FOCUS ON EXCEPTIONAL CHILDREN

The Microcomputer —
Its Applicability to Special Education

Florence M. Taber

"Computers represent a technology we will be using in the future" was a prediction of the 1960s. The future is here! The most significant advance from the schools' viewpoint, the microcomputer, is with us today — and will be for some time to come. Because of the many possible applications of microcomputers, everyone involved with education should become computer literate. Computer literacy involves the "history, operation, and applications of computers, as well as the social, psychological, and vocational impact of computer-based technology" (Thomas, 1980).

Particularly because of the applications possible with the handicapped, to provide them avenues of communication through which to receive information and express thoughts, special educators should familiarize themselves with the microcomputer. This involves hardware, software, peripherals, and uses. The following discussion offers a "take-off" point — a brief history of the microcomputer, how it operates, how it is used in regular and special education, considerations in purchasing hardware and software, how to create elementary programs, and projections into the future.

HISTORY

To begin to understand the full impact of the microcomputer, one should realize the short time involved in computer development to its present level. This allows one to recognize how rapidly this technology is changing and to perceive the possibilities for the next few years.

It is hard to comprehend that in 1964 eduators were saying, "Perhaps we should begin to think about computers in education" and in 1972 they were already saying, "Now is the time." By 1977 the influx of computers in the schools had been enormous, although the uses were primarily confined to mathematics, science, and record keeping.

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Actually, the computer was first used in the classroom in the 1960s, but at this stage multiple-choice questions simply appeared on the screen and students were to respond to the questions. True interaction between the computer and the operator was lacking. Then, in the 1970s, the microcomputer was developed, which allowed for interaction between machine and operator.

Several sources are available to those who are interested in becoming acquainted with the history of the computer and the microcomputer. Among them are *The Mind Tool* (Graham, 1980), *On Computing* (Morgan, 1981) and *Teachers' Guide to Computers in the Elementary School* (Moursund, n.d.).

THE MICROCOMPUTER: DEFINITION AND DESCRIPTION

"A computer is a machine designed for the input, storage, manipulation, and output of symbols (digits, letters, punctuation). It can automatically and very rapidly follow a step-by-step set of directions (called a computer program) that has been stored in its memory" (Moursund, 1980). Simplifying the definition, Moursund stated, "By adding a keyboard to a calculator, giving it some directions, and increasing its speed, it would become a computer. A microcomputer is a very small version of a computer. It combines a microprocessor, or a small central processing unit, with a silicon chip having memory." Microcomputers are sometimes called personal computers, and can be used in classrooms, homes, or businesses that have need for this type of computer.

Putting the functions of the microcomputer simply, the brains are in the box marked "keyboard," which houses the computer's machine language and has internal or permanent memory. This part of the computer, called the Central Processing Unit (CPU), translates the program that is in external memory into machine code based on a binary system (0, 1s) that is used automatically to run a program.

The external memory system stores the information written by the programmer. Programs are typed on the keyboard and are usually kept on a disk or a cassette tape.

To view the program that has been entered into the computer, a video output is connected. A television or video screen is used for this purpose. Figure 1 illustrates these concepts in the simplest terms.

Figure 1
Simplified Computer Diagram
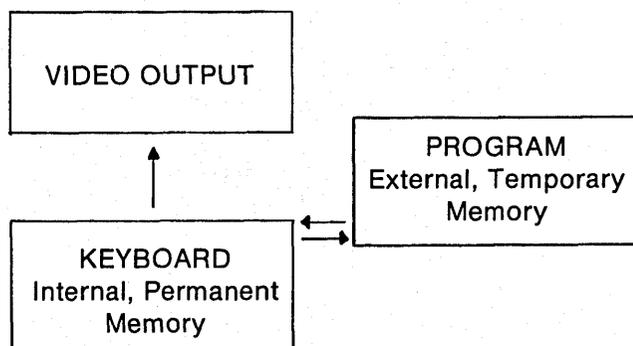
The term "memory" has been used a number of times. The CPU that controls the activities of the computer (microcomputer) involves that internal memory and determines how much information the computer can store and manipulate. This has nothing to do with the extent of memory on the disk or tape, which involves external or temporary memory.

The smallest fragment of memory is called a *bit,* and the smallest unit of memory (usually eight bits) is termed a *byte.* When referring to memory, the term K indicates the way memory is accessed. For example, 16K means one bit wide but including about 16,000 bytes. The higher the K, the more bytes can be stored in the computer at one time.

Memory can be increased by purchasing various additions. These additions must be compatible with the system's power supply, compatible with the memories presently in use in the computer, and so forth. Therefore, one should get expert advice before purchasing additions, along with advice as to whether the memory chips are ROM or RAM. ROM refers to Read Only Memory and can program up to 128,000 bits on a chip but is preprogrammed. RAM refers to Random Access Memory, which can program up to 64,000 bits of information but can be reprogrammed or edited (Schneider, 1981).

