiple meanings, succinct, free of jargon.

c. Objectives should be stated in terms of expected student behaviors.

The package should include both general and specific statements of purpose. That is, the overall purpose of the package ought to be concisely stated, with specific objectives stated for specific components.

5. <u>The package achieves its defined purpose.</u> Courseware can be evaluated in much the same way that other instruction is evaluated, the starting place being the instructional objectives. Based on these objectives, the student using the instructional package should learn what the material sets out to teach, rather than merely being engaged in the process.

The most effective way to substantiate this aspect of instructional quality is through a sample run of the program, preferably with a learner from the target audience. However, if such a learner is not available, the evaluator should make a judgment as to how well the package would actually accomplish its objectives when used by a student of the appropriate maturity and ability, based on the evaluator's experience with students of that type.

6. <u>Presentation of content is clear and logical.</u> The focus of this item is on <u>how</u> the terms, facts, concepts, and principles of the subject matter are presented, rather than on the content itself.

a. The information is well organized.

b. The structure of the presentation is evident to a user.

c. Definitions and explanations are available when necessary.

d. There is a smooth transition between concepts and cognitive clusters.

e. The progression of presentation is logical and well identified.

f. Examples, counter-examples, and illustrations are used when possible and appropriate.

g. The examples are relevant to the point of instruction.

7. <u>The level of difficulty is appropriate for the target audience.</u>

a. The means of response (i.e., multiple choice, manipulating graphics, single keystroke, etc.) is appropriate to the target audience.

b. The readability of support materials and program text is consistent with the expected ability level of the audience. Vocabulary, phrasing, and sentence length are specific considerations here.

c. Examples and graphic illustrations are suitable for the maturity of the student.

d. The time required for typical student use does not exceed the attention span of the target audience.

e. Size of steps in logical processes are suited to the ability level of the student.

f. There are multiple levels of instruction, with diagnostic and reinforcement routines, for individual differences in the target audience. For example, the program automatically branches to remediation subroutines if user responses require, the program automatically progresses to more difficult problems to continually provide a challenge to the user who has mastered the easier problems, or the program automatically provides easier problems to the user who is having trouble.

8. <u>Graphics/sound/color are used for appropriate instructional reasons</u>.

a. Graphics, sound, and color enhance rather than detract from the instructional process.

b. Use of sound does not disturb others in a classroom environment.

c. Graphics, sound, and color focus attention on important content areas.

d. Good message design principles are used in order to place emphasis on important concepts.

e. Visual and auditory effects stimulate student interest.

9. <u>Use of the package is motivational</u>.

a. Students are effectively addressed in a personal style.

b. Narratives in the program use humor and a conversational manner.

c. The overall tenor of interaction is warm, friendly, helpful.

d. The package provides for a variety of student responses and response modes.

e. A variety of responses to student inputs are used.

f. Reinforcement is positive and dignified.

g. A student is left with a desire to use the package again, or to pursue the topic in other ways.

h. A student is left with a positive attitude about the experience.

i. Using the package is a pleasant experience.

10. <u>The package effectively challenges student creativity</u>.

a. The learner is involved in an active, rather than passive, manner in the instruction. For example, the student has control over as many input variables as the program permits, the computer is used in a "hands-on" way rather than merely in a presentation mode, or the program design allows the student as many decisions as possible.

b. The package provides opportunities to answer open-ended questions that have no "right" or "wrong" answers, and gives the student evaluative criteria to judge his/her own responses.

c. The program is designed to anticipate a wide range of possible responses.

d. The student is provided with new ways of looking at the world.

e. The package demonstrates a creative means of using the knowledge being acquired by the user.

f. The package suggests areas of further exploration or other activity.

g. The student is challenged to change an underlying model or design an alternative model.

11. Feedback on student responses is effectively employed.

a. The feedback is relevant to the students' responses and therefore "credible."

b. The feedback is non-threatening, yet corrective when necessary.

c. The feedback is timely, i.e., given with appropriate frequency and given immediately after a response.

d. The feedback remediates (gives cues, hints, and explanations).

e. There is quantitative feedback when valuable. For example, the program indicates the number and percentage of problems correct out of the number of problems attempted.

f. The feedback tells "why" the response was incorrect. For example, "You should have spelled the names correctly" or "Use no punctuation."

g. The judgment of student responses properly assesses the concept being taught, not merely its form. For example, is word order more important than the content of the response?

h. The program adapts to the learner by adjusting the difficulty level of content.

12. <u>The learner controls the rate and sequence of presentation and review.</u>

a. Student has control over the time allowed for solving problems, allowing for quickening or slowing the pace as the user deems necessary.

b. Student has control over the rate of presentation of display material so that he/she can read and absorb the information at his/her own rate.

c. The program does not lock the student into a linear instructional sequence.

d. The program allows the student to begin at a point appropriate to his/her past achievements.

e. The program has a provision for review of instructions initiated by the user.

f. The program defines "functions" for learner options such as HELP, HINT, DICTIONARY.

13. <u>Instruction is integrated with previous student experiences.</u>

a. Instruction is designed to take into account the background experiences typical of the target audience.

b. Inductive reasoning is employed. Known situations are used to explain new situations.

c. Commonly experienced examples are used. For example, some students may better understand liquid metric measurements within the context of filling the car with gasoline rather than filling a graduated cylinder with water.

d. Instruction moves from the concrete to the abstract, simple to complex, familiar to unfamiliar.

14. <u>Learning can be generalized to an appropriate range of situations.</u>

a. The learning is applicable to a student's future experiences. For example, the instruction prepares the user for the next unit in the package.

b. The student is presented with opportunities that require generalization of the rules acquired at the computer and opportunities to apply those rules to "real life" situations away from the computer.

c. The processes and information learned are useful in domains and situations other than the subject area of the package.

d. The content is organized in such a way as to facilitate recall and application away from the computer and outside of the immediate content domain. For example, is the metric system taught within the context of the decimal system, or as isolated measurements (meter, gram, liter, etc.)?

Technical Characteristics

15. User support materials are comprehensive. In this item, you are assessing the completeness of the package in terms of its support for the teachers and students in the intended pattern of use, and reasonable optional uses. Many different types of information may be included in the printed material accompanying the program. The components of good user support materials identified here can be packaged in many ways. Separate identification does not imply a need for separate booklets, although that may be desirable. (See also item 16.)

a. Student Materials: Sufficient materials for a variety of student activities should be provided:

--Pre-instruction activities relating to the package

--A guide to use of the package

--Follow-up activities to reinforce the instruction

--Worksheets

b. Teacher's Information

--A description of the instructional activities to take place

--Suggestions for classroom logistics in a variety of hardware situations (single or multiple machines, hardware not in classroom, etc.)

--A rationale for computer use

--Prerequisite skills necessary for best utilization

--Teacher-directed pre and post instructional activities

c. Resource Information

--Bibliography of resources and references related to the content domain

--Sample run of the program

--Possibilities for program modifications

--A description of the model used in simulations

d. Technical Documentation

--Detailed explanation of how the program and package operates

--Program code listings

--Explanation of user definable options to adapt the program for different applications

--Explanation of the software/hardware interface or any other extraordinary features of the program

--Flowchart or other diagrams of general logic of individual programs and package

--Interpretation of error messages

e. Containers

--Folders, binders, pockets for storing printed materials, disks, cassettes, or other components

--Boxes or other container(s) for organizing and storing the entire package

16. The user support materials are effective.

a. The appearance of the materials is attractive.

b. The quality of the paper or binding is appropriate to its intended use and expected life.

c. The printed text is clear, readable, an[illegible]ctive.

d. Pictures, diagrams, and graphs are appropriate and readable.

e. The text, captions, labels, etc. are thoroughly edited and free of errors in grammar, spelling, and punctuation.

f. The packaging of the materials is suitable for the intended use. For example, student worksheet masters intended for reproduction are "loose leaf" or easily reproduced and teacher support materials can be separated from student materials.

g. The program storage media are easily accessible, yet protected from random injury expected in mailing, dropping, etc.

h. The entire package is storable as a unit in standard storage facilities (office shelves, cabinets, etc.).

i. Materials are easily used in table space typically available near a microcomputer station.

