96-178 EPW

CRS Report for Congress

Information Technology and Elementary and Secondary Education: Current Status and Federal Support

Updated January 8, 2001

Patricia Osorio-O'Dea
Analyst in Social Legislation
Domestic Social Policy Division

Information Technology and Elementary and Secondary Education: Current Status and Federal Support

Summary

Interest in the application of information technology to education has risen among federal policymakers, sparked partly by concern over poor performance of U.S. elementary and secondary school students and a growing perception that technology might improve that performance. Since the 1980s, schools have acquired technology at a fast pace. Today the ration of students-to-computers is 6-to-1. Despite these gains, schools have a sizeable stock of old, outdated technology. Further, students have substantially different degrees of access to technology. Perhaps of greater concern is that, even when students have access to the technology, relatively little use is made of it in schools.

Research suggests that beneficial effects of technology on achievement are possible, but the effects appear to depend largely upon local school factors. Strengthening teachers' capabilities with technology is considered one essential step. Another is to develop curriculum that integrates technology into instruction. The financial cost of acquiring, maintaining, and using technology in schools is likely to be a significant hurdle. Estimates of these costs vary widely. Any estimate must be approached with caution because it will be based upon widely varying assumptions about such elements as the configuration of hardware, software, training, and curriculum development.

While there is not set figure on the amount of federal investment being made in technology, the federal government appears to be providing a billion dollars or more annually in support of educational technology through a fragmented effort with support flowing through multiple agencies and many different programs. A large proportion of that assistance comes from federal programs for which technology is not a primary focus. Additionally, the E-rate program, established through the Telecommunications Act of 1996, has provided billions of dollars in discounts for telecommunications services, Internet access, and internal connections to schools and libraries. These discounts are funded by interstate telecommunications carriers. The program has been challenged in the Congress for, among reasons, being more expansive than was intended. Discount commitments totaling over $3.5 billion for its first and second year have been made; the third year of the program is now being implemented.

Shaping federal policy in this area, particularly given that elementary and secondary education is a state and local responsibility, requires addressing at least four major questions: Should the federal government provide support? What activities, if any, should it support? How should this support be provided? What level of support should be provided?

Contents

This document updates the original CRS Report 96-178, *Information Technology and Elementary and Secondary Education: Current Status and Federal Support*, formerly written by James Stedman.

List of Figures

Information Technology and Elementary and Secondary Education: Current Status and Federal Support

Recent Action

The 106th Congress reviewed proposals to amend several of the existing federal education technology programs, such as the Technology Literacy Challenge Fund, as it considered reauthorization of the Elementary and Secondary Education Act (ESEA).[1] None of these proposals was enacted. The 107th Congress is expected to once again consider education technology programs as it reauthorizes the ESEA.

Introduction

In their quest for ways of making elementary and secondary schools more effective, policymakers at all levels have looked to new information technology. As they do, they are faced with myriad claims about technology's actual and potential impact on schools, ranging from assertions that it may revolutionize schooling to warnings that technology may have little impact and, at worst, may exacerbate current problems.[2]

This report provides an analysis of issues involving the application of information technology to elementary and secondary education, and federal policymaking in this area. The report includes the following topics:

- sources of the current interest in bringing technology to education,
- status of technology in schools,
- major issues involving the integration of technology into schools, such as the impact of technology on achievement and the cost of technology,
- Federal support for technology in schools, and
- major federal policy questions.

---

[1] CRS Issue Brief IB98047, *Elementary and Secondary Education: Reconsideration of the Federal Role by the 106th Congress*, by Wayne C. Riddle, *et al.* CRS Report 98-969, *Technology Challenge Programs in the Elementary and Secondary Education Act*, by Patricia Osorio-O'Dea.

[2] For a collection of essays exploring different views of the potential impact of technology, see: U.S. Congress. Office of Technology Assessment (OTA). *Education and Technology: Future Visions*. OTA-BP-EHR-169. Washington, 1995. (Hereafter cited as OTA, *Education and Technology*).

This report will be updated periodically to reflect substantive action on federal programs and policies described below.

For this report, the terms "information technology" and "technology" are used to identify a broad array of different equipment and materials, such as: computer hardware; compact disc (CD-ROM) and video disc players; computer software; electronic databases; television; video material; satellites, modems, and other telecommunications equipment; and electronic networks based on that telecommunications equipment.

Current Interest in Technology for Elementary and Secondary Education

For nearly 2 decades, policymakers at the federal, state, and local levels have been concerned about the poor academic performance of U.S. students relative to their counterparts in many other industrialized nations.[3] At the same time, policymakers have increasingly recognized that technology is becoming a central component of many jobs, changing the skills and knowledge needed to be successful in the workplace.[4] This anxiety about the academic competitiveness of U.S. students coupled with changes in needed work skills has heightened interest in integrating technology into the elementary and secondary curriculum in an effort to address both sets of needs.

With regard to academic performance, many policymakers and analysts believe that new information technology can increase students' achievement and mastery of challenging curricula by providing students and teachers with new environments for learning, new ways of instructing, expanded access to resources, constructive contact with other students or teachers, and new tools to manipulate and present data.[5]

---

[3] See, for example: The National Commission on Excellence in Education. *A Nation At Risk: The Imperative for Educational Reform. A Report to the Nation and the Secretary of Education*. U. S. Department of Education. 1983.

[4] See, for example: The Commission on the Skills of the American Workforce. *America's Choice: High Skills or Low Wages!* National Center on Education and the Economy. 1990. (Hereafter cited as The Commission on the Skills of the American Workforce, *America's Choice*); and Committee for Economic Development (CED). *Connecting Students to a Changing World: A Technology Strategy for Improving Mathematics and Science Education*. 1995. (Hereafter cited as CED, *Connecting Students to a Changing World*).

[5] See, for example: U.S. Congress. Office of Technology Assessment. *Teachers and Technology: Making the Connection*. Washington, 1995. (Hereafter cited as OTA, *Teachers and Technology*); Means, Barbara, *et al*. *Using Technology to Support Education Reform*. Report prepared for the U.S. Department of Education, Office of Educational Research and Improvement. Washington, 1993. (Hereafter cited as Means, *Using Technology to Support Education Reform*); CED, *Connecting Students to a Changing World*; National Information Infrastructure Advisory Council (NIIAC). *KickStart Initiative*. February 13, 1996. As made available through the NIIAC home page on the World Wide Web. (Hereafter cited as NIIAC, *KickStart Initiative*) The NIIAC, a panel created by an

(continued...)

Concurrently, many contend that, with an increasingly technological workplace, schools should be equipping students with a different mix and level of skills. These, it is argued, include familiarity with technology and the ability to use it in the workplace. Further, the integration of technology into work is seen as creating demands for higher levels of mathematics and science competence, and such other skills as being able to work in teams, exercise judgment on work-related issues, and quickly master new skills.[6] In the eyes of many critics, schools as currently structured are relics of an industrial age that is passing, inappropriately engaged in "prepar[ing] students for a world that no longer exists, developing in students yesterday's skills for tomorrow's world."[7]

Status of Technology in Schools

Information technology is spread broadly, but not deeply, across elementary and secondary education. Despite nearly 2 decades of influx of technology, the extent to which elementary and secondary schools provide students with *continuing* and *effective* access to new information technology remains limited.

Throughout the 1980s and 1990s, much of the focus has been on the presence of computers in schools. Today there are an estimated 8.2 million instructional computers in schools, with an additional 600,000 used for administrative purposes.[8] This acquisition of computers has dramatically cut the ratio of students-to-instructional computer. Most recent figures indicate that in 1999 the students-to-computer ratio was 6-to-1.[9]

Despite this sizeable reduction in the ratio, many experts believe that current ratios still do not provide the level of access necessary to realize this technology's educational benefits. For example, the students-to-computer ratio for computers with Internet access was 9-to-1 in 1999.[10] Further, some analysts believe that a lower students-to-computer ratio — four or five to one — should be the target for

---

[5] (...continued)
executive order issued by President Clinton, provides advice on the national information infrastructure.

[6] See, for example: The Commission on the Skills of the American Workforce, *America's Choice*; CED, *Connecting Students to a Changing World*; and OTA, *Education and Technology*.

