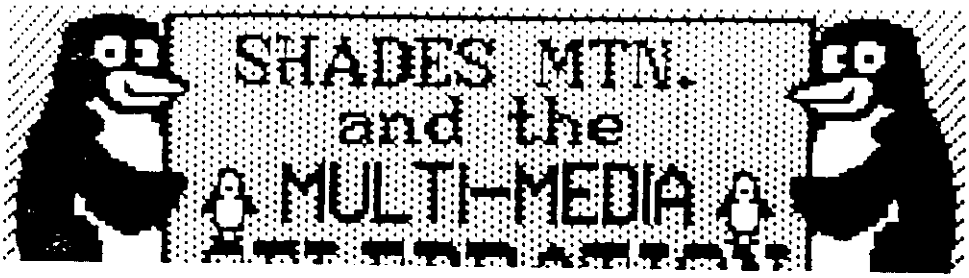
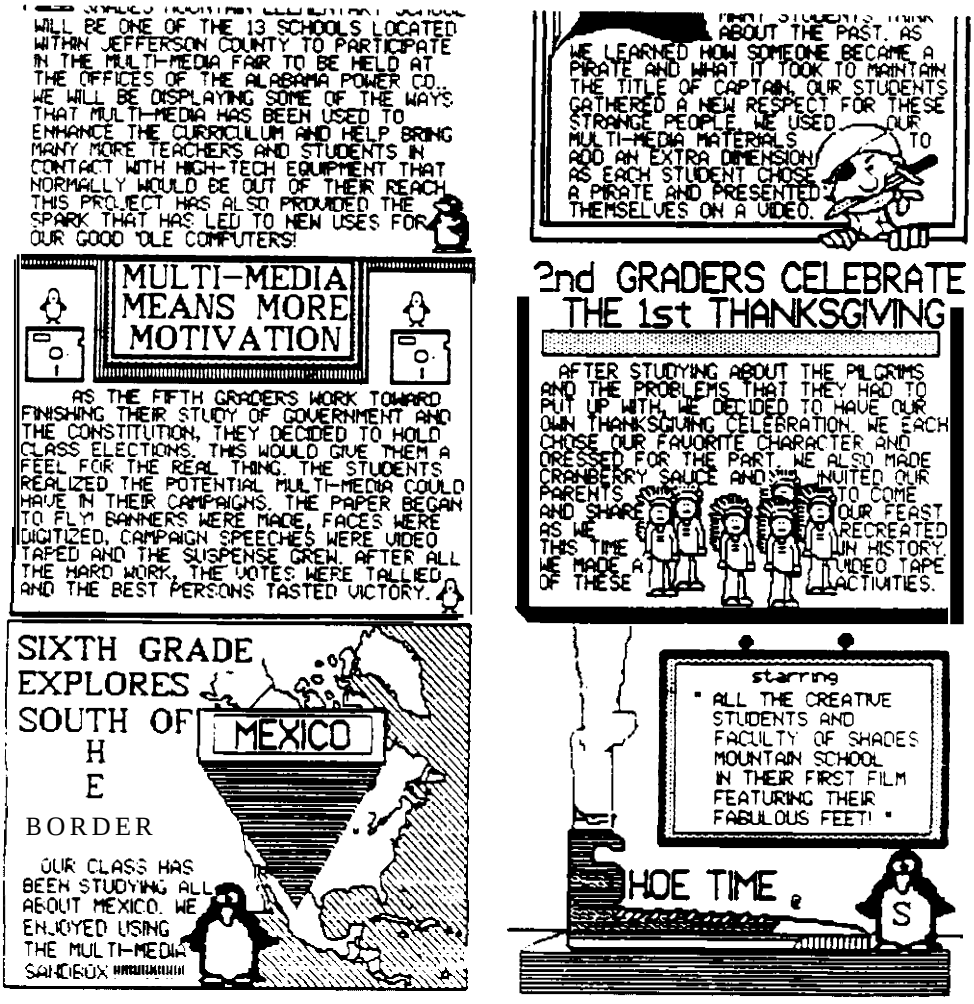


Chapter 2

Interactive Technology in Today's Classrooms



Credit: *Shades Mountain Elementary School. Hoover,* ***Alabama***

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Chapter 2

Interactive Technology in Today's Classrooms

The information age has arrived, and most societal institutions are experiencing profound changes as a result.

Samuel Y. Gibbon[1]

FINDINGS

- There are currently between 1.2 and 1.7 million computers in U.S. public schools. Over 95 percent of all elementary and secondary schools now have at least one computer intended for instructional use, compared to 18 percent of schools in 1981.
- The current installed base provides an average of 1 computer for every 30 children enrolled in U.S. public schools. School size as well as socioeconomic status of students are important determinants of the ratio of students to computers. However, actual student utilization of the technology depends on many other factors, including the organization of computers in laboratories or classrooms, the availability of appropriate software, and the presence of qualified and interested instructors.
- Differences in access to computers between black and white students have abated as more schools have acquired computers. Gender differences in student access and utilization tend to dissipate when computer use is highly structured and closely linked to the curriculum.
- Acquisition of video technology by schools has grown appreciably, following the pattern of computer acquisition. Today some 91 percent of all public schools use video technology (videocassette recorders, VCRs) for instruction.

