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EXECUTIVE SUMMARY

The goals of this study were twofold. The first goal was to describe the uses of federal funding for telecommunication technologies in a select sample of K–12 school districts nationally. The second goal was to identify emerging patterns from these case studies that might provide valuable insights into the progress and challenges faced by K–12 school districts as they integrate technology and telecommunication into the educational environment.

The rapid growth of telecommunication capabilities has placed significant demands on K–12 schools. In the last ten years, the education community has seen an increasing amount of federal support for telecommunication in education. These federal programs have been designed expressly to assist schools in their attempt to keep up with rapidly changing information and communication technology and to provide students with access to the tools and skills that will be necessary to compete in a global electronic environment.

The results of this study are gleaned from both quantitative and qualitative data obtained from six school districts over a nine-month period from September 1999 to May 2000. This information cannot be interpreted to represent all telecommunication funding and resulting projects, nor does it draw comprehensive conclusions regarding the current state of telecommunication in K–12 schools. It does, however, provide a snapshot of telecommunication planning processes, funding procedures, and activities performed in six unique school districts and offer insight into the progress that has been made in recent years due, in part, to the availability of federal funds.

Results

The results of this study indicate that:

• Federal funding has played a major role in supporting the initial implementation of telecommunication technologies in K–12 schools.

• Districts had to rely on multiple sources of funding (federal, state, and local) to pay for their telecommunication programs.

• Students were learning about computers, that is, how to use the tool. There appeared to be more instruction about technology than with technology.

• Physical space and infrastructure for computer labs, districtwide networking, and equipment upgrades were priority budgetary concerns.

• Professional development for teachers is critical if schools are to realize technology’s benefits for learning. Many teachers indicated that they were still fearful of using technology and needed help in knowing how to use technology tools and how to adapt their pedagogical approach to accommodate the new tools.
Some districts indicated that they had identified formal evaluation procedures in their technology plans, however implementation of the evaluation process appeared to be problematic.

Federal funding has indeed played a significant role in introducing telecommunication technology into the K-12 educational environment. The experience of the school districts in this study suggests that future funding priorities should include professional development, telecommunication integration into the curriculum, research and evaluation of how telecommunication influences student achievement, and the deployment of emerging technologies.
Telecommunication in K–12 Education:
A Report for the Fund for the Improvement of Education

I. OVERVIEW

I-1 Goals of the Study
The goals of this study were twofold. The first goal was to describe the uses of federal funding for telecommunication technologies in a select sample of K–12 school districts nationally. This description includes information regarding needs assessment; federal and other funding sources; overall telecommunication presence in instruction, curriculum, and professional development; and efforts to evaluate specific programs. The second goal was to identify emerging patterns from these case studies that might provide valuable insights into the progress and challenges faced by K–12 school districts as they integrate technology and telecommunication into the educational environment.

I-2 Background
Technology, through telecommunication, has become not only a tool that provides students with access to resources beyond their school boundaries but also a tool that allows students to communicate, collaborate, share, and work with people throughout the world. These same capabilities are quickly becoming the standard for the workplace, and the use of telecommunication tools is rapidly becoming a requirement for many careers. The McKinsey & Company report, “Connecting K–12 Schools to the Information Superhighway,” states that 60 percent of careers in the year 2000 already require computer connectivity/networking/information technology skills.¹

The rapid growth of telecommunication capabilities has placed significant demands on K–12 schools. Hardware, network infrastructure, software, and training and professional development for users require substantial human and financial resources. In addition, these are not one-time costs; such efforts require long-term plans for equipment maintenance, depreciation, and upgrades. In the last ten years, the education community has seen an increasing amount of federal support for telecommunication in education. These federal programs have been designed expressly to assist schools in their attempt to keep up with rapidly changing information and communication technology and to provide students with access to the tools and skills that will be necessary to compete in a global electronic environment.

In other words, we are in an era in which teachers and books are not the only sources of information and lectures are not the only method for delivering and acquiring knowledge. This is particularly true concerning the workplace of tomorrow, in which telecommunication and technology specialized labor will be more and more in demand.

This report, funded by the Department of Education’s Office of Educational Research and Improvement (OERI) through the Fund for the Improvement of Education (FIE), was completed by CORD of Waco, Texas, and the Burns Telecommunications Center (BTC) at Montana State University–Bozeman. The results offer insight into how selected school districts across the country are attempting to meet these significant challenges. This case study relates how six school districts have used federal, state, local, and private funds and how this funding has supported the expansion and integration of telecommunication within the educational setting.

