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ABSTRACT

In response to the increasing use of computers in school by young children, this paper provides definitions of concepts and discussions of topics related to computers and young children. The first section takes up the issue of computer literacy, describing various uses of the term and discussing the controversy concerning teaching computer literacy in schools. The second section examines two aspects of microcomputer experiences for young children: effects of microcomputers on children and computer applications for young children. Diverse applications briefly discussed include computer literacy, computer assisted instruction, computer programming, computer art, word processing, and administrative uses. Thought to be of particular interest to those involved with young children are the in-depth discussions of computer assisted instruction, computer programming, and word processing. Specifically, general features of drill and practice, educational games, simulations, and tutorials are pointed out in the subsection on computer assisted instruction. The Logo computer language for young children is described in the subsection on programming, and the use of word processing to promote language development is discussed in the final subsection. In conclusion, two brief discussions are devoted to issues of training educators in the use of computers and to the need for active involvement of early childhood educators in integrating computer use into the curriculum. (RH)

MICROCOMPUTERS IN EARLY CHILDHOOD EDUCATION

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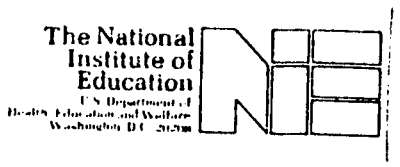

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Not too long ago an APPLE was a fruit, a PET was a cat or dog, and computers were strictly for adults. Today in some classrooms, a preschooler may be able to learn to discriminate between "above" and "below" on an Apple microcomputer, a first grader might practice arithmetic problems on her classroom TRS-80, and a second grader might check his spelling on a Commodore PET. No longer the exclusive property of highly specialized computer scientists, computers today are used in an increasing number of offices, schools, and homes. Preschools and day care centers are also starting to use microcomputers to teach and entertain children and to keep business records.

As computers become easier to use and more widely available, children will begin to take them for granted just as many of today's adults learned to take television for granted when they were children. The development of software (the instructions for the computer or the computer program) suitable for children is likely to accelerate this process. Many major publishers now have electronic publishing divisions and are either commissioning or producing software for school and home computers.

Manufacturing efforts to produce better hardware and software have coincided with schools' attempts to provide greater accessibility to computers for children. According to a report by the National Center for Educational Statistics, more than half the schools in the nation had acquired at least one computer by 1981 (National Center for Educational Statistics, 1981). A later survey conducted by Market Data Retrieval of Westport, Connecticut, reported that the number of schools having a

computer had increased by 60% in the last year "Minnesota Schools Winning the Microcomputer Race," 1982). Many of these computers were being used primarily for administrative, recordkeeping, and accounting purposes, but the use of computers for instructional purposes was also increasing as teachers became more aware of the microcomputer's capabilities and more knowledgeable about educational software.

The age at which children first encounter computers in school has been steadily decreasing. There are now a number of research reports on children as young as 3 and 4 using computers successfully. Piestrup (1981) found that children even at this early age can be taught to operate a computer to the point of inserting floppy disks into the machine. Preschool teacher Sally Larsen reports teaching almost 300 4- to 12-year-old children to write short programs in Basic (Campbell, 1982). Other instances of children's use of computers are discussed in a report from the Institute for Communication Research at Stanford University (Paisley & Chen, 1982). Kindergarten programs on computer literacy are also becoming more common (Hungate, 1982; Rosen, 1982), and microcomputer learning activities are being introduced in many preschools and day care centers (Lewis, 1981; Swigger & Campbell, 1981).

Perhaps most surprising about the schools' rapid acquisition of microcomputers is the fact that even though microcomputers were not readily available in significant numbers until the late 1970s, the new technology earned an early and rapid acceptance in school settings. Even allowing for aggressive marketing techniques,

microcomputers appeared to offer something intriguing to educators.

Quite apart from the obvious utility of learning to use computers in a society increasingly making use of high technology, microcomputers offered the potential to change the nature of education. Even though other technological developments, such as television, have been heralded as having the capability to change educational theory and practice, the interactive nature of computers makes them significantly different from former technologies.