[1]Samuel Y. Gibbon, "Learning and Instruction in the Information Age," *What Curriculum for the Information Age?* Mary Alice White (cd.) (Hillsdale, NJ: Lawrence Erlbaum Associates, 1987), p. 1.

ADOPTION OF COMPUTER AND VIDEO TECHNOLOGIES: A DECADE OF GROWTH

Currently there are between 1.2 and 1.7 million computers in U.S. public schools.[2] Since the 1981 academic year, when data on computer use in schools began to be collected, the number of public schools with computers has grown from about 15,000 to about 77,000, representing an average annual increase of about 11 percent (see figure 2-1). Peak growth occurred between 1983 and 1984, when 55 percent of the schools without computers acquired at least one (see figure 2-2). There are now computers in at least 95 percent of the 81,000 public schools (see figure 2-3).

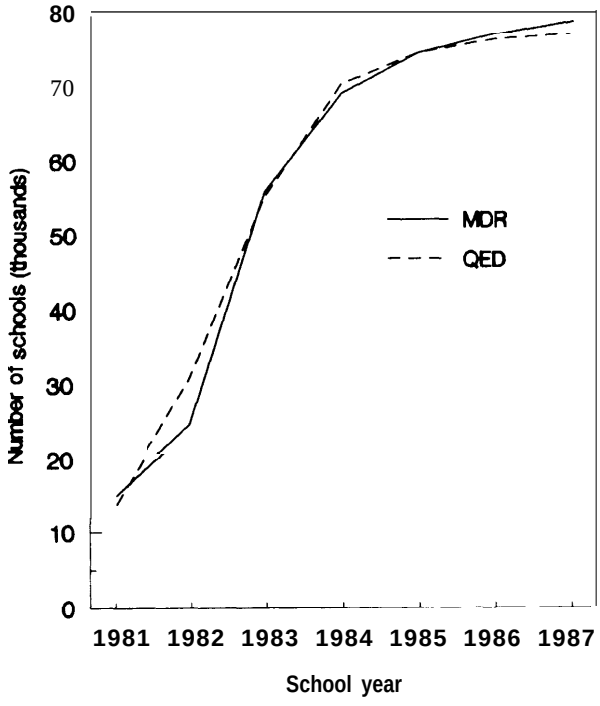
School adoption of the VCR, easily the second most prevalent new technology of instruction, started off a bit more slowly. In 1982, for example, when 37 percent of the schools had computers, only 31 percent had video. But by 1987, some 91 percent of schools were using video, close to the 95 percent that had computers[3] (see figure 2-4).

This record of growth is impressive, and clearly suggests a widespread willingness on the part of

[2]Market Data Retrieval, Inc. and Quality Education Data, Inc., the leading market research firms specializing in school technologies, estimate the 1988 total at about 1.2 million available for instructional use. TALMLS, on the other hand, a firm that collects data on the computer industry more broadly, reports a total current base of 2.03 million, of which about 375,000 are in private schools. Finally, *T.H.E. Journal*, a prominent educational technology magazine, reports the highest figure, 2, 1 million overall, with 1.7 million in the public schools, based on their recent survey. Variations among these estimates are due largely to differences in sampling methodology and timing of surveys.

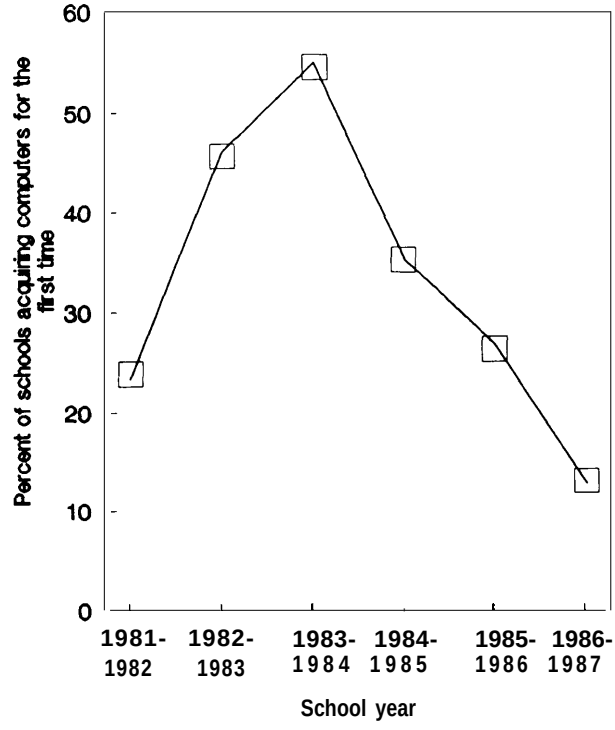
[3]Quality Education Data, Inc., personal communication, May 1988.