The need for such information has been cited by numerous reports, federal lawmakers, and policy experts. Linda Roberts, Special Technology Adviser to the President for the U.S. Department of Education, stated, “We need to target our resources; we need to constantly assess our efforts.” She called for further studies into how technology can be used most effectively to produce desired results.

The above-mentioned McKinsey & Company report says, “Once a school district has set goals for infrastructure deployment, the pace of progress depends primarily on the availability of funding, adequate development opportunities for teachers and other school professionals, and appropriate courseware.” Current federal funding has provided much-needed support for Internet access and has strengthened the K–12 telecommunication infrastructure.

II. METHODS

II-1 Introduction

The results of this study are gleaned from both quantitative and qualitative data obtained from six school districts over a nine-month period from September 1999 to May 2000. This information cannot be interpreted to represent all telecommunication funding and resulting projects, nor does it draw comprehensive conclusions regarding the current state of telecommunication in K–12 schools. It does, however, provide a snapshot of telecommunication planning processes, funding procedures, and activities performed in

---

2 Linda Roberts, Special Technology Adviser to the President for the U.S. Department of Education. Keynote address to educators, November 1998 Schools News conference on grants funding for school technology.
six unique school districts and offer insight into the progress that has been made in recent years due, in part, to the availability of federal funds.

For the purpose of this study, the term telecommunication refers to electronic connectivity to people and resources for the purpose of supporting the learning and teaching process. This connectivity includes Internet connection, videoconferencing, satellite, cable, and telephone. Computer-based learning (software) is excluded. The intent was to obtain information specifically on the use of telecommunication technologies that provide students, teachers, and administrators with connectivity to human and information resources that are not available within the school itself.

II-2 Site Selection Process

A purposeful random sample of six school districts was drawn from the public K–12 school districts listed in the School District Data Book produced by the National Center for Education Statistics, U.S. Department of Education.

In selecting the school districts, the following constraining criteria were met to ensure that the sample addressed concerns about critical segments of society in the United States:

a. Geographic region: The United States was divided into five geographic regions—northwest, southwest, central, northeast, and southeast—and at least one district was drawn from each region.

b. Population density: At least one school district meeting the definition of urban and one meeting the definition of rural were included in the sample.

c. Socioeconomic status: “Free lunch” eligibility status was chosen to describe the socioeconomic status as low (40 percent or greater), medium (between 10 and 39 percent), and high (less than 10 percent). At least one school of each type is in the sample.

d. Racial and ethnic diversity: The sample comprises at least one relatively predominant Caucasian district; one relatively predominant African-American district; and one relatively predominant Hispanic district.

e. District size: Districts were classified by number of students served: small (less than 500 students), medium (between 500 and 2500 students), and large (more than 2500 students). The sample comprises at least one school of each type.

The goal of the sampling procedure was to select school districts that collectively met the above criteria.
II–3 Participating School Districts

Six districts meeting the required criteria agreed to participate in the study. District 1 was located in a small town of 1,400 surrounded by national forest. District 2 served a population of 7,800 in Amish country. District 3 was located in a city of 18,000 in an urban/rural area. District 4 spent almost $4 million on facility improvements over the past five years and recently passed a $31 million construction and renovation education referendum. District 5 was located in a town of 13,500 in an agricultural region. District 6 has undergone a major demographic shift. Twenty years ago the district served a rather affluent, blue collar, predominantly white community; today 52 percent of the students are economically disadvantaged and 29% have limited English speaking proficiency.

Table 1 describes some additional features of the six school districts that participated in this study.

<table>
<thead>
<tr>
<th></th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>District size</td>
<td>Small</td>
<td>Medium</td>
<td>Medium</td>
<td>Large</td>
<td>Large</td>
<td>Large</td>
</tr>
<tr>
<td>Number of students</td>
<td>350</td>
<td>1223</td>
<td>1998</td>
<td>3005</td>
<td>2800</td>
<td>18,500</td>
</tr>
<tr>
<td>Number of schools</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>Medium</td>
<td>Medium to high</td>
<td>Low</td>
<td>Medium to high</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Racial/ethnicity</td>
<td>Caucasian</td>
<td>Caucasian</td>
<td>African American 47%* Caucasian 52%</td>
<td>Caucasian 73% Hispanic 17%</td>
<td>Hispanic 35%* Caucasian 61%</td>
<td>Hispanic 59% African American 21% Caucasian 17%</td>
</tr>
<tr>
<td>Population density (urban/rural)</td>
<td>Rural</td>
<td>Rural</td>
<td>Urban/rural</td>
<td>Urban</td>
<td>Urban/rural</td>
<td>Urban</td>
</tr>
</tbody>
</table>

(*) Relative predominance: Based on the percentage of a certain racial or ethnic group in a school district being larger than the national average considering a 95% statistical confidence level.