[7] OTA, *Education and Technology*, p. 5.

[8] Market Data Retrieval. *Technology In Education 1999*. Data provided at MDR website [http://www.schooldata.com/pr18.html], June 9, 2000.

[9] U.S. Department of Education. National Center for Education Statistics. *Internet Access in Public Schools and Classrooms: 1994-1999*. Issue Brief. February 2000. (Hereafter cited as ED, *Internet Access in Public Schools and Classrooms: 1994-1999*).

[10] *Ibid*.

schools.[11] As is explored in a later section in this report, the ratio of students-to-computer continues to provide relevant information for policymaking, particularly when it is disaggregated to consider the access that different kinds of schools and students have to computer technology.[12]

A substantial number of schools have acquired the newest information technology during the 1990s. Between 1994 and 1999, the percentage of public schools with access to the Internet rose from 35% to 95%.[13] In 1999, the percentage of classrooms, computer labs, and library/media centers connected to the Internet was 63%, 21 times greater than the 1994 percentage (3%). Internet access is considered in more detail later in this report. Despite substantial acquisition of other elements of the new technology during 1990s, their availability may still be relatively limited.[14]

Major Issues

In this section, we briefly consider a number of the major issues that directly affect the effort to integrate technology into elementary and secondary education:

- impact of technology on academic achievement,
- cost of technology,
- differences in access to technology,
- amount of technology use and kinds of uses in schools,
- technology-related knowledge and skills of the teaching force, and
- integration of technology into the curriculum.

Impact of Technology

One of the key questions for policymaking at all levels is whether information technology has, or can have, beneficial effects on education. Overviews of available research suggest that positive effects are possible, not only for students, but also for teachers and the schooling process in general. Among the reported outcomes for students are increased academic achievement, more positive attitudes about school work, and achievement gains by special populations of students (e.g., those with learning disabilities). Consequences for teachers reportedly include greater interaction with colleagues, and changes in teaching styles from lecturing to coaching and facilitating students' work. It is suggested that information technology can be an important force for restructuring the educational process, not just the role of teachers,

---

[11] CED, *Connecting Students to a Changing World*, p. 39.

[12] We would note that the students-to-computer ratios for individual states vary widely. See, Education Week. *Technology Counts '99.* September 23, 1999. (Hereafter cited as Education Week, *Technology Counts '99*).

[13] ED, *Internet Access in Public Schools and Classrooms, 1994-1999.*

[14] See: Hayes, Jeanne. Equality and Technology. *Learning and Leading With Technology*. October 1995; and Coley, Richard J. *et al*. *Computers and Classrooms: The Status of Technology in U.S. Schools*. Educational Testing Service. 1997. (Hereafter cited as Coley, *Computers and Classrooms*).

but also such aspects of education as how time is used in schools; how lines of authority are drawn among teachers, administrators, schools, school districts, etc.; and where schooling occurs.[15]

Some analysts have reached somewhat less positive conclusions concerning the current or potential impact of technology in elementary and secondary schools. They raise concerns about such issues as whether educational institutions will be able to use technology effectively, whether all groups of students will be able to take advantage of technology, whether technology will isolate students rather than bring them together, whether technology will be a distraction from more serious academic learning, whether technology investment will divert resources from other critical school needs, whether the evidence is really persuasive that technology can improve academic performance, and whether technology will be used to support current educational practice and structure, rather than to promote change.[16]

Policymakers are particularly interested in the effects of information technology on students' academic achievement. Traditional analysis of the academic effects of technology seeks to address this interest by following the "horse race" approach of comparing the educational impact of one kind of technology with another or with conventional instruction. The focus is on identifying winners and losers. Available data from such studies suggest that some uses of technology, such as computer-assisted instruction, are found to be either more effective than, or equally as effective as, conventional instruction.[17] However, such a generalization has serious limitations. For example, studies covering shorter periods of time have found stronger positive results than have studies assessing effects over a longer period of time. This led one analyst to suggest that "novelty effects boost performance with new technologies in the short term but tend to wear off over time."[18]

Perhaps even more important is the growing understanding that "horse race" studies may not provide sound guidance for policymaking because they fail to account for the local **context** within which technology is applied in schools. The elementary and secondary education enterprise is exceedingly complex and the circumstances under which technology may be introduced into the instructional process will vary

[15] See, for example, OTA, *Teachers and Technology*; NIIAC, *KickStart Initiative*; Means, *Using Technology to Support Education Reform*; McKinsey & Company. *Connecting K-12 Schools to the Information Superhighway*. 1995. (Hereafter cited as McKinsey & Company, *Connecting K-12 Schools*); and The CEO Forum on Education and Technology. *School Technology and Readiness Report. Professional Development: A Link to Better Learning*. Washington, 1999. (Hereafter cited as CEO Forum, *School Technology and Readiness Report*).

[16] See, for example: OTA, *Education and Technology*, p. 18-19; Cuban, Larry. Computers Meet Classroom: Classroom Wins. *Teachers College Record*, winter 1993; and McCluskey, Lawrence. Gresham's Law, Technology, and Education. *Phi Delta Kappan*, March 1994. Stoll, Clifford. *High Tech Heretic: Why Computers Don't Belong in the Classroom and Other Reflections by a Computer Contrarian*. New York: Doubleday, 1999.

[17] See for example: Means, *Using Technology to Support Education Reform*, chapter V; and OTA, *Teachers and Technology*, p. 14-16.

[18] Means, *Using Technology to Support Education Reform*, p. 74.

among the approximately 14,800 school districts, over 85,000 public schools, and 26,000 private schools in which children are educated. Linda Roberts, the director of the Office of Educational Technology in the U.S. Department of Education (ED), has asserted that "under the **right** conditions new interactive technologies contribute to improvements in learning."[19] For policymakers, the research on the effects of technology in education may be most important for identifying those **right** conditions under which technology will be effective.

Among the conditions that may make technologies more likely to be effective in schools are careful and systematic planning, direct access for students and teachers to a broad variety of technologies and supporting materials, and the time and opportunities for teachers to become well trained and comfortable in the use of these technologies. For instance, a recent study by the Educational Testing Service (ETS) found that technology may be an important learning tool if teachers are well-skilled in its use.[20] Using data from the math section of the 1996 National Assessment of Education Progress (NAEP), the study found that 8th graders whose teachers used computers for "simulations and applications," which are generally associated with higher-order thinking skills, performed better on the NAEP than did students whose teachers did not use computers in this manner. Students whose teachers used computers mostly for "drill and practice" performed worse on the NAEP.

Cost of Technology

Estimates of the total cost associated with equipping schools with advanced technology (including access to networks and to data, voice, graphical, and video services) vary greatly. They provide a moving target for policy analysis because they are dependent upon a host of assumptions concerning the configuration of technology being established; they become outdated quickly as prices change for some elements in the technology configuration. Further, comparing different estimates by different analysts is often exceedingly difficult. As a result, any estimate should be used with caution. Note that the data discussed below, while providing an example of the estimated cost of equipping schools with technology, are fairly dated; they are not intended to reflect the current potential cost of equipping K-12 schools with technology, particularly given the substantial recent investments that have been made.

Most recent data are from a 1995 analysis of several options for connecting schools to the Internet; these data suggest how wide the range in cost estimates can be.[21] According to this analysis, a "baseline" model for Internet connection which

---

[19] Written testimony presented to the House Subcommittee on Elementary, Secondary and Vocational Education, March 23, 1993. (emphasis added)

[20] Educational Testing Service. *Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics*. New Jersey, September 1998.

[21] Rothstein, Russell I., and Lee McKnight. *Technology and Cost Models of Connecting K-12 Schools to the National Information Infrastructure.* MIT Research Program on Communications Policy. October 1995. Report provided at program Web site [http://rpcp.mit.edu], February 13, 1996. (Hereafter cited as Rothstein and McKnight, *Technology and Cost Models of Connecting K-12 Schools*). See, also, Rothstein, Russell I.