Figure 2-1 .—U.S. Public Schools With Computers, 1987-88'



[a]Total number of U.S. public schools: approximately 81,000.
SOURCE: Office of Technology Assessment based on data from Market Data Retrieval, Inc., and Quality Education Data, Inc., 1988

Figure 2-2.—Annual Rate of Adoption of Computers in U.S. Public Schools, 1981-87[a]



[a]This graph shows the annual acquisition of computers among schools which had no computers in the previous year
SOURCE: Office of Technology Assessment based on data from Quality Education Data, Inc., 1988.

school districts, schools, teachers, and parents to explore the possibilities of the new learning technologies. Schools have not embraced the new information tools as enthusiastically as American business firms, where office automation and computer-based data processing are ubiquitous; but they have shown an extraordinary eagerness to adapt these technologies to classroom teaching and learning. According to at least one prominent educator and advocate of increased use of electronic information tools, the U.S. has quickly become a world leader in its attempts to integrate computer-based learning in public schools. [4] In a period of less than 10 years, computer-based technologies were introduced to students with quite different intellectual and behavioral needs by teachers and administrators of varied backgrounds, experience, and technical skill, working in schools of diverse demographic, racial, ethnic, and economic composition. Indeed, the available evidence points to a remarkably high rate of use: as of 1985, the latest year for which such data are available, less than 5 percent of the computers or terminals on school premises were not in use. [5]

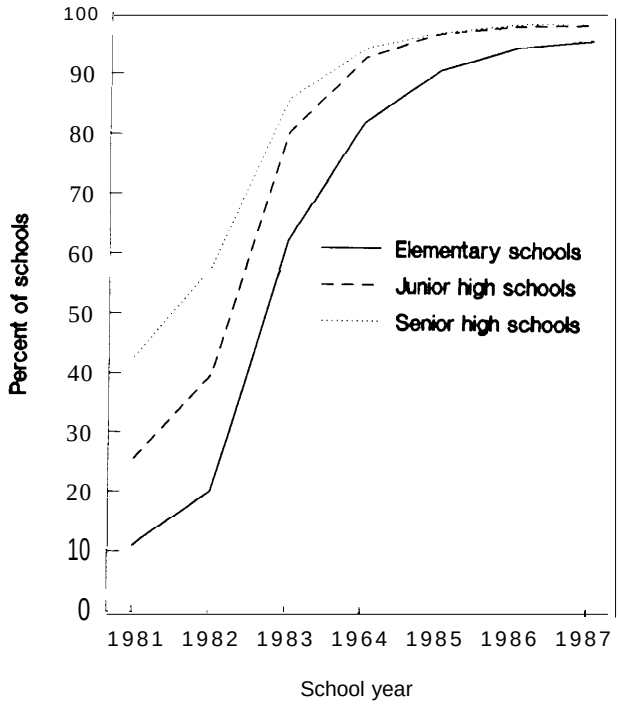
Effects of Widespread Distribution

These growth statistics tend to obscure an important fact about the rate and magnitude of computer acquisition. As of 1985, only half of the computer-using high schools and 6 percent of the computer-using elementary schools had 15 or more computers in any one classroom; it is doubtful whether all or even half the students in typical classrooms had ac-

[4]Speaking at the 1987 National Educational Computing Conference in Philadelphia, Mary Alice White noted that American public school adoption of computers in the last 7 years was the largest and fastest in the world.

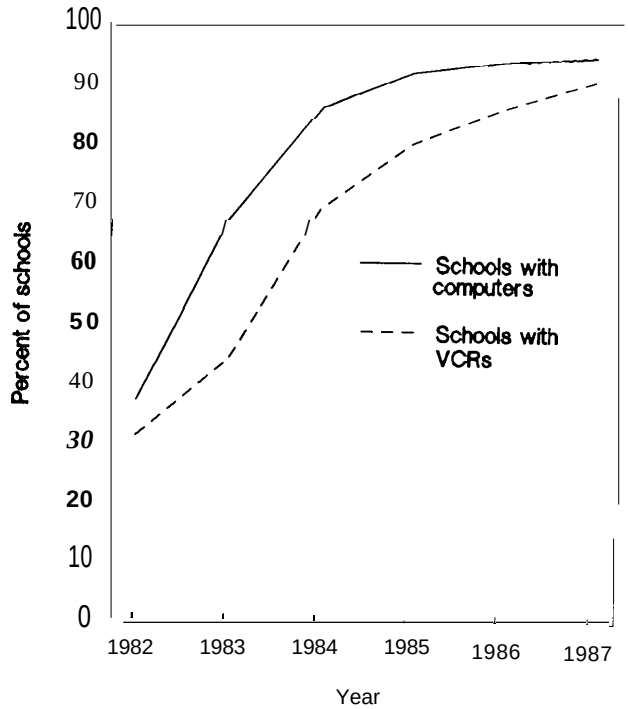
[5]This figure is based on unpublished data from Henry Becker's survey of school use of computers. For more information on this survey see Henry Becker, Center for Social Organization of Schools, The Johns Hopkins University, "Instructional Uses of School Computers: Reports From the 1985 National Survey" Issue No. 2, August 1986.