New patterns of classroom teaching and learning are part of the changes anticipated by many administrators and teachers. Among the areas potentially affected are methods of presenting factual information, methods of testing children's achievement, the role of the teacher in instruction, and aspects of the relationship between home and school. In addition, teacher education, curriculum planning, and traditional concepts of grade levels and sequences of instruction may be changed. More important than any single effect, however, is the possibility that using microcomputers will affect the way children think and learn.

COMPUTER LITERACY

As computer use becomes more common in society, what kinds of computer-related skills or knowledge may be needed by children and adults? Presently, people are expected to be able to use the telephone system; operate simple machines such as television

sets, stoves, or typewriters; and know the rudiments of using a checking account. Understanding how to do these things is considered a normal requirement for adult life. It appears that knowing about computers and how to use them is also becoming essential and that teaching about computers will ultimately be the responsibility of the schools. The term "computer literacy" is often used to describe such computer-related skills and knowledge.

Despite wide use of the term, there is as yet no consensus as to what constitutes computer literacy. Computer literacy has variously been defined as learning about computers and what they can do, learning to program, or a combination of these activities. Some define computer literacy as the ability to read and write via computer--that is, to read and write computer programs. Computer literacy has also been defined as the ability to use computer programs rather than to create them. Other definitions include the study of the history of computers, the way computers work, and the potential impact of computers on society. Projects are currently underway to explore the concept of computer literacy in schools (Hunter, 1980; Bitter, 1982). Despite a variety of opinions, whatever definition of computer literacy is accepted by educators will be reflected in the curriculum materials and activities used to teach children to be computer literate.

Some people suggest that the rush to teach computer literacy is premature. They believe that instead of having to teach the technical terms and skills necessary to use computers today,

future computers should be designed so that people can use them easily without special training. This point of view may prove to be increasingly sensible as more "user friendly" software is developed and marketed. Though much of the software so labeled is still disappointingly difficult to use, the urgent need for easy-to-use software is being articulated by most software users, and producers are begining to respond.

If most computer software becomes user friendly and if computers become widely available, much of what is now considered essential knowledge about computers will no longer be necessary, and the concept of computer literacy may become as outmoded as the concept of "telephone literacy." Just as children now learn to use telephones by watching their parents at home, playing with toy telephones, and later using the real phone, so computers will become a commonplace part of children's daily lives.

Given today's interest in children's learning to use computers, it seems likely that efforts will be made to include computers in most early childhood curricula. Early childhood educators are already beginning to explore the question of what young children can and should learn about computers and what they should learn first. For example, should a child first learn about the parts of a computer and how they are used? Or should she begin using computers in an exploratory way to find out what happens when she presses the keys or runs a program? What concepts are most relevant for young children? Does it make sense to explain a memory chip to a 3-year-old or teach a 5-year-old to program?

While no firm answers to these questions exist, appropriate approaches and content may depend on a child's age and developmental level. When more research evidence on children's use of computers has been collected and teachers have had more experience in working with children and computers, more reliable information should be available for making decisions on how best to introduce computers.

Some educators question the value of having young children learn about computers and are asking for more evidence as to the potential positive and negative effects before proceeding to use them. Despite their concerns, it seems unlikely that the move towards computer use in early childhood education will be reversed. What may be more important is that thoughtful educators and parents continue to become knowledgeable about computers and to influence the way computers are used with children.

MICROCOMPUTER EXPERIENCES FOR YOUNG CHILDREN

According to most reports, parents and teachers are very positive about children's experiences with microcomputers. The children themselves are both enthusiastic and less inhibited than adults in learning how to use microcomputers. But teachers and parents also ask about the effects of computer use on children and wonder whether such activities as playing games or learning numbers on the computer will be helpful to children's development. Specifically, some questions asked are, Will computerized lessons help children learn to read more easily than

standardized or conventional methods? Can children learn to solve problems more quickly when challenged by an interactive computer program that provides feedback about his answers? and, Will use of the computer isolate children from one another?

