Conditions That May Affect the Further Application of Information Technology in Education

The development of good-quality software is a major barrier to the educational application of information technologies. Here at Oxford High School, Oxford, Mass., educators are preparing course material for a summer workshop for computer educators from across the State of Massachusetts. The conferees review published material as well as on-line computer software for inclusion in their courses

Conditions That May Affect the Further Application of Information Technology in Education

When attempting to forecast how, when, and where information technology might be utilized in the education process, particularly by publicly funded institutions operating on the elementary, secondary, and postsecondary level, it is necessary to look at what is and what is not known about present uses and potential applications. While certain forms of information technology-television, for example-have been in use in education for a number of years and maybe evaluated based on widespread applications (e.g., the programming developed by the Children's Television Workshop), other forms of technology-such as the microcomputer and the video disk-are relatively new and in what might be described as the initial stages of utilization.

Whether or not these technologies live up to their potential in educational environments such as the school, the workplace, and the home is difficult to predict, even in light of successful demonstrations made possible through public and private funding. A discussion of what is known about current conditions and common perceptions in segments of the education community where technologies have had some impact *and* a description of perceptions of hardware and software vendors about the structure and potential of the education market are the best means to gain an understanding of the circumstances that now prevail.

Available Data on Educational Applications

Since few measures have been made of how information technology is presently being applied in public and private schools, this discussion is limited to interpretations of data collected about the use of microcomputers, terminals, video cassette recorders, and video disks.

Microcomputers and Terminals

Based on results of a 1980 survey of a sample of 579 of 15,834 school districts in the United States, it was projected that about one-half of all districts had one or more computer terminals available for student use. Within these districts, approximately one out of four schools (or one-half of all public institutions on the secondary level, 14 percent of those on the elementary level, and 19 percent of the vocational, special education and other types) had at least one microcomputer or terminal dedicated to student instruction (see table 27). This number seems large in the aggregate. However, within individual school districts computer availability to individual students is severely limited. About 18 percent of the local education agencies—the majority small districts of 2,500 students or less–had no plans to initiate computer-based student instruction for the following 3 years (see table 28). It was determined that some 52,000 microcomputers and terminals were scattered throughout local school districts for student use, with microcomputers outnumbering terminals by 3 to 2.[1] A 1982 industry survey con-

---

[1] *Student Use of Computers in Schools* (Washington, D. C.: National Center for Education Statistics, 1981).

Table 27.—Public School Districts Providing Students Access to at Least One Computer for Educational
Purposes: United States, 1980 (table entries are school districts providing access)

Type of access	Total (at least one level) (1)	Elementary level (2)	Secondary level (3)	Combined elementary/ secondary schools and special schools (4)	More than one level (5)
			Type of school, by grade level		
At least one microcomputer or one terminal	7,606	2,196	6,161	678	1,884
			(in percents of column 1)		
At least one microcomputer or one terminal	7,606	29	87	9	25
At least one microcomputer	6,631	29	84	9	22
At least one terminal	2,973	21	99	5	25
At least one microcomputer *and* one terminal	1,998	17	95	3	15

NOTE :Column 1 represents the unduplicated number of districts providing access to computers at any level, Since some districts make computers available at more than one type of school, the percepts in cols. 2-4 include duplicated counts of districts. The difference between the total duplicated counts (cols. 2-4) and the unduplicated count (col. 1) represents the percent of districts providing computer access at more than one level (col. 5).

SOURCE: *Student Use of Computers in Schools* (Washington, DC.: National Center for Educational Statistics, 1981).

Table 28.—Availability of Computers Within Districts: United States, Fall 1980

By number of computers per district

Number of available computers per district	Districts providing access To microcomputers	To terminals
At least one	6,631	2,973
	(in percents)	
At least one	100	100
One	40	35
2-4	37	37
5-1o	13	14
11-20	6	6
More than 20	3	8

By the number of schools with access, per district

Number of schools with access per district	Districts providing access At elementary schools	At secondary schools
At least one	2,196	6,616
	(in percents)	
At least one	100	100
One	56	68
2-4	24	25
5-10	13	6
11-20	4	(a)
More than 20	3	(a)

¹Fewer than 1 percent

NOTE: Percents may not sum to 100 because of rounding.