II–4 Instruments Administered

Participating school districts completed questionnaires that were tailored for three distinct respondents: 1) district personnel, 2) school staff, and 3) teachers. The questionnaires were designed to detect emerging patterns on broad themes such as funding for telecommunication projects, level of telecommunication usage in schools, facilities, information technology
infrastructure, individual involvement and community support, teacher training and professional development opportunities, perceived impact of telecommunication implementation on curriculum and instruction, needs assessment, district and state plans and goals, and perceived attitude toward technology. Questionnaires were mailed in advance of the site visits to district administrators, who selected the individuals from their district to complete the questionnaires.

The number of individuals who completed questionnaires is shown in Table 2.

### Table 2
**Distribution of Questionnaires**

<table>
<thead>
<tr>
<th>Individuals Surveyed</th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>District personnel</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>School staff</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Teachers:</td>
<td>16</td>
<td>27</td>
<td>25</td>
<td>24</td>
<td>8</td>
<td>11</td>
<td>111</td>
</tr>
<tr>
<td>K to 6</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>19</td>
<td>3</td>
<td>3</td>
<td>65</td>
</tr>
<tr>
<td>7 to 12</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>Grade level not reported</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

In addition to collecting survey data, the project team conducted interviews with teachers, students, administrators, and technical staff and toured facilities during visits to the districts. The interviews were designed to obtain a greater level of detail regarding the actual implementation and use of telecommunication and a “firsthand” understanding of the overall awareness and use of telecommunication at various professional levels throughout each district. All interviews were conducted by project staff members and used a predetermined set of questions. Each site visit was conducted over a two-day period.

To help the project staff better understand the contexts in which the districts operated, technology coordinators for state departments of education also were asked to complete questionnaires by e-mail about the evolution and implementation of telecommunication technologies in schools within their states. Responses were received from three of the six states.

**III. Themes**

This section of the report delineates findings from the questionnaires and site visits concerning the uses of telecommunication technology in education and its perceived impact on learning and teaching.
The section is organized around the following salient themes that emerged from studying the data:

1. *Funding, planning, and community support*
2. *Telecommunication use, support, and connectivity in schools*
3. *Facilities infrastructure and equipment*
4. *Impact of telecommunication on instruction and curriculum*
5. *Professional development and training opportunities*
6. *Evaluation of the telecommunication plans and programs*

The remainder of this section will elaborate on these themes.

**III-1 Funding, Planning, and Community Support**

*Merging and leveraging of federal, state, and local funds*

A common denominator within the six participating school districts was that telecommunication projects were paid for with *federal, state, local, and private sector dollars*. All of the districts in this study reported that they had to rely on multiple sources of funding to pay for the infrastructure (equipment and facilities) and professional development. In most of them, federal dollars initiated a technology improvement effort that drew on both state funds and local donations. The following table illustrates the sources of dollars that were used in the six districts to fund telecommunication projects during the past five years.

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>State</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Local</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Private Sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

None of the districts was able to pay for telecommunication projects with just one source of funding. Nor were the districts able to pay for telecommunication projects with just one type of federal funding. The following table lists the types of federal funding that were used in the districts.
### Table 4
Types of Federal Telecommunication Funding

<table>
<thead>
<tr>
<th>Type of Federal Funds</th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eisenhower Professional Development(^3)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Perkins Vocational and Applied Technology(^4)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>School to Work(^5)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Star Schools Programs(^6)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Literacy Challenge Fund(^7)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goals 2000(^8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Title I(^9)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Title II(^10)</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Title XI(^11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>E-Rate(^12)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

These programs have helped fund the computer labs, the interactive video classrooms, and the Internet connections in the districts interviewed, as well as the professional development.

---

\(^3\) Eisenhower Professional Development Program—Supports locally guided teacher training in the core academic areas.

\(^4\) Perkins Vocational and Applied Technology Program—Provides funds to help pay for vocational training programs at both secondary and postsecondary levels in accordance with state-developed plans.