Figure 2-3.— U.S. Public Schools With At Least One Computer, by Grade Level, 1981.87



SOURCE Off Ice of Technology Assessment based on data from Market Data Retrieval, Inc , 1988

Figure 2-4.—VCRS and Computers in U.S. Public **Schools, 1982.87**



SOURCE: Office of Technology Assessment based on data from Quality Education Data Inc., 1988

cess to computers.[6] Most schools still do not have the quantity of computers that would be necessary to make them an integral part of the instructional day. Note, however, that the available data show differences by grade level in acquisition patterns and in the size of the installed base. As shown in table 2-1, very few elementary schools have a large number of computers, while over half the high schools do.

Broad diffusion of the new technology characterized the first decade of this instructional innovation. Perhaps a more selective introduction of computers and software could have been more effective at achieving certain well-defined instructional goals.[7]

[6]Henry Becker, Center for Social Organization of Schools, The Johns Hopkins University, "Instructional Uses of School Computers: Reports From the 1985 National Survey," Issue No. 1, June 1986.

[7]See, for example, James W. Guthrie, "Campaign '88 and Education: A Primer for Presidential Candidates," *Phi Delta Kappan*, vol.69, No. 7, March 1988. The author writes: "The prevailing strategy for introducing computers in U.S. education has not been to find effective ways to supplement human instruction, hut rather to ensure that each student has an **equal,** if inadequate, number of minutes each day on the computer" (p. 51 6).

There is a general consensus, however, that decentralized acquisition and implementation created an exploratory atmosphere in which students' learning styles, teachers' pedagogical methods, and various approaches to software design could be tried.[8] Preliminary results from this "natural experiment" are just now coming in (see, for example, chapter 3), and while there is already a basis of data on which to formulate strategies for the next round of technology implementation and utilization, there is still a need for open-mindedness and ongoing evaluation.

Student Access to Computers

Today's inventory of school computers translates to a rough average of 1 computer for every 30 chil-

[8]For an alternative view espousing greater State-level targeting of computer resources, see Stanley Pogrow, "Policy Recommendation> for Developing Appropriate Uses of Technology in California Schools, " testimony before the Assembly Committee on Economic Development and New Technologies, California State Legislature, on the Educational Technology Local Assistance Program, Jan. 5, 1988.

Table 2-1.– Distribution of Schools by Computer Inventory, 1987=88

Schools with computers	Number of computers 1	2-5	8-10	11-20	21+	Total
Elementary	5,388 (11.2°/0)	13,164 (27.3%)	13,059 (27.10/o)	12,647 (26.30/o)	3,900 (8.1%)	48,158
Junior high	354 (2.90/o)	1,636 (13.4°/0)	2,135 (17,5°/0)	3,505 (28.70/o)	4,592 (37.60/o)	12,222
Senior high	340 (2.30/o)	1,348 (9.0°/0)	2,073 (13.9°/0)	3,817 (25.60/o)	7,320 (49,1°/0)	14,898
Total schools with computers	6,082	16,148	17,267	19,969	15,812	75,278

[a]Excludes approximately 1,600 schools that are not classified as elementary, junior high, or senior high.

SOURCE: Office of Technology Assessment based on data from Quality Education Data, Inc., 1988 update.

Photo *credit:* Massachusetts *Institute of Technology*

Available evidence points to a high rate of computer utilization: as of 1985, less than 5 percent of the computers on school premises were not in use.

dren. Some teachers have turned this constraint into an opportunity by connecting the classroom computer to a large screen and involving the entire class at once in various learning activities. However, on average, computer-using students spend only about 1 hour per week on the computer. Between 1983 and 1988, the national average improved from about 92 students per computer to the current level (see table 2-2). In exceptional cases, each child has a computer at school and another one at home. But most schools still do not have sufficient quantities to allow most students in a typical class access at the same time (see table 2-3).

There is substantial variance in use of computers across schools of different size, demographic composition, and location. As OTA reported in 1987,[9] school size is a significant correlate of computer ownership and pupil access. In absolute terms, small schools have fewer computers than large ones, but

[9]U.S. Congress, Office of Technology Assessment, "Trends and Status of Computers in Schools: Use in Chapter 1 Programs and Use With Limited English Proficient Students," staff paper, March 1987.

Table 2-2.—Average Number of Students Per Computer in U.S. Public Schools, 1983=87

Grade level	1983	1984	1985	1986	1987
Elementary	112.4	79.3	55.3	43.7	36.8
Junior high	92.3	61.2	41.6	32.9	27.6
Senior high	76.6	51.5	37.9	31.1	26.3
All	92.3	63.5	45.5	36.5	30.8

SOURCE: Market Data Retrieval, Inc., 1966.

