

# Potential and Limits of Computers in Schools

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Both grandiose claims and dire warnings have accompanied the expansion of the role of computers in American education. Providing computer literacy has become an important goal in some secondary schools. Yet many educators still lack a clear understanding of the potential and limits of the computer in the school.

## The Computer as Teacher

Computer-assisted instruction (CAI)—the computer as teacher—has been the focus to date of public schools' involvement with the computer revolution. A fundamental rationale is that this technology offers a special capability for individualizing instruction, thereby freeing the student from the rigidity and inflexibility of group instruction.

Commercial vendors have promoted this vision of the electronic classroom by stressing the presumed savings in direct instructional costs. According to some vendors, computer-assisted instruction also answers the question of how to provide instructional equal-

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*From instruction to management, computers are taking their place in today's schools. Using them effectively and getting the most value for the dollar demands planning and careful evaluation of sales claims.*

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ity for students in rural schools where small enrollments limit course offerings. It is also touted as a painless, efficient way to teach basic skills to reluctant learners.

Few educators have the technical sophistication to challenge some of this hyperbole. Awareness of the relative costs, benefits, and limitations of computer-assisted instruction is frequently minimal. Consequently, teachers sometimes assume a defensive posture, fearing they will be replaced by machines. Direct experience reveals that these fears are greatly exaggerated. Successful employment of the computer as teacher depends on many human variables, including the adequacy of the "courseware" design,

the "off-line" follow-up activities conducted by teachers, the consistency of course objectives with student interest, and the way in which the CAI experience is integrated with the student's instructional and socialization program (Thelen, 1977).

There is also a definite limit to how much time students can profitably spend working with a computer terminal. Some authorities recommend a maximum of 20 to 30 minutes a day. The computer is an intense and demanding teacher. Students generally tire more quickly than they would in group instruction involving changes of pace, wider perceptual fields, and social experiences.

As for efficiency, research suggests that learning time can be compressed with CAI. In a recent review of literature, Thomas (1979) concluded ". . . it is clear from the studies reviewed at all levels, that CAI reduces the time required for a student to complete a unit." Edwards and others (1974) concluded, on the basis of the sparse research available at the time, that long-term retention appeared worse



for CAI than for conventional instruction, but Thomas noted that studies reported since then "lean more toward equal retention."

Administrators should note that if the rate of learning were to be accelerated for all learners using CAI, there would certainly be no savings. The way schools now operate, students would cover, and perhaps retain, more material during their schooling, but there would be a need to extend the scope of the curriculum, resulting in increased instructional and material costs. On the other hand, if school systems were to adopt the provisions of California or Florida for early graduation through proficiency testing, they might save some money by adopting CAI.

### The Computer as Manager

Education, like most other sectors of our society, has been deluged by the paperwork of record keeping and documentation. As a result, long before questions about the adequacy and appropriateness of computer teaching are resolved, the computer will be institutionalized in the American school as a management tool.

In education of the handicapped, for example, the individualized educational programs demanded by law consume resources voraciously. In conducting individualized instruction, teachers must maintain detailed records of stu-

dent performance and match students with instructional resources. These responsibilities force instructional resources to be shifted from direct service to costly clerical functions. Moreover, individual items of information become increasingly difficult to find and interpret as records accumulate.

This in itself has created a vast market for computer manufacturers and a prime job market for computer experts. Control Data Corporation, for example, is hard at work designing computer systems to assist the teacher in maintaining organized and immediately accessible information. The paperless classroom with computer-managed instruction (CMI) "... guides each student through a curriculum along a learning path which is designed by the student's instructor, maintaining records of student achievement for use in evaluating the effectiveness of the educational resources" (Control Data Corporation, 1977).

Beyond assisting teachers in the management of instruction, computers have already proven their value in school business management. Purchasing, budgeting, inventories, forms, management, personnel, "compliance" management, and the reporting of data requirements by the government are all part of the educational leadership role. Computers are able to perform management functions in each of these areas.

Until recently most educational applications of computing have involved the use of "time-sharing" systems in which large central computers are linked through a telecommunications network to terminals located in widely distributed schools. There are, however, a number of disadvantages to this system.

First, telecommunications between the school and the central "networked" computer may cost several thousand dollars a year, in addition to membership fees, also amounting to thousands of dollars. Second, what happens at "the other end of the line" is not well understood by school administrators. Often the information produced is not easily understood or useful to school personnel in conducting their daily business. Third, the computer system down-time and the busy signals encountered during times of high system use, usually during school hours, further promote user disenchantment.

### The New Wave: In-House Microcomputers

Partly as a result of these drawbacks, microcomputers designed to function on their own or to double as terminals for central processors are drawing increasing attention. One of the reasons for the expanded capability of microcomputer systems and steep declines in equipment costs has been the development of small integrated circuits, originally used in the space program. This advance has permitted an incredible degree of miniaturization with many attendant savings in manufacture and maintenance.

The demonstrated capabilities of microcomputers selling in the \$800 to \$1,800 range compare favorably with those of large time sharing interactive systems. Courseware is emerging that provides drill and practice, simulations, tu-





torial instruction, graphic displays, and animation.