\(^5\) School-to-Work Program—Provides seed money to every state and interested communities for developing and launching comprehensive school-to-work systems that combine school-based and work-based learning to prepare students for jobs.

\(^6\) Star Schools Programs—Encourages improved instruction in mathematics, science, foreign languages, and other subjects, such as literacy skills and vocational education, and serves underserved populations through the use of distance learning technologies.

\(^7\) Technology Literacy Challenge Fund—Supports development and implementation of state and local technology plans to apply technology to school reform, acquire hardware and software to improve student learning, acquire connections to telecommunication networks, and provide professional development in integrating technology into curricula.

\(^8\) Goals 2000—Helps parents, teachers, and community leaders improve schools by raising academic standards; addressing safety, discipline, and basic skills; attracting and training better teachers; and strengthening parent involvement.

\(^9\) Title I—Directs about $7 billion to help disadvantaged children in about half of the schools in the country.

\(^10\) Title II—Supports efforts to reduce shortages of qualified teachers in high-need school districts by changing the ways teachers are recruited, prepared, licensed, and supported.

\(^11\) Title XI—Supports making university technical and human resources available to the community and linking students’ academic experiences with opportunities for work in the community.

\(^12\) E-Rate—Provides schools and libraries access to telecommunication services for educational purposes at discounted rates.
necessary to use and integrate this technology in the classroom. All districts applied for, and all but one received, funding from the Schools and Libraries Universal Service Fund E-Rate Program, part of the Telecommunications Act of 1996, public law 104–104. During the study, all of the districts were in the process of submitting applications for the current year. Although frustration was voiced about the initial application process, all the districts felt that the procedure had improved significantly. Most interviewed districts reported that federal E-Rate funding provided the impetus for introducing telecommunication in their schools.

Survey results indicated that state government dollars were also adding to the foundation that federal funding provided. Three of the districts had received state funding that was earmarked for telecommunication infrastructure. Local bond issues were also being used to support infrastructure in several of the districts. Two of the districts approved referenda for building schools and remodeling those that were not physically capable of handling the infrastructure required to implement telecommunication.

Much of the initial federal funding was used to purchase hardware. Most districts were able to purchase more than was planned because of decreases in hardware costs. Some expressed concern about the costs of upgrading, maintaining, and replacing equipment because of the constant change in technology. The following table illustrates the types of telecommunication projects that had been funded during the past five years in the six participating districts.

<table>
<thead>
<tr>
<th>Use of Funds</th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiring</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Internet Access</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>District LAN</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Computer / Media Centers</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Computer(s) in Classrooms</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephones in Classrooms</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Interactive Videoconferencing Classroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Good partnerships with area businesses were developed in the majority of the districts. Some of the projects could not have been completed without those partnerships. Four districts received help from local telephone companies in wiring buildings and classrooms. One local telephone company donated all of the wire and employees to wire the classrooms. All of the districts held
“net days” to help with the initial labor-intensive job of stringing wire. District staff, school staff, parents, board members, businesspeople, and students all participated in the net days.

**Technology plan (state and district)**

Most of the districts in this study reported that they developed *formal telecommunication and technology plans* because of federal or state funding requirements. The majority of these plans were developed to cover five-year time frames, and several districts were in year four or five of their plans. Although technology plans were available from most of the state departments of education, not all of the districts’ technology people knew of their existence or used them for guidance.

*Telecommunication planning committees* included district board members, community businesspeople, school administrators, parents, and teachers. At least one district hired a professional consultant to evaluate issues and help formulate a plan.

Technology and telecommunication plans seemed to have similar *goals* throughout the districts studied. Common goals included equipping every classroom with computers and access to the Internet, having computer labs both for student use and for class projects, making sure that students were competent in the use of computers, incorporating technology into all curricula to enhance teaching and learning, providing technology training for staff members so they could better train students, and ensuring that all students had access to technology. Several of the districts also wanted to make sure that access and training were available for community members.

Most of the people who were part of the *planning process* said during the interviews that the goals were realistic at the time they were created. They said that most of the goals had been met or were being met. Many indicated that the plans are undergoing scheduled revision to keep abreast of changing technologies.