Effects of Microcomputers on Children

Even though extensive research on microcomputer use with children is still to come, reports on the effects of using large mainframe computer systems developed in the 1960s and 1970s, such as the PLATO or TICCIT systems, are available. Hallworth and Brebner (1980) reviewed studies of computer assisted instruction (CAI) intended for age groups ranging from kindergarten children through individuals enrolled in college. Computer lessons were made available on large computer systems in the United States and other countries. Two results were consistent across studies: (1) individuals were able to learn as well using computers as they did using more conventional materials and methods, and (2) they enjoyed learning in this manner.

The report also indicates that certain children, especially those who learn slowly or need to repeat lessons, appear to learn more readily when they can proceed at their own pace through the computerized lessons and can repeat each lesson as often as they choose. Similarly, exceptionally capable children, who are often bored or restless during repetitive teaching or when they must wait for others to learn, adapt readily to CAI. When able to proceed through lessons as rapidly as they choose, Children progress more quickly through materials and appear to enjoy

controlling the pace of their work.

Computer feedback to children on how they are doing during lessons also appears to motivate them and thus improves time on task and attitudes towards learning. In programs that automatically move the learner to a higher level of difficulty when the previous level has been mastered, children were able to cover more material than they might have otherwise in the same period of time (Hallworth & Brebner, 1980).

The research on use of large computer systems is consistent with early results on microcomputer use. Although often describing studies of short duration or research conducted with small samples, preliminary reports on microcomputer use--as well as reports by teachers already working with children and microcomputers--also indicate improved learning and enthusiasm in children using microcomputers. For example, at the 1982 meeting of the Association for Education Data Systems in Orlando, Florida, teachers who had brought children from their classes to demonstrate the use of microcomputers stated that the children's learning improved and that their enthusiasm for working with computers, plus computer feedback, provided learning motivation. At the Bing Nursery School on the Stanford University campus, Piestrup worked with 55 3- and 4-year-old children, helping them learn reading readiness concepts such as "above," "below," "left," and "right" on an Apple II microcomputer. She reports that both teachers and children were enthusiastic and that criterion tests on the four reading skill concepts showed that children improved after the 3-week period with the computer

(Piestrup, 1981).

Economically disadvantaged kindergarten children at a San Francisco Bay Area school worked weekly with Commodore PET microcomputers from October 1980 to May 1981. Programs focused on basic mathematics, visual discrimination, and name and telephone number practice. Each of the 12 children involved had a computer to use and was allowed to explore the keyboard extensively and learn the connection between pressing a key and seeing something new appear on the screen. Gradually, the children learned to work the computer and go through the programs, increasing the amount of time they could work with the computer from 15 minutes to more than 35 minutes. In later tests of the children's ability to learn from the computerized instruction, four children performed better on certain math, counting, and telephone number tasks than six children who had not used the computer (Hungate, 1982).

Sheingold (1983) suggests that microcomputers might be used to help children get in touch with the symbolic aspects of what they already know or are learning about from other kinds of experiences. For example, by having real chick eggs incubating in a preschool classroom at the same time a computer simulation of the development of a chick inside an egg is available in class, children might be encouraged to make connections between the real world and the image on the computer.

Although the reports of improved learning and children's eagerness to spend time with microcomputers are positive, teachers and parents have posed additional questions. Two of the most common of these are, How much time on the microcomputer is the

right amount for a young child? and, Will children's social development be negatively affected by early exposure to computers? A fairly obvious answer to these questions seems to be that there is probably no such thing as a "right" amount of time and that children need to engage in a variety of activities: play with their friends, spend time outdoors, and interact with computers as one of the many experiences they will have. Sheingold (1983) suggests that early childhood educators learn to think of the microcomputer as one of many learning tools that children might use and as an additional source of learning experiences for preschools rather than as a replacement for other activities.

Contrary to earlier fears that using a computer might prove to be an isolating experience, mutual consulting, cooperation, and collaboration among children has been reported often by teachers and by children themselves. It may be that the computer contributes to sociability rather than to the opposite. Another social effect of using computers appears to be that a child's sense of self or self-esteem is fostered by the confidence and satisfaction generated by having control of the computer, making choices during a program, learning to program, and so on. Self-concept development has been noted by several teachers working with young children. At one preschool, a shy child gained the respect of class members and improved his social skills as a result of his "expertise" on the computer.