17. <u>Information displays are effective</u>. Good message design principles are incorporated into the visual arrangement of display material.

a. Graphic displays are not too complex or full of too much information. There is adequate spacing on the screen or printed materials for clarity. Static and dynamic graphics are used when applicable. Screen and printed displays make effective use of open space.

b. Text narrative on the monitor or printer is clear and easy to read.

c. Narrative is not ambiguous.

d. Text information is not too lengthy or "wordy."

e. The user is given adequate time to read and absorb the information given in the displays.

f. Text is free from spelling and punctuation errors.

g. Character sets employed are appropriate for the intended audience.

h. Graphics are not too repetitive or too slow in presentation.

i. Input options are independent of color, or at least avoid common color blindness problems.

j. There is not too much text for the display. The text position is consistent and/or predictable (i.e., the student does not have to hunt for the information).

k. Graphics are appropriately mixed with text material to give variety to the presentation.

l. Transitions from display to display on a video screen are smooth and unobtrusive.

m. Scrolling is used appropriately. Only pertinent information is retained on the screen.

n. Adequate teacher/student options for use or nonuse of sound are provided.

o. Graphics are not distracting to the user.

18. <u>Intended users can easily and independently operate the program</u>.

a. The program has enough internal documentation to permit ease of use even without external paper documentation.

b. Formats and protocols for user-computer communication are consistently applied and logical.

c. Directions are accompanied by useful examples where appropriate.

d. Help pages and functions are provided and accessible at likely points of need.

e. The program does not allow the user to get lost in the program with no apparent way out. The student always has some options for getting the program running again, or returning to a beginning point.

f. The program doesn't stop or appear to be doing nothing without clues.

g. Traps are used copiously to catch potential errors of any kind, and to avoid moving control from the application to the operating system software.

h. Instructions and error messages are clear and unambiguous. They give the user clear directions as to what he/she must do to effectively use the program.

i. The program responds to inputs as the directions indicate.

j. The user can easily exit the program, return to menus, or move to another section with program-described conventions.

k. The program accurately evaluates student input, i.e., it does not misinterpret student responses and thereby identify a response as incorrect when it is in fact correct.

l. Computer operation does not interfere with concentration on the activity.

m. The program can be used with a minimum of computer competencies.

n. The user isn't uneasy using the software due to its complexity of operation.

o. The user is informed of which function keys he/she will use in the course of the program and their purpose.

p. There is the necessary cueing for function key usage.

q. Those function keys referred to in the program are available on the hardware.

r. The use of function keys does not necessitate re-input of user responses previously input into the computer.

19. <u>Teachers can easily employ the package</u>. Not only should the program be easily used by the students, but it should be equally employable by the teachers. Many of the same considerations as in item 18 can be applied here, but also:

a. The program can be used by a person having a minimum of computer competencies.

b. The program requires a minimal amount of equipment manipulation by the teacher.

c. Software modifications or unusual manipulations of disks are not required to use the program effectively.

d. The package is easily adaptable to a variety of classroom learning environments, including placement of hardware inside or outside the classroom.

e. Error handling and identification are sufficiently detailed so the teacher can easily help a student.

f. Students require a minimum amount of teacher supervision while using the program.

20. <u>The program appropriately uses relevant computer capabilities</u>. The success of the computer as a means for instruction is due to those capabilities inherent in the technology. Computer software should take full advantage of the unique aspects of the computer rather than merely doing the same activities in a new way.

a. The application is well suited to computer use and not one that can be handled more appropriately by other means.

b. Course management or computer collection and organization of data on instruction is available. For example, the information about the student's performance is stored for retrieval at a later time.

c. The computer is used in a dynamic, interactive way. For example, the computer makes decisions based on student performance according to the teaching strategies inherent to the program.

d. The computer makes effective use of other peripheral devices (e.g., printers, light pens, paddle controllers, joysticks, etc.) for alternate input modes.

e. The computer is used to simulate activities that are too difficult, dangerous, or expensive to demonstrate in reality.

f. The computer is used so that students are actively involved in a "hands-on" manner rather than only passively observing.

g. The computer responds to natural student input such as "YES" or "NO" or "Y" or "N" rather than "1 = YES, 2 = NO."

21. The program is reliable in normal use.

a. The program will consistently run under all normal conditions. No special precautions such as clearing memory are required for effective program execution.

b. The program will consistently load into the computer without undue complexity, such as re-loading.

c. The program is free of programming and operational errors.

ERIC

4. SOCIAL AND EDUCATIONAL ISSUES AND DIRECTIONS

To feel comfortable using computers to help you meet your educational objectives, you probably need some understanding of the social and educational issues surrounding the computer age and of the ways the new technology might affect both educational practice and the society at large.

Although it is not our intention to provide a thorough discussion of this complex, unknown, and perhaps controversial subject, this chapter introduces some of the dimensions of this intriguing area. We hope the readings will provide you with the beginning of a perspective about the broader issues and a context into which you can place your computer-assisted classroom activities.

In our first reading, "Less Thunder in the Mouth; More Lightning in the Hand," W. Robert Houston describes the pervasiveness of computers in our lives that is expected to occur within one generation and theorizes about the impact of this pervasiveness on our schools. Computers will be an integral part of the adult lives of the children who are now in school, a generation that accepts computers as natural. Houston feels "schools must base instruction programs on (these) pragmatic realities. Schools must learn to cope with this new reality, use it, build on it, not be cowered by it."

In "Microcomputers: Dreams and Realities," Henry Jay Becker discusses some of the practical problems and obstacles associated with attempts to use computers to attain educational goals, and some "dreams" regarding future possibilities. The author tries to provide a balanced perspective concerning both the long-range capabilities of the computer in education and the present classroom realities.

In an excerpt from their article, "Computer Technology and the Social Studies," Allen D. Glenn and Daniel L. Klassen provide a thought-provoking discussion of how social studies education should prepare our youth for the computer and information age. This article does not concentrate on the computer itself, but upon social and political issues and problems that the school children of today will be forced to face as adult citizens. Implications for social studies education are presented.

Finally, Mary Hepburn's article, "The New Information Technology: Critical Questions for Social Science Educators," further discusses the implications of the computer age for social studies educators. The focus is on the larger social and professional issues that are emerging; the critical questions the author suggests must be addressed.

Taken together, these four readings provide a broad and balanced overview of both the social and educational issues currently facing us. The teacher familiar with these issues will have a firmer foundation upon which to build, as he or she explores the computer as an educational tool.

LESS THUNDER IN THE MOUTH; MORE LIGHTNING IN THE HAND

by W. Robert Houston

This old Indian proverb summarizes the potentials and perhaps the problems of the microcomputer as an evolving technological educational system in schools. Unbelievable advances have occurred during the pas two years; the next two promise even more radical changes. In this la chapter, it is appropriate to examine some of these implications. Mor important, we must act, not just talk about the potential of this evol ing educational resource.

Change is so pervasive in our society today that it is accepted a inevitable, though with some reluctance. Many of us, like Custer the Dragon in Ogden Nash's delightful story, might long for a nice safe ca where everything remains stable. But such is not the fate for educato Particularly for those who are concerned with the development of micro computers as educational tools, obsolescence is the "name of the game. New and improved approaches to instruction, computer programs, expande computer capability, and new systems of technology are all dated even before they are adequately tested.

For four hundred years, the printed page has been accepted as the appropriate medium for transmitting knowledge; today this is being cha lenged by computers, television, microfiche and microdots, and other more transient and flexible media. Indeed, the authors and editors of this book were challenged to use another medium for conveying the stat of the microcomputer revolution as of January 1981. We are under no delusion that what you are reading is current. Like seeing the light from a distant star, you are interacting with the knowledge-base that months or years old.

As we look forward, several generalizations and caveats seem appro priate.