**Community Support**

Private businesses and community members provided support for the introduction of technology in general and for telecommunication technology in particular for the districts in this study. In most of the districts, community members, teachers, and business volunteers helped string wire to get their schools connected by participating in local “net days.” They donated computers and expertise in setting up systems and in training. The communities seemed to take great pride in their schools and in helping them prepare students for the challenges to come.
III-2 Telecommunication Use, Support, and Connectivity in Schools

Use

Although the types of telecommunication uses were similar in all the districts in the study, levels of usage varied between and within the schools. Primary uses of computer technology were for word processing, presentations, and research via Internet by both teachers and students. Teachers used the Internet for their own research and to locate lesson plans. Most of the participating districts recorded grades and attendance electronically. A few districts used videoconferencing to enhance their curricula. Uses included taking students into various workplaces, connecting students in different locations, and offering courses that would otherwise not be available. Teachers in one district used videoconferencing to connect with area health care professionals to learn how to more effectively work with developmentally disabled students. In another district, students were able to study Japanese and Latin courses that were taught on another school campus.

Support

Technical support for the “users” of telecommunication in participating schools varied from district to district and from school to school within the districts. The “support structure” for the six school districts is described in Table 6. In many of the schools, the technology person was also a full-time teacher. Five of the school districts indicated that they would benefit by having at least one full-time, nonteaching technology person per school. In most cases, it

In one district an impressive computer classroom was created almost entirely through the efforts of one teacher. The classroom boasted a laserdisc player, computer projection screen, television, videotape player, several computers, and a remote mouse. The teacher had successfully applied for grants, solicited donations, and used personal funds to create the technology-enhanced classroom. The equipment was used daily to project classroom notes; display video, graphics, or audio clips; play videotape or laserdisc segments to supplement lessons; and handle administrative tasks such as grading. The classroom was an obvious source of pride for students, other teachers, and administrators in the district.

In one innovative district the high school targeted one subject and required both teachers and students to integrate technology into their study of this subject. Teachers reported increased participation and higher quality of work in the technology-infused subject, and failure rate dropped from 30 percent pretechnology to 7 percent posttechnology in that subject area. The school planned to adapt this approach systematically to other subject areas.

Another school introduced a popular course called “PowerNet,” which incorporated Internet basics and research skills with PowerPoint® presentations. Students used the Internet for research and collected video, audio, and graphics to incorporate into formal presentations for their classmates.
was acknowledged that progress had been made in that area but that more staff was still needed. One district did have a technology specialist at each school and found this arrangement most beneficial.

### Table 6
**Professional Support for Telecommunication Technology**

<table>
<thead>
<tr>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 computer technician</td>
<td>No technology specialist</td>
<td>2 technology specialists</td>
<td>2 technicians</td>
<td>1 technician</td>
<td>1 technology coordinator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 facilitator</td>
<td>1 tech coordinator</td>
<td>1 technology integration specialist</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 technology coordinator</td>
<td>2 part-time aides</td>
<td>6 technicians</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25 technology specialists</td>
</tr>
<tr>
<td>2 schools</td>
<td>5 schools</td>
<td>8 schools</td>
<td>7 schools</td>
<td>5 schools</td>
<td>25 schools</td>
</tr>
</tbody>
</table>

**Connectivity**

During the interviews, school district officials and technical staff members reported varying degrees of connectivity. Computers in every classroom and connections to the Internet seemed to reflect the overall short-term goals and achievements (following either state and/or district technology plans).

All districts reported that the majority of their computers were networked and had access to the Internet. Networking protocols being used were Ethernet—both twisted pair and coaxial—Fast Ethernet, and Token Ring, and one district was completing an FDDI Ring. The primary operating systems being used were either WindowsNT® (NT / 95 / 98), Novell NetWare® (3.2 / 4.2 / 5.1), or AppleShare®.

Table 7 summarizes some of the features of the telecommunication systems in place within the participating school districts.
<table>
<thead>
<tr>
<th>District</th>
<th>District</th>
<th>District</th>
<th>District</th>
<th>District</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Number of multimedia computers</td>
<td>125</td>
<td>75</td>
<td>241</td>
<td>473</td>
<td>271</td>
</tr>
<tr>
<td>Operating system</td>
<td>Linux-NetWare</td>
<td>Windows, AppleShare</td>
<td>Windows, NetWare</td>
<td>Windows, AppleShare</td>
<td>Windows, AppleShare</td>
</tr>
<tr>
<td>Internet access / bandwidth</td>
<td>56K</td>
<td>T1</td>
<td>T1</td>
<td>T1</td>
<td>T1</td>
</tr>
<tr>
<td>Internet filters</td>
<td>CyberPatrol</td>
<td>I-Gear</td>
<td>Bess</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer labs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Videoconference capabilities</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Telephones in classrooms</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

### III-3 Facilities Infrastructure and Equipment

**Infrastructure**

When the topic of implementing the goals of telecommunication plans was addressed, district officials mentioned that one of the primary obstacles to realizing these goals was facility inadequacy. The older schools were not equipped to handle electrical needs of this new technology and, therefore, were stretched as far as they could be stretched. In several of the districts, population growth required moving equipment from computer labs to libraries so the computer labs could be used as additional classrooms. Two school districts recently had held successful bond issue elections, passing referenda to remodel, build additions, and build new schools. One district’s voters turned down a referendum four times before finally approving it.