(continued...)

provides students and teachers with the ability of fully engaging in telecommunications opportunities involves networking of the computers in each school, connections for every classroom, equipment and resources at the school site necessary to permit multiple connections to the Internet and to permit the school to reduce its dependence upon the school district's central computers, significant renovation of school facilities, and extensive teacher training. The range of estimated up-front costs are between $9.35 billion and $22.05 billion, with annual costs ranging from $1.75 billion to $4.61 billion. At the high end of this range of estimated costs is a model that builds on the baseline model by providing **each student and teacher** with a technology-rich environment complete with a high capacity computer and other technology, and full access to the Internet. According to this analysis, estimated up-front costs range between $51.2 billion and $113.52 billion; annual costs may range from $4.02 billion to $10.03 billion.

These and other cost estimates depend upon several key factors, including the configuration of technology being acquired;[22] the amount of renovation and repair (retrofitting) necessary for school buildings; and, how the technology is to be supported and to what extent.

Differences in Access to Technology

Certain types of schools, as well as the schools attended by certain groups of students, are less likely to be able to provide access to technology than are other schools. This has been a recurring issue since personal computers first became commercially available in the late 1970s and began making their way into schools. Of particular concern to educators and policymakers in the 1980s was that schools serving substantial populations of low-income or minority students had fewer computers relative to the size of their enrollment than did schools with more affluent students or fewer minority students.[23] Other kinds of schools that appeared to

---

[21] (...continued)
Connecting K-12 Schools to the NII: A Preliminary Assessment of Technology Models and Their Associated Costs. U.S. Department of Education. Office of Educational Technology. Working Paper. August 4, 1994. Hughes, David. Appropriate and Distributed Networks: A Model for K-12 Educational Telecommunications. *Internet Research*, winter 1993; and OTA, *Teachers and Technology*, p. 21-24.

[22] According to a 1995 GAO report, over 50% of schools lacked the infrastructure needed to support new technology. The degree to which this percentage has changed is unknown, however, before computers and other technology can be integrated into the curriculum, many schools may still need to undertake certain steps, such as installing additional electrical outlets and phone lines, laying down fiber optic cables, and upgrading their air conditioning and ventilation systems. Morra, Linda. *America's Schools Not Designed or Equipped for the 21st Century*. General Accounting Office. April 4, 1995. HEHS-95-127.

[23] See, for example: Sutton, Rosemary E. Equity and Computers in the Schools: A Decade of Research. *Review of Educational Research*, winter 1991. p. 475-503. (Hereafter cited as Sutton, *Equity and Computers in Schools*). One national survey conducted in 1982-1983 found that the median students-to-computer ratio in all elementary schools was 183 to 1, while in predominantly minority elementary schools the ratio was 215 to 1 (The Johns Hopkins (continued...)

provide significantly less technology access to students included: (1) large schools, (2) urban schools, (3) private schools, and (4) elementary schools.[24]

More recent data suggest that somewhat similar patterns of uneven access to technology still apply to different groups of schools, but that some changes may have also occurred. Perhaps one of the most significant findings by the 1992 IEA Computers in Education Study was that differences in the students-to-computer ratios in U.S. schools based on their minority enrollments have largely disappeared at the high school level, are very small at the elementary level, and are modest at the middle school level.[25] Nevertheless, other data continue to depict substantial disparities in access for schools' with student populations that are **substantially** minority or poor.[26] For example, according to one source, in 1995-1996, schools with enrollment that was less than 25% minority had a students-to-computer ratio of approximately 10 to 1; schools with 90% or more minority enrollment had a ratio of 17.4 to 1.[27] Of concern to some analysts is the substantially lower access to computers that black and Hispanic students have at home than do white students.[28] According to U.S. Census data, in 1997, 54% of white students in grades 1 through 8 used a computer at home while only 21% of black students and 19% of Hispanic students did so. For students in grades 9 through 12, 61% of whites, 21% of blacks, and 22% of Hispanics used computers in their homes.

Access to the Internet

A central theme to recent analyses of educational technology is the importance of providing elementary and secondary schools and classrooms with access to telecommunications networks, particularly the Internet. Advocates of such access argue that students and teachers need to go "online" because of expected educational benefits from exploring the wealth of information now being made available on electronic networks, sharing information, and communicating with students, teachers, and experts in various fields. Although it is too early to identify the overall

---

[23] (...continued)
University. Center for Social Organization of Schools. *School Uses of Microcomputers*. Issue No. 3. October 1983. (Hereafter cited as The Johns Hopkins University, *School Uses of Microcomputers*).

[24] The Johns Hopkins University, *School Uses of Microcomputers*, Issues No. 1 and 3. 1983; and Market Data Retrieval. Microcomputers in Schools 1983-1984. 1984. Sections III and IV.

[25] Becker, Henry J. *Analysis of Trends of School Use of New Information Technology*. Report prepared for the U.S. Office of Technology Assessment. March 1994. p. 51. (Hereafter cited as Becker, *Analysis of Trends*). Anderson, *Computers in American Schools 1992*, Table 2.3.

[26] Coley, *Computers and Classrooms*, p. 10-26 (based on data from Quality Education Data, Inc.).

[27] Coley, *Computers and Classrooms*, p. 11.

[28] Differences in home access are highlighted in: U.S. Department of Education. *Digest of Education Statistics, 1999*. NCES 2000-031. Washington, 2000. This report uses data gathered by the U.S. Bureau of the Census.

educational effects that access to telecommunications networks will have, there is a growing literature describing students' and teachers' reportedly positive experiences with particular online applications or activities.[29]

Importantly, there is a recognition that access to the Internet is unevenly shared by schools across the country. Surveys by ED have assessed **public** schools' access to telecommunications technology, particularly connections to the Internet.[30] As shown in the figures below, schools in these surveys were differentiated by instructional level, enrollment size, metropolitan status,[31] geographic region, minority enrollment, and income of students.[32] The figures below show that elementary schools, city schools, schools in the Central region of the country, and schools with substantial percentages of low-income or minority students[33] are **less likely** to have access to the Internet. However, these figures also depict gains in all categories over a 1-year period, with the largest gains in Internet access among urban fringe schools, the West region, schools with less than 300 students, and schools with 50-70% low-income student enrollment. While the gaps in Internet access among schools with various characteristics have been reduced, data were not available to determine whether schools with large minority enrollments have experienced similar gains (as a result, 1999 data are not shown for schools by minority enrollment in **Figure 2**). Overall, the reduced gaps in access to the Internet may be due in part, to the E-rate program.

---

[29] See, for example: CED, *Connecting Students to a Changing World*, p. 13-14; Eisenberg, Michael B. *Networking: K-12*. ERIC Digest, 1992. 4 p.; and NIIAC, *KickStart Initiative*, "Reinvigorating and Improving Education."

[30] ED, *Internet Access in Public Schools and Classrooms, 1994-1999*; U.S. Department of Education. National Center for Education Statistics. *Internet Access in Public Schools and Classrooms: 1994-1998*. Issue Brief. February 1999.

[31] The metropolitan status categories shown in the figures below are: city (central city of a Metropolitan Statistical Area (MSA); urban fringe (a place within a large or mid-sized central city's MSA); town (a place classified as urban by the U.S. Bureau of the Census but that is not within an MSA, and that has a population greater than or equal to 2,500); rural (a place defined as rural by the Census Bureau and having a population below 2,500).

[32] Data on schools with more than 50% minority enrollment were not included in ED, *Internet Access in Public Schools and Classrooms: 1994-1999*.

[33] Low-income status was determined by whether students were eligible for free or reduced-price school lunches.