Two other distinctions should be made. When purchasing a computer, one is purchasing the *hardware.* When purchasing or creating a program to run on the computer or hardware, one is dealing with *software.* In creating or purchasing software, one must be aware of what language the computer understands. Computer languages are languages just as are French or English. Because each language is different, a programmer must be able to speak (write) the same language a particular computer understands. Table 1 lists the most common programming languages and the entities that commonly use them (Moursund, 1981):

TABLE 1
COMMON PROGRAMMING LANGUAGES
AND THEIR PRIMARY USERS

Language	Primary Users
FORTRAN	Scientists
BASIC	College Students; Educators
COBOL	College Students; Business
LOGO	Elementary Students
PILOT	Educators
PASCAL	College Students; Government

USES IN EDUCATION

Special educators should look at computer uses in both regular and special education because of the state of the art. The uses are already almost limitless, and new uses are being created all the time. Therefore, the more one learns about present uses, the more creative one can be in accommodating the microcomputer to the needs of special education.

How the Microcomputer Assists the Educator

In general, the microcomputer can assist the educator:

— in individualizing instruction;

— in providing a nonthreatening presentation to the learner;

— in teaching process and product through sequential steps;

— in extending the teacher's expertise;

— in simplifying record keeping and other administrative duties.

Individualizing Instruction

Through the computer, students can receive information at their own rates of speed. Through branching, the learner can receive information at his or her correct conceptual and reading levels. In other words, when learners interact with the computer, they branch to more complex material, to more simplified material, or remain at the same level. In this way, each can be constantly challenged and yet be successful at the same time.

With multiple terminals hooked to one external memory receptacle, many learners could receive the same program but be individualized through the program at different reading and/or conceptual levels. Little software is available at present that has been programmed to individualize to the needs of particular learners. Most programs that do claim to branch branch "the program to accommodate the individual learning requirements by providing additional drills" (Schneider, 1981). Obviously, if the learner did not comprehend the information the first time, drill is not the answer.
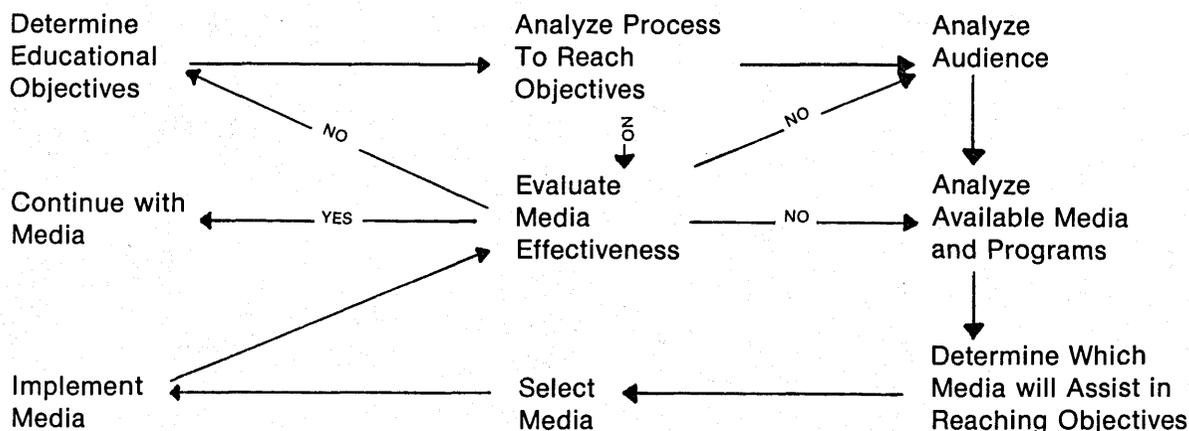
Nonthreatening Presentation

As one young teenager said, "It's okay to make a mistake. The computer doesn't yell at you." She did not mean that the teacher yells at her. She just meant that she did not feel threatened by a machine. Bill James, who designed the Alpha Menu program, based it on the philosophy that the computer should be fun, as it teaches how to use the computer "for communication and environmental control" (Luttner, 1981).

Teaching Process and Product
Extending the Teacher's Expertise

The third way the microcomputer can assist the educator is through software that is carefully task-analyzed to teach a process or a product. This leads to the fourth benefit — extending the teacher's expertise. Bagley (1981) supported this use of the microcomputer by stating, "Learners are asked to stretch their knowledge. Subjects who have learned through 'discovery' methods can solve problems that require relating what they knew previously to the principle learned. . . . Paper-and-pencil and linear A/V instructional materials will always have a disadvantage in creating discovery learning."

Not all learning is most effective through the use of a computer, however. The following diagram should be considered in determining the most effective method to reach specific objectives:

Administrative Applications

Following are just some of the many administrative applications made possible by computers:

athletic team statistics	library records and
auto parking permits	reports
basic competencies	rank in class
records	school calendar
business/personnel	student activity records
records	student deficiency reports
daily attendance	student permanent
equipment inventory	records
grade distributions	student progress reports
honor roll	textbook inventories

General Microcomputer Uses in the Classroom

Numerous uses for the microcomputer within the classroom and with the learner have been discovered. Each classification in Table 2 should be considered and used to its maximum potential.