Reprinted from Barbara R. Sadwoski and Charles Lovett (eds.), Using Con puters to Enhance Teaching and Improve Teaching Centers (Houston: University of Houston, 1981). Used by permission.

1. Soon after the turn of the century, the microcomputer will be accepted by children and youth as a typical and usual part of life. Just as television and telephones are considered integral to homes today, so too will some form of microcomputer be accepted in less than one full generation. Experiments already are well-advanced in Japan and Ohio that demonstrate the power of cable TV/telephone/microcomputer systems. Children growing up in those homes are less likely to experience the trauma of many adults when faced with the computer age.

Computers are reshaping our lives at a rapid pace: plastic credit cards and their telephone/computer checking system are an accepted part of life today; airline reservations are computerized; billions of dollars are transferred monthly between banks--not by armored car but by computer transfer; letters are drafted on word processors where corrections can be made readily before final typing; automobile ignition systems depend on small computers to monitor and control the flow of fuel. These are but harbingers of future changes. Toffler, in his recent book The Third Wave (1980), projects the electronic cottage as a future common place. Goods can be ordered and paid for; news items selected from a potpourri of possibilities on the evening broadcast (rather than the preprogrammed, singular, sequenced, and condensed evening TV news of today); letters typed and proofed on a word processor, then transmitted via phone lines to their destination; elections held and results announced almost immediately; and children studying at home.

The school as we know it may not exist. There may be testing centers and socializing centers. There may be curriculum production centers and tutorial centers. There may be, as Boulding (1980) proposes, inventories of the knowledge and skills of everyone in the community, with students studying with appropriate persons through interactive computers. Through similar processes, scholars and learners could keep in touch with counterparts throughout the world.

That world may seem strange to us now, but certainly no stranger than life and values of today would be to a Kansas farmer at the turn of the century. But society and individuals grow into a new culture, transform technology and that culture, and are transformed by them. Even in the dizzying blur of social change, the young will continue to accommodate to the new reality. There is nothing eternal about any particular culture--even the one in which we currently live.

2. Schools will change, or cease to exist. Because schools have been assigned by society the task of translating cultural values to the next generation, they tend to be conservative in approach, content, and values. Innovations and radically new practices seldom grow directly from such institutions. When advocates of rapid change make their mark on school policy or practice, pressure builds from groups with more fundamental beliefs that force their position back toward more conservative postures. The experimental science, mathematics, and social science programs of the sixties were followed by back-to-the-basics in the seventies. The rise of academicians as determiners of school curriculum content led to the rise of consortia. Teacher shortages led to increased preparation programs, to teacher oversupply, to massive publicity, and then to teacher shortages.

In the preceding section, several potential impacts on schools were suggested. These will be resisted. But schools will change; they must. The microcomputer will be integral to that shift--not alone, but in conjunction with the videodisc, TV, telephone, and other advanced technologies.

3. The impact of microcomputers is not limited to schools. Television provides a parallel to help understand this notion. Television in the home has impacted the values and perception of youth to a greater extent than television in schools. Educational television has suffered from inadequate budgets, weak visual and auditory messages (talking heads, lectures), and inappropriate ties to curriculum and child development. As a social intervention, it compares poorly with commercial TV's fast-paced drama, instant news, football with instant replay for clarification and analysis, and thirty-second commercials.

The parallel with microcomputers is obvious. Microcomputers will become integral to the lives of people, and schools must base instructional programs on pragmatic realities. Schools must learn to cope with this new reality, use it, build on it, not be cowered by it. Children will grow up with computers, considering them as natural parts of their lives. Teachers will learn to interact with home microcomputers in ways similar to those of teachers today who use Sesame Street and the National Geographic Specials on TV as bases for instruction. Individualized, linked with other technologies, and interactive, the microcomputer broadens the concept of learning so as to provide powerful alternatives to current school practice.

4. Schools have a dual responsibility: teach children and youth how to use the microcomputer and use the microcomputer to teach children and youth. In the coming years, both uses of microcomputers will become more sophisticated. Its use will be considered routine, casual, integral, necessary to life and to teaching.

5. Microcomputers as entertainment may enhance instruction. The parallel with television again is obvious. TV is viewed by most people as basically a means of entertainment, not education. Such was its first role, and its major one today. Microcomputers, too, are being used as much in electronic games of physical and intellectual skill as in purely educational contexts. The inherent interest and challenge in gaming poses a challenge for educators seeking more effective ways to engage students in higher-order cognitive processes.

6. Microcomputers are limited because they do not process feedback effectively. This is a basic flaw in most computer-assisted instructional systems to date. They are not able to process nonverbal, effective feedback from learners and use these data in modifying instruction. They cannot give emotional support despite the pseudowarmth often programmed into instruction ("good job," "Hello, Tom, are you ready to study arithmetic?").

Instructional materials developed for computer use must be much more precise and comprehensive than materials handled by teachers. Teachers use student verbal and nonverbal feedback to alter plans. Developing adequate computer-based instructional programs is far more complex because of this need for lack of ambiguity and the lack of noncognitive feedback. One of the problems facing the profession today is the dearth of even adequate, much less exquisite programs. Inadequately tested materials are flooding the market.

7. Students are not machines. Yet, many instructional processes appear to treat them as such. Some advocates, enthusiastic about the potential of the new tool, appear to consider the computer inherently as valuable rather than valuing what it can do for people. Dede (1979)

warns us of the dangers of the "computer chip" mentality where children are trained to be machines.

The danger for many persons who are deeply immersed in technology is translating problems into algorithms or problem statements that are solvable through computer programs. While such a process may provide a more powerful data-cruncher, it is no substitute for intelligence nor for conceptually-oriented problem solving.

Despite the caveats listed in the previous section, thoughtful and innovative educators are finding the challenge of the microcomputer revolution, its vibrancy, and its potential to be invigorating and promising. It has the potential for freeing education from mass schooling where everyone learns virtually the same things in the same sequence.

It has the potential, too, of linking schools and society, schools and home, schools and the work place as no other technological advance has. The "synergistic linkage of communication and computer capabilities makes possible bookless libraries, paperless news (teletext), teleconferencing, portable language translators, and campusless and professorless universities--among myriad other mind-bogglers (Shostak 1981, p. 357)."

Of such is the challenge and the promise of the 1980s. For educators, the watchword is drawn from a thousand-year-old Plains Indian culture: "Less thunder in the mouth; more lightning in the hand."

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MICROCOMPUTERS: DREAMS AND REALITIES

by Henry Jay Becker

> We should not predict or expect that the personal computer will foster a new revolution in education just because it could. Every new communication medium of this century--the telephone, the motion picture, radio and television, has elicited similar predictions that did not come to pass. Millions of uneducated people in the world have ready access to the accumulated culture of the centuries in public libraries, but they do not avail themselves of it. Once an individual or a society decides that education is essential, however, the book, and now the personal computer, can be among the society's main vehicles for the transmission of knowledge. (Alan Kay, Scientific American, September 1977)

In the last two years, many educators have become excited about using the new generation of relatively inexpensive desktop computers, or "microcomputers," to assist teachers in classroom instruction and to broaden students' intellectual experiences. This excitement has reached many teachers and administrators who have never touched a computer. But it has also been shared by curriculum developers, computer scientists, and others who have tried for many years to apply the capabilities of digital computers to educational purposes and settings. The new microcomputers, although no more computationally powerful than the first machines for computer-assisted instruction developed nearly two decades ago, are now simpler to use, allow more interactive student-computer dialogue, and, most significantly, are far lower in cost.

Despite this excitement about using the new microcomputers in schools--an excitement reinforced by commercial efforts to sell computers and software products to this potentially large and relatively centralized market--many people are reserving judgment. They doubt that most schools can justify single or multiple purchases of instructional equipment costing hundreds or thousands of dollars per item unless unprecedented academic accomplishments can be expected to follow.