Figure 1 Percent of Public Schools **Without** Internet Access, by Type and Size, 1998 and 1999

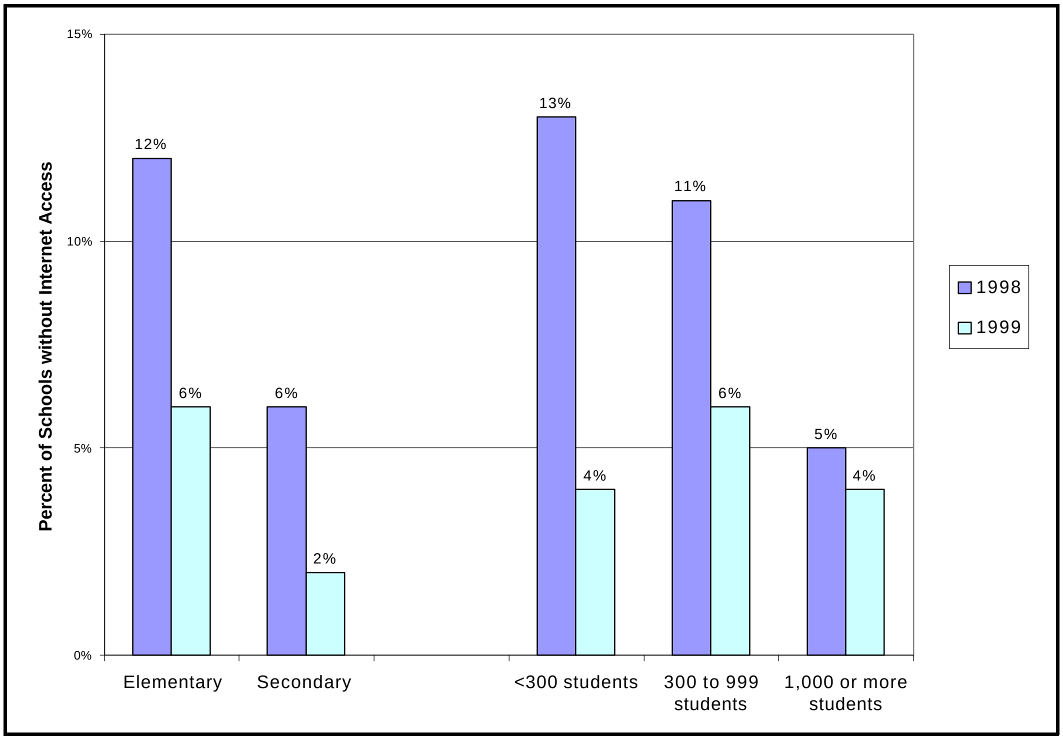


Figure 2 Percent of Public Schools **Without** Access to the Internet, by Location, 1998 and 1999

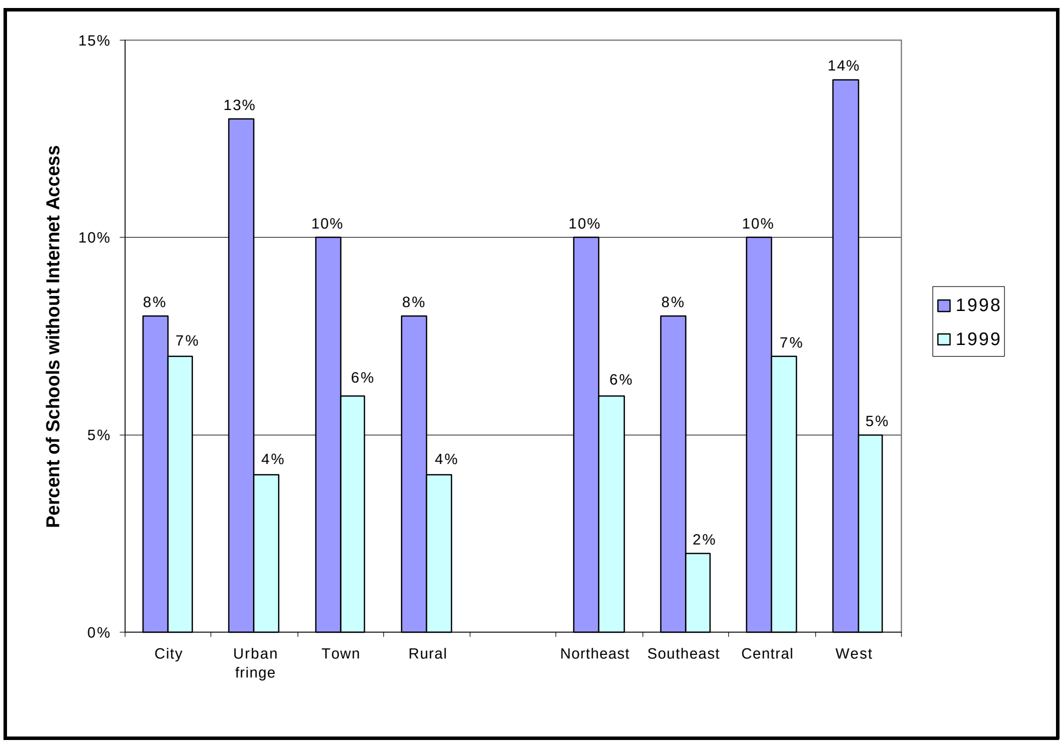
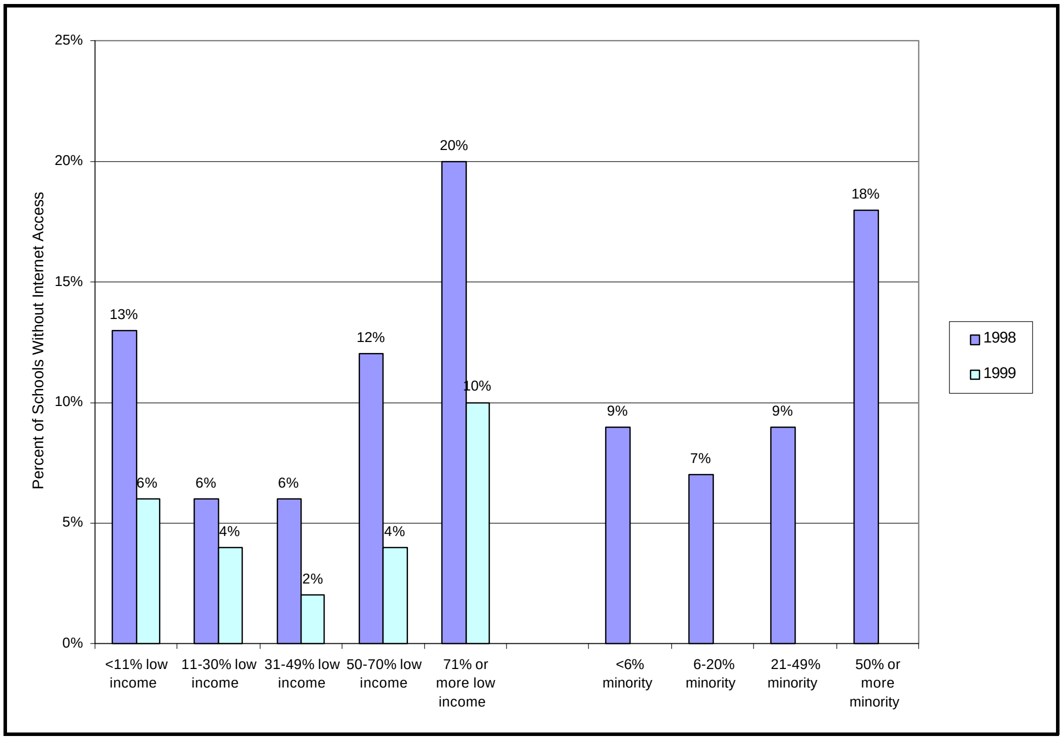
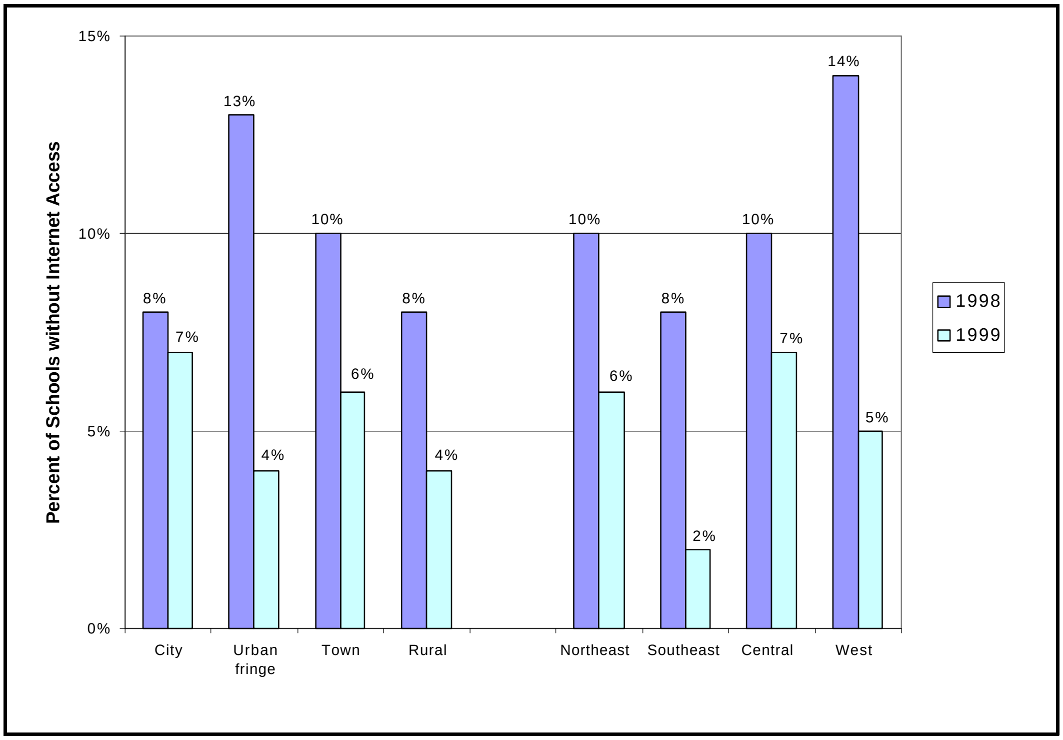