SOURCE: *Students Use of Computers in Schools* (Washington, D.C.: National Center for Education Statistics, 1981).

ducted by Strategic, Inc., provides forecasts of microcomputer usage in public and private elementary, secondary, and postsecondary schools as well as projections of micro-computer courseware sales through 1990. Assuming a total new shipment base of 36,000 units of hardware in 1980, there will have been, by the end of 1990,2,030,000 such shipments to schools. In addition, by the end of 1990 the installed base of microcomputers will grow from 70,000 in 1980 to 8,860,000, with the average cost per unit dropping from $2,100 in 1980 to $1,100.[2] Computer courseware sales are expected to increase during the same period from $4.7 million to $257.5 million. If the projected aftermarket (the sales carried over from previous years, including course-ware sold with microcomputer systems and re-placement software) is factored into the pro-jection, the total sales figure is expected to rise from $6.4 million in 1980 to $599.1 million (see table 29.)

In yet another study of the potential 1980 educational market for hardware sales, schools represented the smallest of five potential markets. The other four—in rank order—were small business, scientific, home and office, but a projected growth rate of 300 percent by 1985 would place annual sales at $145 million by that year.[3] However, by 1985, the school

[1]The newest generation of home computers now sell for be-tween $300 and $1,000, which has made it possible for many more parents to consider purchasing them as educational aids for their children ("The Home Computer Arrives," *New York Times,* June 17, 1982, D-1, D-6).

[2]Interview with Denis P. Hoye, Director, U.S. Client Services, Strategic, Inc., San Jose, Calif., regarding report entitled *Up-date on Educational Software: Converging Technologies and Strategies,* report No. 1500, 1982.

Table 29.—Total Shipments of Microcomputers in Public and Private Schools Operating on the Elementary, Secondary, and Postsecondary Levels and Forecasts of Courseware Sales

Total shipments	1980	1985	End of 1990
Total new			
shipments . .	36,000	600,000	2,030,000
Installed base .	70,000	1,630,000	8,860,000
Average cost			
per unit	$2,100	$1,600	$1,100
Courseware sales			
New courseware			
sold	$4.7 million	*$77.3* million	$257.5 million
Aftermarket			
sales (carry-			
over from			
previous			
years and			
courseware			
sold with			
systems). . . .	$1.7 million	$51.5 million	$341.6 million
Total	$6.4 million	$128.8 million	$599.1 million

SOURCE *Update on Educational Software: Converging Technologies and Strategies* (San Jose, Calif. Strategic, Inc , 1982)

market was projected to grow at a rate of 300 percent, placing annual sales at $145 million by that year.

Other factors complicate this picture of market potential. In a 1981 study of 15,442 school districts, it was found that 42 percent had at least one microcomputer (6,441) with 43 percent of these being senior high schools. Junior high and high schools with larger enrollments were found to be the most likely to have acquired microcomputers, as were those schools with per-student instructional materials budgets of over $60,000.[4]

"Market Survey Discovers Where the Micros Are, " *Electronic Learning,* March/April 1982, p. 14.

Video Cassette Recorders and Video Disk

The growth rate of the general market for video cassette recorders is expected to be very high, based on 1980 estimates of 1.5 million recorders and 6 million prerecorded cassettes sold. However, there are no projections that differentiate the education or school market from other markets such as the home, so growth in this type of utilization is hard to predict.[5]

Views differ about the potential popularity of video disk, even in light of successful programs such as the "First National Kidisc." One study estimated that sales to all types of consumers were less than 50,000 in 1980, although manufacturers predicted that 250,000 units and 5 million video disks would be sold in 1981.[6] Another market analysis, conducted by Strategic, Inc., in 1982, suggests that by 1985 when educational programs and disks become more widely available, over 250,000 video disk players integrated with microcomputers will be in use. Again, this analysis does not isolate the school market. At present, Department of Education officials estimate that there may be less than 100 video disk units in place in schools.[7]

"Videopublishing: Licensing, Manufacturing and Distribution, " *LINK Research Memorandum,* vol. *2, No. 15,* December 1981.
Ibid.
[7]F. B. Withrow and L. G. Roberts, "The Videodisc: Putting Education on a Silver Platter," *Electronic Learning,* May/June 1982, pp. 43-44.

Climate for Use of Information Technology in the Schools

Information gathered in this study about the use of information technology in selected school districts seems to indicate that the computer-based education is far and away the most accepted at this time. As the case studies in this report illustrate, computer literacy programs for instructors and students represent the most common use, followed by drill and practice and some simulation exercises. Computer literacy courses are particularly popular in some areas on the junior high level.[8]

8A. Luehrmann, "Computer Literacy: What It Is; Why It's Important, " *Electronic Learning,* May/June 1982, PP. *20, 22.*

A 1980 survey of school districts sponsored by the National Center for Education Statistics (NCES) confirms the widespread frequency of computer literacy courses within schools with at least one terminal or microcomputer. NCES also cites cases where the computer has been used to improve student learning in selected subject areas and to stimulate high achievers. Less than half of the districts responding to the survey utilize the computer in remedial and compensatory programs. When sample districts contacted in the course of the survey were asked to identify operational and planning needs critical to the initiation of use or to the expanded use of computer-assisted instruction, the two most frequently mentioned were teacher training and greater variety of instructional software programs.