**Equipment**

Bandwidth and associated costs for Internet connections varied depending on district location and proximity to urban areas. Computer hardware actually in use depended greatly on the type of school. In these six districts, middle schools and high schools were primarily PC based, with some Macintosh computers available. On the other hand, the elementary schools tended to have Macintosh equipment. This seemed to be driven by the availability of software for the age group, incentive programs offered by Apple for K–12 educators, and the fact that, as high schools upgrade and expand, the used equipment is moved to the elementary schools.
III-4 Impact of Telecommunication on Instruction and Curriculum

**Instruction**

Telecommunication technology was making its way into the instructional strategies of all the sites that were visited, albeit at different levels. In all six of the districts, students could use computers with access to the Internet, either in their classrooms or in computer labs. Lab time for the students averaged a minimum of an hour a week. In some districts, the labs were open for student use before and after school. Thus, although access was limited, the technology was within reach of all students. Nonetheless, sustainability of state-of-the-art equipment for instructional purposes was a primary concern across all districts.

All districts were making efforts to integrate telecommunication technology into instruction. However, in all districts surveyed, the integration was not as complete as they would like. The reasons mentioned for this lack of integration included 1) varying levels of technical expertise among teachers, 2) limited access to computers, 3) lack of computer projection devices, 4) time constraints, 5) priority given to preparing students for standardized tests, 6) lack of familiarity with equipment capabilities, and 7) lack of familiarity with instructional strategies for integrating technology.

**Curriculum**

The six districts all had computer classes to help students become proficient in the use of telecommunication technology. Most sites felt that, in these classes, students had attained an acceptable level of computer literacy that would serve them well in the workplace. Most sites reported the need to have basic computer skills introduced earlier in the elementary school curriculum.

In most districts, both teachers and students who were interviewed said that, apart from formal computer training programs, much of the technical training or reinforcement fell to the teachers. They said that students who had teachers with technical skills and the desire to incorporate technology in their lessons continued to cultivate their own computer skills and benefit from classes that used technology-enhanced curricula. Numerous teachers in the study, however, were still uncomfortable with the use of technology for educational purposes. Despite the availability of formal computer training, proficiency in the use of telecommunication technology as an educational tool was highly teacher dependent, and the districts all found themselves challenged by a situation in which many teachers lacked the necessary technical skills to serve the computer literacy needs of students.
Many of those interviewed said that they believed the curricula in their districts tended to be driven by standardized tests and that proficiency in telecommunication took a back seat to student performance on the tests. However, many of them had the perception that instructional software increased test scores on standardized tests, though there were no empirical data to substantiate this claim. At any rate, the districts made wide use of instructional software, such as Accelerated Reader® and Accelerated Math®, and were pleased with the results they were seeing. There seemed to be an overall perception that telecommunication usage in school increased the students’ preparation for the world of work.

III-5 Professional Development and Training Opportunities

As expected, school administrators, staffs, and teachers in the six districts all supported the need for professional development in telecommunication. All districts in this study provided some type of professional development opportunities. Some classes were offered outside regular school hours, with voluntary attendance. Other courses were regular in-service training that teachers were expected to attend. Some districts also offered classes for parents. Most of the districts offered individual training for teachers who requested help. Training opportunities were offered on the specific software that was being used either in the classrooms or for administrative purposes, such as grading or attendance programs or e-mail. Internet use was also a common class offering. The written questionnaires indicated that the most frequent topic for training teachers was the Internet; the second most frequent topic concerned specific software applications. Slightly more than a third of all teachers surveyed had attended classes concerning hardware. About the same percentage said training had been provided in ethics and the responsible use of technology.

Technical staff members similarly indicated in the written questionnaires that the most frequent topics for professional development were the Internet and specific software. More than half said that their districts had provided training in how to use technology to enhance teaching, and half of them also indicated that training had included ethics and the responsible use of technology.