Figure 3 Percent of Public Schools **Without** Internet Access, by Student Characteristics, 1998 and 1999



It is important to note that gains in school access to the Internet do not necessarily translate to gains in classroom access. Data on the percent of **instructional classrooms** without Internet access show that schools with the highest percentage of low income student enrollment continue to have a significantly larger percentage of classrooms without access to the Internet. While schools with lower enrollments of low income students experienced gains in Internet access between 1998 and 1999, 61% of instructional classrooms in schools with enrollments of 71% or more low income students did not have access to the Internet. Schools with enrollments of 50-70% low income students had the largest one year gains; the percent of instructional classrooms without Internet access dropped from 60% in 1998 to 38% in 1999.

Figure 4 Percent of Public Schools **Without** Access to the Internet, by Location, 1998 and 1999



Amount of Technology Use and Types of Uses

Information technology can be used in the classroom in many ways. Among them are computer-based simulations, word processing, data manipulation, telecommunications, student assessment, and record keeping.[34] How much is information technology being used in schools and for what purposes? Available data show that students spend relatively little time in school actually working with computer technology, and different groups of students may be more likely than others to use computers.

Most of the available data addresses utilization of computer technology, rather than other kinds of information technology. A key message from these studies is that the average elementary and secondary school student spends **very little time working with computers in school**. One 1992 estimate is that, on average, a student uses a computer only **1.7 hours a week at the elementary school level, 2.0 hours at the middle school level, and 3.0 hours at the high school level. Overall, in 1992 students averaged just 2 hours a week with computers**.[35]

---

[34] These and other uses are described in various sources, including OTA, *Teachers and Technology*; Means, *Using Technology to Support Education Reform*; and CED, *Connecting Students to a Changing World*.

[35] Becker, *Analysis of Trends*, p. 32.

Recent data present information on students' **use of the Internet at school**. These figures suggest that students' Internet use has been increasing.[36] Between 1997 and 1998, students who reported using the Internet at school between 1 and 5 hours each week increased from 22% to 30%. Nevertheless, the study found that **most students use the Internet at school for 1 hour or less each week**. In 1998, 35% of students spent less than 15 minutes each week using the Internet at school and 30% of students used the Internet for 15 minutes to one hour each week. Note that these data do not include students' total computer use in school, nor do they identify how the Internet was used (i.e., research, online courses).

Distance learning is one kind of use to which many school systems are putting information technology. At the core of most definitions of distance learning is that it is instruction in which "the educator and the learner may be separated by time, distance, or both."[37] It may involve, for example, television broadcasts, satellite transmissions, computer networking, cable transmissions, and telephoning. In recent years, a substantial portion of school districts report that one or more of their schools is engaged in distance learning.[38]

Concerns have been raised periodically that even when technology is available in schools, certain groups of students are less likely to have opportunities to work with it.[39] These concerns have most frequently focused on minority students, girls, and low-income students. Recent survey data from the Bureau of the Census show black and Hispanic students as **less** likely to use computers in school.[40] Students with lower socioeconomic status (SES) are also less likely to use computer technology in schools. In the lower grades (grades 1-6), highest SES students (in the top 20% of all family incomes) reportedly used computers over 15 percentage points more in school than did students with the lowest incomes (86.5% for high income students compared to 70.9% for low income students).[41] Differences in school computer use among older students (grades 7-12) were smaller, with highest income students using computers in schools less than 10 percentage points more than students in the lowest income category (75.4% for high income students versus 67.6% for low income students).

Training of the Teaching Force

Policymakers seeking to increase the application of technology to education are likely to confront substantial professional development needs for the teaching force. It is generally recognized that the ability and propensity of elementary and secondary

---

[36] CEO Forum, *School Technology and Readiness Report*.

[37] Distance Learning Committee. Western Carolina University. As provided by the Distance Education Clearinghouse (University of Wisconsin-Extension) at its Worldwide Website.

[38] Quality Education Data. *Educational Technology Trends 1993-1994*. December 1994.

[39] See, for example, Sutton, *Equity and Computers in Schools*.

[40] U.S. Department of Education. *The Condition of Education, 1999*. NCES 1999-022. Washington, 1999. (Hereafter cited as ED, *The Condition of Education*, 1999).

[41] *Ibid*.

school teachers to use information technology in their classes depend not only on the availability of the technology, but also upon teachers' technology-related knowledge and skills. According to survey data from ED, in 1999 10% of public school teachers having access to computers or the Internet at school reported that they believed they were "very well prepared" to integrate technology into their instruction, and another 23% reported feeling "well prepared."[42] The majority of teachers felt "somewhat well prepared" (54%), while the remainder felt "not at all prepared" (13%). Increasingly states are requiring individuals seeking teacher licensure to have training in technology use. As reported in "Technology Counts '99," prepared and published by *Education Week*, 44 states require teacher preparation to include coursework in educational technology.[43]

Professional development, in general, appears to be treated as a relatively marginal activity by public elementary and secondary education.[44] What may be particularly telling is that "[m]ost states and districts have no idea of what they are actually spending on professional development .... State accounting systems make it difficult to aggregate professional development expenditures and few districts attempt to track them."[45] Technology-related professional development may also be considered a low priority. According to some analysts and policymakers, there is evidence that schools are underinvesting in teacher training related to technology. Currently, local school districts' budgets for technology are largely devoted to acquisition of hardware and software, while substantially less is used for training.[46] According to a recent survey by The CEO Forum on Education and Technology, in the 1997-1998 school year, schools spent 5% of their overall technology budgets on professional development; schools reportedly expected to spend the same percentage

---

[42] U.S. Department of Education. National Center for Education Statistics. *Teacher Use of Computers and the Internet in Public Schools*. NCES 2000-090. April 2000.

[43] Education Week, *Technology Counts '99*.

[44] Professional development may include a wide range of activities such as courses, workshops, seminars, and conferences attended during the school year and the summer. These activities are intended to strengthen teachers' subject matter knowledge and pedagogical skills.

[45] Corcoran, Thomas B. *Helping Teachers Teach Well: Transforming Professional Development*. CPRE Policy Briefs, RB-16-June 1995. p. 2. Corcoran estimates that local school districts are devoting not more than between 3% to 5% of their operating expenses on professional development. We would note that this estimate of spending is significantly increased by inclusion of the present value of salary increases that teachers receive as a direct result of earning degrees or college credits through professional development activities. In one analysis, the value of these salary increases accounted for over 60% of the total estimated expenditures. Although states make some expenditures for professional development, these are likely to be substantially less than expenditures made by local districts. As Corcoran notes, "In most states, local districts bear the brunt of paying for professional development ...." (p. 3.)