Table 2=3.-Ranges of Student Computer Density in U.S. Public Schools

Students per computer	Percent of schools Elementary	Junior high	Senior high
1-29	34.5%	43.4%	53.1 0/0
30-59	33.3	34.3	31.4
60-89	14.4	10.9	8.2
90-119	7.1	4.8	3.4
120+	10.7	6.6	3.9

SOURCE: Office of Technology Assessment based on data from Quality Education Data, Inc., 1968,

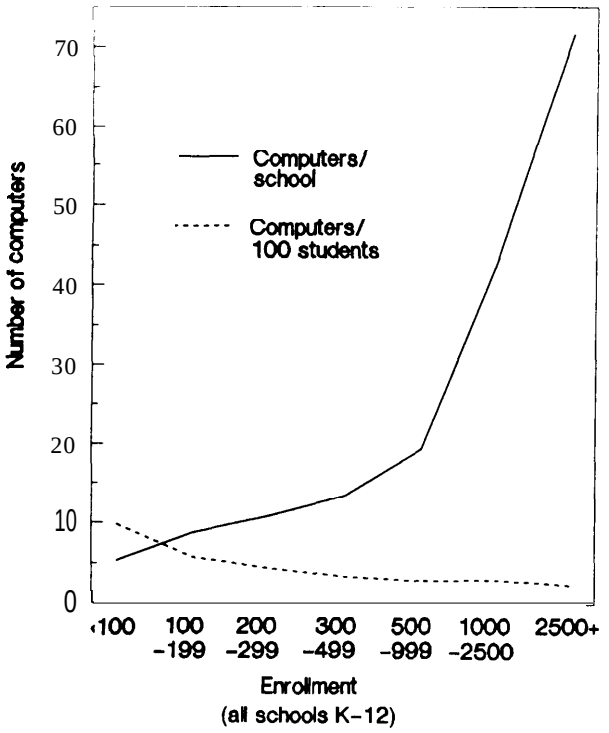
smaller schools have *proportionally* more computers than large schools (see figure 2-5). Thus, students who attend relatively small schools are likely to have greater access to computers than students in large schools. This "enrollment penalty factor" was documented several years ago[10] and seems to have persisted even as overall growth in computer acquisition and utilization has continued. For example, as shown in figure 2-6, schools with 100 to 199 students on average have twice as good a ratio of students to computers as large schools with 500 to 999 students.

Because minority students are more likely to attend large urban schools, their access to computers has been worse than that of white students. This pattern is aggravated by the fact that wealthier schools have acquired technology more rapidly than schools with students of predominantly low socio-economic status (SES). In addition, after controlling for SES and school size and location, all of which have influenced acquisition of new technology, OTA found from an analysis of 1985 data that predominantly black elementary schools were significantly less likely than predominantly white schools to have a computer.[11]

Average student access also varies by region, as shown in figure 2-7. It is interesting to note that access to video equipment varies by State, but that States with relatively good access to one type of technology do not necessarily do as well with other technologies. Alaska, for example, which was ranked first in average number of students per computer in 1986, was ranked 11th in average access to video

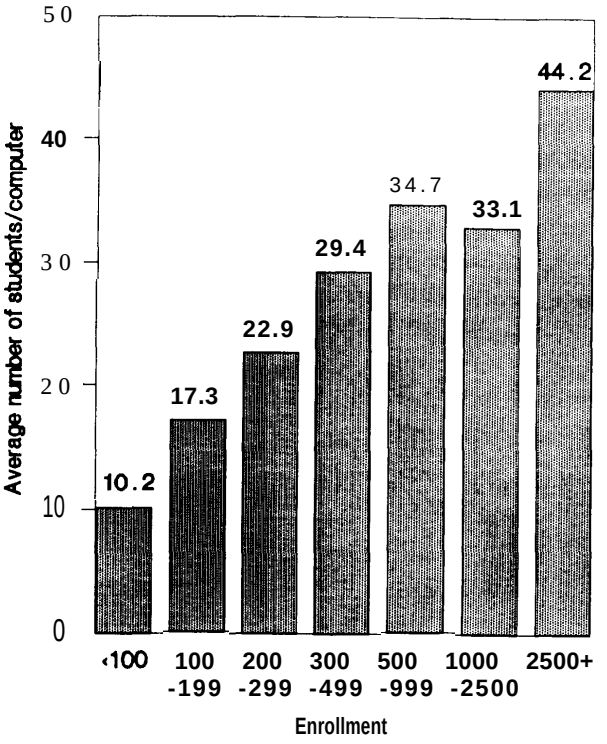
[10] Quality Education Data, Inc., Microcomputers and *VCR Usage in Schools, 1985-1986* (Denver, CO: 1986).