Research Findings

A number of conclusions may be drawn from research as indicated by Gleason (1981):

1. The microcomputer assists learners in reaching instructional objectives.

Figure 2
Media Selection Diagram

TABLE 2

CLASSIFICATIONS OF MICROCOMPUTER-ASSISTED INSTRUCTION

Classification	Use
Drill and Practice	To reinforce information learned and for which practice is suggested.
Tutorial	To present information already taught in the classroom but which has to be broken into smaller sequential steps and/or into a lower conceptual level for individual learners.
Simulation	To place a learner in situations that replicate original situations.
Computer-managed Instruction	To instruct the learner in subjects through individualized sequencing.
Problem Solving	To place the learner in situations to solve problems and to receive appropriate consequences.
Assessment/ Evaluation	To determine where the learner is regarding a specific objective and for pre- and post-test purposes.
Data Retrieval	To provide feedback to the learner as to progress toward objectives, and to analyze data to create individual learning plans.

2. A 20% to 40% savings in time learning is realized through computer programs as compared to "conventional" instruction.

3. Retention after interacting with programs is as good as or superior to "conventional" instruction.
4. "Students react very positively to good CAI [Computer Assisted Instruction] programs; they reject poor programs."

This last point is supported by Bill James according to Luttner (1981) in her statement, "Functional as a given computer and apparatus may be, if it is not fun for the user, it will not be used." Additional research cited by Joiner, Sedlak, Silverstein, & Vensel (1980) concluded that CAI is more effective with low ability students than with middle or upper ability students.

A number of traditional uses for the microcomputer are well known. Although most are in mathematics and science, some are now appearing in other basic subject areas such as reading and spelling. Eventually, total curricula that could be placed on microcomputer programs would total some 6,000 programs, considering at least 10 curricular areas per each of the 12 grades. Then, if one considers that these programs would have to be developed for at least four major manufacturers of hardware, 24,000 programs would have to be created (Isaacson, 1981).

Novel programs have also been developed. For example, "Sesame Place" (in Ohio) has one of the most original collections of educational computers in the country (Cashman, 1981). Children do not just watch Big Bird and the other characters as they would when watching television, but they interact with them in order to be taught reading, music, logic, creative writing, social studies, and hand-eye coordination. At Sesame Place the keylids have been redesigned with one-inch-square letters lined up in order from A to Z, numbers, and special symbols using color identifiers. When children enter Sesame Place, they take their parents to the programs. Each of these programs is programmed for the Apple II microcomputer, which has 48K bytes of memory and is loaded through a network that enables up to 65 Apple II microcomputers to store and share a common disk. Incidently, this type of redesigning was originally accomplished for handicapped individuals.

MICROCOMPUTERS FOR THE HANDICAPPED

Using the microcomputer to benefit the handicapped is probably the most exciting development for this

medium. With various peripherals or additions that can be attached to various computers, especially the Apple, handicapped individuals can receive information that they could not have previously, and they can express themselves where it was impossible before. "People without voices are speaking and people without hands are typing" (Luttner, 1981). Basic living skills such as answering the phone, writing letters, using the radio, and operating other dials are all now possible. For non-verbal students, speech synthesizers take keyboard entries and turn them into speech through a ROM chip. Word boards can also be used by nonverbal students. The following list summarizes uses in special education. Obviously, this is only a beginning. With imagination, this list can become endless!

1. An autocom from Telesensory Systems, Inc. uses a RAM chip containing vocabulary on grid squares on a board that is mountable on wheelchairs or other surfaces. The optical configuration of the autocom allows for changing the size of the squares (Schneider, 1981).

2. The MECC Apple Library Collection has one volume on diskette for special needs students *(Special Needs Volume I)* on spelling. Since typing is often a problem, a box appears over responses, and the student uses the game paddles or any key on the keyboard to respond. The second volume for this population will be available this fall, covering speed drill, number words, and change. In field testing, one student who is nonverbal uses the "Number Word" program to write letters home to her parents (Loewen, 1981).

3. The Prentke Romich Company has a number of electronic aids that could and probably will be interfaced with the microcomputer (*Electronic Aids for the Severely Handicapped* catalog, 1981).

4. Borg-Warner has an EXPRESS series that includes appropriate controls such as the optical head pointer, manual pointer, or rocking lever to operate the computer keyboard. EXPRESS uses the PRC Apple Keyboard Interface with Borg Warner's Micro System 80 Critical Reading Series on an Apple II computer with 48K bytes RAM using disk input (Borg-Warner Educational Systems, advertisement, 1981).

5. The Alpha Menu by Bill James in San Antonio, Texas, has a program that displays letters, numbers, and punctuation marks in a matrix on a video screen (Luttner, 1981). Then messages can be built at the top of the screen. Quadriplegics have used this system successfully using a light pen, a skate controller, and other devices with a number of switches. Light pens can be attached to the mouth or head to touch letters, which are then added to the message at the top of the screen. The skate controller is a "free moving 'bug'" strapped to the arm or hand. The sticks, switches, and other devices adjust to the users' response time.

The Alpha Menu program is used on the Apple II plus the standard Disk II drive and monitor. The devices are placed into Apple's game paddle sockets. A hard copy or printout can also be produced if the printer peripheral is used (Luttner, 1981).

6. A system entitled C2E2 (Control, Communications, Education, Entertainment) from the University of Alabama is governed by voice commands and is used to operate various appliances. This system includes the Apple II computer, two Disk II drives, a CRT monitor, a Heuristics Inc. speech interface, a printer, and a "black box" that connects the computer to the appliances (Luttner, 1981).

7. One system was developed for a three-year-old boy who was injured and paralyzed from the neck down as the result of an accident. Later, he and his brother studied BASIC (computer language) and now do their own programming. The modifications necessary were drawn up in an article by Sand (1981).