[46] McKinsey & Company, *Connecting K-12 Schools*, p. 66-67, estimate that aggregate spending on technology by public elementary and secondary schools in 1994-1995 was $3.3 billion of which $2.2 billion (67%) was for hardware and software and $.3 billion (9%) was for training. The remainder was for such things as financing network connections and system administration.

of their technology budgets on professional development in the 1998-1999 school year.[47]

Reportedly, opportunities for professional development are needed not only for the technology neophyte, but also for those teachers who are already making use of information technology in their instruction. Analysis of a group of teachers accomplished in applying technology to their teaching found that these teachers built their expertise over a substantial period of time extending as long as 5 to 6 years.[48] Even after this initial period of development, over three-quarters of these "accomplished" teachers continued to secure advice and assistance on technology applications.[49]

Further, the introduction of information technology into elementary and secondary classrooms may be an impetus for professional growth by teachers. The analysis of "accomplished" teachers cited above showed that these teachers are likely to modify their instructional and professional practices in ways many policymakers consider to be improvements in current teaching practice: they do less lecturing and more "coaching" in the classroom; they are more likely to engage students in independent, open-ended projects; they collaborate more often with their colleagues; and they seek to restructure the daily schedule to provide more time for planning and integrating technology into their teaching.[50]

Finally, technology can be a means **for** professional development, in addition to being the object of such activities. New information technology is increasingly being used to provide professional development opportunities to new and experienced teachers. These activities reportedly include using technology to provide or supplement teacher education programs and to link colleges of teacher education with student teachers and mentor teachers.[51]

Curriculum Development

Integrating technology into the educational process is likely to require changes to the current curriculum in various subjects areas. Technology may change such things as the topics that can be covered in a subject area, the depth of coverage, and appropriate instructional approaches. It may provide access to a broader array of data and enable teachers and students to work with information in different ways.

---

[47] CEO Forum, *School Technology and Readiness Report*.

[48] Sheingold, Karen, and Martha Hadley. *Accomplished Teachers: Integrating Computers into Classroom Practice*. Center for Technology in Education. Bank Street College of Education. September 1990. p. viii. (Hereafter cited as Sheingold and Hadley, *Accomplished Teachers*).

[49] *Ibid*., p. 7.

[50] *Ibid*., p. 14-17.

[51] Bradley, Ann. Everyone Can Raise Their Hands. Education Week. *Technology Counts '98*. October 1, 1998.

Research to date suggests that this process of integration will be complex and lengthy.[52]

The national curriculum content standards developed in the core subject areas anticipate a greater role for information technology, particularly in the standards developed for science and mathematics. These standards are intended to provide guidance for the development of curriculum in different subject areas and establish measures against which to gauge the quality of the education being provided in those areas. Consider, for example, the national science education standards which were prepared through a process coordinated by the National Research Council (NRC) and partly funded by the federal government.[53] These standards emphasize that science education should be an active process, with students actually doing science. New "science as inquiry" standards expect technology to play a prominent role in enabling students to engage in active scientific inquiry. For example, the standard for grades 5-8 states that "use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes."[54] Further, the NRC effort has produced science education program standards which identify, among other things, the resources that schools should make available to students studying science. Among these resources are "computers with software for supporting investigations."[55]

Whether or not states and localities adopt these national curriculum content standards, the curriculum standards and frameworks already established or under development in several states incorporate technology as a tool for research, analysis, and communication and as a subject for study.[56] As a result, it is likely that interest in the integration of technology into the curriculum will grow in the states, along with attention to many of the other issues considered in this report, such as the availability of technology and teachers' preparation to apply the technology.

Federal Support for Technology in Schools

This section provides an overview of the general characteristics of current federal support for the acquisition and use of new information technology by elementary and secondary education. Following that overview is a description of many of the individual programs that currently provide such support.

---

[52] Sheingold and Hadley, *Accomplished Teachers*.

[53] National Research Council. *National Science Education Standards*. 1996. 262 p.

[54] *Ibid*., p. 145.

[55] *Ibid*., p. 220.

[56] See, for example: Oregon State Board of Education. *Curriculum Content Framework for Oregon Public Schools*. March 4, 1994; Utah State Board of Education. *Secondary Core Curriculum Standards: Levels 7-12 Mathematics*. 1995; and Vermont Department of Education. *Vermont's Common Core Framework for Curriculum and Assessments*. Draft. September 29, 1995.

Characteristics of Current Federal Support

Federal programs supporting the application of information technology to elementary and secondary education have several key characteristics. Foremost among them is its **fragmentation**. No federal authority currently directs or coordinates federal technology support for elementary and secondary education.[57] Education agencies, districts, and schools receive federal assistance from many different agencies and many different individual programs. Another important characteristic is the **diversity** of this assistance. As is shown in the following section, federal funds support a multiplicity of activities such as acquisition of hardware and software, teacher training, demonstrations of applications, curriculum development integrating technology applications, networking for distance learning, etc. For purposes of accounting for federal spending on precollege technology, one of the most complicating characteristics is the **indirect** nature of the support. Much of the federal assistance is provided by programs that are not solely or directly focused on technology. These programs have such broad authorities that schools are able to use their funding for technology purposes. Finally, despite the various difficulties in accounting for the full level of federal support, it is evident that there is a **significant amount** currently being provided. It appears that a billion dollars or more from federal programs is used to support the application of technology to elementary and secondary education.

It is also important to stress that a focus on federal programs, *per se*, masks another important means by which the federal government may support educational applications of technology. Specifically, federal rules and regulations governing telecommunications policy in the U.S. are likely to have a significant impact on schools' ability to have access to new telecommunications capabilities. The E-rate is considered in greater detail below.

Selected Federal Programs and Activities Supporting Technology in Education

This section provides a listing of **selected** federal programs that support the acquisition and use of information technology by elementary and secondary education. Given the multiplicity of sources of support and the flexibility in uses of funding under some of them, it must be stressed that **this listing is not comprehensive**, rather it is primarily illustrative. It includes several major sources of funding, as well as authorities specifically targeting educational technology. Programs in this listing are grouped by federal agency.

U.S. Department of Education. ED programs are initially grouped below into programs with an explicit focus on technology and those reportedly providing

---

[57] Some general efforts to improve the coordination of federal education technology efforts may be supported by recent legislative action. The Improving America's Schools Act (P.L. 103-382) requires the U.S. Secretary of Education to prepare a long-range plan for federal support of technology in education (the final report is discussed below). Further, Goals 2000: Educate America Act (P.L. 103-227) amended the Department of Education Organization Act to establish an Office of Educational Technology.

substantial assistance for technology but whose authority does not have a technology focus.

ED Programs and Activities Focused on Technology. The programs below have been authorized to provide direct support to technology in schools. They include appropriations levels for the 2 most recent fiscal years.

National Programs for Technology in Education (Elementary and Secondary Education Act (ESEA) Title III, Part A) is a general authority for the Secretary of Education to take a leadership role in education technology. In FY2000, $109,500,000 were provided for this authority; funding for FY2001 is targeted to teacher training in technology ($125 million), community-based technology centers ($65 million), and technology leadership activities ($2 million).

FY2000 — $109,500,000
FY2001 — $191,950,000

Regional Technical Support and Professional Development (ESEA Title III, Part A) activities support six regional consortia to disseminate information on technology applications; provide technical assistance in collaboration with state and local educational agencies to help schools, particularly those with substantial disadvantaged populations; and support professional development related to educational technology.

FY2000 — $10,000,000
FY2001 — $10,000,000

National Challenge Grants for Technology in Education (ESEA Title III, Part A) support several demonstrations of high intensity use of technology in education. Funds are awarded to consortia that must include at least one local school district with a substantial number or percentage of poor children. The activities supported by these consortia are to benefit students directly, as well as provide professional development to teachers. Each consortium is to contribute substantial levels of non-federal resources. ED now identifies this authority as the **Technology Innovation Challenge Grants**.

FY2000 — $146,255,000*
FY2001 — $136,328,000*

*Portions of the annual appropriation have been designated for specifically designated projects.