Figure 2-5.—School Size and Student Access to Computers, 1987-88



SOURCE: Office of Technology Assessment based on data from Market Data Retrieval, Inc., 1988.

Figure 2-6.—Students Per Computer in U.S. Public Schools by School Enrollment, 1987-88[a]

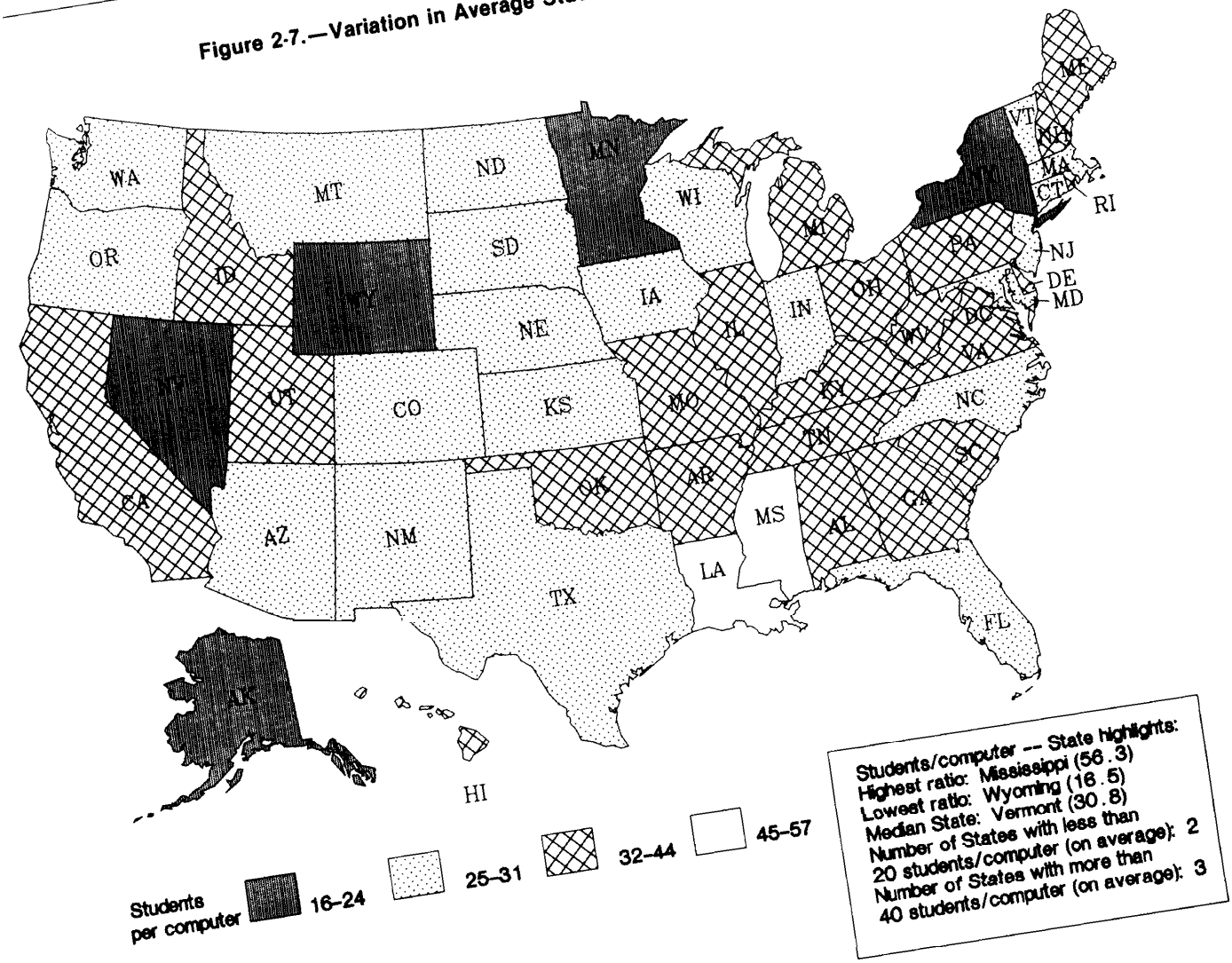


[a] Calculations were based on a sample of 72,159 schools in the database for which all data were obtained.

SOURCE: Office of Technology Assessment based on data from Market Data Retrieval, Inc., 1988.

[11] Office of Technology Assessment, op. cit., footnote 9, pp. 28-29. Note that this problem has abated since 1985, because there are now very few schools left without any computers.

Figure 2-7.—Variation in Average Student-Computer Ratio by State, 1987-88



SOURCE: Office of Technology Assessment based on Quality Education Data, Inc., 1988.

equipment; and California, ranked 43rd in computer access, was number 8 in average student access to VCRs. Note also that these State rankings have varied over time, and that there is considerable within-State variance in student access.[12]

There has been much concern over the apparent tendency for school computer use to be dominated by male students. OTA has found that this phenomenon is abated when application of the technology is closely linked to the curriculum.[13] This poses a potential dilemma: a less structured approach to technology applications, as advocated by educational reformers who believe in increasing teachers' (and children's) classroom autonomy, may lead to unintended inequities.[14]

[12]Quality Education Data, Inc., op. cit., footnote 10.