8. Jay Hewitt at the University of Missouri has developed an Apple-based system that speaks actual words. The operator can speak up to 20 words at a time, selecting from a vocabulary of 5,000 words. The words are located in nested menus so that if two letters are typed, a vocabulary list appears on the screen and the operator has only to select the number of that word — thus minimizing motor coordination and typing skills. A key guard (a plastic frame with finger holes

over the top) placed over the keyboard helps avoid pressing more than one key at a time (Luttner, 1981).

9. Chris Thompson at the Trace Center for the Severely Communicatively Handicapped views the Apple as a useful assessment and training tool since most programs can be changed to meet the growing needs of the child (Luttner, 1981).

10. The microcomputer is also being used in home-bound programs in which the computer is hooked up through a telephone and the teacher can interact with the student. Here both the teacher and the student have microcomputers that display information and process responses (Joiner et al., 1980).

11. Individual education plans (IEPs) and data to develop them can be stored on the microcomputer. This information includes goals, objectives, methodologies, costs of services, and resources (Wilson, 1981).

12. Service bureaus also develop IEPs, maintain curricular data bases and test results, and monitor student progress. These bureaus can be either commercially or publicly supported. An example of a commercial bureau is Gacka Computer-Aided IEPs from Curriculum Associates, Inc., North Bellerica, Massachusetts, and a public bureau is the Child-Based Information System of the Central Susquehanna Intermediate Unit, Lewisburg, Pennsylvania (Wilson, 1981).

13. Control Data Corporation is now developing a system that "monitors a student from initial screening for the handicap through assessment, program selection, IEP development and educational achievement . . . assessed through PLATO terminals" (Wilson, 1981).

14. Interpretive Education, Inc., Kalamazoo, Michigan, has developed programs for mildly and moderately impaired youth through adults who assess and teach basic living skills. The branching concept is incorporated; learners, by their interaction with the microcomputer, are branched to higher or lower reading and conceptual levels. These programs have been developed for the Apple II.

This list of uses in special education is only a beginning — and certainly not conclusive. It is intended to stimulate creativity in the special educator. For example, speech processors could be tried with autistic children. Learning at individualized rates and at variable levels is important for anyone, but is especially helpful to the mentally retarded and the learning disabled. The emotionally disturbed may find computers less threatening than traditional teaching. Computers can be especially helpful with the visually impaired or blind (in teaching braille, etc.), hearing impaired (through visuals and synthetic speech), and with the physically impaired (in allowing them nonverbal communication capabilities).

The Maplewood Handicapped Children's Center in Seattle, Washington, stresses the importance of individualization with the media: "The tricky thing about providing a child with a communication device is that you have to find the most appropriate motor movement the child can use. This is of concern for two reasons. First, you don't want the child to be frustrated because the movement is too difficult or too inefficient; and, second, the extended use of an abnormal reflex pattern may actually lead to physical deformity" (in Luttner, 1981). This concern for individualization is applicable to all handicapping conditions.

CONSIDERATIONS WHEN PURCHASING HARDWARE

Three major considerations are necessary when purchasing hardware, or the microcomputer: technical, training, and software.

Technical Considerations

Besides warranty, the purchaser must consider the availability of repair facilities. A good deal on a microcomputer will turn into a bad deal if it has to be shipped back for a lengthy time.

The machine's capabilities are of utmost importance. How much memory is available? Some microcomputers get 4K of memory, while others get 16K or more. For writing simple programs, not much memory is required. If, however, one intends to use effective software, created

or purchased, the memory aspect is important. Most microcomputers use BASIC, but the BASIC for one machine is not at present compatible with machines from other manufacturers.

Another technical concern involves the device used to load the program from external memory. Tape recorders are readily available, but they are slow to load and are touchy as to whether the heads are clean and the volume is right. Disk drives are popular and are easy and fast to load. One must take care, though, not to mar or bend the disks. Cartridges that are sturdy and yet load quickly are beginning to appear on the market.

The peripherals available, as well as the number of slots for interfacing these peripherals with the microcomputer, must be considered. For example, the Apple has eight peripheral interface slots whereas most microcomputers have fewer. Peripherals such as paddles, printers, speech synthesizers, and so forth are especially important when working with the handicapped.

Training Considerations

Does the company through which the hardware is purchased provide literature on running the computer and how to program it? Is the literature easy to follow or technical enough? Does this company also provide inservice training on computer literacy, running the computer, programming the computer, and how to best utilize it to meet specified needs. Sometimes if the company selling the machine does not provide this service, it can be provided by a private microcomputer consulting firm such as Microcomputer Training and Development Associates (MTDA), 3524 Middlebury, Kalamazoo, MI 49007.

Software Considerations

Perhaps the most important consideration in purchasing hardware is the software. What software is available for the machine? Is it educationally effective? Does it satisfy technical requirements? Too much software on the market either does not run or work, or was created by programmers who have ability in their field but know little about educational effectiveness. As indicated by Joiner et al. (1980), "Purchasers of low cost systems, lacking either the skills or time to do their own programming, may find themselves proud owners of equipment that remains idle for lack of sufficient software."