District-level administrators indicated in the questionnaires that the most frequent training topics offered were software, Internet, and using tools to enhance teaching. During interviews, school district personnel indicated that more training should be offered on such topics as integrating telecommunication into the curriculum, classroom computer management, troubleshooting, developing web pages, and how a computer works.

All three groups overwhelmingly indicated in the questionnaires that there should be more professional development. A number of administrators, technical staff members, and teachers
said that those who were enthusiastic about technology gravitated to the technology training; several indicated that telecommunication-oriented training should be mandatory to try to reach the teachers who are less enthusiastic but in need of the training.

The latter point was considered especially important by some of those interviewed, since, typically, it was the teachers who were teaching the students about telecommunication. If teachers were afraid of or uninterested in learning how to use the technology, they said, their students also did not learn to use it.

Time was mentioned frequently as an obstacle to professional development in telecommunication. In some cases, time was considered more important than financial constraints. Teachers said that they frequently had to attend training after school, on weekends, or during the summer. Those who did attend found it difficult to find the time to practice what they had learned so they could use it in the classroom.

Teachers also said during the interviews that they could attend conferences, workshops, or other training through outside organizations, such as colleges and private businesses, as well as that sponsored by the school district. Again, the training tended to be pursued by those who already had interest in telecommunication.

School district personnel, school staffs, and teachers all indicated on the questionnaires that they perceived that the use of telecommunication in the districts had helped teachers to progress professionally.

Some of the school districts offered professional development in telecommunication continuously; others offered it when the technology was installed and then at various periods, such as yearly, after that.

The information in Table 8 shows the requirements for professional development in the states where the districts in this study are located.
<table>
<thead>
<tr>
<th></th>
<th>District 1</th>
<th>District 2</th>
<th>District 3</th>
<th>District 4</th>
<th>District 5</th>
<th>District 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>State requires teacher preparation to include technology</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>State requires technology training for teacher recertification</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Source: *Education Week*\textsuperscript{13}

In summary, the majority of teachers received training on the Internet, district-specific software, and use of telecommunication to enhance teaching. Also, the majority of teachers said that the use of telecommunication had enhanced their perception of its value as an instructional tool and had helped them to progress in their careers. A large majority of teachers and school administrators thought that more training was needed.

**III-6 Evaluation of the Telecommunication Plans and Programs**

None of the districts had conducted a formal evaluation of its telecommunication program or plan. Some had drafted or were drafting evaluation standards or procedures but had not used them. Most had conducted informal reviews of their progress at telecommunication meetings or among staff members.

All districts felt that their telecommunication efforts had been successful. Their opinions appeared to be based mostly on observation and marking their progress in accomplishing specific measurable goals, such as connecting each classroom to the Internet or installing a districtwide network. All the sites had conducted some kind of informal evaluation. Some involved anonymous feedback from students and teachers; others submitted information for evaluation by state agencies; still others reviewed their progress in telecommunication committee meetings.

Two of the districts had written evaluation plans, while one district had a committee drafting standards for telecommunication to submit to a district office that sets evaluation standards.

\textsuperscript{13} *Education Week*, Volume XIX, Number 4, September 23, 1999.
IV. STUDY LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

It is important to point out that this study had a limited scope and does not claim to provide a comprehensive picture of telecommunication in school districts across the United States. Rather, the study’s intent was to provide an introductory look at how telecommunication is being integrated in a selected sample of districts.

This study does not claim to represent the views of all administrators, teachers, and nonteaching personnel in the districts studied. In most cases, the districts recruited personnel for the interviews. In one district, the study team interviewed just a few teachers; in another small district, every teacher was interviewed. In the remaining districts, the individuals selected for interviews tended to be those who had expertise in and supported telecommunication. Similarly, the questionnaires were mailed to district administrators for distribution, not to each person in the district. Thus, it may be true that not every person had an equal opportunity to respond to the questionnaire. It is possible that those who did respond were likely to be those with some expertise in telecommunication. This is both a strength and a limitation. It is a strength in that these individuals know the most about what is happening with telecommunication in their districts. It is a weakness in that the responses and information gathered cannot be considered to represent all school district personnel.