Teachers report that children often gain a sense of power by using computers (Damarin, 1982; Paisley & Chen, 1982). For instance, the child who is working alone at the computer is

independent of adults or other children. Her own actions determine whether the computer will work or the program will run, giving her a sense of control. If she doesn't do well the first time, she can return to the beginning and try again. The computer is patient, if somewhat rigid in its requirements for responses. The interaction between child and computer is self-reinforcing, and artificial kinds of reinforcement (a smiling face or musical salute) may become unnecessary. Motivation is strong to try another letter, redo a sum, or press a different key so that the child can continue.

According to some reports, the privacy of working alone at a computer is another factor enjoyed by children. The freedom to make mistakes and correct errors without other children or the teacher noticing or commenting on them appears to be a plus. Also, when a child working at the computer wants to share or save something she has discovered or created, she can easily do so.

These reports, which reflect educators' experiences in working with children and computers, indicate that computers can provide exciting and instructive experiences, perhaps in ways not yet conceived of by educators. Although none of these effects occurs all the time or applies to every child or situation, the initial results of using computers in elementary and early childhood education settings are encouraging.

Computer Applications for Young Children

Before teachers and administrators can begin to plan for computer applications in early childhood education, it is

important for them to become aware of the various ways in which computers can be used with young children. The following categories are neither exhaustive nor mutually exclusive but suggest some of the more important ways computers might be used with this age group:

Computer literacy. As has already been suggested, the primary goal of any use of computers with young children might be considered computer literacy (i.e., teaching children what computers can do and how to use them). Computer literacy can include teaching children how to use the computer as a tool (a medium with which to calculate, draw, or write), as a tutor (to provide instruction), as a tutee (to be programmed), or as a combination of these three (Taylor, 1980).

Computer assisted instruction (CAI). When the computer is used as a tutor, concepts, information, or skills normally presented through conventional teaching methods are taught by computer. For example, 4- or 5-year-old children can learn the alphabet, counting, or how to discriminate between similar and different objects by interacting with a computer programmed to present information, receive responses, and offer new information based on the children's responses.

Computer programming. One of the reasons given for teaching young children to program (in other words, to learn to use a computer language to give the computer instructions) is to promote computer literacy and to prepare children for a computer-oriented future. Another reason for teaching children to

program is related to cognitive development. Specifically, programming requires the child who works with the computer to do certain things: to appreciate the fact that there may be many ways to solve a problem, analyze a task, pose alternative solutions to problems, understand how to sequence instructions, and use logic. These kinds of skills are viewed as valuable in themselves and may be generalizable to situations and learning experiences other than those involving computers.

Computer art. A teacher working with young children may introduce computers to them by illustrating how the computer can be used to draw pictures or designs. Children (like many adults) appear to be fascinated by computer graphics and quickly learn the instructions or activities necessary to create their own designs and pictures. In a way, the computer used in this manner functions as a very powerful tool or medium for expression. As children become more skilled, they are able to produce valuable and interesting art based on increasingly complex programs. Through using computer graphics, children gain personal satisfaction as well as an increased understanding of design, composition, and use of color (Piestrup, 1982).

Word processing. Primary school children can use computers as tools to create their own text and practice writing and reading. Word processing programs can encourage young children to experiment with language as well as to record their own writing ("Classroom Computer News Forum," 1983).

Administrative uses. Although not part of children's direct involvement with computers, administrative uses of computers may

free educators from routine recordkeeping to spend more time in instructional activities and at the same time help them to develop computer literacy. Computers in offices are frequently used for accounting, reports, word processing, attendance or personnel records, and budget preparation or management. (A computer purchase can often be justified for administrative purposes and the computer later used for instructional purposes as well.)

The diversity of computer applications suggests that learning how to incorporate a computer in early childhood education is a matter of deciding from among many possible uses. The trend of the late 1970s and early 1980s seems to be for educators to select one or two applications at first, probably on the basis of primary need and funds or equipment available. Until further research is available, educators may have to continue to choose appropriate computer applications according to perceived needs, reports from other educators, and budget considerations.