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Grounds for Skepticism

There is good reason to be skeptical, for example, about whether the microcomputers that schools are now purchasing are cost-effective devices for providing the remedial drill and practice of basic skills touted in the commercial advertisements. Although computers do provide the opportunities for individualization, immediate feedback, and summarization of individual performance that other methods of practicing skills may lack, the performance gains may not be great enough to justify the financial investment on these grounds alone. The potential capacity of computers to diagnose student error patterns and provide corrective tutorial instruction--features which might more reasonably contribute to cost-effectiveness--has rarely been demonstrated in current classroom software materials.

However, it is not only the program content that raises questions in many minds. There are also important organizational and curricular problems to solve before the technology can reliably increase learning efficiency in math, spelling, or any other subject.

The most obvious organizational problem is that while most programs allow profitable use by only one child at a time, schools typically purchase microcomputers in very small quantities--most often a single computer in a single classroom, or even just three or four for the building. For teachers to make effective use of a device which is primarily geared to a single user when they have but one machine for 30 children demands a major planning effort.

Besides these practical reasons for skepticism about using computers in classrooms today, there are both empirical and ethical questions regarding the longer-term prospects for school computer use. If computer-assisted instruction is still to be the primary function of computers in the classroom, one must ask whether providing a new method for having students practice rote-learned rules of grammar and arithmetic is more important than using limited school resources to develop more high-level intellectual skills.

Yet it is understandable that so much effort is going into trying to make microcomputers work in the schools. This first generation of under-$3000 computers--delivering the same computing capabilities as

$30,000 machines did less than a decade ago--are surely the precursors of tools that may revolutionize teaching a decade from now.

Dreams for the Future

After evaluating the current uses of microcomputers, it is possible to come to the conclusion that the technology is just too mechanized and inflexible to be much help in reaching instructional goals. On the other hand, focusing merely on immediate applications is unnecessarily limiting. Only by expanding one's attention to some of the more imaginative ideas of how computers might function in education can one attempt a long-range view. So let us consider some dreams--some of the ways that computers might serve children and adolescents in school settings perhaps 10 to 15 years from now.

Imagine, if you will, 30 second-graders seated in their classroom, each conversing with a personal "videopal." They speak to it in lowered voices, as they have been taught by their teacher, and their videopal, in turn, speaks back to them--instructing them, for example, to read aloud the next word or phrase displayed on the screen. The computer, personalized and responsive, meanwhile assesses the child's performance level, recalls from its memory bank information about the child's recent particular problems, and selects an appropriate stimulus for the next reading task. After the student responds, the machine checks for errors, announces gently how the words should have been pronounced, and provides additional opportunities or examples as follow-ups. Meanwhile, the classroom teacher is circulating through the room, assisting some students with problems that the computer lacks the flexibility to handle, and helping others to get the maximum use out of this electronic learning tool. Elsewhere in the school, fourth- and fifth-grade students are engaged in similar dialogues with intelligent "computer tutors," responding by using the keyboard that they learned during the previous year.

The computers in this scenario communicate by using a stored body of knowledge of both subject matter and teaching method, and by emulating the behavior of a master teacher--knowing what kind of stimulus to present, how to evaluate the response, and what kind of feedback (both substantive and affective) is necessary to assist the child's understanding and to maintain motivation for receiving future simuli.

Now imagine a child in the same second-grade classroom--one who has become interested in the musical patterns and colorful designs that have been programmed into a "videobrush" computer available in the classroom learning center. Through the child's intrinsic interest in musical sound and color, he has learned to manipulate this device (which was programmed, of course, to encourage this manipulation) to create a music-and-color design of his own construction.

At the same time that the computer allows this "play" (i.e., self-directed activity not designed to yield a particularly known and generalizably useful skill), it explains to its user certain properties of color and sound and the human physiological apparatus that senses them. It also provides modifications of the child's construction and queries him about how these modifications might affect the image. A brilliant intermixture of instruction and play maintains the user's interest, develops creative thinking, and assists in understanding a subject matter beyond the usual range of the second-grade curriculum and possibly beyond the capacity of the teacher to explain or even to understand.

There are many other such dreams. For example, we might also imagine a multifaceted computer display screen which another student (probably of high school age) has learned to manipulate as a writing pad, a calculator, a dictionary, a thesaurus, and a variety of news and information sources. This student develops expository skills and information retrieval strategies using the kind of "paper and pencil" which will be available to her in the real world after schooling. She manipulates the keyboard in front of her with an agility coming from several years of experience using such communications devices. She uses special keys to get the computer's help when she cannot remember or does not know how to use the computer facilities to accomplish a desired retrieval or information manipulation. The teacher, meanwhile, is freed to provide more scholarly assistance, helping various students improve their expository style and contributing editorial judgment, leaving the computer to assist with some of the more mechanical aspects of writing, such as syntax and spelling.

In another image, a high school physics teacher is trying to develop his students' understanding of the history of scientific knowledge of physical principles. Using a large-screen video display which the entire class can see, he demonstrates the behavior of objects sliding down an inclined plane, with the objects' behavior conforming to an assumed mathematical equation. The objects, of course, are not real, but dynamic visual computer images which look real to any but the most discriminating observer. After learning how a mathematical equation relates to the objects' behavior, the students are asked to suggest variations in the equation and then judge which equation best conforms to the behavior of objects in the real world. The teacher mentions in passing that without the computer's ability to create these simulated worlds where things behave differently than in the real world, the students could only accept the equations on faith, because proving them would require experiments much to complex and expensive to be done in the classroom.

In a final scene, we find an average high school student of the future who has become bored with using the computer in preprogrammed ways to practice reading and language skills, create musical patterns, write school reports, calculate solutions to math problems, and examine alternative simulation models. Instead, having learned the immense variety of information manipulation of which the computer is capable, the student is busily engaged in creating new functions for the computer for use in his own life or for someone else's.

This capacity to combine known computer capabilities into a new function or product is generally known as programming. Many people believe that such skills are beyond the capacity of the average adolescent, but those who have worked with students--some as young as age 5 or 6--have come to the opposite conclusion. Programming, although requiring logical thought and abstract reasoning, itself generates intellectual growth in these skills, and is simply not a foreign process to those who have used the computer in a variety of ways.

Programming both requires and generates the capacity to perform logical operations on pieces of information, to structure information in a systematic way, and to creatively combine different pieces of information in a new and functional way. Low cost computers, by being available and accessible, may foster these capacities in a much broader population of adolescents than we previously thought possible.

Long-Range Goals

Each of these dreams is impractical today. Each demands from available computer technology, from commercial or internally developed computer programs, or from teacher-possessed computer knowledge more than almost any school is able to obtain or provide. Nevertheless, these scenarios contain most of the goals that those who are excited about the possibilities of computers in the classroom have in mind:

1. The ability of intelligent and communicative machines to provide appropriate instructional stimuli on an individual basis, and to present diagnoses and feedback both to the student and to the teacher-manager monitoring the student's progress.

2. The creation of intellectually stimulating environments for teaching subject-matter generally foreign to the current curriculum, perhaps beyond the competence of the teacher, but important and useful preparation for the world of the future.

3. The resources of a highly complex but flexible information storage, retrieval, and processing machine--comparable to a library, a librarian, a typewriter, and a skilled editor--all accessible to the student and providing necessary skills for subsequent adult experiences.

4. The ability to provide experiences and opportunities through simulations which would be otherwise too costly, too risky, too time-consuming, or simply impossible. People often learn best by participating in a system rather than merely being a spectator; computers provide a way to get close to the real thing without costs or risks.

5. A generation of young adults using logical thought, processing information, and performing analytic tasks far better than previous ones--due to an early and continuous exposure to concepts and methods of computer programming.

Although these classroom goals are highly idealized, it is possible now for software producers to develop programs so that even currently marketed microcomputers could function in ways that would help achieve them. Programs can be written for children and adolescents to explore music and art theory, to receive tutoring in arithmetical operations, to practice retrieving information from a computer's data base, to simulate social environments and scientific principles, and to test students' models of these systems. And classes can be organized to teach students to program computers.

Some Classroom Realities

Yet, even if the producers of educational materials for computers go beyond "drill-and-grill" to produce programs that actually teach rather than merely test, this does not inevitably mean that teachers will be able to use them effectively.

