SUMMARY

TRENDS AND STATUS OF COMPUTERS IN SCHOOLS: USE IN CHAPTER 1 PROGRAMS AND THOSE FOR STUDENTS WITH LIMITED ENGLISH PROFICIENCY

SUMMARY

INTRODUCTION

Computer use in schools mirrors the heterogeneity of the American public education system. Hardware and software span a wide range of products, the organization of these resources varies among schools, and the technology is used in many ways. Some teachers have found effective ways to use a single computer with a classroom of students, while others prefer a concentration of resources. There are also rare examples, in experimental settings, of classrooms equipped with a computer on each child's desk as well as a computer for each child's home. Some schools have concentrated their technological resources in computer centers or labs, while others have one or more computers in various classrooms located in several areas of the school campus, often including the library or media center. One reason for the wide diversity of approaches is the fact that the original focus on computer literacy, and on teaching students programming has shifted: the one dominant theme in the evolving and growing use of technology in schools is that the computer is now seen as a tool for learning that can be integrated into all areas of the curriculum.

DISTRIBUTION OF EQUIPMENT

Between 1981 and 1986, the percentage of American schools with computers intended for instruction grew from about 18 percent to almost 96 percent. There are now more than one million computers in public schools alone, and over 15 million

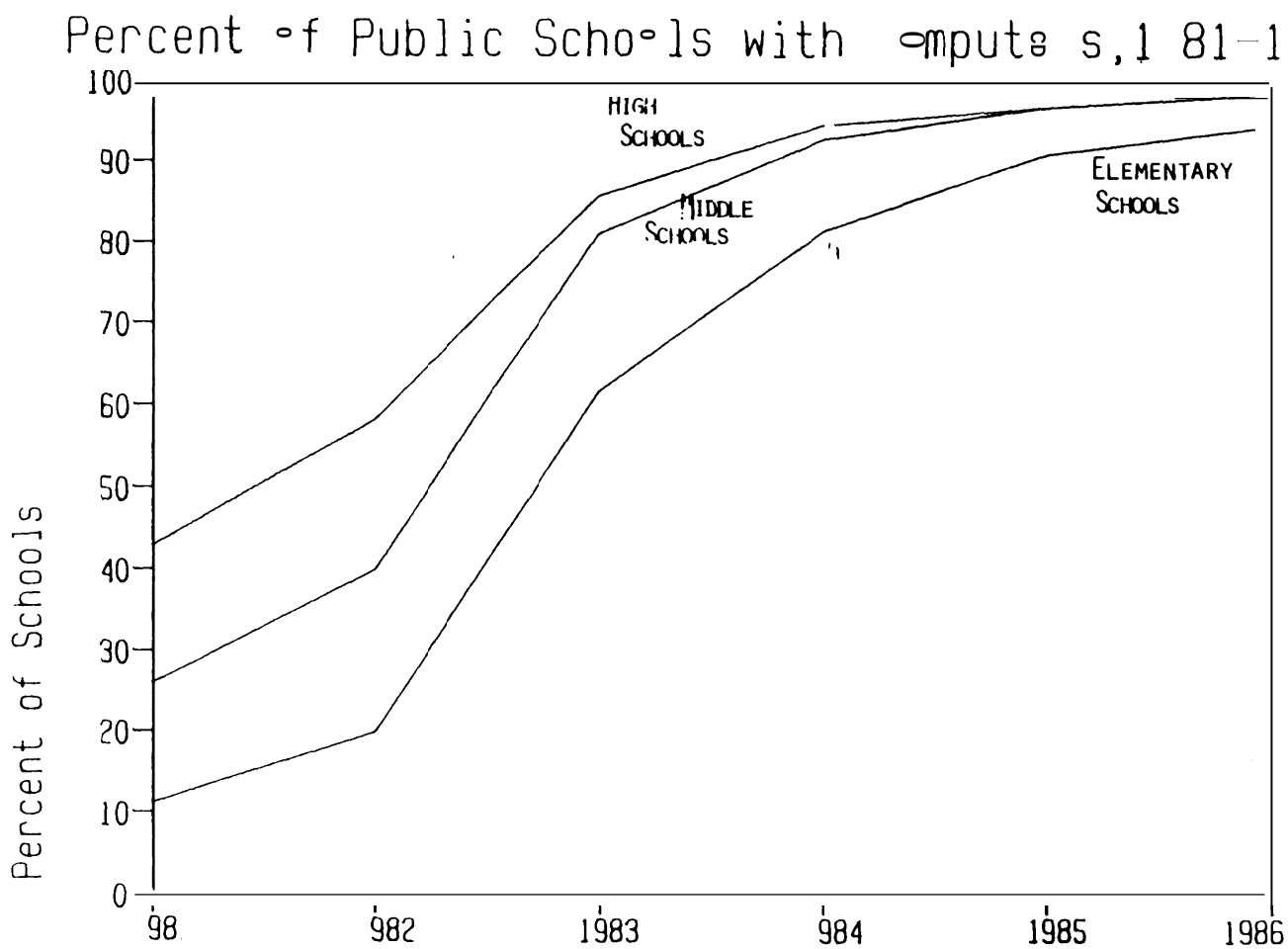
students and 500,000 teachers in public and private schools who make use of computers (stand-alone microcomputers) and related technologies. The national pattern is a widespread distribution of the technology to as many schools as possible, rather than a concentration of specific hardware and software to user groups with particular needs. This pattern of broad diffusion reflects the efforts of parents, teachers, and school systems nationwide. OTA'S analysis shows three striking, recent changes in characteristics of computer use in education:

- Elementary schools are catching up in computer use to the early lead of secondary schools that existed at the beginning of the decade. In the 1986-87 school year, almost 95 percent of all public elementary schools had computers, as did almost 99 percent of all public middle and secondary schools. Private schools are still running behind, with only about 77 percent using computers for instruction. [See Figure 1]

- Pupil access to computers has also improved with increasing investments in the technology by schools. Today, the national average is about 37 students per computer, which means that statistically there is still less than the equivalent of one computer per classroom. There are significant variations in this measure of access by region [See Figure 2] and school size [See Figure 3], and by student characteristics.

- Applications of computers in school vary. Some regions of the country continue to focus on computer literacy and programming at different grade levels. [See Figure 4] At the same time, there is a growing emphasis on integrating the computer into the curriculum.

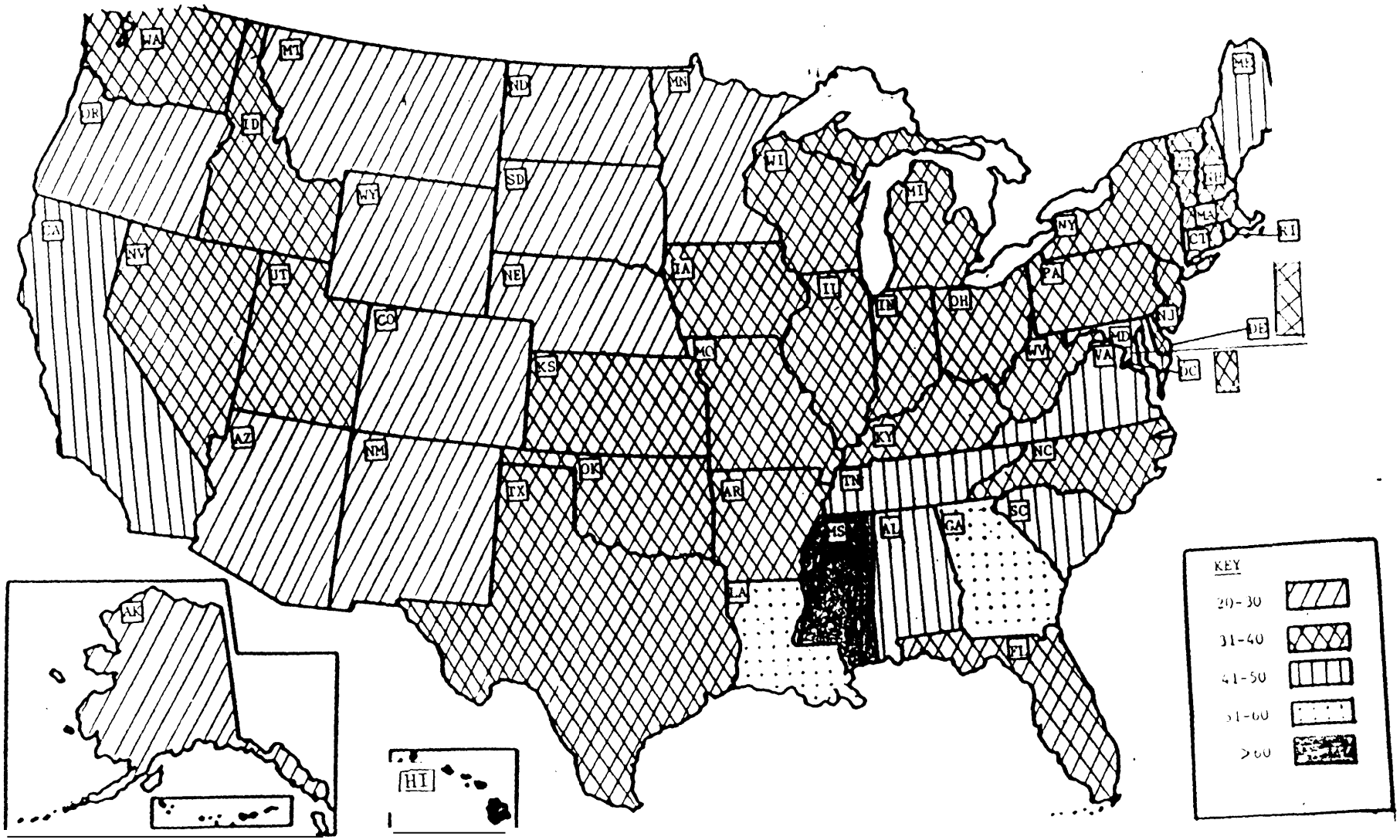
FIGURE



SOURCE: Market Data Retrieval, Inc., Westport, CT, 1986.