State and Local Programs for School Technology Resources (ESEA Title III, Part A) is the statutory authority for President Clinton's **Technology Literacy Challenge Fund**. This is a state formula grant program intended to help implement four goals identified by President Clinton in his 1996 State of the Union Address. These goals are: connecting all elementary and secondary classrooms in the United States to the Internet by 2000; providing teachers with the training and support they need; providing all teachers and students with access to technology; and ensuring that effective software and on-line resources will be available for use with the curriculum. The Clinton proposal is for an aggregate federal investment of $2 billion over a 5-year period. Under this program, first funded for FY1997, states are allocated funds based on their share of funds under the ESEA Title I (Part A) program (described below). To be eligible for funding, states must have a statewide education technology plan. Funds are allocated by states on a competitive basis to local districts; one of the statute's objectives is to provide assistance to districts with the highest numbers or percentages of children in poverty and with the greatest need for technology. Among other activities, funds may be used to acquire hardware, software, and connections to telecommunications networks, as well as to provide professional development to teachers in how to integrate technology into education.

FY2000 — $425,000,000
FY2001 — $450,000,000

Star Schools Act (ESEA Title III, Part B) supports distance learning projects linking students and teachers over large distances using telecommunication technologies, such as satellites and fiber optic networks.

FY2000 — $50,550,000
FY2001 — $59,318,000

Ready-to-Learn Television (ESEA Title III, Part C) provides financial support for the production of educational and instructional video programming for preschool and elementary school students.

FY2000 — $16,000,000
FY2001 — $16,000,000

Telecommunications Demonstration Project for Mathematics (ESEA Title III, Part D) authorizes grants to a nonprofit communications entity or a partnership of such entities for a national project demonstrating use of telecommunications to improve mathematics teaching.

FY2000 — $8,500,000
FY2001 — $8,500,000

Technology and Media Services is a portion of the **Individuals with Disabilities Education Act (IDEA)**. IDEA, in general, authorizes funding for special education, related services, and early intervention services to infants, toddlers, children, and youth with disabilities. Under the IDEA as recently reauthorized, Special Purpose Programs (IDEA, Part D) include a Coordinated Technical Assistance, Support, and Dissemination Program, one portion of which supports Technology and Media Services. Technology and Media Services support development and application of technology and education media activities for disabled children and adults.

FY2000 — $35,910,000
FY2001 — $38,710,000

An **Office of Educational Technology** (Department of Education Organization Act, Section 216) has been established in ED. This Office and its Director are to provide national leadership in the use of technology as a means of achieving the National Education Goals and increasing opportunities for students to achieve state education standards. These leadership activities are to be undertaken in consultation with other federal agencies. Funding is not separately authorized for the Office.

A **Web-Based Education Commission**, authorized by the Higher Education Amendments of 1998, is to conduct a study of educational software available in retail markets for secondary and postsecondary students. Not later than 6 months after its first meeting, the commission is to report to the President and the Congress concerning "the appropriate Federal role in determining quality educational software products." The commission was appropriated for $450,000 for FY2000 and $250,000 for FY2001.

ED Programs Providing Support for Technology Under Broad Authorities. As has been noted, a substantial level of support for technology is provided by elementary and secondary education programs that do not target education technology. Rather, their authorities are sufficiently broad to encompass the use of technology. Among these authorities are the following:

Title I compensatory education program (ESEA, Title I) provides grants to local educational agencies for services to educationally disadvantaged students to improve academic performance. Schools are using a portion of their Title I funds to acquire and apply technology under the broad authority of this legislation. Several hundred million dollars in Title I funds may be used annually for technology in elementary and secondary schools.[58]

Dwight D. Eisenhower Professional Development Program (ESEA, Title II) supports activities to strengthen the skills and knowledge of the elementary and secondary teaching force in all of the core academic subjects (predecessor legislation, Eisenhower Mathematics and Science Education Act, supported only professional development in mathematics and science). Parts A and B of this authority are currently funded. Part A authorizes funding for a wide range of federal activities, including training teachers in applying technology to student learning. Part B allocates funds by formula to states for use by states, local school districts, and higher education institutions. Among other requirements, participating states must have plans that include descriptions of how the state will use technology to strengthen teachers' professional development. Further, authorized activities for states and local educational agencies include preparing teachers to use technology to strengthen student learning in core academic subjects. The actual extent to which appropriations for Eisenhower Professional Development are used for technology is not known.

Innovative Education Program Strategies (ESEA, Title VI) provides formula grants to states in support of education reform activities at the state and local level. This program, formerly identified as the Chapter 2 block grant, was extensively modified during reauthorization of the ESEA by the 103rd Congress. It authorizes

---

[58] It is estimated that $236.9 million in Title I funding was used in the 1997-1998 school year for technology. (U.S. Department of Education. *Federal Education Legislation Enacted in 1994: An Evaluation of Implementation and Impact*. 1999. (Hereafter cited as ED, *Federal Education Legislation Enacted in 1994*)).

formula grants to states to support state and local education reform activities. Among allowable uses of funds is acquisition of computer hardware and software for instructional use.[59]

Fund for Improvement of Education (ESEA Title X, Part A) authorizes the Secretary to support nationally significant projects that improve education. One of the many activities that can be supported under this authority are projects involving public-private partnerships that use computers to extend learning into students' homes. The actual extent to which appropriations for the Fund are used for technology is not known.

U.S. Department of Agriculture. Among the Department of Agriculture's programs is the following:

Distance Learning and Medical Link Grant Program (Rural Development Act of 1990) authorizes grants and loans to support telecommunications links for rural schools to provide students with access to advanced courses and other distance learning opportunities. It also authorizes grants and loans to health care organizations to provide rural residents with access to "telemedicine" services.

U.S. Department of Commerce. Among Department of Commerce programs are the following:

Technology Opportunities Program (formerly Telecommunications and Information Infrastructure Program) (Department of Commerce Appropriations Act of 1995) awards matching grants to state and local governments, as well as nonprofit organizations, to finance their access and use of telecommunications. These grants are intended to demonstrate the potential impact of telecommunications networks and extend these networks into currently underserved areas.

Public Telecommunications Facilities Program (Communications Act of 1934, as amended) awards grants to public broadcasting and other noncommercial entities for acquisition of telecommunications equipment. Awards can support distance learning projects, including those involving elementary and secondary schools.

National Aeronautics and Space Administration. Among its programs is the following:

Educational Technology Program supports a wide variety of activities that focus on two specific areas — development of high quality affordable learning tools and environments, and demonstrations of innovative technology and networking applications. Among activities in the first area is the Classroom of the Future program which supports research, development, and assessment of advanced technology applications in aerospace education. Among activities in the second area is KidSat which permits students across the country to assist in the operation of earth-

---

[59] It is estimated that $68.6 million in Title VI funds was used in the 1997-1998 school year for technology. (ED, *Federal Education Legislation Enacted in 1994*.)

viewing cameras and instruments aboard shuttle missions and to receive images in real time via the Internet.

National Science Foundation. Among its programs are the following:

Educational System Reform program (National Science Foundation Act of 1950) includes several initiatives to achieve systemwide reform of science and mathematics education. For example, Statewide Systemic Initiatives fund several state projects that target the application of technology to these subject areas. In addition, an Urban Systemic Initiative and a Rural Systemic Initiative are underway.

Curriculum Development Program (National Science Foundation Act of 1950) broadly supports the creation and testing of instructional materials for mathematics and science at the precollege level. This program is generally what was previously identified as the **Instructional Materials Development Program**. Some of the projects supported in recent years involve information technology.

Federal Communications Commission — E-rate Program. The Telecommunications Act of 1996, which was signed into law on February 8, 1996, includes public and private elementary and secondary schools as beneficiaries of **universal service** mechanisms that provide reduced rates for telecommunications service (Section 254 of the Communications Act of 1934, as amended).[60] The legislation requires that, if a legitimate request is made, any telecommunications carrier serving a geographic area is to make any of its services that are within the definition of universal service available at reduced rates to elementary and secondary schools and libraries for educational purposes. Further, the legislation directs the FCC to establish rules to further the access that elementary and secondary schools, among others, have to advanced telecommunications.[61] The program of discounts for telecommunication services is known as the education rate or the E-rate.

Under the May 1997 FCC order to implement the universal service provisions, subsidies of up to $2.25 billion a year are made available to support the E-rate. These funds come from an assessment levied on all interstate telecommunications service providers to implement universal service goals in general (not just for schools and libraries). These funds are used to reimburse telecommunications carriers for

---

[60] See CRS Issue Brief 98040, *Telecommunications Discounts for Schools and Libraries: The "E-Rate" Program and Controversies*, by Angele A. Gilroy; and CRS Report 98-604, *E-Rate for Schools: Background on Telecommunications Discounts Through the Universal Service Fund*, by James B. Stedman and Patricia Osorio-O'Dea.

