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Children and computers
The future is today

For a young child using it, the computer is capable of playing three different roles. It may tutor him or her, it may become simply a tool, or it may become something that he or she teaches, as a tutee. Derevensky discusses the effects on learning of each aspect of this tri-dimensional model, and, as a specialist in the learning of very young children, gives special attention to the educational potential of the "Logo environment", the value of which he can endorse from his own experiences.

The computer has beeped and whistled its way into the hearts and minds of children and adults, into offices, schools, and homes. As Time Magazine captured the North American spirit by naming it "Machine Of The Year" (Time, 1983), the computer has captured the imagination, interest, and hearts of tens of millions of children. The spectacular feats of the Starship Enterprise and the Millennium Falcon fail to compete with a child's enthusiasm and excitement over the control and manipulation of his personal computer.

The tremendous influx of computers has brought along its own vocabulary (e.g. "syntax errors", "debugging", "bits", "bytes", "ram", "rom", "looping"), languages (e.g. Logo, Basic, Pascal, Fortran, Cobol), and the educational quest to make everyone computer literate.

Computer literacy

In an attempt to define computer literacy the U.S. Office of Education has funded a national project to help define and measure the computer literacy of students, teachers, and administrators. According to Mourand (1983), the leading experts appear divided into two separate and distinct camps of thought. One group views computer literacy as primarily consisting of a verbal level of knowledge. Thus, the computer literate child would know some historical aspects of computers, the operational definitions of computer terminology, and some knowledge of computer applications in industrial and educational settings. While the approach is primarily conceptual in nature, minimal computer skills are in fact implied.

The second contingent's primary focus is on the "hands on model", in which the child exhibits a greater mastery in the actual use of the computer. Educators and computer scientists readily admit that a significant difference exists between children engaged in preprogrammed activities and those engaged in programming the computer themselves. Papert (1980) has postulated that future research will be directed toward understanding the attributes, talents, and skills individuals bring with them, and toward what end these skills can be realized. Thus, each individual's ability may well determine whether the emphasis should be upon preprogrammed material or upon computer programming. Whether this "hands on" school of thought will view the child learning to use the computer for word processing, skill development, and applications packages, or will expect him to use it for programming in Logo, Pilot, Basic, or Pascal remains unanswered. It is plausible that this approach to literacy will incorporate both the programming model and the appropriate usage of application programs.

As professional educators we must become dedicated to helping children fulfill all these promises. For as Papert (1980) notes, a computer culture presently exists, and the child can facilitate his own cognitive development through his control and manipulation of the environment, moving from the preoperational stage of thinking to that of formal operational thought. The computer makes the formal concrete. Thus, viewed from a cognitive developmental framework, the computer may provide yet another untapped resource in facilitating and optimizing the child's cognitive and intellectual development.

The computer as tutor

The tridimensional educational usage of computers for children (Tutor, Tool, Tutee) has been well delineated by Taylor (1980). As a Tutor, a new level of sophistication of computer use, which has its empirical basis in computer-assisted instruction (CAI), has been evolving. Specific instructional and remedial packages have been developed for children of average ability (Oliver, 1983), those experiencing specific handicaps and disabilities (Beckerman, 1983; Senf, 1983; Taber, 1983), and those with special talents and abilities (Dover, 1983; Nazzaro, 1981). Recent advances in the capabilities of microprocessing computers and in sophistication in programming has moved educational software from the dull, routine, drill-and-practice paradigm to an interesting, exciting format with emphasis on with emphasis on conceptual thought and the development of problem-solving strategies.

With the computer as a Tutor, the effects on mathematical (Suppes, 1977, 1980) and science learning have been well documented (Bork, 1980; Simon, 1983). Interactive computer-assisted testing has also been shown to be a successful learning tool as well as an evaluative device (Cartwright & Derevensky, 1976; Derevensky & Cartwright, 1977). Educational software publishing companies (e.g. Eduware, Hartley, Learning Company, MECC, Spinnaker, Sunburst, Southwest Ed. Psych. Systems, to name but a few) have been actively producing quality educational material with emphasis on skill and on factual and conceptual development. The third and fourth generation of software for microprocessing computers presently provide diagnostic subroutines, which analyze error patterns, and subsequently provide remedial intervention packages. Incorporated within these educational packages are behavioral principles (e.g. immediate reinforcement, steps with increasing difficulty) based upon the S-R theory of learning and pedagogy (Skinner, 1968) accompanied by computer graphics and/or voice synthesizers.

The scope of software is constantly expanding, beginning with the preschool child (e.g. number, letter, and colour recognition, as well as concepts in spatial relations) and continuing through graduate and post-graduate training (advanced medical seminars have been prepared and receive American Medical Association inservice credits). This mass proliferation of 'educational' software packages has not been without its problems. Although offering a larger variety, it has compelled educators to sift through a massive quantity of programs in order to identify quality packages.

The advantages of this diagnostic individualization of curriculum are numerous. Senf (1983) has noted that "microcomputer education and special education share the hallmark of individualization," which in turn tailors instruction toward the most effective learning. Individual instruction in a format incorporating computer graphics has provided a highly-motivated learning environment. Given the positive research results of the academic engaged-time model, which suggest that academic gains are dependent upon the amount of time students are actively engaged in an academic task (Berliner & Rosenshine, 1976), the use of microprocessing computers may significantly provide this direct engaged time. However, preliminary research indicates that time on task, in and of itself, may not be totally sufficient for academic gains to occur. Rather, Berliner (1979) has proposed a new model for Academic Learning Time which includes allocated time, the rate of student engagement, and the degree of appropriateness of the assigned tasks. As Derevensky, Hart and Farrell (1983) have noted, the degree of individualized appropriateness of task is equally important to academic engaged time. Thus, the computer has the various capabilities of engaging a student, maintaining his or her level of interest, and providing for him or her the appropriate diagnostic, remedial, and enrichment programs.