Foremost among the problems to overcome is the contrast between the computer's capacity to interact best with a single student and the school's group-based instructional organization.

Computers, like typewriters and books, are essentially individualized intellectual environments. Classrooms, on the other hand, are primarily group interaction systems, often with a single focus of attention for all individuals. The management of individual activities is often most effective in a setting like a laboratory, designed on the premise that everyone is conducting independent study. In contrast, when a small number of computers are located in a classroom, individual study at the computer becomes difficult since it must compete or alternate with the teacher's presentations to larger groups.

Unfortunately, the designers of computer programs typically do not think in terms of classroom instruction. Even the technically superior computer programs for educational use generally lack a program of activities for a classroom of students. In other words, teachers need help in organizing the 80 to 90% of student time spent waiting for other students to finish their turn at the computer. A useful program of activities might include individual and team worksheets, library research, small group instruction, and reading material. With such flexibly grouped instructional materials, a handful of computer stations could indeed be profitably used in a classroom setting.

It would be helpful as well for developers of computer-based instructional materials to develop learning activities, including game-like drills and simulations, that involve pairs or several students simultaneously. In addition to providing an environment in which more children could be occupied in a computer-directed learning activity, such programs would also accommodate the preferences that most young people have for interpersonal rather than individualized learning situations.

Writing programs that are peer interactive as well as computer interactive certainly requires more creativity than writing drills. However, for now, such group-based programs may be more functional for typical classroom learning environments than the individual student drills. The programs could involve students challenging one another with problems for which the computer is official scorer or judge (regarding issues of "fairness" as well as "right" and "wrong"); interactive games in which the computer is the playing board; and simulations in which students take on different roles or work together to solve group problems.

Getting There From Here

Most educators today have contrasting feelings on these issues. On the one hand, there is excitement over the idea that the microcomputer may be a harbinger of monumental change in the capacity of information machines to affect students' education. On the other hand, there is a strong feeling that applying current microcomputer technology with limited equipment and without forethought about integration into traditional classroom instruction will produce disappointments, poorly utilized resources, and wasted expenditures.

However, although it may not be possible to implement computer-based instruction in every classroom today, many actions can still improve the way that computers affect tomorrow's educational process:

--Researchers should work closely with school systems attempting pilot implementations of computer-based instruction. In this way we can maximize what we learn about making instructional software programs effective.

--Developers should pay more attention to the social requirements of classroom teachers. They need to develop comprehensive learning programs--not just computer programs--that consider the classroom as the unit of instruction and that take into account the likelihood of only one or two computers being available.

--School systems should seek to develop computer literacy among as many staff members as possible, particularly staff librarians and secondary teachers in math, science, English, and business. Teachers with strong objections or with strong inclinations should be excluded or included as they choose. By computer literacy, we mean familiarity with the variety of instruction-related tasks that microcomputers have now or will have in the future, as well as experience in using microcomputers for text preparation and editing, test scoring, and preprogrammed instruction. For motivated teachers, computer literacy should also include acquiring the ability to write BASIC language programs on existing microcomputers and to teach programming to students.

--Teachers, finally, should remain resolutely critical, though unafraid to learn about how this new technology could--but may not--revolutionize the way we teach.

The advances being made during this decade in the capacity of electronic media to store, retrieve, and process increasing amounts of information at a steadily decreasing cost is one of the more exciting trends in an often discouraging world. Someday, schools may be able to use the fruits of this technological growth surge to help young people attain greater academic competencies than the generations before them.

However, it will not help for us to accept uncritically every "computer-based" gimmick that comes to market. We must think clearly about how we want our children's education to improve, what computers can do to help, how that assistance can in fact be accomplished, and whether or not any of this is reasonably affordable. Through appropriate research, well-organized strategies of instructional program development, and careful school policy-making and staff development, we may be able to make today's dreams about computers and kids into tomorrow's realities.

COMPUTER TECHNOLOGY AND THE SOCIAL STUDIES

by Allen D. Glenn and Daniel L. Klassen

Two Essentials: Computer Literacy and Informatics

Teaching students about politics has as its goal helping them to acquire needed knowledge, skills, and attitudes to enable them to participate effectively in the life of the political system. Political education and citizenship training in some form or another have long been a social studies tradition. The National Council for the Social Studies and the American Political Science Association Committee on Pre-Collegiate Education have developed specific guidelines about what should be included in the political education of youth. The ultimate goal is the preparation of young people for the intelligent participation in the political process. Given the tremendous growth of computer technology and related information systems and their use in the political decision making processes, this goal of intelligent participation cannot be achieved unless the young person has knowledge and awareness in two critical areas: computer literacy and informatics.

Computer Literacy. Computer literacy has as its own goal the development of an informed citizen capable of understanding the social and political impact of the computer on society as well as a general understanding of the technical and operational features of the computer (Johnson et al. 1980).

In most schools today, computers are studied in the mathematics area. Students learn how computers function, how to write programs, and how to use computers to run selected programs. Only 4 percent of the social studies classrooms sampled in a recent study indicated that the computer was used for instructional purposes (Weiss 1978). This finding indicates the existing gap between what is happening in the classroom and the events that are occurring outside the classroom. Students need to know more than computer "hardware"--how the machine works. They need

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to understand the social and political ramifications of computer technology on society. Such an exploration is at the heart of the social studies. Information gathered daily is used by the government. Computer crime is one of the fastest growing criminal activities in the nation (Lasden 1981). More and more information is being made available and can be stored on minute computer chips. The microcomputer is revolutionizing the computer industry. A computer-literate person needs to be aware of the knowledge and value questions related to computers and the use of information.

Informatics. Informatics is a way of looking at information as a physical entity and as a form of energy available to humankind. The French Academy offers the following definition:

> Informatics is the science of the systematic and effective treatment, especially by automatic machines, of information seen as a medium for human knowledge and for communications in technical, economic, political, and social contexts (Guidelines for a National Policy 1975).

Informatics studies the relationship between how information is gathered and processed and how that information is used in making decisions. It is significant because it is of primary importance in the political, social, and economic life of countries, and it influences the forms and habits of society more deeply than any other development since the industrial revolution. A report suggests:

> The attitude towards the informatics phenomenon is nearly the same as that vis-a-vis the industrial revolution at the beginning of the nineteenth century: The states, which understood the phenomenon of the industrial revolution and accepted it, caught up and overtook the others. Similarly, the countries which are becoming aware of the importance of Informatics, and are taking appropriate action thereto, are those which will be the most advanced at the end of the twentieth century, while those which are neglecting and overlooking this phenomenon will be less developed in the year 2000, whatever their present level of development may be (Informatics 1975).

Most interestingly, it is the developing countries which are most active in this area, primarily because of the importance these nations place on the development of information processing technology relative to economic, social, and political development (Lecarme and Lewis 1975).

Social studies students need to know how information is collected, stored, and used by political decision makers. Questions regarding public versus private information, databanks, surveillance, depersonalization, and the concentration of power must be studied. These questions strike at the very core of the political process, human rights, and social studies education.

Implications for Social Studies Education

If young people are to enter the political world with a knowledge and understanding of the growing use and potential misuse of computer technology and informatics in government decision making, social studies educators should carefully consider the following goals (Anderson and Klassen 1981). The citizen of tomorrow needs to:

1. Understand the role of information in highly diversified political systems and the issues related to the balance between the ideals of freedom and privacy and the need for information.
2. Understand an individual's rights concerning information collected by government agencies.
3. Understand how data are collected, stored, analyzed, and used in making policy decisions.
4. Know how computer technology is used within government agencies.
5. Have an awareness of and the ability to use research techniques in the collection and processing of information utilizing the capacities of the computer.
6. Explore socially relevant topics such as computer crime, databanks, and systems analysis to gain an understanding of the impact of these topics on the social, economic, and political lives of the individual.
7. Explore his or her own value positions in relationship to computer technology.