Among the principles that must guide the development of these universal service mechanisms are that quality telecommunications service should be available at just, reasonable, and affordable rates; and that elementary and secondary schools should have access to advanced telecommunications services.

[61] There is a related provision in the new legislation (Section 706) that requires the FCC and state commissions to facilitate access to advanced telecommunications for "all Americans (including, in particular, elementary and secondary schools and classrooms)." The FCC, 30 months after enactment of the legislation, and regularly thereafter, is to determine whether it needs to take action to increase such access.

providing services at reduced rates to schools and libraries. Discounts ranging from 20% to 90%, depending upon the poverty of a school's student population and its location in an area with a high cost of telecommunications service, are available for telecommunications access costs, the internal wiring of facilities, and Internet access costs.

The E-rate program became effective January 1, 1998 and is in its third year. A total of $3.5 billion was committed for discounts in the first 2 years of the E-rate. Applications totaling over $3.72 billion for the third year of discounts are currently being processed; the FCC recently set the funding level for the third year of discounts at $2.25 billion.

Other Federal Activities. There are various other activities that the federal government is undertaking in this area. Among them are the following:

The **National Information Infrastructure** is a multifaceted, multi-agency effort undertaken by the Clinton Administration to create an integrated system of high-capacity telecommunications networks that would link business, government, education, health care, and the public. Part of the National Information Infrastructure (NII) is the Computing, Information, and Communications (CIC) R&D program (formerly known as the High Performance Computer and Communications program), an ongoing effort which was initiated during the Bush Administration.[62] An aspect of these efforts has been policies and activities to ensure that elementary and secondary schools have access to national information networks. Among the programs listed above, the Department of Commerce's Telecommunications and Information Infrastructure Assistance program is viewed as a part of the NII endeavor. The level of spending under the NII aiding elementary and secondary education, *per se*, is not available.

An **augmented federal income tax deduction for corporate contribution of computer technology and equipment** was enacted as part of the Taxpayer Relief Act of 1997. Under this provision, corporations generally are able to deduct a larger charitable contribution for donations of computer technology and equipment to be used for educational purposes in grades K-12.

Federal Policy Questions

Efforts to shape federal policy in this area confront a multitude of difficult issues. The discussion above of the academic impact of technology suggests that even the most basic questions, such as whether the anticipated achievement gains from technology warrant federal support, are not easily answered. Consideration of federal policy is complicated further by the fact that the federal role is fragmented with many federal programs and activities directly and indirectly supporting the application of technology to elementary and secondary education. Finally, an overarching factor is that responsibility for elementary and secondary education rests with states and

---

[62] CRS Report 97-31, *Computing, Information, and Communications R&D: Issues in High-Performance Computing*, by Glenn J. McLoughlin.

localities, while the appropriate federal role is often considered to be relatively marginal. This section presents brief analyses of several of the key questions that should be considered in the development or redevelopment of federal policy regarding education technology.

Should the Federal Government Provide Support for Applying Technology to Elementary and Secondary Education?

There are at least two major issues that need to be resolved. The first is whether there is sufficient justification for any support of technology applications in education, at all, regardless of whether or not such support comes from the federal government. If it is concluded that there are adequate, or even compelling, reasons to integrate technology into schools, then one might appropriately consider whether the federal government should have a role in that effort.

There is no consensus around a resolution to this first issue. For many policymakers and others, there certainly are persuasive reasons for integrating technology into schools. An early section of this report presented some of those reasons. Nevertheless, as the OTA report on competing visions of technology demonstrates, there is no unanimity among those who anticipate substantial positive educational outcomes from technology — visions differ substantially — and, further, as noted earlier, some question whether technology's effects in education will even be positive.

Perhaps of most significance for policymaking in this area is the finding delineated earlier that technology's educational benefits may be realized only under the "right" local conditions which involve a host of factors. These range from presenting students with adequate access to technology, to ensuring that the teaching force is prepared to utilize technology, to developing curriculum designed to incorporate technology. Simply providing access does not guarantee any particular outcome. Thus, the consequences of a technology effort in education may depend on which of the local conditions are addressed and how well.

At some level, it is a moot point whether a federal role is warranted. There already is a role as expressed through multiple federal programs and activities, including telecommunications regulations. That federal role is in flux and has been under scrutiny by the Congress. Many have argued that federal support of some kind is critical to generating the technical or financial resources necessary to integrate technology into education. Activities in which advocates would consider federal support to be critical may include leveraging or promoting private sector investment, generating national attention to technology application in education, and ensuring that all groups of students and schools realize technology's benefits. Conclusions about which areas are appropriate for federal action and for which federal action is critical will help shape federal involvement. Finally, the fragmentation of the current federal involvement may be an appropriate issue for policymakers to address.

What Activities, if Any, Should the Federal Government Support?

If federal support is provided, the analysis in this report suggests that a number of different kinds of activities may merit particular attention. As was just argued above, the acquisition of technology alone, without development of such other school-based capabilities as a technologically literate and skilled teaching force, may be of limited value. Thus, perhaps most critically, federal policy should be developed with a clear understanding of the critical interplay among the various factors that will influence the impact of technology. Among the various activities that might be supported in addition to teacher training, are planning, technical assistance, software and hardware development, curriculum development, and research. Further, some may argue that federal aid should have a primary focus of ensuring that technology resources are becoming available on an equitable basis.

How Should Federal Support be Provided?

If it is determined that federal support should be provided, the range of options is broad. Which approaches are appropriate will depend upon decisions on myriad issues, such as the extent to which states and localities will have flexibility in how they utilize federal support or, indeed, whether they choose to support technology at all. A few of the possible options are considered briefly below.

Categorical grants for technology are among the ways in which federal funding currently supports technology in education. These programs target their assistance on technology, limiting recipients to a relatively circumscribed set of activities. This option would maximize the extent to which federal funds were focused on technology at the expense of state and local flexibility. Grants with flexible authorities, such as **block grants**, would permit recipients to exercise substantially more discretion in determining how to use their funds.[63] Spending on technology would be but one option for recipients; the decision to support technology would reflect local priorities. At the same time, this method of support offers no assurance of any technology spending. Changes in federal tax policy could be made to provide technology providers and developers with **tax incentives** to enhance schools' technology resources. It should be noted that such federal tax incentives were frequently proposed in the early and mid 1980s, but failed to be enacted.[64] Of significance, these proposals evolved over time to include requirements that beneficiaries of the tax incentive provide additional services to schools, such as teacher training. Federal efforts might be directed to **leveraging resources** from state, local, and private sources. The federal government is already engaged in such efforts. For example, the Technology Innovation Challenge Grants (see program description above) requires private sector support in each demonstration site. One of the primary advantages to this kind of approach is that the federal financial involvement may be kept relatively limited while still targeting significant aggregate resources to educational technology. Finally, federal support may be provided by **calling national attention** to technology's role in education. While costs may be minimal, the net effects may also be relatively limited.

[63] For an analysis of block grants in education, see CRS Report 95-890, *Education Block Grants: Options, Issues, and Current Legislation*, coordinated by Wayne Riddle.

[64] See CRS Report 88-419, *Computers in Elementary and Secondary Schools: An Analysis of Recent Congressional Action*, by James B. Stedman.

What Level of Federal Support Should be Provided?

The estimated costs associated with any effort to ensure that all classrooms or students have adequate technology resources are very high. Given these prospective costs, it is typically suggested that the federal financial role be relatively small compared to the resources made available from other levels of government and the private sector. It is beyond the scope of this paper to suggest what the size of the federal financial involvement, if any, should be. Clearly, though, the level of support that might be considered appropriate will be determined, in part, by how the questions considered above are answered. For example, decisions concerning the areas in which federal support may be critical and perceptions about what technology's overall impact will be on education will directly influence the level of support that might be advocated. Ultimately, though, among the most substantial constraints on federal support will be decisions made concerning the overall size of the federal budget.