The computer as tool

Considerable attention has been given to using the computer as a tool for normal, handicapped, and learning disabled children. An examination of the role of the computer as a Tool returns us to the first definition of computer literacy, that being the ability to use computers and the knowledge of computer applications in industrial and educational settings. Being able to use microprocessing computers for word processing (e.g. Bank Street Writer), for business spread sheets (e.g. Visicalc), or for instructional paradigms would fulfill this criterion.

In essence, while this use of the computer may provide the child with some new information, and have it act as a mediating teacher, its use as a teaching model is unintentional and not of primary consideration. Whereas the "Bank Street Writer Tutorial Program" may be viewed as incorporating the tutor model, the word-processing package itself is an example of a functional tool.

The heavy usage of the computer as a tool has been widely advocated and accepted (Bork, 1980; Papert, 1980; Suppes, 1980) although the educational implications are somewhat limited. While using the word-processing modality greatly facilitates the child's ability to write prose text as a most positive by-product, this is an artifact of the process itself, the computer merely producing a Hawthorne effect.

The computer as tutee

If one were to assume that microprocessing computers could merely perform the function of tutor or tool, their pedagogical usefulness, applications, and popularity would be somewhat limited. Today, educators and psychologists are placing emphasis on the computer as a potential means of faciliting cognitive thinking strategies, using simulations and programming experiences. The Tutee mode for the computer suggests that programming by a student may significantly facilitate his development of abstract thinking (Doorly, 1980), of problem-solving skills (Machworth, 1974; Zuber, 1980), of combinatorial and self-referential thought (Papert, 1980), and of logical thinking (Milner, 1974; Suppes, 1977, 1980). Not only does this function works exceedingly well for average school-age children, (and clinical evidence suggests that some children aged four and five possess the ability to begin using the computer in this manner), it has been shown to work equally well with gifted children (Dover, 1983) and special education students (Davis, and special education students (Davis, 1983).

By interacting with the computer the student assumes the role of the teacher, the computer becoming the student's tutee (Milner, 1974; Papert, 1980), and the student subsequently acquires greater and more sophisticated information-processing skills. The educational benefits of a child working as a tutor in traditional educational environments have been well documented (Allen, 1976). Computer programming inherently requires the child to think about the processes involved in learning, thereby permitting him to master and control the computer and have it do the desired tasks. With the use of computer programming, whether using the Basic, Logo, or Pascal languages, the child's problem-solving skills are significantly challenged facilitating his thinking and viewing events in a new manner (Lewis, 1979). In addition, computer programming may improve and optimize the student's ability to construct conceptual models (D'Ignazio, 1981). Computer programming allows the child to take the abstract and make it concrete.

Considerable attention has been given in recent years to providing a Logo environment for young children. Taken from a Piagetian perspective, Logo is a computer language which can be both simple and powerful simultaneously (Abelson, 1982; Papert; 1980). Through the development of Logo, Papert (1980) provided n an environment for children in which they could learn by doing and by thinking about what they did. Using the Logo language a child continuously explores the capabilities of the computer, constructing and debugging objects through the use of Turtle graphics. Much has been written about the appropriateness and powerfulness of this language as a mediator of facilitating the child's conceptual thought processes (cf. Abelson 1982; Harvey, 1982; Papert, 1980; Solomon, 1982), although cautions have been expressed concerning its appropriateness for younger children at the preoperational stage of thinking (Barnes & Hill, 1983).

Conclusion: not just 'literacy'

In student-controlled or "solo-mode" computing, the individual often exhibits an unexpected raw power for eliciting complex learning behaviors which are qualitatively different from those experienced in a traditional school environment (Papert, 1980). Clinical evidence from working with children in computer-activity programs and in after-school projects with Kidbits Computing Systems clearly substantiates this view. The excitement, the task analysis, and the enthusiasm with which children approach problem-solving tasks is unequalled in most traditional educational settings. While a valid argument can be made for the use of the computer as a Tutor and Tool, it would be regrettable to limit its potential exclusively to these two modalities without considering the powerful implications of its role as Tutee.

The educational potential of the microprocessing computers remains largely undeveloped. To use the computer in one modality without examining the others, to avoid its tremendous impact as a facilitator of problem-solving skills, and to merely make children "computer literate", is to take the educational potential of computers back to the little red school house. Helping the child to view problems in a different perspective, to analyze errors (debugging), and to transfer these skills to other non-computer activities, becomes the challenge to every classroom teacher. For children and computers - "the future is today".

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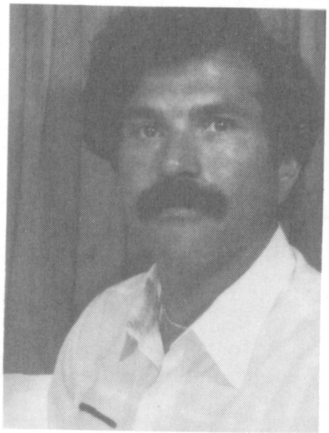

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