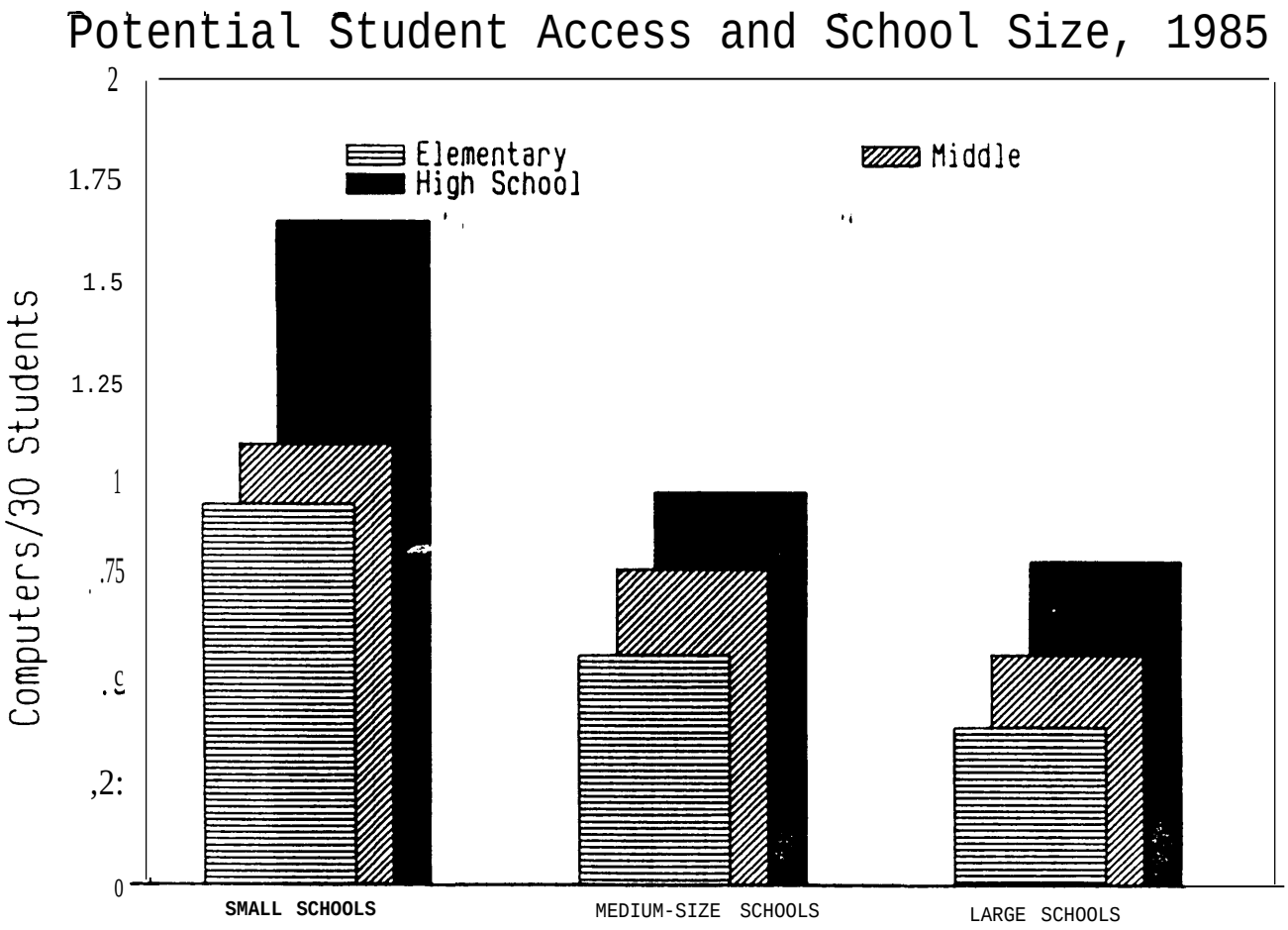
FIGURE 2

CROSS-STATE DIFFERENCES IN AVERAGE NUMBER OF STUDENTS PER COMPUTER, 1986



SOURCE: OTA

FIGURE 3

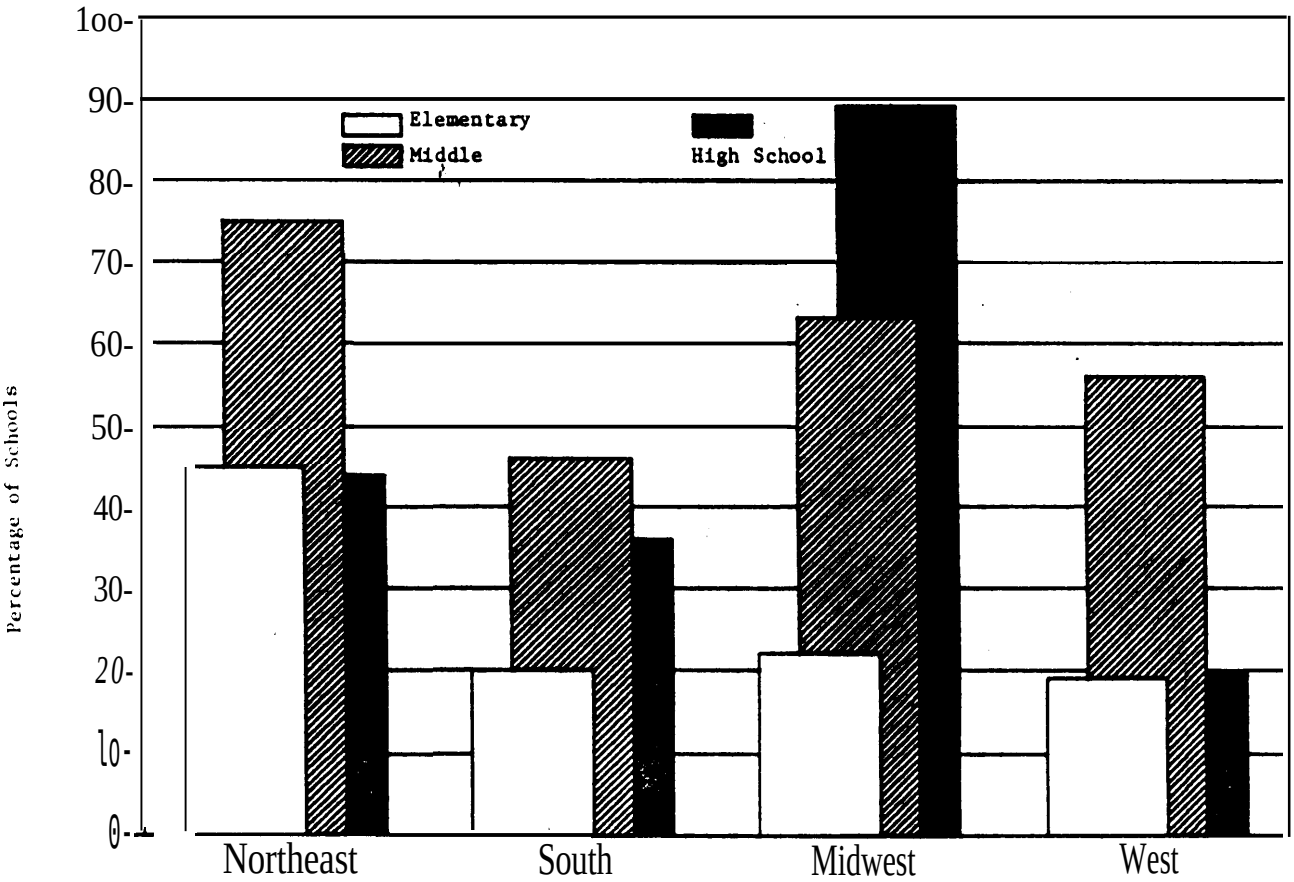


SOURCE: 1985 National Survey of Instructional **Uses** of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

NOTE: Small, medium, and **large** size categories are specific to grade span of school.

FIGURE 4

REGIONAL VARIATIONS IN COURSE REQUIREMENTS*



*Semester-long courses in computer literacy or Programming.

SOURCE: 1985 National Survey of Instruction Uses of School Computers, Center for the Social Organization of Schools, John Hopkins University.

EQUITY AND ACCESS

Despite the widespread diffusion of computers in the Nation's schools, there has been a persistent-concern with equity of access, particularly in terms of possible differences between the rich and poor, black and white, and boys and girls. In the early part of the decade, unequal access was inevitable: computers were coming into the homes of those who could afford them, and into schools located in communities with ties to the microelectronics industry and/or where parents were actively involved in acquiring the technology for schools. While OTA finds that — in terms of the number of schools with computers and the number of students per computer — the gap between rich and poor has been narrowing, important differences still exist:

- Generally, students in relatively 'poor" elementary or middle schools have significantly less potential access than their peers in relatively "rich" schools. At the high school level, however this trend disappears. [See Figure 5]

- Differences between access for rich and poor students vary across the 50 States and the District of Columbia.

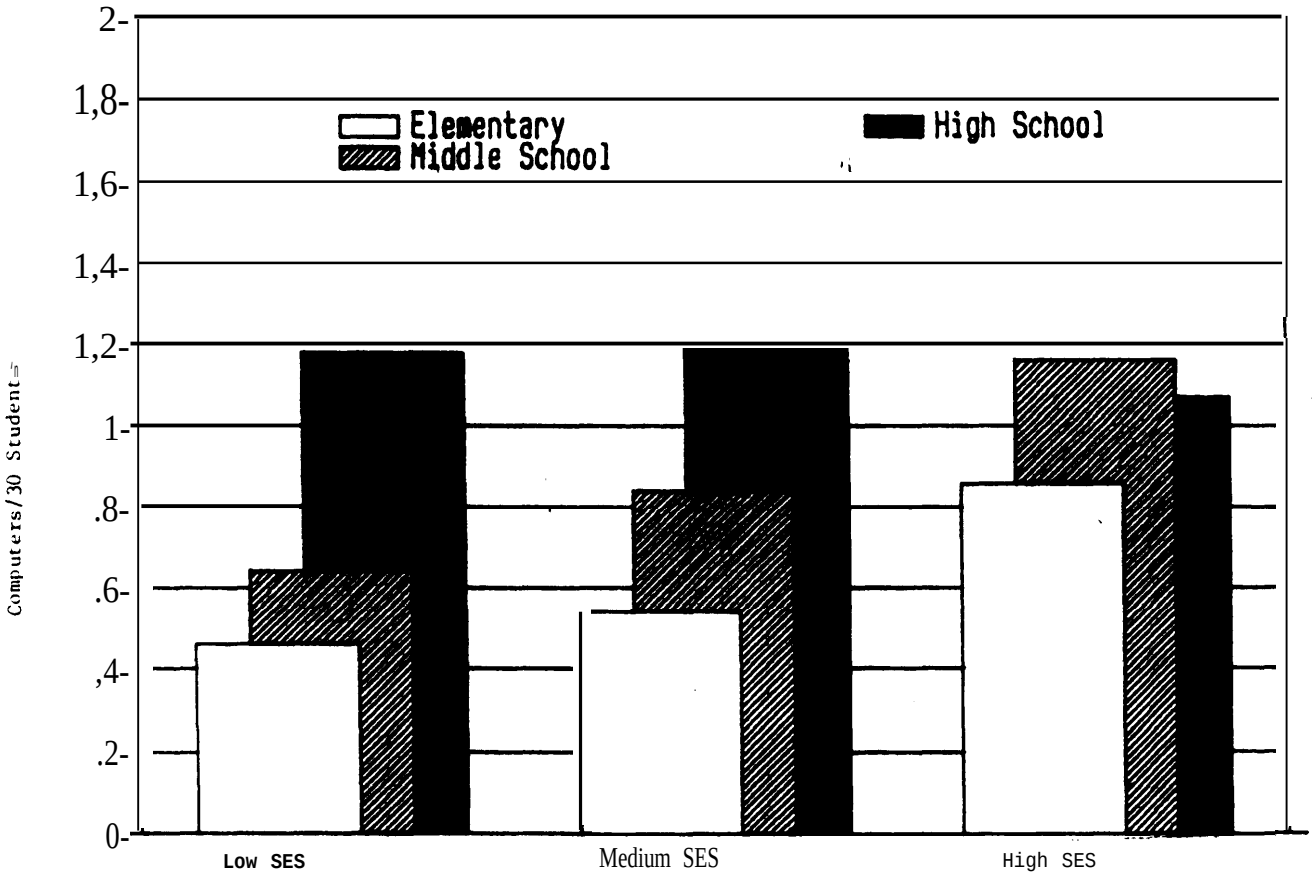
Differences in the number of schools with computers also exist between black and white students:

- In 1985, black children were less likely than white children to attend elementary schools with computers. [See Figure 6] However, since today almost all schools have computers, these differences found in 1985 are narrowing.