Approximately one-third of all districts indicated the need for assistance in program planning, technical support once programs are initiated, and financial assistance for hardware and software purchases.[9] Taken together, the OTA case studies of local school districts show that funding often became a critical factor in the use of computers in education, especially in light of reductions in Federal support to schools, as well as diminishing State and local resources. When traditional funding sources in these districts were insufficient or unavailable for establishing computer programs, com-

puter manufacturers or foundations were approached and/or individual parents or PTAs made donations. These efforts were not equally successful, since local communities vary significantly with respect to the level of resources that they can make available for educational activities.

The lack of available courseware was also identified in the case studies as a major obstacle to initiation and/or expansion of computer education programs in schools. Often, when hardware is available and when instructors have a positive view of it, the lack of commercial courseware induces teachers to create their own courseware either through use of school purchased authoring systems or other means. The quality of this courseware varies significantly, frequently because instructors have mastered—usually on their own initiative—only the basics of the authoring system or programing language.[10]

In some instances, the price of the courseware may be an obstacle to more widespread computer use. Table 30 includes information on the average prices, which range from $37.00 to over $200.00, for courseware available for sale through industry, Government, and foundations.[11]

---

[9]National Center for Education Statistics, op. cit.

[10]A. Bork, *Large Scale* Production *and Distribution of Computer-Aided Laming Modules (Irvine,* Calif.: Educational Technology Center, University of California, n.d.).

[11] Th₌Education] *Microcomputer Software Market* (Oak Park, Ill.: TALMIS, 1981).

Table 30.-The Educational Courseware Industry

Developer/distributor	Investment		Sales		Production	
	Total	Average	Total	Average/median	Number of products	Average price
	(× 1,000)		(× 1,000)			
Scott Foresman.....................	$1,000[a]	$1,000[a]	(b)	(b)	10	$208.38
Other ED./AV Publishers	$2,121	$177	$1,3371	$99/$45	66	$203.31
Hardware manufacturers	$665	$166	$1,670	$418/$165	65	$50.75
Software houses	$1,574	$87	$4,526	$242/$100	302	$48.75
Small developers[c]	$4,800	$31	$2,500	$15/$10	1,500-2,500	$37.73
Government foundations	$1,100	(d)	$600	(d)	111 (sample)	$60.00
Total	$11,260	$40	$10,667	$37/$50	2,000-3,000	$50.03

NOTE: All data provided is for the period July 1980 through June 1981 only. Only products available during that period are included.
[a]Published approximations: TALMIS does not report any financial information by company.
[b]TALMIS does not report any financial information by company.
[c]Extrapolated from an 11% sample (see app. IX).
[d]Data insufficient.
SOURCE: TALMIS Annual Report, 1981.

Incorporating the use of the computer in a traditional school environment-characterized by set class schedules, primarily daytime programs-can present some complex problems, even if the technology is highly valued as an effective and efficient instructional resource. Teacher resistance may also be a factor, in the use, or the extent of use, especially if limited school budgets have resulted in heavier teaching loads and less time for teachers to consider possible new pedagogical approaches. A lack of understanding of the potential of the technology in the classroom and the lack of instructor knowledge of programing or use of authoring packages for courseware development may also determine if and how information technologies will be applied.

Hardware and Educational Software Vendors: Views of the Education Market

In addition to conditions that might affect the use of technology in the schools, there are certain circumstances that may have a bearing on how producers of hardware and educational software approach the education market–in particular, publicly funded institutions.

For several years, hardware producers, especially manufacturers of microcomputers such as Tandy, Apple, and Commodore, have attempted to develop the school market while cultivating the home market. Apple and Commodore have in some instances placed micros in schools free of charge, in order to create awareness in teachers and administrators as well as to create opportunities for experimentation. In most instances to date, the companies were responding to requests of school districts. Apple and other producers have also been active in pushing for Federal legislation that would create tax incentives for the donation of computers and related equipment to elementary and secondary schools. H.R. 5573, "The Technology Education Act of 1982, " introduced in the 97th Congress calls for raising the maximum allowable corporate charitable contribution from 10 to 30 percent of annual income. The bill was stimulated by Apple's offer to donate computer centers to 75,000 elementary and secondary schools—a gift valued at between $200 million and $300 million.