Isaacson (1981) reinforced this opinion by his statement of "the difficulties educational computing face: lack of trained personnel, lack of planning, and lack of the 'fuel' to power the computer — high octane software."

Gleason (1981), in discussing software today, indicated:

1. Production of high-quality programs is expensive; $10,000 per instructional hour is not unrealistic.
2. Companies find that they have to provide extensive training for their production staffs.
3. Programs made for one kind of machine probably will not run on another.

Further support regarding the limited amount of high quality software came from Bagley (1981). She, too, indicated the presence of many poorly designed and poorly written programs on the market, which appear to lack a "systematic approach to instruction."

Holznagel, president of the Association of Educational Data Systems (AEDS) (as reported by Isaacson, 1981), indicated that the available software today falls within three classifications:

1. High octane material	(Little exists)
2. Good ideas, but needs revision	(Some exists)
3. Programs that "knock" badly — poorly designed and implemented, contain bugs, no clear objectives, etc.	(Most programs — especially those that are classroom-designed)

Until the industry becomes standardized or a peripheral is designed to make the various machines compatible, the software available for each machine must be considered *before* purchasing the hardware. To determine the effectivenes of software from both a technical and educational point of view, an evaluation plan is of utmost importance.

EVALUATING SOFTWARE

Programs have to be created with a wedding of educational specialists and computer technologists through

a third person who has knowledge in both areas. Isaacson (1981) agreed that a team of educators and technicians is required, and that the educator must have experience in computer programming, psychology of learning, and motivation. He also indicated that education centers, like that of the University of Oregon, are beginning to offer degreed programs in computers in education.

Interpretive Education, Inc., Kalamazoo, Michigan, has developed programs combining the expertise of special education and computer technology, and has designed programs for the special needs audience using regular and special education principles. It has organized the following evaluation form (Figure 3, pages 10-11) based on these principles, which the firm believes can be used to evaluate all educational software.

Several organizations that are also evaluating software and can provide information to the reader are:

Trace Research and Development Center
University of Wisconsin
314 Waisman Center
Madison, WI 53706

Dresden Associates
PO Box 246, Dept. CN-1
Dresden, ME 04342
Phone: (207) 737-4466

MECC Users Newsletter
2520 Broadway Drive
St. Paul, MN 55113
Phone: (612) 376-1117

Minnesota Educational Computing Consortium
2520 Broadway Drive
St. Paul, MN 55113

J E M Research
Discovery Park
University of Victoria
PO Box 1700
Victoria, BC V8W 2Y2

Association for Educational Data Systems
1201-16th Street NW
Washington, DC 20036

Micro SIFT Project
Northwest Regional Educational Laboratory
710 S.W. Second Avenue
Portland, OR 97204.

In addition to the foregoing, some evaluation is being implemented on the regional level. For example, the Michigan Association for Computer Users includes members who voluntarily review and evaluate acquired programs. The results are then published by the Association two to three times yearly.

CREATING SOFTWARE

The importance of software evaluation should not deter the special educator from learning about and doing some computer programming, for the following reasons:

1. Some programs on the market can be altered to fit individual needs of a learner. Other programs have security systems that do not allow access. These are usually programs that have been carefully planned and sequenced, and altering them would have an effect on educational effectiveness.
2. Software on the market is in need of development. To have many high quality educational programs, the educator should gain some expertise in programming.
3. Because many areas in the curriculum have not yet been approached in programming, educators are forced to create programs.

A note of "warning": The desire to create programs may be present, but programming can be like eating a favorite chip — once you start, it's hard to stop, and your temporal concepts deteriorate!

To gain knowledge in microcomputing, one might:

1. Learn from a course in BASIC at the local or nearby college.
2. Take a course from a business that sells computers.
3. Enroll in inservice education.
4. Read books and try out your new knowledge on your own.
5. Find a high school student or friend who can spend a few hours a week with you.

Programming

Programs consist of lines of data, comments or information, and commands. Lines are numbered, and the

Figure 3
Evaluation Form
Microcomputer Education Program (MCE)

	Excellent	Adequate	Inadequate	Not Relevant
I. Instructional Content				
1. Is the content consistent with the goals and objectives of the program?				
2. Is the program one of a series in which carefully planned learning objectives have been followed?				
3. Are program goals provided that are usable for individualized education plans?				
4. Are evaluation materials and/or criteria provided that are usable for individualized educational plans?				
5. Are prerequisite skills, vocabulary, and concepts determined and presented?				
6. Is vocabulary defined or paraphrased in text or in the prerequisite skills portion of the "Program Principles" section of the Instruction Manual?				
7. Are diagnostic or prescriptive procedures built into the program?				
8. Does the text follow established rules for punctuation, capitalization, grammar, and usage?				
9. Are supplemental materials provided for student and teacher?				
10. Are concepts and skills task analyzed into appropriate steps?				
11. Is the product designed for appropriate age and ability groups?				
12. Are examples provided with directions when appropriate?				
13. Are redundancy and drill used effectively?				
14. Is language appropriate in tone and selection?				
15. Are concrete applications for concepts provided?				
16. Is feedback immediate?				
II. Organization/Implementation of Program Materials				
1. Is instructional design of high quality, using accepted learning theory?				
2. Is the program student operated?				
3. Are students always the target of interaction with the computer — a personalized element?				
4. Are positive responses reinforced?				
5. Are frames that follow incorrect responses nonpunishing?				
6. Is reinforcement variable and random in content and provided on schedules as established by behavior management principles?				