Of particular interest to those involved with young children may be three of the six applications already mentioned: CAI, computer programming, and word processing. The following three sections of this chapter are therefore devoted to a more in-depth discussion of these uses.

COMPUTER ASSISTED INSTRUCTION

One way to use computers in education is to transfer to the

computer a part of the job of teaching children. Although computers do not have a regular classroom teacher's flexibility and comprehensive view of each child's needs, they are powerful, patient machines that can be programmed for many instructional activities.

For example, a computer system can present new material or concepts to children, ask questions, and record responses. Or a child may practice arithmetic problems presented by a computer and receive feedback on his or her answers. These kinds of uses are referred to as computer assisted instruction (CAI). CAI is not new, but a variety of CAI software for microcomputers has only recently become available. CAI can be used to teach almost any subject and, as in most teaching, content can be presented in a variety of ways. Since the 1960s, when CAI began, several formats, based in part on traditional educational methods, have evolved. These formats, now conventions for presenting CAI, include drill and practice, educational games, simulations, and tutorials.

Drill and practice refer to programs which allow students to review and practice basic concepts and skills. For example, a computer can present arithmetic problems appropriate for each child's stage of development, give feedback, provide supplementary information, or present easier or more difficult problems based on the student's responses (Suppes, 1980).

In early childhood education, programs asking the child to match letters or numbers to specific keys on the keyboard,

discriminate between "same" and "different," or supply the next number in a series are all examples of drill and practice. Some drill and practice programs can also provide teachers with a report on each child's progress or responses. Such programs can be used to provide practice of concepts introduced earlier by the teacher or as a separate activity.

Educational games on the computer are designed to help the child learn almost as a by-product of playing the game. A child's enjoyment of the game appears to motivate him to spend more time than he might if the game material were presented in another format (Malone, 1980). An example of an educational game for young children might be one that asked the children to practice the directions left and right by finding their way through a maze displayed on the computer screen. Another game might invite children to guess the name of an animal stored in the computer memory based on computer responses to the child's listing of animal attributes (fur, hooves, etc.).

Simulations are programs in which a child takes a role in a model situation set up by the computer. The situation can be either realistic or fantastic. For example, a "realistic" simulation might involve the child in buying the family groceries and deciding what to choose from the different food groups displayed on the screen. An older child might be asked to spend only a certain amount to acquire the necessary groceries. A more fanciful simulation might portray an ocean bottom and ask the child to make choices, such as what a fish should do when a shark appears or a hook comes down into the water. While it is

important to remember that a simulation only deals with a small segment of a situation, it is expected that children experiencing simulations will acquire concepts that would be more difficult (or less fun) to acquire in other ways.

Tutorials are programs in which the computer, as the teacher, presents information to the child and asks the child to respond. Questions may be asked and the child may choose between different alternatives; the computer then provides feedback based on the responses. For example, in an early reading program, children might be shown a story and then asked to identify actors or actions from the story.

One of the limitations of a tutorial program is that all students' responses must be anticipated and built into the program. Therefore, there is no room for the spontaneity or major strategy changes that a classroom teacher might introduce. Another limitation for early childhood uses are the reading skills required by most tutorials available today. Nonetheless, tutorial programs can be useful in presenting new material or reinforcing concepts.

Despite the general need for the child to possess reading skills, computer assisted lessons have been developed for children as young as 3 and 4 years of age. When children are too young to read, graphics or an audiotape can be used to present information or instructions. At this time, only a limited number of software programs use graphics and audiotapes for younger children, but the number is expected to increase in the near

future as more microcomputers are purchased for homes and early childhood centers.

COMPUTER PROGRAMMING

The computer may have a greater impact on education by introducing new concepts about teaching and new ideas about learning than by automating teaching practices and providing learning experiences that have been available for decades. Learning to program at an early age, particularly using computer languages developed especially for children, may affect the way children approach problems or think about their environment. Although children are being taught to program in several languages (for example, Basic and Pilot) the Logo language is of particular interest to early childhood educators.

In his book Mindstorms, Seymour Papert (1980) describes Logo as based on a Piagetian model in which children are builders of their own intellectual structures and learn through programming the importance of exploration and discovery. Although Papert does not always agree with Piaget on the ages at which children can profit from different learning experiences, the ideas underlying the Logo language substantially draw from Piaget's developmental theories.