- Pupil access varies with the percentage of black students in the school.

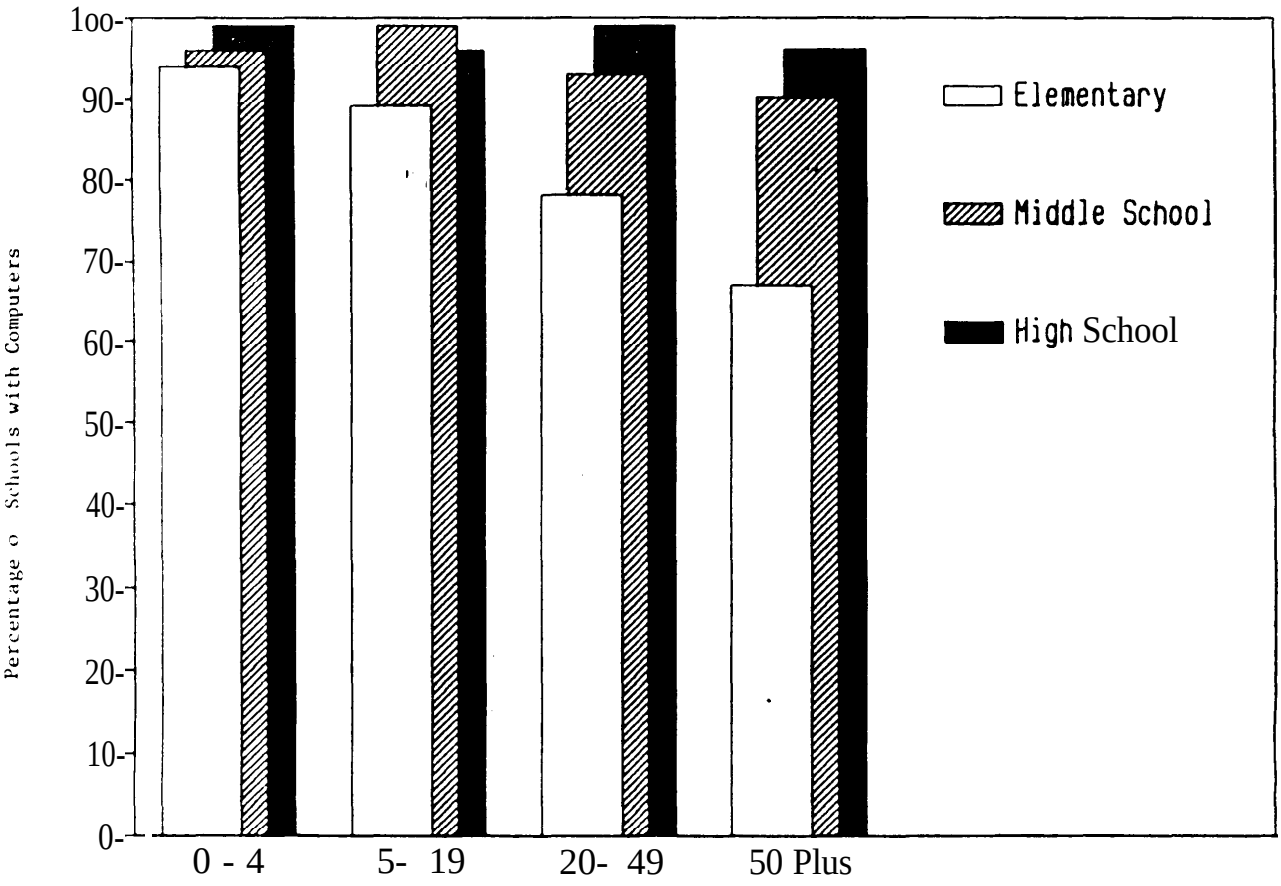
FIGURE 5

SOCIOECONOMIC STATUS* AND ACCESS (1985)



*SES measure based on school-wide index of parents' occupations and incomes

SOURCE: 198S National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.



SOURCE : 1985 National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

[See Figure 7] However, this effect can be explained in part by the fact that black children typically attend relatively large schools, in which pupil access to computers — for all students in the school — is lower than in relatively small schools.

In some respects, boys and girls use computers about equally, especially when computers are tied formally to curricula:

- Boys and girls are about equally enrolled in elective computer programming classes in middle and high schools, and in high school programming courses with algebra or advanced mathematics prerequisites.

- There is no apparent gender difference among students in overall use of computers or in word processing during the regular school day.

- Boys tend to dominate computer use during non-school hours (before and after the regular school day).

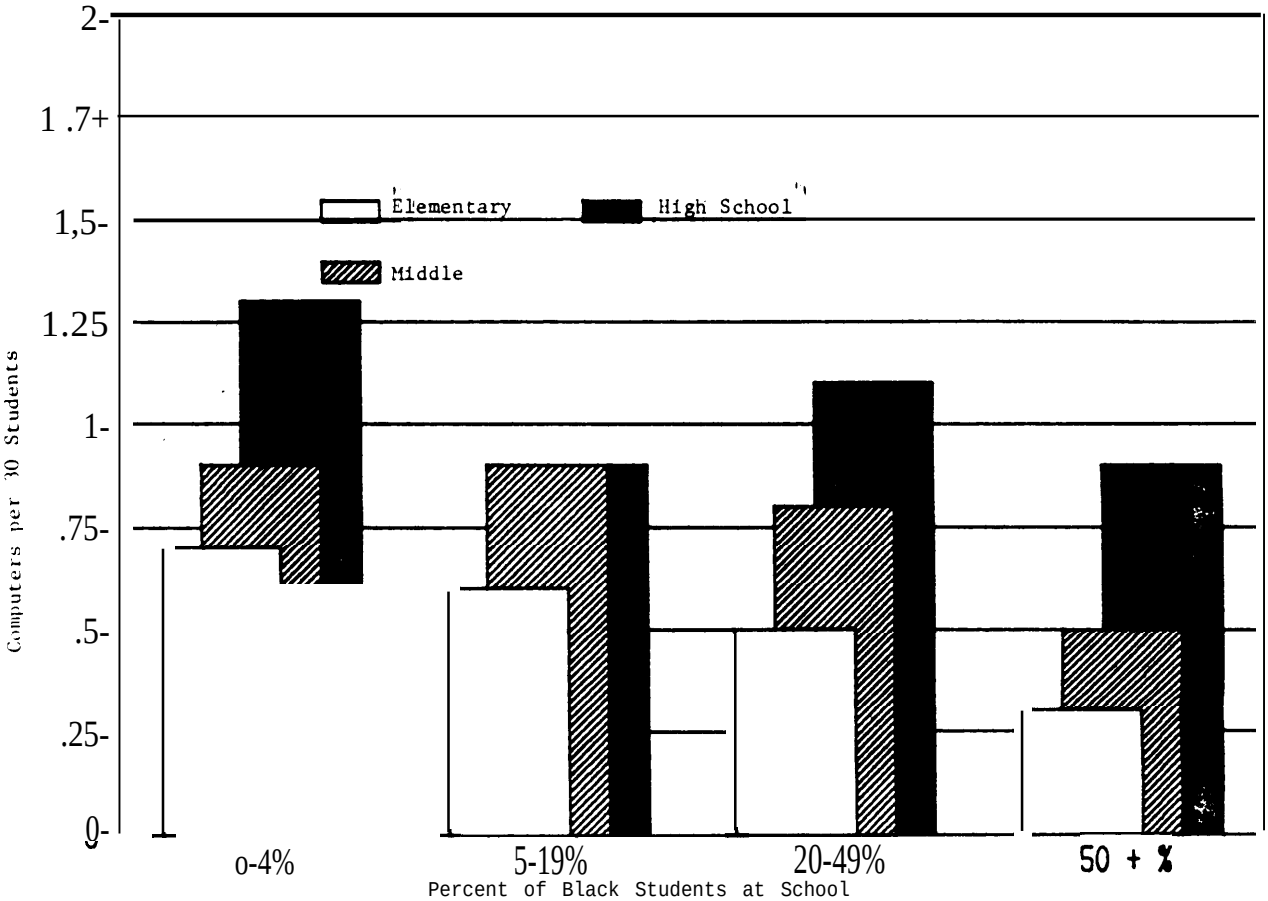
- In some schools, boys dominated all types of computer use, while in very few schools, girls infrequently dominated any type of activity, except for high school word processing.

INSTRUCTIONAL APPLICATIONS

Typically, students who were using computers a decade ago were learning to program them. If not programming, they were learning "about the computer," and only to a limited extent were they using it directly in subject matter areas. This emphasis on

FIGURE 7

PUPIL ACCESS BY PERCENT OF BLACK STUDENTS AT SCHOOL



SOURCE: **1985** National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

programming was expected, as most early teacher advocates were computer aficionados, and also because very little educational software was available. Patterns of use changed with the advent of more powerful hardware, varied content-related software, child-oriented programming languages such as LOGO, and generic software tools, as well as broader involvement of the teaching staff. By 1985, student instructional time on computers overall was divided almost evenly between drill and practice, programming, and all other uses, including problem solving and word processing. OTA finds, however, that there are important differences in use by schools of different grade spans and between schools with many low achieving students and schools with many high achieving students:

- Elementary school students spend most of their computer time on drill and practice; middle and high school students spend more time on programming and word processing. [see Figure 8]

- Low-achieving students use computers to practice and reinforce basic skills while high-achieving students concentrate more on programming and problem solving. [See Figure 9]

- Students in poorer (low socioeconomic status) schools typically spend more time with drill and practice than students in richer (high socioeconomic status) schools. [See Figure 10]