(continued)

Figure 3
Evaluation Form
Microcomputer Education Program (MCE) (continued)

	Excellent	Adequate	Inadequate	Not Relevant
II. Organization/Implementation of Program Materials *(continued)*				
7. Is branching used where the student demonstrates need for further concept development before proceeding?				
8. Are avenues of communication from the student to the computer logical and at comprehensible levels?				
9. Are color, graphics, and animation used effectively to enhance the lesson?				
10. Is music employed for attention and reinforcement purposes?				
11. Is syllabication provided for new and/or unfamiliar words?				
12. Is sentence length dependent on need and student levels?				
13. Is the student always provided with frames that allow for progression through the program?				
14. Will the program run to completion without being "hung up" because of unexpected responses?				
15. Are the programs difficult or impossible to be inadvertently disrupted by the student?				
16. Is the amount of material on each frame appropriate?				
17. Is the length of each section appropriate?				
18. Can students operate the programs independently?				
19. Are words and lines spaced for ease of reading?				
20. Is variation of type and organization of textual materials appropriate for a clear presentation?				
21. Are the programs difficult or impossible to be inadvertently disrupted by the student?				
22. Does the program end with suitable directions for the student?				
23. Is the program designed for appropriate age and ability groups?				
24. Is the educational technology (i.e., microcomputer) the best available for presenting this subject matter?				
25. Does the Instructional Guide provide information, suggestions, and materials to assist the teacher in successfully implementing the program?				

Courtesy of Interpretive Education Inc., Kalamazoo, Michigan.

program executes the lines in consecutive order (e.g., 100, 110, 120, etc.). The elementary programmer, especially, should leave at least 10 lines between each one programmed, in order to add lines of data. The programmer can go back and do that because the computer will execute the lines in consecutive order regardless of the order in which they are programmed. After typing a line, the Enter or Return key is pressed, which places that line in memory.

If a mistake is made while typing in a line, the back arrow key (←) can be pressed to the place of error, or one can type that line number with nothing else. Let's say you spelled a word wrong. Just backspace to the point over the letter you want to change, and finish typing the line correctly. If you are on another line and notice a mistake in a line above, when you start a new blank line, type the line number on which you made the mistake and press Return (or whatever key this is on your machine). The line is erased from memory. If you want that line left in but with corrections made, just retype it.

Following is a very simple program example that will be discussed:

```
110   REM TO PRINT YOUR NAME.
120   PRINT "PLEASE TYPE YOUR NAME."
130   PRINT "TYPE IT NOW."
140   INPUT A$
150   PRINT "YOUR NAME IS"; A$;"."
160   END
```

Line 110 starts with the word REM, which stands for Remark. REM statements are not part of the program but are there to help the programmer with organization; they serve the same purpose as an outline. Lines 120 and 130 begin with PRINT and have statements within quotation marks. These statements will be printed out in the program. Line 140 begins with INPUT, indicating that the viewer is to type in something — in this case his/her name. The A$ means the computer expects the person to type in a series, which in this case is a name. The line 150 tells the computer to print out the statement, "Your name is _____." The blank represents the person's name as typed in line 140. The last line, 160, is a command that tells the computer to end the program. If you want to check the program, type LIST, and the program as you have entered it will appear on the screen.

Next, you will probably want to see your program. Type RUN, and this would appear:

PLEASE TYPE YOUR NAME.

TYPE IT NOW.

?   (The program will wait for your name).

YOUR NAME IS _____

If you want to save this program and put it into external memory, type in SAVE. On a disk, the program will then be placed in memory on that disk. If placing it into memory on a tape cassette, you would press the keys on the tape recorder that allow you to record information first. If you do not want to save a program, type NEW, and it will be erased forever.

Other kinds of statements one must become familiar with are IF . . . THEN and FOR . . . NEXT statements, which command the computer to do something if certain things are true and do something else if not true. Also, one will become familiar with GOTO statements, which command the computer to go to a particular line. Obviously, the exact command and ways of entering data differ from machine to machine. All are similar, however. Table 3 lists a few of the BASIC commands and how they are executed by four of the major microcomputers (Li, 1981):

TABLE 3
BASIC COMMANDS FOR
FOUR MICROCOMPUTERS

COMMAND	MICROCOMPUTER			
	APPLE II	**TRS 80**	**ATARI**	**PET**
CLEAR, or erase	CLEAR	CLEAR	CLEAR	CLR
LOAD, or bring in program from memory	LOAD	CLOAD	CLOAD	LOAD
SAVE, or place into memory	SAVE	CSAVE	CSAVE	SAVE
NEW, or delete a program	NEW	NEW	NEW	NEW
LIST, or list all lines in a program	LIST	LIST	LIST	LIST

Educational Planning

To educationally plan a program, the educator must write out each frame exactly as it will appear on the screen. Each frame must also be numbered in the order on which it will appear on the screen. The educator must provide information as to exactly what is correct, incorrect, or inappropriate on a question frame when input or interaction with the person is expected. Figure 4 is an example of a flowchart for educationally planning a