A language that allows even young children to create their own programs for the computer, Logo was developed under Papert's direction at the Massachusetts Institute of Technology in the 1960s. As part of the early testing of Logo with young children, a mechanical toy--a turtle that could be controlled by the

computer--was developed. Children as young as 4 were able to use Logo to instruct the turtle to draw shapes on paper taped to the floor. In later versions of Logo, the turtle became a triangular shape on the computer screen; programming this turtle resulted in pictures on the computer screen (Lough, 1983).

The Logo commands that control the turtle are simple ones. For example, if a child enters the command "Forward 100," the turtle on the screen will draw a line 100 turtle steps long (about 3 inches) in the direction it was facing. The command "Right 90" tells the turtle to turn 90 degrees to the right. Repeating this sequence of commands three more times would therefore result in a square. The child might store this group of commands under the name "Square." From then on, the simple command "Do Square" would invoke the longer list of commands to create the picture of a square on the screen.

According to Papert, it is not necessary to teach the child that a square is an enclosed figure with four equal sides and right angles because Logo, a tool to "speak math" with, gives him access to and personal knowledge of mathematical concepts. Using Logo additionally teaches about problem solving, analyzing a task, sequencing, and refining multiple strategies or approaches.

Papert also describes Logo as an "object to think with." He believes children can learn to communicate with computers as naturally as they learn to communicate with other people and that this communication can change the way children learn about other things. In other words, the experiences a child has with the computer can create models, strategies, or skills related to

learning that can transfer to other areas of activity.

Preschool, elementary, and secondary school-age children have been exposed to Logo in research and educational settings. The Lamplighter School, a private school in Dallas, Texas, was the site of a 4-year project using Logo with children 3 to 9 years old. The project was a collaboration between the MIT Logo group, Texas Instruments, and the school. In most instances, children demonstrated increased understanding of the concepts of mathematics and enjoyment of things mathematical, although they did not necessarily improve their performance on standardized tests (Watt, 1982).

The nature of the learning experience provided by use of a language such as Logo is different from that resulting from computer assisted instruction (CAI). In CAI, the learner is basically a responder who is to progress through computerized lessons preselected by educators. In a sense, the content is fixed: an answer on a drill and practice problem in math is either right or wrong. In contrast, Logo is a more expressive tool, one that permits the child to learn about mathematics and other concepts through experimentation and discovery. Logo is also nonjudgmental in that there are no right or wrong answers in designing a program. One of the reasons for educators' interest in Logo is this open-ended quality.

WORD PROCESSING

Computer word processing programs, which allow children to

write and modify their own work, may have the same impact on children's learning language arts as Logo appears to have had on mathematics learning. The use of a word processing program, which lets a child easily insert or delete text, may encourage her to write more freely and fully than she would have without the help of such a program. Another benefit is that a word processor with a printer produces more attractive, "grown-up looking" text than a child's handwritten copy. An older child can edit his own work, easily move chunks of text around, and otherwise revise work without having to recopy. Teachers report that this freedom encourages children to write more and that the quality of writing is improved (Levin & Kareev, 1980; "Classroom Computer News Forum," 1982).

As children are introduced to keyboards at earlier and earlier ages, typing (even one letter at a time) also becomes a more natural part of the writing process. According to "Classroom Computer News Forum" (1982), word processing programs are being developed especially for use by children.

When is a child old enough to effectively use a word processing program to type letters of the alphabet, numbers, and other symbols? At what point can a word processor aid a child in beginning to write simple sentences, paragraphs, stories, or poems? There are no easy answers to these questions: a child's maturity, capability to identify keys, and the availability of adult assistance in teaching use of the program are all factors in determining when word processing can be successfully introduced.