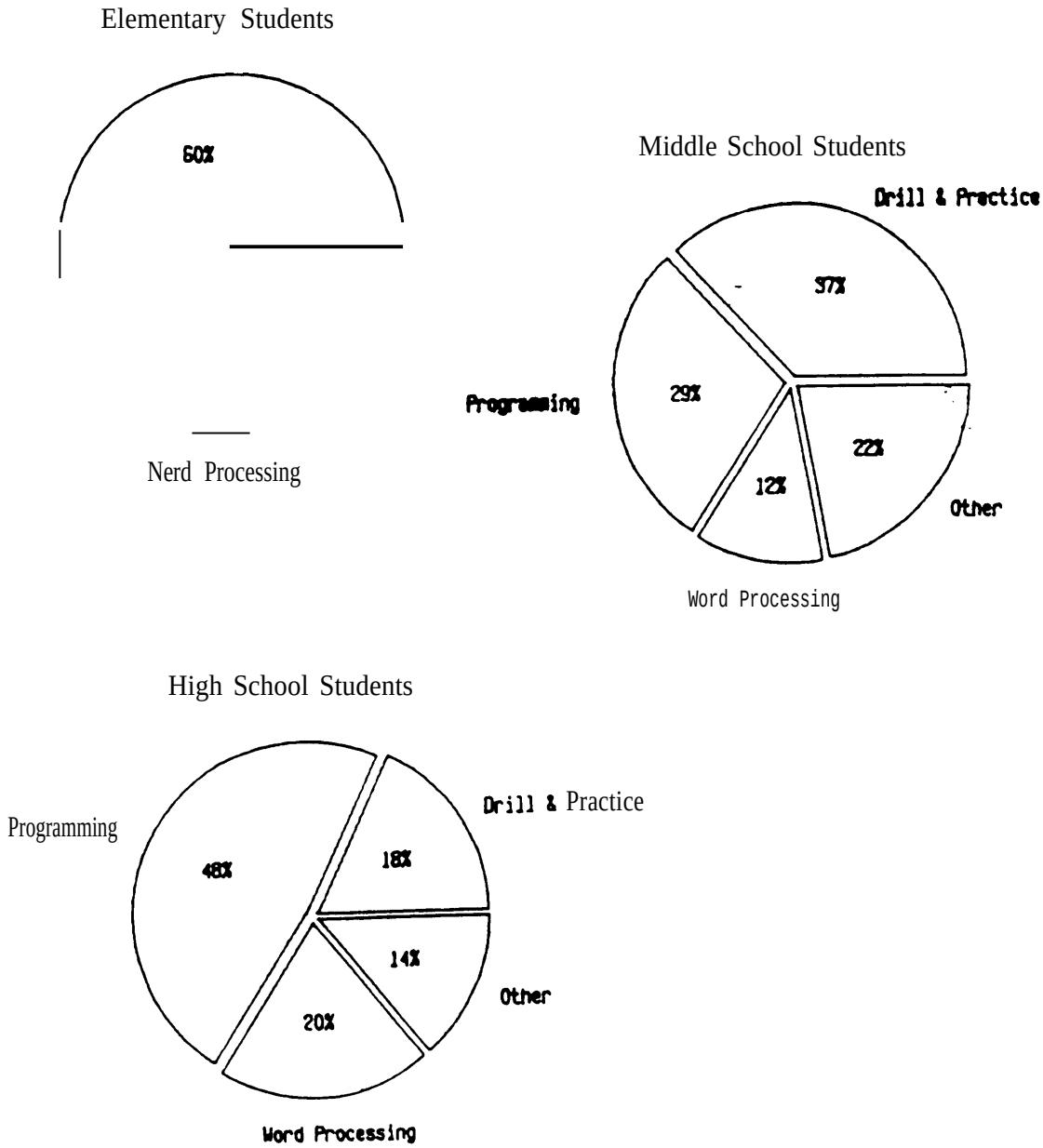
Computer Use in Chapter 1 Programs*

In every State, Chapter 1 programs funded the purchase and/or lease of computer hardware and software.[1] While not all Chapter l programs use computers, 58 percent of

* Chapter 1 of the Education Consolidation Improvement Act (ECIA) provides compensatory educational and related services to educationally disadvantaged students who attend schools in low-income areas.

FIGURE 8

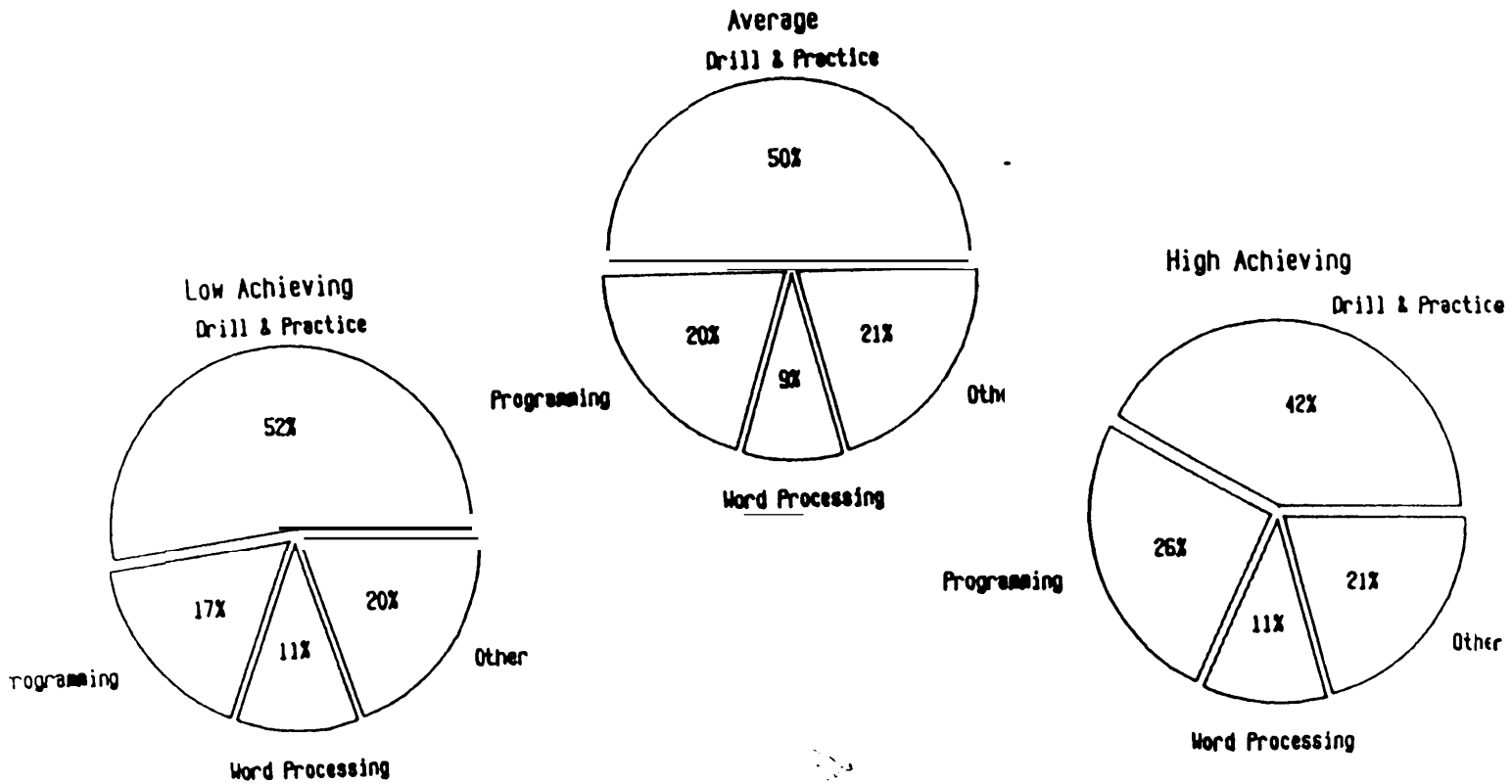
INSTRUCTIONAL APPLICATIONS OF COMPUTERS: VARIATIONS BY GRADE SPAN OF SCHOOL



SOURCE: 1985 National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

FIGURE 9

INSTRUCTIONAL APPLICATIONS OF COMPUTERS: VARIATIONS BY ACHIEVEMENT LEVEL*

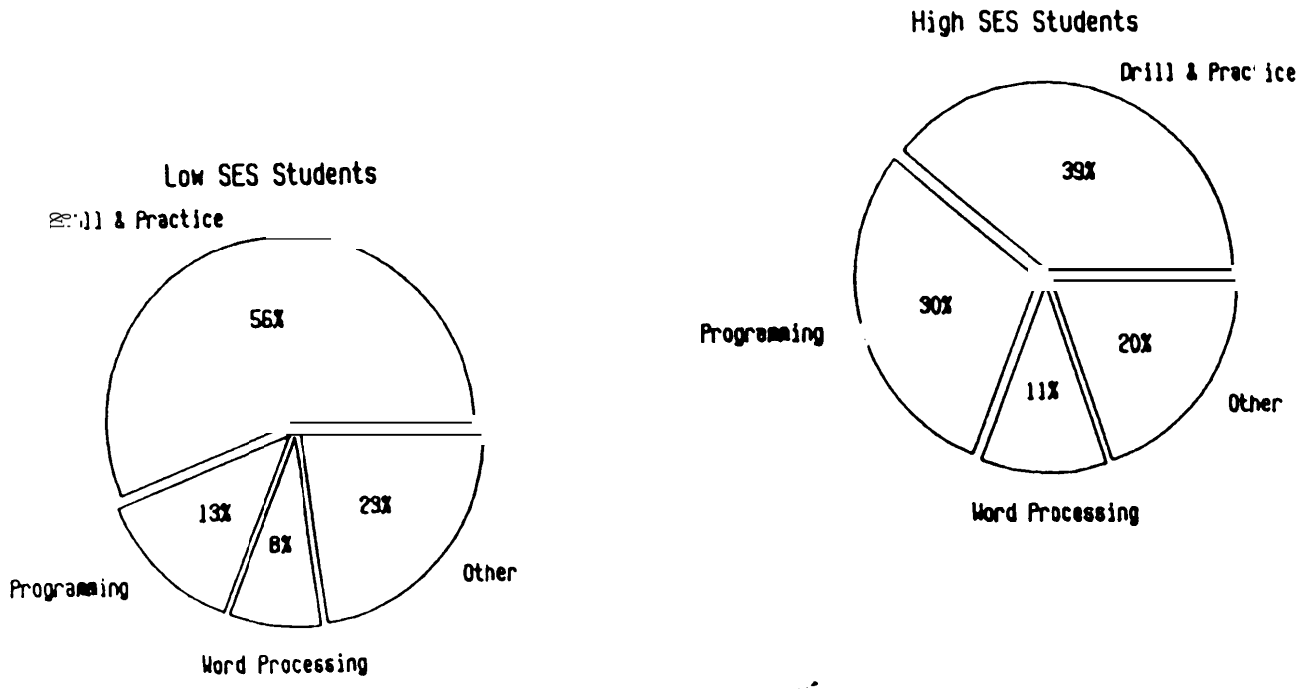


* SCHOOL-WIDE ABILITY MEASURE

SOURCE: 1985 National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

FIGURE

INSTRUCTIONAL APPLICATIONS OF COMPUTERS: VARIATIONS BY SOCIOECONOMIC STATUS OF STUDENT



SOURCE: 985 National Survey of Instructional Uses of School Computers, Center for the Social Organization of Schools, Johns Hopkins University.