[13]Becker, op. cit., footnote 5.

[14]For more discussion of gender differences see Office of Technology Assessment, op. cit., footnote 9, pp. 30-31; also ibid.

It is important to keep in mind that these estimates of student access provide rough measures at best. For example, while a school with 300 students and 3 computers has a better ratio (100 students per computer) than a school with 2,250 students and 15 computers (150: 1), access and use might be superior in the latter school. If the large school has acquired more sophisticated software, or has installed modern computer laboratory equipment (such as networking or communications devices), children in that school could benefit more from the technology than their counterparts in small schools which do not have the important additional equipment and which may not be as technologically advanced.

BEYOND COMPUTERS AND VIDEO

Computers and VCRs have become familiar fixtures in the American classroom. There is a strong belief on the part of many educators that these learning tools belong in the classroom, and there is widespread interest in understanding the conditions necessary for the new technologies to realize their potential. In addition, the rapid adoption of computers for classroom use has stimulated great interest in even more advanced systems, and in linking the powers of the computer to other communications and information technologies.

Indeed, much of the current school equipment is technologically crude compared to the advanced systems commonly found in business, scientific, and military settings. Computers typically found in schools, compared to typical office computers, operate with one-quarter the speed and about half the screen resolution quality. Thus, while these computers are being used in many areas of instruction, they typically cannot accommodate the latest developments in software that call for substantial storage and high-speed processing.

The new instructional technologies are costly. Even free-standing computer and peripheral equipment, such as disc drives and printers, can be taxing to local school budgets (see chapter 4). Nevertheless, advanced systems have begun to appear in some schools. For example, as discussed in greater detail in chapter 8, there are over 6,000 schools with modems, [15] and over 26,000 schools in districts with modems; 35 States currently support "distance learning" programs, many of which use satellite technology to bring instruction to children in isolated areas; there are roughly 650 school districts with satellite dishes; and some schools have installed networked systems of computers, which often include integrated instructional and classroom management software. At the same time, advances in software design, which tend to outpace the capacity of schools' hardware, have shown how basic research in cognition and learning might be applied to classroom instruction. Some of the newest software exploits the increasing convergence among computer, television, and telephone technologies, embodied in such devices as the laser disc or the electronic bulletin board. But these systems are still prohibitively expensive for most schools.

At present, the most sophisticated technologies for interactive learning are still in the experimental stage—in the research laboratory and in a handful of classrooms, Their fuller implementation awaits continued evidence of their potential effectiveness, and will depend on an array of factors: their compatibility with teachers' current and future classroom roles; the crafting of economic and organizational policies to stimulate the production and distribution of affordable and appropriate software; and research that blends laboratory findings with the realities of current and future classrooms. We turn now to these issues.

[15] Modems enable computer users to communicate over telephone lines. See ch. 8.

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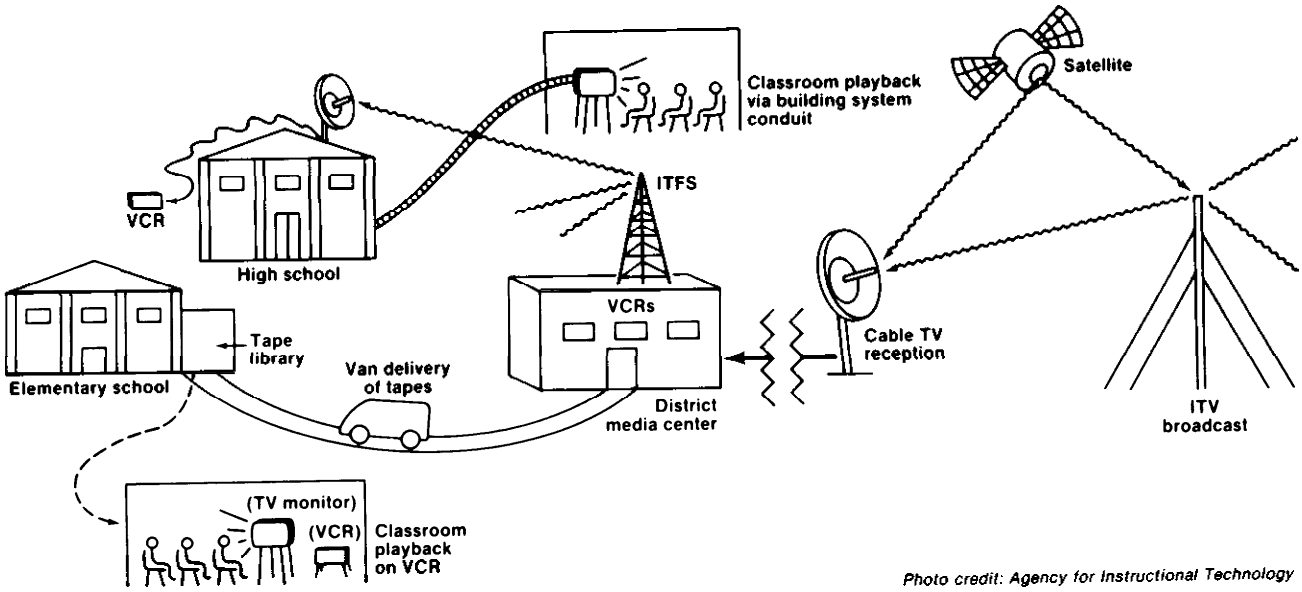