As soon as a child has command of sufficient vocabulary and syntax to begin expressing thoughts in writing--perhaps in the primary grades--a word processor can be a useful tool. Even though the child may only be able to write simple sentences, such as "The boy runs" or "The dog eats," the word processor permits her to change the noun or verb in either sentence to create two new sentences without losing the originals. The teacher can correct errors, leaving the sentence in its original form for the child to see the difference. As the child learns new words or expands ideas, she can add to the original work that has been stored for her, in several versions if necessary, until she is satisfied with the creation. In one sense, using a word processor documents the child's progress both to the child and to the teacher. A printout for parents can also be made for reporting purposes.

Improved reading comprehension is another potential benefit of using word processing programs to assist language development. Children highly motivated to interact with the computer learn quickly that reading is an essential step to getting the computer to respond as they want. Reading to understand directions or to determine which answer is needed by the computer for the program to progress gives children a reason for developing proficiency, immediate reinforcement when they do become proficient, and the ability to move to more complex programs requiring more sophisticated reading skills.

Many educators are predicting that as word processors become less expensive and easier to use they will increasingly be found

in classrooms.

TRAINING FOR EDUCATORS

Training in the use of computers is cited repeatedly as a major need for educators at all levels (Clements, 1983; Sheingold, 1981; Oliver, 1983). In addition to learning how to use a computer, teachers and administrators need information and experience before they can evaluate and choose from among the increasing number of computer applications. For example, a teacher who learns Basic programming as part of a computer literacy course in college may be less interested in using computer assisted instruction (CAI) or Logo than in using the computer to teach children programming.

Lack of sufficient training can be costly. Too often a school system spends a great deal of money to purchase hardware and software but spends very little on teaching the teachers and administrators to integrate computer use into their regular activities. As a result, the computers are seldom used or are stored until someone learns more about them. Educators are often expected to spend their own time acquiring the necessary information to use the equipment. In this situation, one teacher may eventually learn about the computer and teach others--or may establish territoriality about the computer. In the latter case, others may then find the computer too difficult to access or may decide it is too complicated to master. An enthusiastic teacher or principal can help other staff members learn about the computer,

but inservice sessions are needed and should be considered an integral part of the school's plan to bring computers into the classroom.

The ideal training situation is one which is relatively labor-intensive. It takes many hours of an instructor's time to acquaint teachers with the full range of a computer's potential. Particularly important is hands-on experience, which gives teachers an opportunity to become familiar with the computer by actually using it. Hands-on practice necessitates access to a number of computers and a variety of software, as well as good teaching skills on the part of the trainer. Different learning styles and possible feelings of anxiety or reluctance to learn about computers on the part of teachers should also be considered in planning training sessions.

Training is also occurring outside of work settings. Many university colleges of education are now responding to demands for information with preservice and inservice courses on computer literacy, CAI, and programming. Most colleges that have started such programs, particularly for practicing teachers, have been overwhelmed with the number of students who sign up to take classes. Often a relatively general course, such as introductory programming or an overview of computer applications, is offered to try to meet the needs of most students. An increase in short courses, weekend and evening classes, and workshops is still needed in most communities.

Early childhood educators should be concerned that the training offered to future and practicing teachers be relevant to

the needs of younger children. How many colleges presently offer coursework in Logo for young children, provide information on input devices for nontypists, or teach about voice output for nonreaders? At the graduate level, seminars, independent study, or special-problems courses might focus on ways in which interaction with computers can address the special needs of children (Clements, 1983).

INVOLVEMENT OF EARLY CHILDHOOD EDUCATORS

Important issues related to young children and computers have yet to be fully addressed by specialists in early childhood education. These issues range from such basic considerations as how computer use affects children and how computers should be used in classrooms to policy and curriculum issues about what should be taught, when, and how. Investigators have already begun to collect data on some of these subjects, but more time is needed before answers are forthcoming.

Another factor related to the successful use of computers in teaching young children may be the degree to which educators choose to become actively involved in developing plans for integrating computer use into existing curricula. Teachers' input is also needed in the development and critical review of early childhood education software if computer-related activities are to be all that they could be.

Two possiblities exist with regard to development of software. Early childhood education software may become primarily

a computerized version of traditional materials, incorporating traditional methods, or it may be designed to take advantage of computer power to introduce new and different learning experiences. Teachers' involvement, especially at this early stage of software development, can make a difference. The alternative to involvement may be to have to accept by default the products of this new technology.

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