Chapter 1 public elementary school teachers and 60 percent of public Chapter 1 middle/high school teachers use computers to teach their students. Of the over 3 million Chapter 1 elementary school students nationwide, about 2.4 million (71.6 percent) have Chapter 1 teachers who use computers. Of approximately 960,000 Chapter 1 middle/high school students nationwide, 540,000 (56.1 percent) have Chapter 1 teachers who use computers. [See Figure 11] These aggregate statistics should not obscure important details:

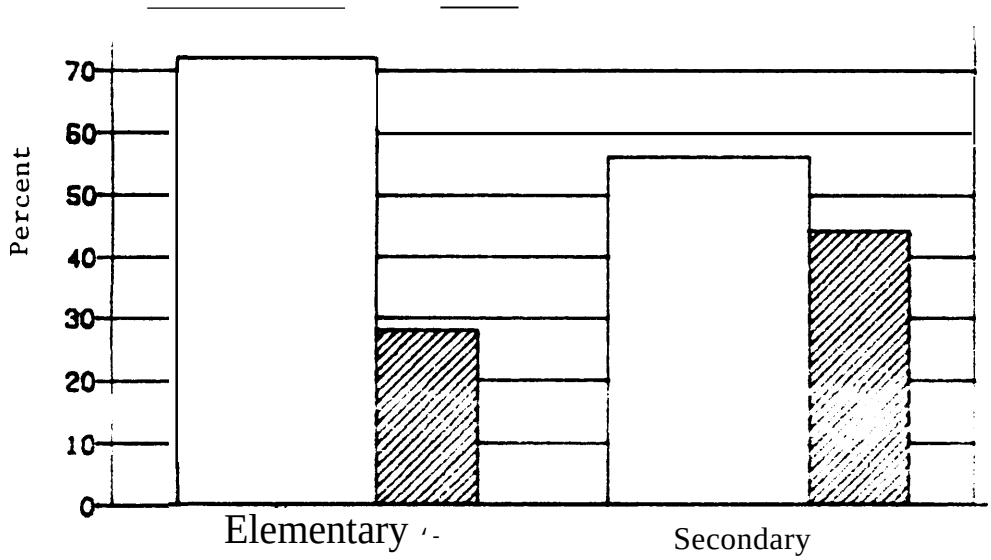
- Chapter I teachers working in high schools where more than 40 percentof the students are eligible for free lunch are less likely to use computers than teachers working in other high schools.

- Except for the poorest schools, the use of computers by Chapter 1 teachers in elementary schools increases with the school% concentration of poor students; in the very poorest elementary schools — where more than 75 percent of the students are eligible for free lunch — the percentage of Chapter 1 teachers using computers is lower than in any other schools. [See Figure 12]

- There appears to be a slightly higher proportion of low-ability students in the classrooms of Chapter 1 teachers who use computers than in classrooms where Chapter 1 teachers do not use computers. [See Figure 13]

The principal use of computers in Chapter 1 programs is for drill and practice for basic skills with every State reporting such use. Many States also report that computers are being used in these programs for problem solving and for exploring other approaches, including using the technology to teach higher order thinking skills, or to teach computer

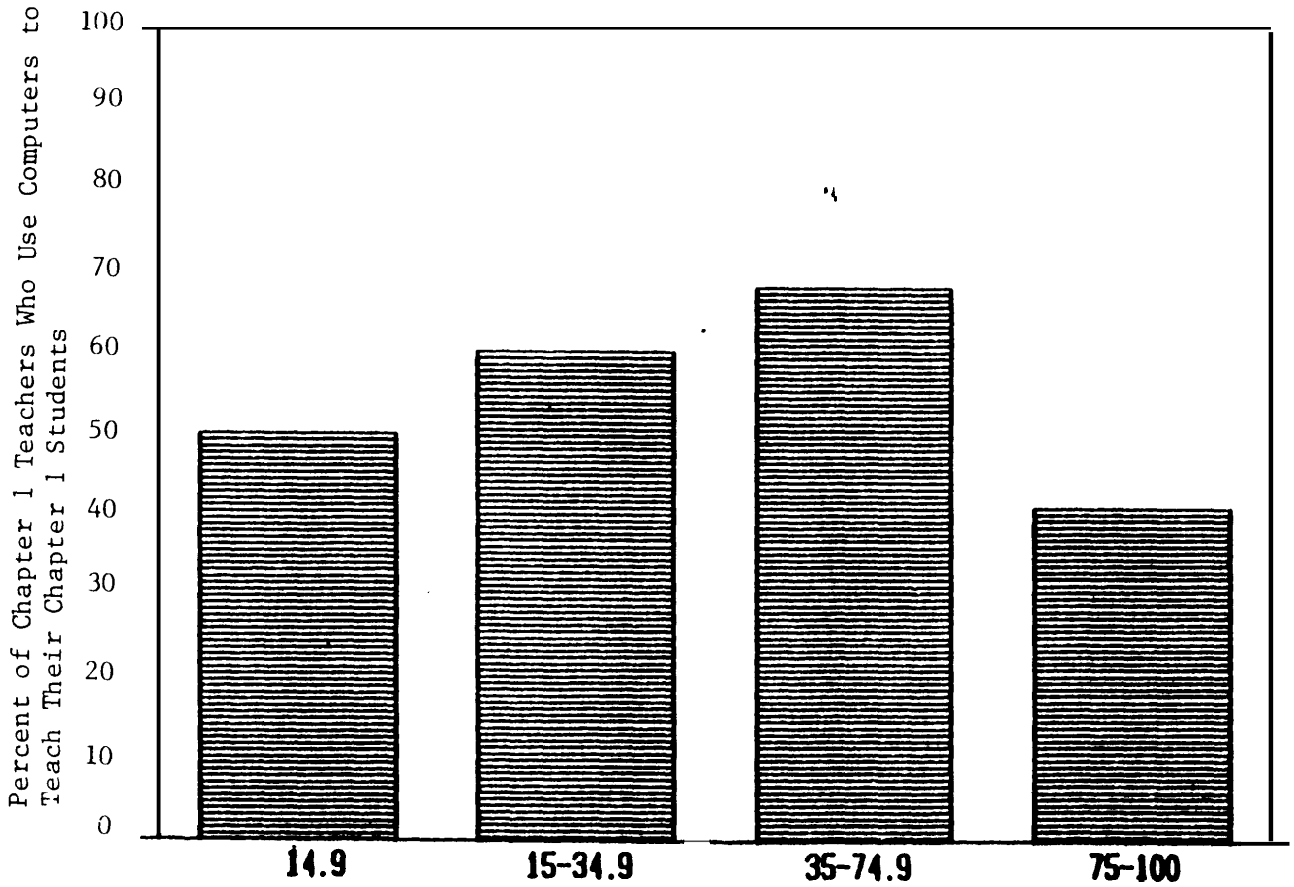
1. OTA estimates that this has amounted to more than $89 million since 1980. Moreover, approximately $21 million is expected to be spent in the 1986 to 1987 school year. OTA, "Survey of State Chapter 1 Coordinators," October 1986.



SOURCE: Westat Corporation, National Survey of ECIA Chapter 1 Schools, 1986.

FIGURE [illegible]

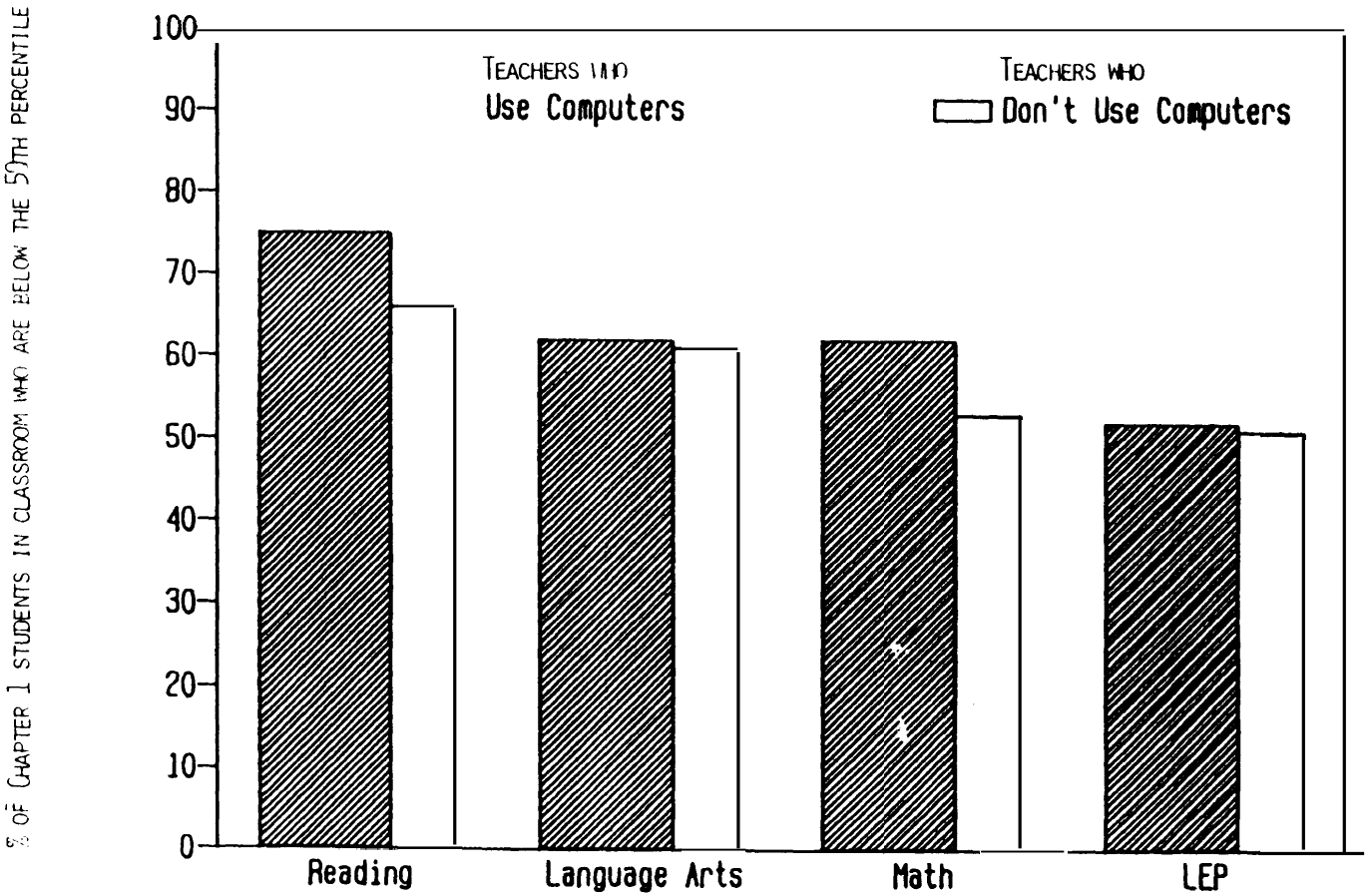
CHAPTER 1: COMPUTER USE AND ELEMENTARY [illegible]CHOOL POVERTY LEVEL



SOURCE: Westat [illegible]rporation, Na[illegible] Survey of ECIA Chap[illegible] 1 [illegible]ls, 1986

FIGURE 13

COMPUTER USE BY CHAPTER 1 TEACHERS; VARIATIONS BY ABILITY LEVEL OF CHAPTER 1 STUDENTS IN THEIR CLASSES



SOURCE: RAND CORPORATION NATIONAL SURVEY OF ECIA CHAPTER 1 SCHOOLS, 1986

literacy skills.

Given the Chapter 1 emphasis on remediation of basic skills and instruction geared to meet individual needs, and the wide availability of software in reading, mathematics, and language arts, the use of computer technology in Chapter 1 has clearly been appropriate. In addition, Federal funds made it possible to take advantage of comprehensive and costly computer-assisted instruction (CAI) systems that were originally developed for disadvantaged learners.