These are not necessarily all the goals that may be developed; however, such goals suggest insights into areas heretofore neglected in most social studies curricula. These are goals that can be included anywhere in the K-12 curriculum, but they are probably most appropriate for the middle and secondary school student. These goals do not require that another course be added to the curriculum, but they could easily be incorporated into civics, government, sociology, economics, anthropology, and social problems courses. What is needed is an attempt by social studies educators to include in the study of various topics those issues of the twenty-first century which are current in the 1980s. Computer technology and information processing are not fads that will pass with time. They will continue to play an important role in the life of each citizen.

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THE NEW INFORMATION TECHNOLOGY:

CRITICAL QUESTIONS FOR SOCIAL SCIENCE EDUCATORS

by Mary Hepburn

As social scientists and educators, we cannot help but marvel at the metamorphosis taking place in our work environment. We are in the midst of an information revolution. Microcomputers, which have become widely available in only the last five to six years, are now accessible as powerful and reliable tools for the computation and storage of vast amounts of data. Moreover, they are relatively portable and inexpensive. They make the huge mainframe computers of my graduate student research years look as outsized and cumbersome as the giant at the top of Jack's beanstalk.

Videodiscs, cable television, and satellite telecommunications are also contributing to the information revolution as it unfolds all around us. Videodiscs, for example, have nearly an unlimited capacity for information storage and reproduction. A single videodisc can contain over 100,000 frames of visuals, and that disc can be reproduced by stamping a copy disc in a fraction of a second. These remarkable advances are changing every facet of our lives including work, recreation, and education.

Change is taking place so rapidly in this electronic revolution, and educators have been inundated with so many questions concerning practical matters of adaptation, that it has been difficult to discern the larger issues of our profession. Much of the response among social studies professionals thus far has been addressed to "how to do it" (e.g., Diem 1981; Cohen 1983; Martorella 1983). Of course, we do need to learn about the techniques of new information technology. We must obtain basic descriptions and learn practical applications. However, it is more important to us as social science educators that we reflect on the <u>nature</u> of the changes taking place and attempt to grasp the implications for individual and collective perceptions of reality. Will the new technology change substantially the way people view the world and each other?

Excerpted from a paper presented at the annual meeting of the Social Science Education Consortium, Athens, Georgia, June 1983. Used by permission of the author.

The larger social and professional issues do not emerge readily from the general literature on the new technology. The articles, reports, viewpoints, and early research reviewed by this novice suggest that the lack of high resolution regarding the big issues may be attributable to the fact that there are three planes of interest which cross each other only now and then.

One is a utilitarian approach to the technology; i.e., what it is, how it works, how to use it. The second is what the Europeans refer to as "informatics," which is a more specific applied approach to the technology; i.e., examination of how the technology can be related to specific subject matter. The third, which thus far has very limited development in the social studies literature, is a kind of participant-observer examination and analysis of new tech lifestyles in schools and elsewhere in the society; i.e., assessments of what computers and telecommunications are doing for us and to us, and how individuals and groups are responding.

It seems to me that all three types of investigation have something to offer us as we set out to reassess purposes and means in the profession and chart directions. Therefore, I will attempt to draw upon these several levels of discussion in raising critical questions to be addressed by social science/social studies educators.

1. How Is the Revolution in Information Technology Changing the Schools and Education, Especially Social Studies Education?

Education generally deals in information and information skills. The school traditionally has been the center of a wealth of information sources which were unavailable in the home. Libraries, laboratories, displays, films, maps, and quantities of textbooks made the school a special place for information. But that is rapidly changing. The newer information sources have first become available outside of the schools. Television, utilized only minimally in schools, provides an information source in every home which has gradually shifted the balance. Microcomputers, in use in businesses and in home recreation years before extensive use in the schools, have tipped the balance. Schools are no longer the centers of information.

Perceptions of the schools and education are changing. Children have direct sources of information in television sets and microcomputers; they need not depend on the teacher. Parental and public confidence in schools is declining. The recent report of the National Commission on Excellence in Education (U.S. Department of Education 1983) registers a public outcry against declining achievement scores. The average school graduate of today is reportedly not as well-educated as the average graduate of 25 or even 35 years ago. It is interesting that the action called for is not to junk the schools as educational institutions but rather to raise "standards" and reform teaching approaches. Computer applications stand out among the recommended reforms.

In these technological reform efforts social studies educators can help to meet several student needs. One is in the area of "training"--training youngsters in the skills needed to organize, utilize, and evaluate the great wealth of information available to them. The technology, if used creatively, can provide an effective means to move away from narrow facts-memorization teaching. Others point to the need to avert personal isolation from electronic education by providing opportunities to practice group decisions and examine group values. Still another challenge for social studies educators is in the need for counterbalancing simplistic or stereotyped realities conveyed on television and in electronic games which tend to "homogenize" childhood (Johnson 1981).

So what is new in these challenges? Haven't these been among the objectives of social studies education for many years? We should not be misled by their familiar ring, because the situation in the schools and universities is changing. The communications style of education is being imposed from without, not from within. The technological advances now engulfing all levels of education are rapidly changing the ways in which we do research, the ways in which we design and teach our courses, and the ways in which we must serve social studies education in the schools. The electronic revolution is raising a whole raft of practical where-to-use-it and how-to-do-it questions for social studies educators. To enrich and update the curriculum and to invigorate and revise methods of instruction, we must work with programmers, business firms, politicians, and systems developers.

As we assess professional obligations, however, we must not overlook the larger significance of the electronic revolution to us as social studies educators. Technological change is creating social, economic, and political issues as it is making history. In short, the content of the social sciences and history, which is the subject matter of the social studies, is being amended and extended. Just a few examples: Employment patterns are changing with declines in heavy manufacturing and agriculture and increases in information occupations; institutional power hierarchies are shifting as exemplified by the rise of systems analysts in business and higher education; the huge world markets for electronic equipment have become highly competitive and fragmented, and related international hostilities have developed; serious needs are arising for governmental protection and regulation in regard to rights related to issues of information privacy and software ethics.

2. <u>How Great Are the Inequities Created by Initial Distribution Patterns and How Can Equal Access Be Promoted?</u>

In the U.S. the older information technology, namely radio and one-way television, obtained wide distribution across social and economic lines. What about the new technology? In the area of interactive satellite telecommunications, the question of costs still looms large. Naisbitt, in his book <u>Megatrends</u> (1981), for example, dismisses interactive satellite technology as too costly for mass application and mass availability in the near future. Computers, thus far, are providing an information resource mainly for upper and middle class homes and well-heeled school districts without budget problems. In fact, participants at a 1982 conference sponsored by the National Institute of Education identified "equal access regardless of economic status" as the single most important issue of information technology in schools (Deck 1982).

Declining costs in computer production and the rising priority given to computers in school budgets suggest that availability will increase rapidly in the near future. We should keep in mind, however, that the most effective use of the newer information sources requires an active rather than a passive user. Unlike television and radio as we now use them by pushing a button and sitting back to passively observe and listen, the more recent technology requires responses and some skills on the part of the user. Accessibility, therefore, is based not only on hardware but on knowledge and training.

Interlinking the use of computers to television and to satellites has brought about a communications revolution of international dimensions and raised issues of accessibility on an international scope. Equal access is emerging as one of the major political and social questions of international governance. Article 19 of the Declaration of Human Rights adopted by the United Nations states that everyone has the right to seek, receive, and send information and ideas through all types of media. In recent years in the U.N., developing countries have expressed resentment at the manner in which they have been flooded with news and advertising from the larger industrialized nations. They seek an equal capacity to disseminate information (Powers 1980).

Overall, given the interest in the accessibility of hardware and skills it seems likely that in the next few years the schools will be called upon to examine existing inequities and assist in reducing them by providing equal opportunities for learning the skills and uses of innovative technology. This is not a new obligation for schools and educators in democratic countries, but it is not an easy one to fulfill. As social educators in a democracy, we must be concerned about open access to knowledge resources. How we approach the question of equal access will require important decisions in national and local political arenas and in the profession very soon.