The central problem faced by microcomputer producers and manufacturers of other types of hardware, such as the video cassette recorder and the video disk, is that they cannot define the real potential of the school market either in its individual segments or in its aggregate form. A recent industry-sponsored market analysis for video disk, for example, cautioned against being overly optimistic about sales to all types of consumers over the next few years.[12] And, as is illustrated by the variety of different projections on microcomputer sales in general and potential sales to educators in particular, the future response to this technology is still open to question. Because of these uncertainties, using existing sales strategies with the school market as a way of testing the market potential without having to add significantly to market overhead. However, this approach may further impede potential sales, if hardware and software specialists unfamiliar with curriculum design and other aspects of school administration attempt to sell to educators.

"*LINK Research Memorandum,* op. cit.

Conditions Affecting Commercial Courseware Development

A recent issue of *Electronic Learning* contains a directory of zoo educational software producers.[13] An industry-sponsored study conducted in 1980 identified some 304 educational software developers—including traditional print publishers, hardware manufacturers, software firms of various sizes, and foundations and government-sponsored projects (see table 31). Although, these numbers would seem to suggest that the educational courseware business is thriving, this is not the case. There is considerable skepticism—especially within the software industry-about the school market and its potential. Industry representatives interviewed in the course of the 1982 Strategic, Inc., survey were concerned about the difficulty of segmenting the software market in order to develop products targeted to particular grade levels and subject matter needs. Print publishers who have entered the industry are doing so judiciously in most cases by adapting existing textbooks to machine-readable form or by creating software to enhance existing textbooks and other hard-copy materials. This situation differs from that in the software development market for personal computers where there are now some 1,000 active firms and over 5,000 available programs.[14] Some hardware and software firms have developed authoring systems for use by educators, but commercial courseware now available does not meet many of the needs of local school systems. Courseware quality is also of concern to some educators. At the same time, the up-front costs associated with courseware development—estimated by one industry representative at over $250,000 per package—is more than most firms, given the market uncertainties, want to risk on an "unknown quantity. " The Department of Education's recently announced "Technology Initiative" provides for matching funds to be made available to commercial software devel-

---

[13] " Electronic Learning Software Directory," *Electronic Learning,* May/June 1982, 1-A-1O-A.
[14] "Using Personal Computers, " *LINK Research Report,* vol. *3,* No. 1, 1982.

Table 31.—What Are the Industries Competing for Business

Education/AV publishers—Companies traditionally supplying books and AV products to the school marketplace.
  12 companies during the period under study (18 with products as of September 1981) including:
    Educational Activities
    Milliken
    Random House
    Scott Foresman
    SRA
    Society for Visual Education
    Sterling Swift Publishing

Hardware Manufacturers-- Microcomputers manufactures developing courseware products for the schools.
  5 companies, including:
    Apple
    Atari
    Commodore
    Tandy
    Texas Instruments

Software houses—Software companies selling more than $85,000 in courseware or companies with total software sales over $150,000.
  19 companies, including:
    Brain Box
    Creative Computing Software
    Data Command
    Edu-Ware
    Hartley Software
    Micro-Ed
    MicroSoft
    MUSE
    Programs Design, Inc.

Small developers-Software companies selling less than $85,000 in courseware and with total sales of all products less than $150,000.
  Approximately 250 companies (13.6°/0 sampled for this report-see app. IX), including:
    Avant-Garde Creations
    Betamax
    Bluebird's
    Cook's Computer Co.
    Custom Computer
    Educational Courseware
    Micro pi
    Teacher's Pet
    T. H. E. S.I.S.
    Teach Yourself by Computer

Foundations and Government-sponsored projects—Orga- nized development and dissemination projects sponsored by private foundations, schools, and local, State, or Federal Government.
  Approximately 12 agencies, including:
    Apple Education Foundation
    CONDUIT
    Department of Education
    MECC
    National Science Foundation

SOURCE: *The Education/ Microcomputer Software Market* (Oak Park, Ill,: TALMIS, 1981),

opers to assist in the creation of courseware for the schools that, because of market size, may not otherwise be developed. It is still unknown, however, whether this incentive will be sufficient to attract more commercial interest.

Summary of Current Conditions

Given what is known about present applications of information technology in the schools, it is clear that the use of computers and other forms of technology is far from being institutionalized at this time. Limited school funds, educators' limited recognition of the potential of the technology, limited computer literacy among instructors and students, and the limited variety and range in high-quality, commercial courseware have all contributed to this situation. It is difficult to predict when or if conditions in publicly funded educational institutions will change. However, expanded use of information technology-especially computers—in the home and in the workplace may result in pressure from parents, students, and even employers on local school districts to utilize technology in the instructional process.