Computer Use in Programs for Limited English Proficient Students

With respect to bilingual and English as a second language (ESL) education, (programs designed for limited English proficient students), there are important differences in computer use between Chapter 1 and regular classrooms [see figure 14]:

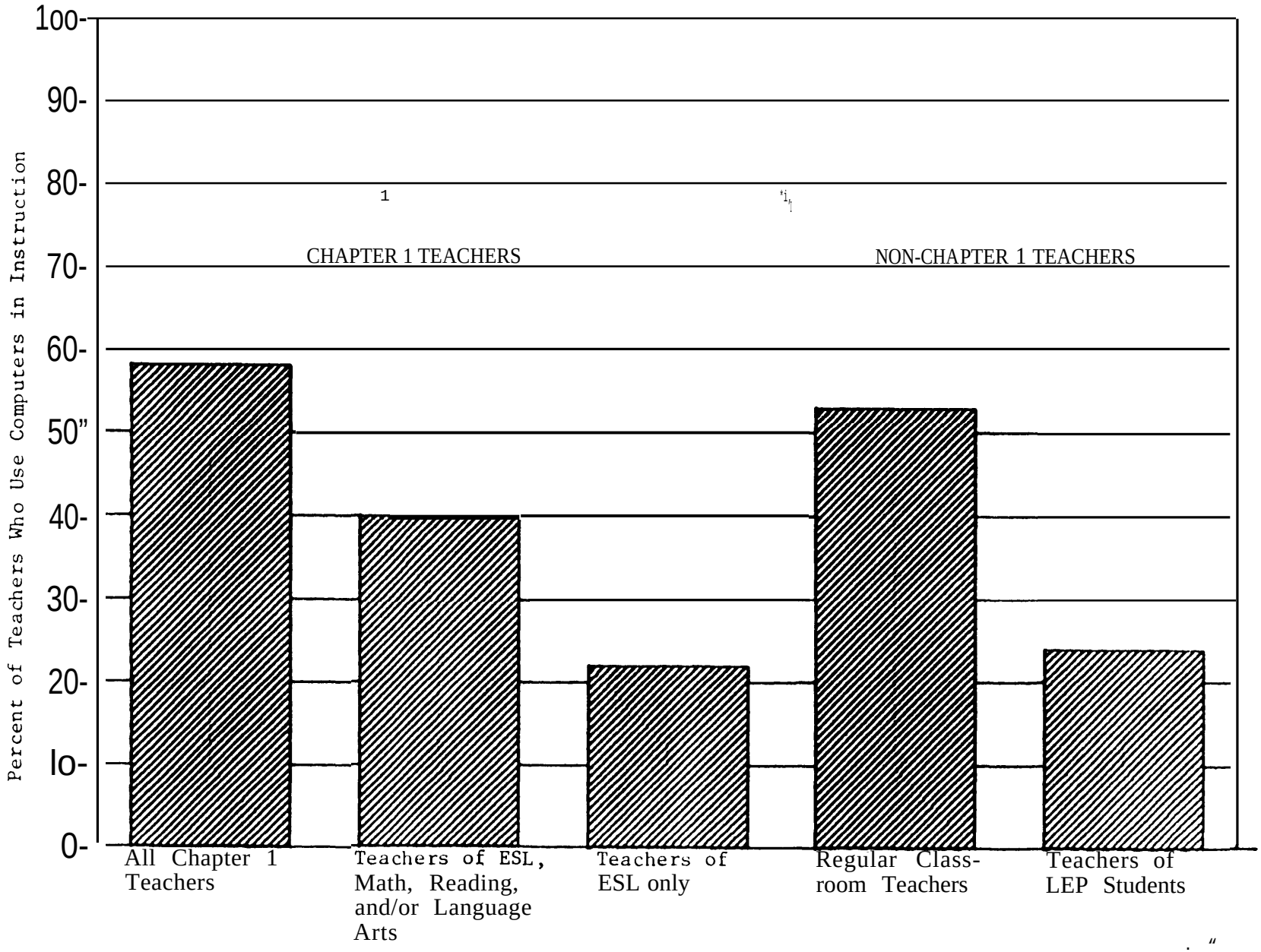
- Among Chapter 1 teachers who teach ESL (and possibly other subjects), 40 percent use computers. Among Chapter 1 teachers who teach ESL only, just 24 percent use computers. These two figures are consistently lower than the proportion of other Chapter 1 teachers who use computers.

- Among regular classroom teachers who teach limited English proficient (LEP) students, 22 percent use computers. This is" even lower compared to the proportion of all regular classroom teachers (50 percent) who use computers.

Data suggest, too, that LEP students are more likely to use computers if they receive Chapter 1 services. However, OTA identified several Title VII projects, * local district efforts, and university-sponsored projects that employ computer resources to increase students' English language skills. A Title VII project in District 1 of the Seattle Public

* The Bilingual Education Act, Title VII of the amended Elementary and Secondary Education Act of 1965, provides educational services for school-age limited English proficient (LEP) students to help them learn the English language well enough to fully function in all-English classes.

FIGURE 14. -TE`ACHERS* USING COMPUTERS IN INSTRUCTION



*In schools receiving Chapter 1, State, or other compensatory education, or special education services.

SOURCE: Westat Corp., National Survey of ECIA Chapter 1 Schools, 1986

Schools developed their own CAI for Vietnamese, Cambodian, and Laotian high school students.** In San Diego, Spanish-speaking students use computers after school to develop English literacy and computer expertise in a model program developed by university researchers.

EFFECTIVENESS

As computer use expands in schools, generally, and in Chapter 1 programs, questions are inevitably raised regarding benefits and costs. The issue of overall cost effectiveness of computer technology remains unsolved. This reflects the difficulties of comparing the technology to other irstructional choices, problems associated with fully identifying costs, and the complexities of defining and measuring the full range of effectiveness criteria. However, leaving aside the question of cost, there is considerable agreement that computers are effective.

Research and national reports on computers in education convey a common theme of positive effectiveness, with the caveat that current practice can be improved. More than two decades of research on computer-assisted instruction (CAI) show that students make learning gains, as measured by test scores, when they use programs that are primarily drill and practice. The particular benefits of CAI for disadvantaged youngsters have been well documented in the research literature.

Additional data on effectiveness come from local district evaluation studies of Chapter 1 computer use. These studies document significant achievement gains in mathematics and reading through computer drill and practice, in comparison to "regular" Chapter 1 instruction. Lack of standardized data among various programs make it

** The software itself is bilingual, with text and instructions generally in English, and vocabulary in English and the native language. Native language instruction is utilized to explain the operation of hardware and software, clarify vocabulary, facts and concepts, and link this knowledge with students' conceptual framework of native language, culture, and history.

difficult to compare results among various approaches. Furthermore, none of the Chapter 1 program evaluations compared the benefits of drill and practice with other types of computer based instruction, such as use of simulation or problem solving approaches, or to other nontraditional approaches. Future research might consider these issues.

In response to an OTA survey of State Chapter 1 coordinators, one message came through strongly: the coordinators emphasize that the computers an effective learning tool but that the teacher is not replaced. The teacher plays an essential role throughout.

Research studies on uses of technology with LEP students are not extensive; few studies have been conducted and more are needed. Several projects exploring use of computers with LEP students show promising results: for these students, word processing and computer networking provide vehicles for students to function effectively in both their native language and in English.

With both Chapter 1 and LEP students, there is a considerable overlap of needs created by poverty. OTA finds that there is a general belief among researchers and practitioners that computer technology enhances motivation for learning, because it can be nonjudgmental, it provides immediate feedback, it allows students to work at their own pace, and it helps raise students' "status" in their schools.

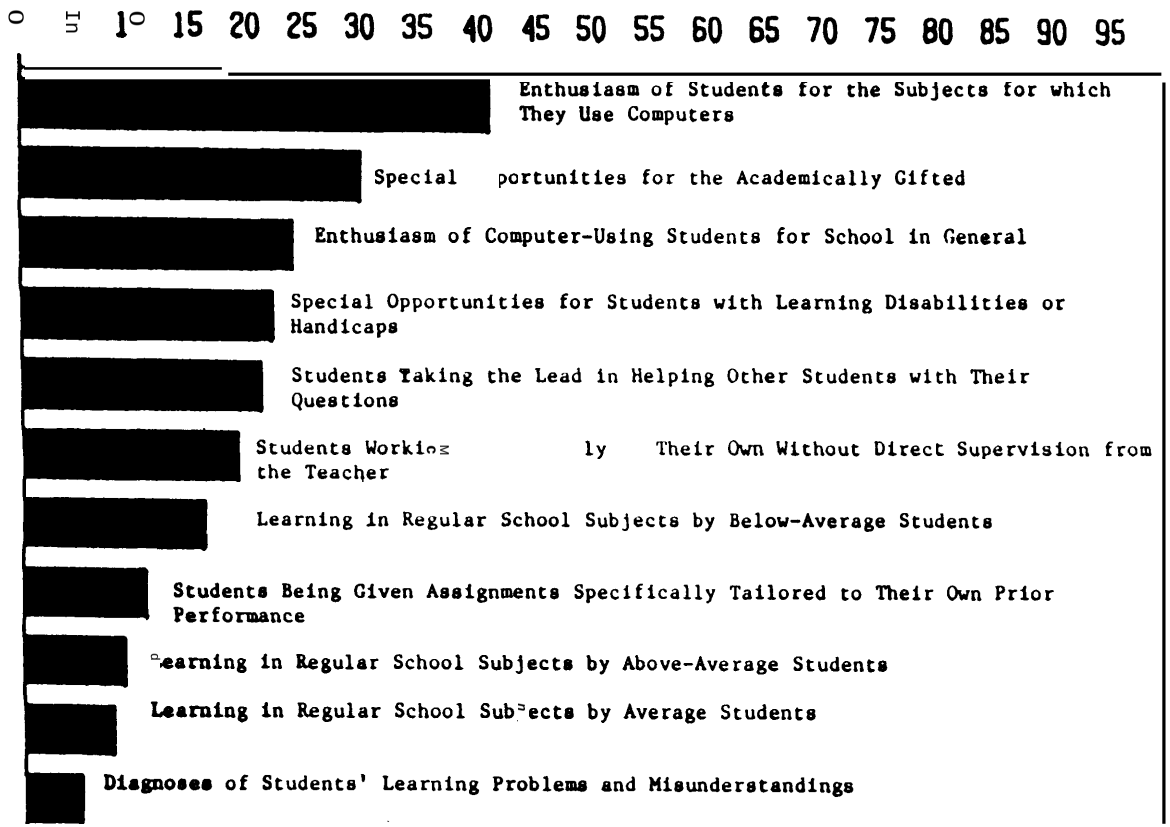
Research on the use of computers to develop higher order thinking skills has not yet produced definitive results. Some work with Chapter 1 students looks promising. In general, research on the impacts of learning to program a computer has not been able to show that there are significant gains in problem solving skills or that this learning transfers to other subjects.

Survey data on teachers' and principals' perceptions of the effects of computers provide additional insights [See Figure 15]:

- Computer use is perceived by many teachers to raise students' enthusiasm for subjects in which computers are used.