Figure 4
Microcomputer Education (MCE) Flowchart

Courtesy of
Interpretive Education Inc.
Kalamazoo, Michigan
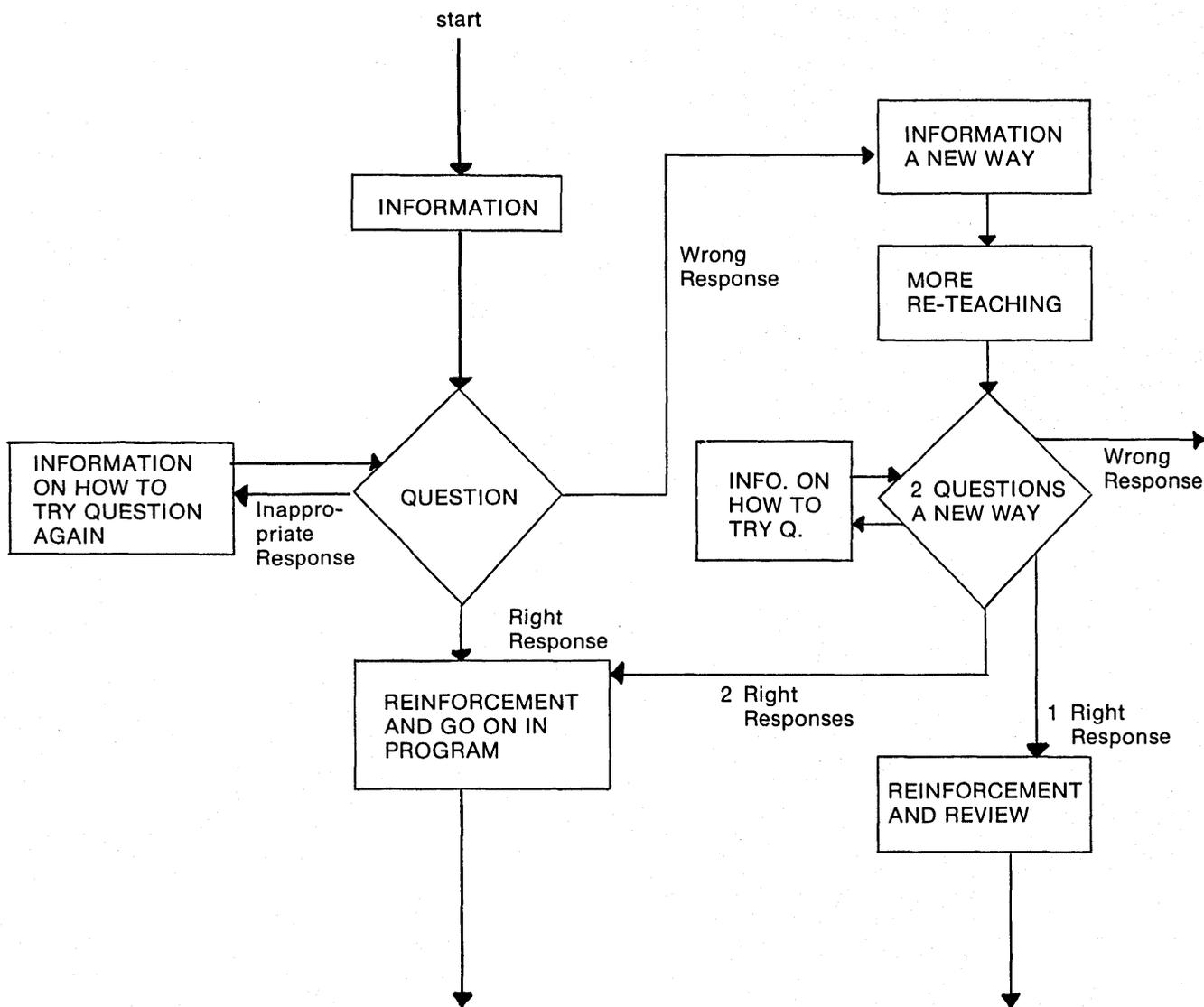
program. Of course, each program will have a different flowchart depending on that program.

MICROCOMPUTERS IN THE FUTURE

Educators had better get ready for a new wave in education, because education as we know it today will soon be as antiquated for communication as the quarter picture show or the Pony Express. "Technology will have a dramatic and far-reaching impact on schooling. In the near future, it may *not* be necessary for the child to go to 'school' to learn many of the basics in education" (Gleason, 1981). Home-based and community learning centers may be common. "Computers will not replace teachers, but change the role of teachers from that of transmitters of information to the far more significant role of planning and providing those higher learning experiences" (Gleason, 1981).

The sky is the limit when creative educators team up with creative computer technologists. In special education our job must involve the fast developing uses of technology to assist the handicapped:

— in their quest for effective communication

— in their quest for education

— in their quest for normalization!

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CLASSROOM FORUM

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> **I have heard a lot lately about using error pattern analysis to help detect repeated mistakes in learning. Can you tell me more about it and how I can use it in my classroom?**

Error pattern analysis is just a more organized way of looking at the mistakes or mislearning a child evidences in his or her work. By keeping a continuing record of a student's mistakes, a teacher can analyze these mistakes and use the results of the analysis to determine the nature of the mistakes. If the teacher detects a pattern in the errors being made, it can provide direction in remediation procedures. The teacher is looking for indications of incorrect learning patterns that would require unlearning and relearning. The teacher is also looking for patterns that may have developed because of incorrect generalizations on the learner's part.