The trend toward individualized instruction and precision teaching has also led to the increased use of microcomputers in management of diagnostic and prescriptive information. For example, at St. Thomas District High School in Braddock, Pennsylvania, a microcomputer was used to manage student progress and objectives (Duch, 1979). Kehler (1977) reported the successful use of microcomputers in the teaching of analytic grammar. In another recent application Baker (1978) concluded that the test scoring and psychometric analyses performed by microcomputer were as adequate as the results obtained from larger time sharing systems.

An appealing feature of microcomputers is the ease of access to hardware they provide for students and the consequent heavy use rate. A statewide survey in 1978 of microcomputer users in Minnesota disclosed that the equipment was used almost constantly during school hours, with students consuming 95 percent of the computer time logged. One reason for the high rate of use is that, being present in the classroom and subject to the control of individual users, the machine comes to be viewed as the tool it is rather than as a mysterious oracle.

Microcomputers are no panacea, however. Despite the increasing availability of courseware from commercial sources such as Micronet TM, schools are likely, at least for the near future, to need to develop capabilities for custom programming of courseware. The Winnipeg school system, for example, spent \$36,000 over three years on courseware development for microcomputers and still more development is needed (Sandals, 1979). While the programming language used with microcomputers, BASIC, is relatively easy to learn, it is rare for teachers or principals

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to possess sufficient programming expertise to allow them to develop their own CAI and CMI programs. This is a serious limitation because one of the presumed advantages of a microcomputer is the capability it offers for tailoring programs specifically to local needs. Where staff programming skills are unavailable, hiring a programmer will be necessary. The Ortonville, Minnesota, school system trained its own high school students as microcomputer programmers to work with teachers in creating courseware suited to their needs (Joiner and Silverstein, 1979).

Another approach to the microcomputer programming problem is to draw upon available courseware and software developed by or for users of the large time sharing systems. In Minnesota, for example, numerous local school districts have access by telephone to programs stored in the Minnesota Educational Computer Consortium's central library of programs. Many of these programs are being converted to microcomputer application by local users. After conversion, the programs are "uploaded"; returned to the central library via telephone line for storage and further dissemination.

From a technical standpoint, microcomputers are a long way from perfect. A 1978 survey in Minnesota reported that educators using these systems had found a number of weaknesses, including the lack of computer-assisted instruction languages for microcomputer application; limited ability to perform repetitive calculations and

limited ability to store and recall large data files.

Educators should beware of microcomputers sold as "blank slates" that must be programmed from scratch. Although these devices possess the potential to perform instructional and analytic tasks, many hours of technical assistance may be required to create the necessary programs. Mathews (1978) warns that most of today's microcomputers do not have sufficient courseware to make them useful for classroom instruction "off the shelf."

### **Implications for Professional Development**

To realize the full potential of microcomputers, schools should provide either preservice or inservice courses for teachers in computer-assisted instruction, computer-managed instruction, microcomputer programming, and computer applications. This may be easier than it sounds. Once exposed to using computers in their classrooms, teachers tend to become interested in developing skills so they can develop their own student-oriented courseware (Joiner and Silverstein, 1979).

An indirect benefit of involving teachers in the development of courseware is the increased sensitivity they often gain to the organization of information and the learning process. By observing students using microcomputers for instruction, teachers could also detect flaws in existing courseware. The cumulative improvements could



benefit not only themselves, but everyone using the system.

### Comparing the Costs

Engineering and marketing trends suggest that microcomputer capabilities will increase while costs decrease (Bork, 1978; Sturdivant, 1977). There is a great deal of variation in hardware costs, however, depending on the configuration selected to meet user requirements. At present microcomputer prices range from \$600 to \$20,000+, depending on the type of microprocessor and auxiliary devices added.

Comparing the costs of microcomputer and time sharing systems is difficult and sometimes deceptive because they are often used in combination to complement each other. Although microcomputers themselves are relatively inexpensive, the prospective purchaser should ask a number of questions relating to the onsite application that will help determine overall costs.

1. Will the microcomputer serve as a terminal in a timesharing system? If so, what are the membership and telecommunication costs?

2. How many microcomputers will need to be acquired to adequately serve the projected demand level of the school?

3. What are the costs of: (a) teaching computer programming; (b) teaching computer literacy; (c) computer-assisted instruction such as educational games, drill and practice, tutorials, problem solving, and sensory motor training; (d) computer-managed instruction such as testing, recording student progress, student files, and IEP's; and (e) business management such as monthly reports to the school board, payroll, mailing labels, vouchers, accounts receivable and payable, student scheduling, optimized bus routes, and personnel records?

4. How will equipment distribution and programming be handled? Who will do it, at what cost?

5. Will staff need to be trained? Will this be done through inservice? Who will provide the training? At what cost, to whom?

6. How will existing courseware and software be acquired? What will it cost?

7. How will courseware and software development needs be identified? How will these needs be prioritized and met?

8. What is the anticipated life of the hardware? How should it be amortized?

9. What service provisions are available from the manufacturer? How remote is the service facility? What is the turn around time for repair?

10. What about Parkinson's Law? Will work expand to fill the available computer resources?

11. Will any material purchases be reduced by the computer application, such as workbooks or remedial kits?

12. How will computer-assisted instruction be integrated with existing curriculums?

Careful consideration of these questions will help school administrators appreciate the complexity of cost considerations relating to computers. Some of these factors could go overlooked if one were to consider only the promotional literature provided by computer manufacturers. *ET*

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