FIGURE

Perceived Effects of Computers



Percentage of primary computer-using teachers who reported that "as a result of computers, this is MUCH IMPROVED at our school" (Respondents could have chosen "somewhat improved" or "little changed" or "negatively affected")
SOURCE: 1985 National Survey of Instructional Uses of School Computers, Center for Social Organization of Schools, Johns Hopkins University.

- Many teachers report that computers offered new and challenging activities to academically gifted students who might otherwise have been restricted to conventional curriculum materials.

- The number of teachers who perceived that computers helped below-average students learn regular schools subjects was higher than the number of teachers who perceived that computers helped average or above-average students.

ADMINISTRATIVE USES

In Chapter 1 programs, OTA found that the computer is becoming an essential administrative tool in the instructional process: for example, tracking student progress, keeping records, preparing reports, and other tasks. There is promising evidence that these administrative tools increase the productivity of the Chapter 1 program by allowing teachers to spend more time with students. Another improvement mentioned is an increase in the ability to coordinate Chapter 1 student activities with regular classroom objectives.

There is another area, however, where questions are being raised. Given the considerable investment in hardware and software, a number of Chapter 1 program managers and other school administrators would like to find a way to make better use of the technology. Under Chapter 1 regulations, equipment purchased with Chapter 1 funds can only be used to benefit Chapter 1 students. The result is that equipment stands idle when Chapter 1 classes are not scheduled. If there were ways to use these technology

resources more fully, greater benefit could be made of the investment. The flexibility of the technology, the fact that the hardware can be used for many hours a day, and the cost of the instruction all support an approach of maximizing use of the equipment rather than limiting it. This is an area where further guidance regarding Federal requirements appears to be needed.

Some Chapter l programs are experimenting with using computers on a shared basis with other programs. In these other programs, e.g., regular classroom, parenting program, or after school enrichment, one approach is to purchase technology with general funds and avoid problems of restricted use. Another suggestion is to allow schools to prorate costs for use between Chapter 1 and other programs, so that other students or special programs can also use hardware and software.

THE SPECIAL CASE OF AGUILAR v. FELTON

By law, local Education Agencies (LEAs) are required to serve eligible Chapter 1 students who attend private schools. On July 1, 1985, the Supreme Court, in the case of Aguilar v. Felton, ruled unconstitutional a common method of providing Chapter 1 services to eligible children who attend nonpublic sectarian schools. According to the decision, the provision of instruction by public school teachers traveling to those schools led to excessive and unacceptable entanglement of Church and State.[2] Thus LEAS are trying to sort out the options that come out of a mandate to provide services to these students and a prohibition on the way these services were provided. There area number of ways to solve the problem. One solution is to deliver instruction to students via the computer.

Thus some LEAs are making investments in technology to provide services to Chapter 1 students in nonpublic sectarian schools. In some configurations, the LEA

2. Aguilarv. Felton, 105 S.Ct. 3232.

maintains and operates a mainframe or host computer on a public school site or administrative office. This system is linked to dumb or smart terminals at nonpublic sectarian schools where Chapter 1 students receive instruction directly from the computer.

OTA finds that while it is technically feasible to install and operate a distributed computer system, several important issues arise about the long term viability of this approach. These issues include substitution of computer systems for teachers and the tradeoff between flexible, stand-alone computers and a distributed system that must be externally operated to assure compliance with the law. There is also the issue of the costs for such a system: this includes not only hardware and software, but also telecommunications lines and transmission fees, and training of teachers at the LEA sites, and training of "monitors" at the delivery sites. It is important to assess how quickly these fixed systems might be replaced by superior technologies, as they represent a substantial investment in a hinge, dedicated hardware system. The continued evolution of computer hardware may provide new solutions to these questions, e.g., the recent advances in local area networks to link stand-alone computers in distributed networks.

OTA also finds advantages to this specific use of the technology as one remedy to the Aguilar v. Felton issue. Instruction can easily be monitored and student progress assessed using the management components of these systems. In addition, system uniformity provides a standardized instructional processor all students. Some districts already using distributed systems report significant achievement gains by students. Some also report lower per pupil costs.

IMMEDIATE AND FUTURE NEEDS

OTA finds four areas that need attention to improve the use of technology already in schools and to reach the potential that technology can offer. These are teacher training, software development, dissemination of information, and evaluation and research.

Teaeher Training

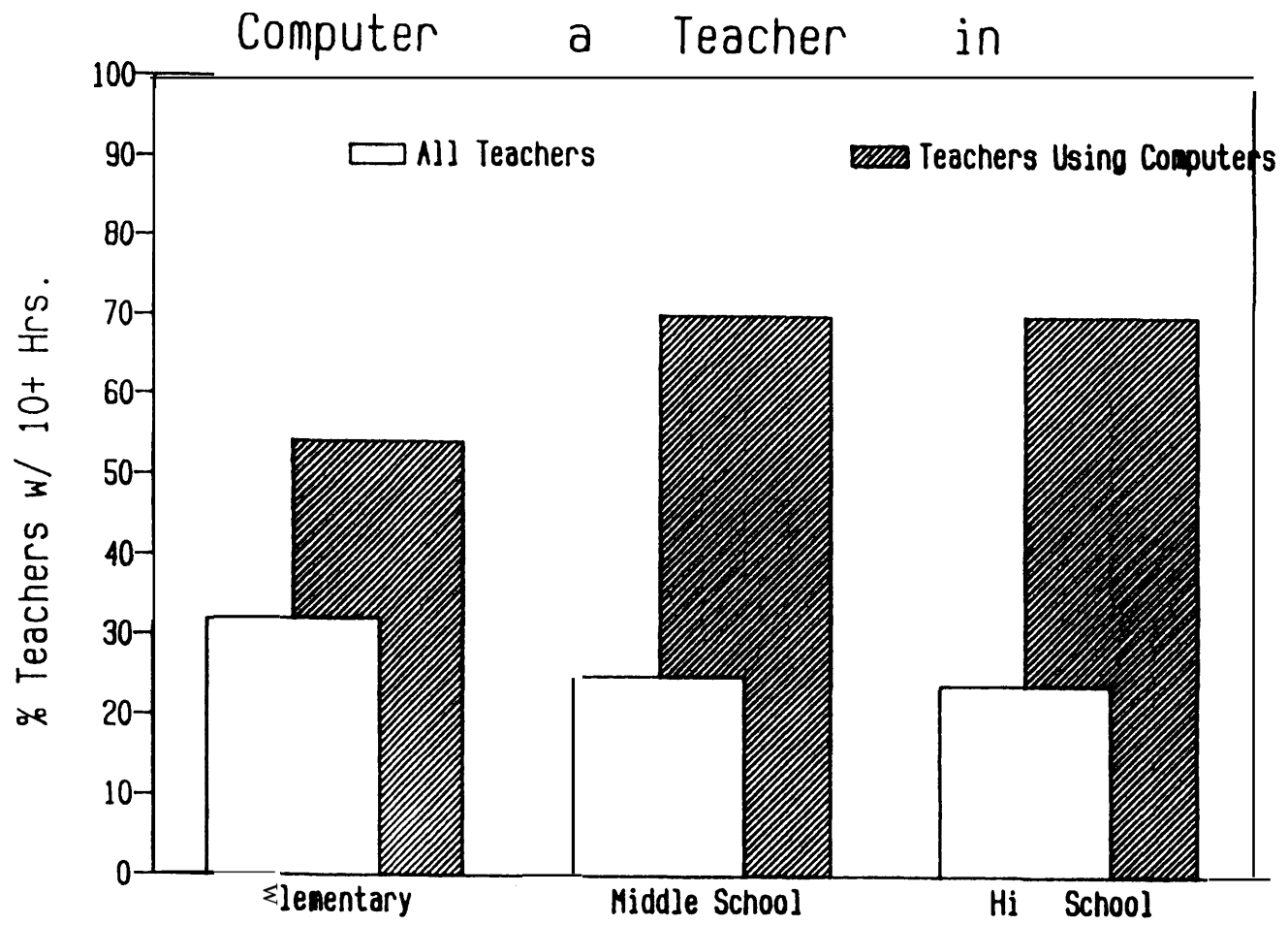
The expansion in the number of teachers using computers can be measured in many ways. One example of this growth is in the formation of self-help groups, such as Computer-Using Educators. In 1978, there were 50 educators who met together in various locations in and around the Silicon Valley; today there are over 8,000 members nationwide, and similar organizations in many States. In 1984-85, about 25 percent of all U.S. teachers used computers with their students. The most recent data show the number has grown to over 50 percent.

As more and more teachers use technology, perhaps the most important question is whether they have been adequately trained. OTA analysis of available data answer the question in part:

- Less than one-third of all U.S. teachers, but more than one-half of all computer-using teachers, have had at least 10 hours of training. [See Figure 16]

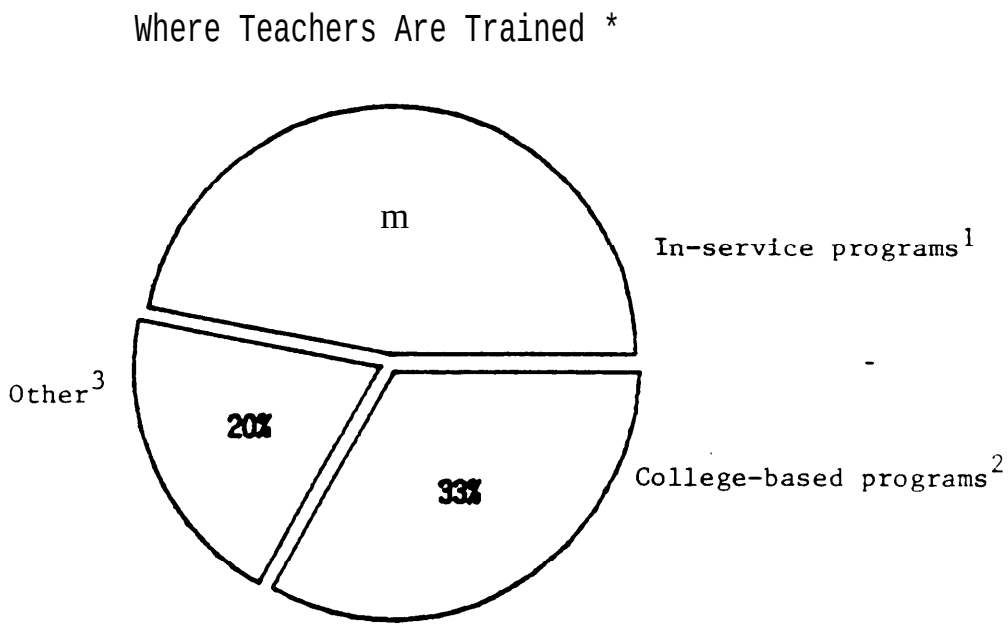
- Although teachers traditionally receive in-service training onsite, more than one-half of teachers who received training learned about computers in other ways: taking courses for college credit, attending training sessions offered by vendors, or in some other ways. [See Figure 17]

FIGURE 16



SOURCE: 1985 National Survey of Instructional Uses of Schools, Center for the Social Organization of Schools, Johns Hopkins University

FIGURE 17



* Teachers with 10 or more hours of computer-related training.
1. In-service programs, typically offered on school premises.
2. In a college classroom for academic credit.
3. All other settings, including computer dealers.