Photo credit: Agency for Instructional Technology

Thirty-five States currently support distance learning programs, many of which use satellite technology to bring instruction to isolated areas. This generic system combines broadcast or narrowcast with VCR use in a media center or class. Most systems have some, but not all, of these elements.

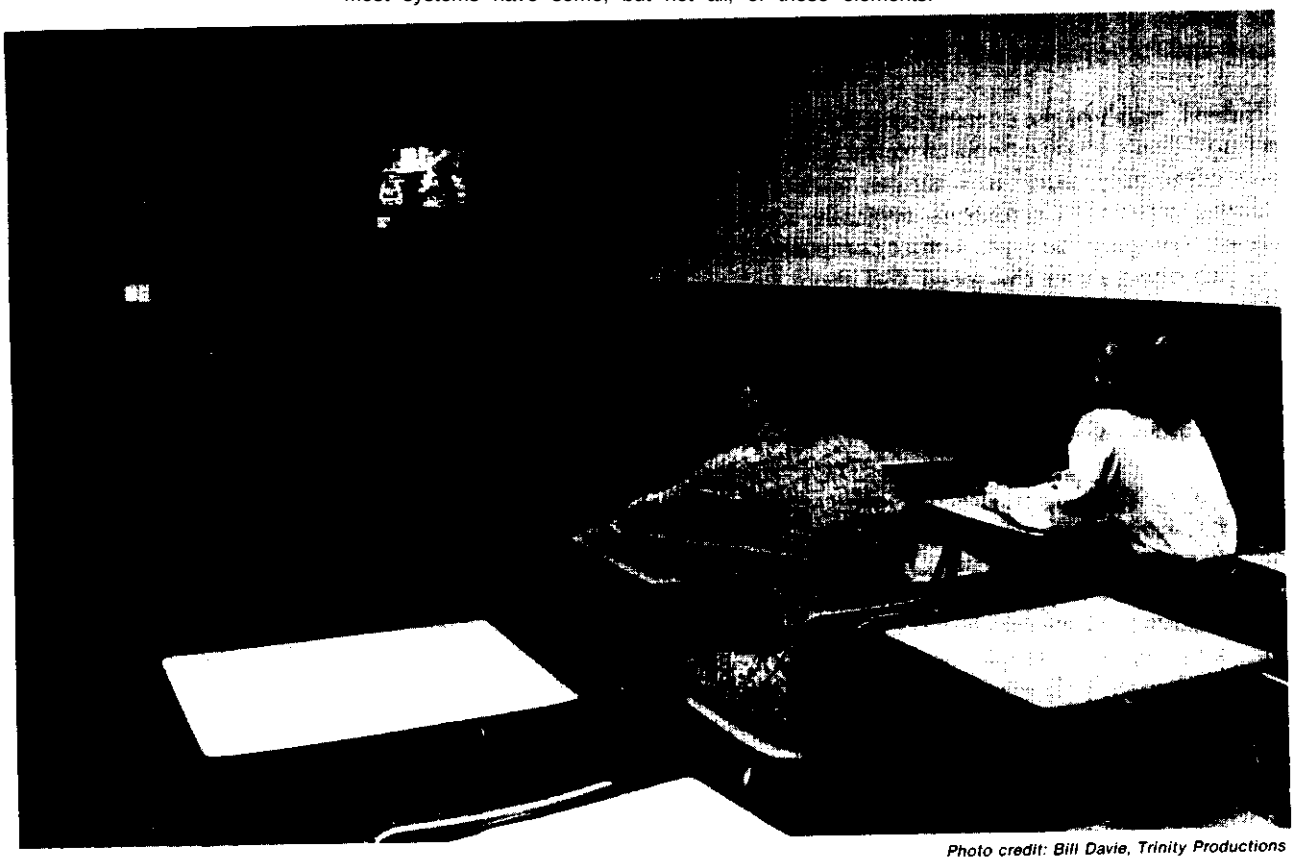

Photo credit: Bill Davie, Trinity Productions

Interactive television made it possible to offer a foreign language class for the first time in 20 years to students in Mackinaw City on Michigan's Upper Peninsula.