3. <u>As New Technology Becomes Integral to Instruction in the Classroom, How are Student Learning Processes Affected?</u>

School learning is shifting from an overwhelming dependence on learning from print resources to more and more use of electronic resources. Video screens have brought about some change in learning processes in the last few decades, but this was mostly outside of schools. Today microcomputers and videodiscs promise highly accelerated change in the ways in which students learn both in schools and out.

Educational psychologist Mary Alice White (1982) has done some pioneering work in the analysis of electronic learning which can be enlightening to us in social studies education. She has defined three stages of electronic learning: (1) the television stage, which began in the 1940s, (2) the computer stage, which we have recently entered, and (3) the stage of "the complete electronic learning center," which she predicts is "just around the corner."

White proposes that a theory of electronic learning is needed, and a whole new body of research conducted. Motivation, memory, attention, control, and interaction must be studied anew in the new electronic learning environment. As a beginning point she urges careful comparative studies of electronic and print learning. Then, as a first step she provides an interesting comparison of some characteristics of print learning with two types of electronic learning--receptive learning (television, cable) and interactive learning (computer, videodisc, interactive cable).

The differences between receptive and interactive electronic learning seem to me to be most significant for social studies education (see Hepburn 1978). The interactive modes offer high motivation and attention along with high user control, opportunities to ask questions and respond to questions in decision and gaming formats, and greater relative potential for high image communication. The content of social studies is people centered, and it is dynamic, continually expanding and changing. Clearly, content which involves people, issues, and decisions is best taught in an interactive mode. New information technology appears to have the potential to stimulate and increase social studies learning not only by providing freer access to information but also through learning activities which require frequent active utilization of content. The proposition begs for research.

4. In What Theoretical Context(s) Shall We Set Objectives for Redesigning Content, Materials, and Strategies of Social Studies Education as We Proceed into the Information Revolution?

Belief and actions regarding social studies depend not only on learning theory but on social and educational philosophies, and the two are not often easily reconciled (see Hunt and Metcalf 1968). Today we are subjected to a loud clamor from the public arena in which so many education decisions are made. It resounds with calls for action--from government, from business and industry, from academic, from local communities. All demand improved school education in the new technological era. But the voices are not united. The various formulas for improvement reveal differing philosophic viewpoints.

Before leaping into "high tech," social scientists and social studies educators should reflect on underlying purposes and implied outcomes. For example, high in the arena a group we might call the "modern-day essentialists" are demanding that we meet the needs of the new era by strengthening education in the basic traditional subjects. The call is for more rigor in school education to produce greater intellectual skills as evidenced in higher test scores. New information technology is to be used to produce a more efficient knowledge-of-the-basics education. Using the technology, teachers are to demonstrate the means to specific knowledge and thus enrich student retention and access to important <u>factual information</u>. In this view the significance of the technology is that we can use it to better learn and better communicate the observed and measured reality in which we live (e.g., Scandura 1981).

From another part of the arena come the cheers of another group, whom we might call "modern-day progressives." They welcome technological development with differing expectations. The call is for a reinvigoration of the problem-solving approach to education using electronic information tools (e.g., Ray 1982). The new technology is envisioned as a means for teachers to improve conditions for student learning of <u>processes</u>. They foresee that in the future classroom the teacher's role as guide or aide will be enhanced, and the temptation for the teacher to act as a conduit of knowledge will be minimized. In this view the significance of technology is that it provides a more efficient means to test hypotheses and to examine unchallenged truths.

Of course, there are other perspectives. Some view the information revolution as possible means to social reconstruction. Others foresee a fearful technocracy. A few are calling for new social theories to reconcile changing interests in both materialistic and humanistic advancement (see Hartoonian 1983).

The unprecedented rapid rate of technological change makes careful reflection difficult. Nevertheless, social studies educators must take time to examine the assumptions and implications of proposed development programs. We must attempt to define the theoretical contexts of the choices we are making as we decide individually and in large professional groups just how we shall respond.

5. <u>How Shall We Define Social Studies "Computer Literacy" and Thus the Extent to Which We Will Attempt to Educate Students and Teachers to Utilize Computers in the Social Studies?</u>

The term "computer literacy" applied to students or teachers is controversial. It is widely used by educators to refer to <u>some</u> minimum competency of learning about computer applications, but there is little agreement about what the minimum should be. One group of educators uses the term to refer to competency in recognizing and describing the capabilities of computers, their impact on society, and some practical information about their application in work areas. A group of Swedish educators, for example, has experimented with teaching "computer appreciation" in mathematics and civics courses in upper secondary school. Students develop an awareness of the use of computers in workplaces by reading, discussion, and field trips, and by using the computer to solve math problems (Kollerbauer 1982).

Other educators argue that "computer literacy" means the ability to actually <u>do</u> computing including programming skills (Kelman 1982; Calhoun 1981). Some have suggested that computer software be used to teach about the nature of computers and their role in economic and social change. For teachers, instructor-created software could be used to review the effects of computers on the curriculum (Hofmeister 1982).

Another view is that school computing experience should be provided only for those who are interested, rather than forcing it on every student (or every teacher). It is argued that the demand for universal computer literacy has been based on a false impression of computer education as a means to a good job and social mobility (Harvey 1983). Given the limited number of computers in each classroom, it is argued, those who are interested and who are progressing should have greater access.

The question of how much social studies teachers and social studies students must know about computers and how skilled they must be in the use of computers is a serious issue in our subject area, for social studies teachers are reported to be "at the bottom of every usage survey." Even those few who utilize computers in social studies instruction, use them mainly for drill and practice or canned simulations rather than teaching social science processes (Roberts 1982).

We can gain some insight into the usage problem from Western European educators who gathered at a conference in Italy last fall to report and discuss their experiences with computer applications in education (Council for Cultural Cooperation 1982). All the reports emphasized the initial need to alleviate teacher fears of the computer. Commentary in U.S. computer journals and in the European reports suggests that once teachers have enough training to feel familiar with the hardware and are given enough time to experiment, they, like their students, will be caught up on the activeness, challenge, and versatility of the medium (Ray 1982; Olds 1983).

We have learned from past innovations in social studies curriculum that the confidence and cooperation of teachers is required for successful application with students. "New social studies" materials and more recently citizenship education strategies presented teachers with curriculum materials which were mainly in the age-old nonthreatening print medium. The obvious question is: if success was limited then, how can we expect to successfully innovate using a completely new microelectronic medium?

One response is that we are just finding the appropriate medium for some of the older messages of the social studies curriculum. The more open, interactive, information-fed format of learning based on the new technology <u>can</u> help to promote inquiry and problem-solving learning. Debugging <u>can</u> provide some powerful lessons in both logical and critical thinking. Programming requires conceptualizing and a series of hypothesis-testing activities. Moreover, today there is a nonhostile environment for discovery learning, perhaps because it is in the technological mode. The social and economic climate tends to encourage all types of computer education.

6. <u>How Will the Revolution in Information Technology Affect Human Interaction in Schools and Classroom?</u>

Educators from 12 European nations at the computer technology workshop last fall discussed several concerns about the human effects of computerization in schools (Council for Cultural Cooperation 1982). One of these was teacher fear of replacement by technology. Another was the threat of replacing teachers with technically trained persons from the business world. Participants determined that teacher replacement was far-fetched. And, although the hiring of teachers with business world experience with computers was encouraged for some vocational programs, proposals and recommendations were built around the assumption that subject area teachers will learn enough about computing through inservice or basic teacher education courses to be able to use the technology as a teaching tool in their subject area. Two important changes in the teacher's role were predicted however: teachers will no longer be the prime source of information, and teachers will develop new skills and will become more professional.

Not too many years ago American teachers could be heard to express concerns about being replaced by computers. Some had conjured up images of a clanking metal robot with flashing lights teaching World History in a droning electronic voice. Now, computers are hardly threatening because they are everywhere visible outside the school--the grocery store checkout, the appliance section of department stores, post offices, travel agencies, brokerage firms, airline ticket counters, nursing stations in hospitals, and in the living rooms and offices of favorite soap opera characters. Increasingly, teachers can be heard expressing impatience at not having a microcomputer for their own classroom.