Let's take a look at some samples of error that might surface in the classroom. Math is one of the easiest subjects in which to detect error patterns, especially when daily papers are turned in for the teacher to correct. For example, the completed problems below reveal a typical type of error. After you have figured out the pattern, work the incomplete problems, applying the pattern you have detected.

1.
```
 275      785      932
+329     +498     +248
 594    1,173    1,170
```

1.a.
```
 279      643
+365     +975
```

2.
```
 729      231      935
×  5     ×  7     ×  3
5,005   2,817    3,025
```

2.a.
```
 264      525
×  9     ×  4
```

3.
```
  112       122       211
6)573     4)528     7)376
```

3.a.
```
4)782     9)893
```

In the first set of problems, the (incorrect) answers to the 1.a. problems are: 534 and 1,518. The error pattern involves correct addition but failure to "carry" to the next column. This could occur for several reasons. One, the child may not know how to carry. Or he or she may not understand place value. Or he or she could have been distracted at the point of carrying the numbers. Many other reasons are possible, so the best way to determine the real reason is to ask the student to work the problems orally. Often, when students verbalize their work, they detect their own problems. If this dosen't happen, the teacher should attempt to find exactly where the error begins and work from there toward remediation procedures.

In the second set of problems, the answers for the blanks are: 9,016 and 2,460. In this error pattern, the student has carried, but incorrectly — adding the carried number to the multiplicand first and then multiplying to get the answer — instead of multiplying first and then adding the carried digit. It appears that the child has little or no concept of place value, but to check this hypothesis, the teacher should ask for a few sample problems orally.

The final set of problems is a little more difficult to analyze because several options appear to be feasible at first glance. The answers to the blanks are: 122 and 113. In this error pattern the student has always divided the smaller number into the larger one and merely gone on to the next digit without any concern for working out the necessary multiplication procedures. The student appears to not understand how to divide *or* multiply. Perhaps going back to single-digit multiplication problems may be necessary in this case.

In short, error pattern analysis is really a decision-making process the teacher follows in order to develop remedial procedures. Once an hypothesis is developed, the teacher tries to apply the "rules" detected in the pattern to test the hypothesis. If the rules do not fit all instances, another hypothesis must be developed and

tried. This procedure continues until the correct rule pattern is discovered and proves true in all instances.

Error pattern analysis is based upon the premise that the errors children make are frequently not random errors. Rather, they are the result of the learner's interpretation of the "rules" governing a particular task. An excellent example of this occurs during the language and speech pattern development of normal children during the preschool years. How many times have adults chuckled over a young child's use of the word "feets" to indicate "feet." Yet, when the rules pattern is analyzed, the mistake is logical. If you have one beet, you may have two beets. By the same token, if you have one index and two indices, you should have one kleenex and two kleenices! Or if you have one mouse and two mice, you should have one douse and two dice!

The problem is that the "rules" governing our language system cannot always be applied to every individual situation. As children hear the correct language and speech patterns of adults, they internalize these rules and gradually apply them to their own usage. When learning a foreign language that also has exceptions to the rules, adults often make similar mistakes.

Another important "given" in error pattern analysis is that frequently the errors being made are productive in nature, and some errors are more productive than others. Here are some samples of reading errors made by one child when reading orally from a book:

Written (book)	Spoken (child)
little	tiny
picnic	party
water	pond
smell	sniff
bad	terrific
begin	start
lines (to a play)	part
laugh	happy
plan	idea
insects	bugs
see	find
baby	brother

The child was able to guess at the unknown words by using context clues within the sentence or paragraph. Although the boy was unable to figure out the correct words, the synonyms he used completed the idea pre-

sented in a productive manner. If he had read the passages silently, he could have answered the content questions with a fair degree of accuracy, providing that his memory skills were adequate. Thus, his errors provided clues to his comprehension of the reading material and were therefore productive errors for him.

Unfortunately, not all errors are as productive as those of the reading sample just given, or as consistent as in the math samples. It isn't always this easy to detect the pattern. Even with larger samples, the teacher's "detective work" is not always easy.

By knowing how to collect data samples and analyze them for error patterns, however, the teacher is able to take the first step in determining the best remedial procedures for each child. A careful study of students' unique patterns of error, along with their verbalizations of the processes they are going through in order to apply their rule systems to the task at hand will give the teachers much valuable information toward correction procedures. Such information will indicate what the child has learned, what has to be unlearned and retaught, and also where teachers should begin with remedial teaching procedures.

The teacher's exact approach to remediation will then be determined by findings of the error pattern analysis and the student's individual learning style. By combining all this information, along with one's professional skills, the teacher will be on the correct path toward helping students learn to the best of their abilities.

ALERT

A conference entitled, "Computers, Productivity, and Special Education Administration" is to be held in Washington, DC on October 23, 1981, and in San Francisco on November 20, 1981. Sponsored by the National Association of State Directors of Special Education (NASDSE), in cooperation with Learning Tools, Inc., it will focus on uses of computers to increase efficiency of special education management. Conference goals are (1) to review what kinds of software are now available for special education administrators; and (2) to demonstrate exactly how computers can improve special education productivity.

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