SOURCE: 1985 National Survey of Instructional Uses of School Computers, Center for Social Organization of Schools, Johns Hopkins University.

- The majority of State Chapter 1 coordinators indicated that teacher training must be apart of any further investment in computer technology.

- Researchers and State and local policymakers in programs that serve limited English proficient (LEP) students emphasized the need for training in the application of programs to meet students needs, especially since so few software programs have been designed for such students.

As computer use in education has become more pervasive, State education agencies and local school districts are taking an active role in providing teacher training. There is general agreement that there is no quick and easy way to provide the training teachers need. To the extent that training relies on nonschool sources, there is concern regarding the ability of vendors to provide balanced information about appropriate software and about its best uses in the classroom. As development of more "user friendly" computer systems continues, along with increased use of content-related software, teachers will need a different kind of training. The issue of continuing teacher training is the one most frequently mentioned by educational researchers, computer manufacturers, software developers, and educational policymakers as the top priority to assure successful continuation of the use of computers in schools.

In view of continued training needs, there is a crucial need to identify practices that are working effectively and draw on the most recent research and evaluation of teacher training efforts.

Software

In the earliest days of computer purchases, many schools discovered that for a variety of reasons, there was a very limited range of software: (1) software written for

one computer system would not run on any other; (2) most was of poor quality and had limited educational value; and (3) software programs tended to be electronic versions of drill and practice exercises found in workbooks.

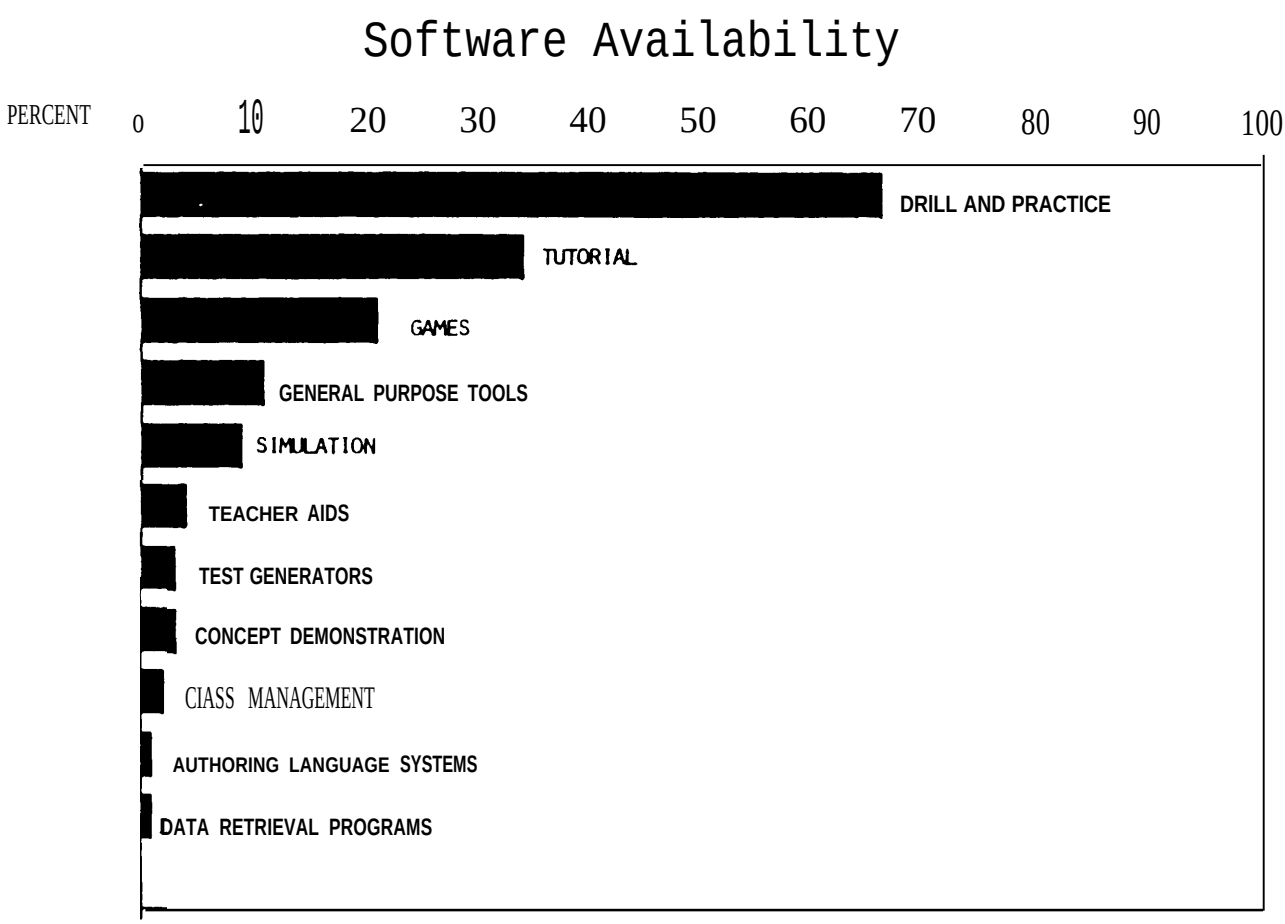
Today, educational software products are vastly improved and there is a wider range of content-related materials and types of application. [See Figure 19] Some software developers and publishers are able to produce software in more than one version to run on the major hardware systems in schools. As software has become available, schools have been quick to adopt and experiment with it. [see Table 1]

In Chapter 1 programs, software that offers both instruction and management of student progress appears to be working. At the same time, some Chapter 1 programs are experimenting with other applications and approaches. Some Chapter 1 managers question the need for experimentation, while others (including outside researchers) welcome such experimentation. The latter are concerned that Chapter 1 students may be limited by computer systems that simply drill them in skills at the remedial level, while other students get to use computers in many different ways and at various levels of functioning. A number of researchers suggest that Chapter 1 students may need more, not fewer, avenues to reach their potential level of development and full functioning.

In comparison to the range of software applications that are geared to remediation of basic skills, OTA finds that far less software has been developed for limited English proficient (LEP) students. This lack of specific software is a barrier to use of technology by the teacher with these students. However, OTA found examples of software that had been developed by the local district with a major infusion offending for development, or software developed by teachers themselves, to meet the specific needs of different language groups. Other programs are making effective use of word processing and writing tools that can be adapted for use in either ESL or bilingual programs.

OTA also finds that recent technological advances have positive implications for LEP students. These developments include: (l) low-cost chips, which add dual language

FIGURE 19



SOURCE: Baaed on data extracted from The Educational Software Selector (TESS) Database, May 1986, personal communication, Bob Haven, Educational Products Information Exchange (EPIE), Water Mill, NY.

Table 1

Distribution of Commercial Software Products by individual Subject Matter Areas

Subject Matter	Number of Software Products
Agriculture	16
Aviation	12
Business	189
Comprehensive[1]	536
Computers[2]	306
Driver Education	10
Early Learning-Preschool	150
English-Language Arts	751
English as a Second Language	34
Fine Arts	172
Foreign Language	305
Guidance	110
Health	92
Home Economics	113
Industrial Arts	
Logic and Problem solving	111
Math	1,646
Medicine	67
Miscellaneous	27
Physical Education	37
Reading	636
Religion	24
Science	1,013
Social Science	375

1. Generic software that can be used in all subjects.
2. Computer programming and computer literacy.

Source: Based on data extracted from The Educational Software Selector (TESS) Database, May 1986, personal communication, Bob Haven, Educational Products Information Exchange (EPIE), Water Mill, N.Y. Note: Haven estimates that a very small proportion of the software listed in TESS could easily be used by limited English proficient students.

character generation and make writing in Spanish or English possible on the same microcomputer; (2) digitized speech and audio devices, which make it possible to include native language speech output as a part of the microcomputer instructional program; and (3) dual audio tracks on video disk, which allow instruction of any subject in English and the native language.

Whether these technical capabilities will be utilized in developing resources for ESL and bilingual program applications is not certain. First of all, technology is still only a small part of these programs for LEP students. With limited funds available, most districts place priority on human resources (teachers and specialist staff). Second, software developers and distributors point to the thin markets for bilingual education and ESL materials. This factor discourages the investment of development dollars necessary to create software to suit varying needs of LEP students language minority speakers across the K-12 curriculum. However, there may be ways around some of these problems, such as seeding small scale development and encouraging development of general purpose software that can be customized for different language groups.

More generally, there may still be formidable barriers to effective software development. The marketplace for educational software is specialized, as State and district level curricula differ. The cost of researching, writing, designing, marketing, and distributing new software is significant. Some of the most successful programs are therefore, of necessity, widely applicable utilities like word processing and spreadsheets. Others fill specific niches that have been clearly identified. Some of the most effective and most used educational software programs were originally developed with Federal support. Many private software companies may not be able to recover the costs of development, due to the varying characteristics of the education market, to the nonstandard nature of educational purchasing practices, and to the widespread practice of illegal copying. The scope of this problem requires further study.

Dissemination of Information

As data show, computer use and application expanded at both elementary and secondary levels. At the same time, the technological environment is changing and becoming increasingly complex. Staying on top of lessons learned from widespread implementation efforts and keeping abreast of new hardware and software is very difficult even for those districts that are far ahead of most. State efforts such as the California computers in the curriculum project, local and regional networks of districts, and national computer user organizations play unimportant role. Nevertheless, these dissemination efforts do not reach all groups or cover all aspects of the information base.

OTA finds a need to disseminate information about programs using technology with LEP students. Several Title VII projects have information or materials of value but no resources to share them. Similarly OTA found researchers and schools making breakthroughs using technology with LEP students. It is important to ensure that dissemination agencies such as the National Clearing house on Bilingual Education, or the regional technical assistance centers, have the capacity to increase access to these important developments underway, and make use of this opportunity.

Chapter 1 technical assistance centers provide some training and information about technology to local districts. Several Chapter 1 programs using technology are part of the National Diffusion Network. Vendors and hardware manufacturers provide information as well. In spite of these resources, many State coordinators reiterated that they need more systematic information regarding the impacts of computer use.

Evaluation and Research

Because most implementation efforts focus on acquisition of technology and teacher training, evaluation has received less attention. Today, educators at all levels emphasize the need for more systematic evaluation of computer use. Many feel that

there is a need to develop criteria that can be used to compare the variety of efforts taking place. Such criteria would make it possible to make better use of information that States and districts have collected, and identify critical components that are missing. Chapter 1 State coordinators stress the need for further research and evaluation. In addition, they see the need for demonstration sites, where advanced technology is integrated to meet the critical needs of Chapter 1 students. These sites need not be restricted to these students, but could include a wide range of approaches and a wide range of students, including LEP students. Those working with all of these students point to the need for research and development to create software for a variety of learning and language needs.

There may also be very valuable evaluation and research opportunities in a number of "experimental" demonstration efforts already in place. These include statewide activities such as Project Impact in Arkansas, and State supported demonstration projects and model sites in California and Minnesota, for example. In addition, it maybe important to follow what happens to students and teachers in a number of classrooms that have high concentrations of hardware provided by several vendors, such as the Apple Classroom of Tomorrow, Writing-to-Read, and the Waterford School. These experimental projects can provide a rich source of data for research and analysis.