One of the human problems about which American sociologists and psychologists have expressed concern is the impersonality of computers. Computers will not adjust to us as people do. They adhere to a specific program. A typical example is the kind of irritation one feels after many years of paying the light bill on time when on return from vacation a short unpleasant letter is found threatening to turn off the power because the payment is three days late. The telltale dot-matrix print in the letter reveals that it was prepared by a computer. But how do you explain your situation to an impersonal, inflexible, and cold machine?

On the other hand, in some situations computers have been found to be more "humane" by reducing embarrassment and put people more at ease. Patients in hospitals preferred computer interviews, and alcoholics more honestly reported their alcohol consumption to computers than to sympathetic human interviewers (Calhoun 1981). Computers do not give us a glance of disapproval or a condescending response--unless programmed to do so. Certain school children may be better motivated to learn in computerized trial-and-error learning modes in which they feel free to make errors without receiving disapproving glances or remarks from teacher and classmates.

Will we lose the opportunities for cooperative learning and group discussion afforded by traditional print-oriented classrooms? White (1982) reported a study conducted at Teachers College in which pupils interacted with each other more in the computer room than in the regular classroom. Moreover, much of the interaction in the computer room was concerned with learning, while in the print-oriented classroom much less of the interaction was productive.

Telecommunications can add another dimension of human sharing to the microcomputer and video screens. Telecommunications make interaction possible between student groups across many miles, across continents. In addition to exchanging information, they may also exchange expressions of attitudes and feelings. The process could be beneficial for human understanding across regions and across nations.

Overall, there is every indication that electronic learning need not be dehumanizing and can, in fact, promote humanistic and democratic attitudes if programmed properly and used in an open and interactive manner.

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5. RELATED RESOURCES IN THE ERIC SYSTEM

The resources described in this chapter have been entered into the ERIC (Educational Resources Information Center) system. Each is identified by a six-digit number and two letters: "EJ" for journal articles, "ED" for other documents. Abstracts of and descriptive information about all ERIC documents are published in two cumulative indexes: Resources in Education (RIE) for ERIC documents and the Cumulative Index to Journals in Education (CIJE) for journal articles. This information is also accessible through three major on-line computer searching systems: DIALOG, ORBIT, and BRS.

Most, but not all, ERIC documents are available for viewing in microfiche (MF) at libraries that subscribe to the ERIC collection. Microfiche copies of these documents can also be purchased from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Paper copies (PC) of some ERIC documents may also be purchased from EDRS. Information about the availability of every ERIC document listed is included at the beginning of the abstract, along with prices for both microfiche and paper copies. When ordering from EDRS, be sure to list the ED number, specify either MF or PC, and enclose a check or money order. Add postage to the MF or PC price at the rate of $1.55 for up to 75 microfiche or paper copy pages. Add $0.39 for each additional 75 microfiche or pages. One microfiche contains up to 96 document pages.

Journal articles are not available in microfiche. If your local library does not have the relevant issue of a journal, you may be able to obtain a reprint from University Microfilms, 300 N. Zeeb Rd., Ann Arbor, MI 48106. The following information is needed: title of the periodical or journal, title of article, name(s) of author(s), date of issue, volume number, issue number, and page numbers. All orders must be accompanied by payment in full, plus postage. Contact University Microfilms for current price information.

Ahl, David H. "Computer Simulation Games." Teacher 97, no. 5 (February 1980), pp. 60-61. EJ 226 890.

The author suggests the computer simulation game as a powerful motivational and teaching tool in many grades and subject areas. He briefly describes a few social studies and science computer simulation games.

Bolton, Harold and Mosow, David K. "Microcomputers in the Classroom: A Foot in the Door." Educational Computer 1, no. 3 (September/Octobe 1981), pp. 34-36. EJ 268 688.

Studies teacher and student attitudes toward computer assisted instruction. High school and middle school teachers and students were given a knowledge/attitude survey before and after a simulation exercise on the microcomputer. Results show that attitudes toward computer-assisted instruction improved after the simulation.

Diem, Richard A. Computers in the Social Studies Classroom. How to Do It Series, Series 2, No. 14 (Washington, DC: National Council for the Social Studies, 1981). 8 pp. ED 209 165. EDRS price: MF-$0.97 plus postage. PC available only from National Council for the Social Studies, 3501 Newark St., N.W., Washington, DC 20016 ($1.50, quantity discounts available).

Introduces social studies teachers to computers and suggests ideas for potential applications in the social studies classroom. A good introduction to a variety of related topics.

Hantula, James. Using the Computer in the Social Studies Classroom. Paper presented at the Annual Meeting of the National Council for the Social Studies, Houston, 1978. 13 pp. ED 164 424. EDRS price MF-$0.97; PC-$2.15, plus postage.

Discusses classroom use of computers in social studies, and some problems and impediments. Provides examples of computer projects of special interest to social studies teachers. Suggests various uses of computers and describes their advantages.

Hodges, James O. A Bibliography of Microcomputer Software for Social Studies Education. (Richmond, Va.: Virginia Dept. of Education, 1982). 58 pp. ED 224 727. EDRS price: MF-$0.97; PC-$5.65, plus postage. Also available from Social Studies Service, Virginia Dept of Education, P.O. Box 6-Q, Richmond, VA 23216 (single copies free while supply lasts).

More than 160 elementary and secondary social studies programs are in this annotated bibliography. The annotations are derived from supplier catalogs rather than user experience and analysis.

Klassen, Daniel L. Computer Simulation in the Social Sciences/Social Studies. Paper presented at the Association for Educational Data Systems Annual Convention, New Orleans, 1973. 8 pp. ED 087 429. EDRS price: MF-$0.97; PC-$2.15, plus postage.

An older paper discussing the use of computers as instructional tools in secondary school social studies education, especially the "new social studies." Gives examples of simulations, including those useful in introducing the student to dynamic marketing, political and demographic analyses.

Lewis, Lawrence T. "All-Purpose Learning Games for Computer-Assisted Instruction." Journal of Geography 78, no. 6 (November 1979), pp. 237-244. EJ 216 783.

Describes a package of programs developed to blend entertainment with geography learning objectives. The games can be adapted to a wide range of subject matter and to various educational levels.

Martorella, Peter H. and Kohn, Dixie. "Computer-Related Materials in the Social Studies/Social Sciences." Social Education 34, no. 8 (December 1970), pp. 899-908, 916. EJ 030 672.

An older, pre-microcomputer article that provides a framework for the social studies educator to use in developing a basic understanding of the educational uses of the computer related to social studies/social science. Discusses use of the computer as a teaching device and as a tool for information storage and retrieval.

"My Favorite Software." Electronic Learning 2, no. 2 (October 1982), pp. 50-55. EJ 270 063.

A list of 93 programs favored by educators, compiled from a questionnaire sent to 2,000 teachers and administrators. Included are programs for use both in administration and in teaching; several content areas, including social studies, are covered. Ordering information and comments on program use are included.

Shaw, Keith. "Some Educational Uses of Computers in UK Schools." SASTA Journal, no 812 (August 1981), pp. 16-25. EJ 252 853.

Discusses current uses of computers in United Kingdom schools. Suggests reasons why teachers are using computers. Describes applications in simulation; model construction, evaluation, and modification; and academic games.

Stewart, L.R. "Here's What Classroom Computers Can Do." American School Board Journal 169, no. 3 (March 1982), pp. 32-45. EJ 259 510.

Briefly outlines how computers can be useful in teaching nine different subjects, including social studies, and in managing the central office.

Visich, Marian, Jr. The Use of Computer Simulations in High School Curricula (Stony Brook, NY: State University of New York, Huntington Computer Project, 1974). 36 pp. ED 089 740. EDRS price: MF-$0.97; PC-$3.90, plus postage.

Describes a number of pre-microcomputer simulations for high school, including some in social studies, and presents an evaluation of their use. Outlines some of the situations in which computer simulations can make a significant contribution to learning.

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