It is also important to point out the difficulty of isolating and allocating one source of funding per one project or piece of a project. Installation and infrastructure upgrading for telecommunication projects were expensive, took multiple years to accomplish, and are still evolving. Federal, state, local, and private-sector dollars pooled together were required to accomplish the objectives. Pinpointing funding sources also is difficult because of the multiple use of much of the technology in these school districts. The computers that are used extensively for such programs as Accelerated Reader® and Accelerated Math® are the same computers that are used for Internet research. Thus, one source may have provided funding for the computers, another may have provided wiring for the Internet, and still another provided training for teachers in using the equipment.

The qualitative information collected in the current study does help define several research questions that would require much more ambitious funding and scope. For example, many of those surveyed and interviewed believed that the use of telecommunication had improved students’ performance and their chances of success in the workplace. It was beyond the scope of this study to attempt to document these perceptions. Such claims would be difficult to document because of the number of confounding variables, such as the number of homes with computers, the wide variety in telecommunication programs offered, and the difficulty—
in any education research—in proving cause and effect. However, the question of whether telecommunication has an impact on student performance is an important one.

Further, most teachers said they believed that learning about telecommunication had improved their professional development. However, the types of training offered and how well it is being disseminated to all teachers is not well documented. Neither are there data showing the types of training that are most effective in helping teachers learn to integrate telecommunication in the existing curriculum.

Numerous people also said they believed that an emphasis on improving student performance on standardized tests means less time to teach such new areas as telecommunication. The impact of standardized testing on other academic areas would make a rich research topic.

District personnel also listed a number of other factors that they believe are hampering the integration of telecommunication into the curriculum. They were 1) varying levels of technical expertise among teachers, 2) limited access to computers, 3) lack of computer projection devices, 4) time constraints, 5) priority given to preparing students for standardized tests, 6) lack of familiarity with equipment capabilities, and 7) lack of familiarity with instructional strategies for integrating technology. It would be worthwhile to further study whether their impressions are correct.

V. SUMMARY OF FINDINGS

This section contains comments suggested by the themes identified in this study.

1. **Funding.** The results of this study indicate that federal funding has played a major role in supporting the initial implementation of telecommunication technologies in K–12 schools. In addition, all the districts in this study indicated that federal funding requirements, such as those for E-Rate funds, provided the impetus for establishing telecommunication plans for their districts. Although it was clear that federal funding had helped districts secure the funds for initial technical infrastructure needs, it was also evident that districts had taken the initiative to leverage the federal funds with state and local dollars from both the public and private sectors in order to obtain sufficient funds to support the necessary investment. In addition to initial infrastructure costs, the districts were all concerned about ongoing costs, in particular the cost of upgrading equipment as technology advances, and in many cases provisions had not been made for budgeting these long-term costs.

Larger districts appeared to be more knowledgeable about securing funding through many agencies and programs, probably due to the availability of staffing resources to focus on
that task. Some districts also benefited from state technology departments that more actively help districts seek and obtain funding. Overall, the availability of future funding was the major concern cited by the interviewed districts if schools were to continue to use telecommunication technology for educational purposes.

2. **Integration in the Classroom.** The districts in this study were teaching students about computers, that is, how to use the tool. Research for class assignments using the Internet was cited as the most common use of computers in the classroom. Creating slides for the presentation of assignments was also cited as a common use of technology. Yet, although students had increased access to computers and computer applications courses were taught, the time that students spent using computers was limited. On average, students might spend one hour a week in a computer lab. In classrooms that did have computers, usage was low due to the logistical challenge of how to structure instruction when there were far more students than computers.

There appeared to be more instruction about technology than with technology. While four districts in this study identified “computers in every classroom” as a goal, only two of the six districts identified the “incorporation of technology into every program to enhance the educational process” as a goal.

Integrating telecommunication technology into a curriculum is a complex process. Questionnaire and interview results indicated that teachers felt that lack of time, limited access to computer labs, and small numbers of classroom computers all contributed to the problem. This integration was just beginning in most districts and was primarily dependent on individual teacher personality and experience. Only one district in the study had district personnel developing strategies for integrating technology into the curriculum for classroom use; in the other districts, integration was a result of the initiative of individual teachers.

The study did find best-practice examples of teachers who were using telecommunication technology to enhance the learning and teaching process, but, again, this was due to a few individual teachers with interest and experience in using technology. “Best-practice” examples attributable to teacher initiative were evident in every district in this study.

3. **Facilities, equipment and technical support.** Physical space and infrastructure for computer labs, districtwide networking, and equipment upgrades were priority budgetary concerns. Districts with older physical structures and rural areas with limited Internet access options faced unique challenges for funding telecommunication access. Districts in this study also identified physical space for computer labs and equipment as problematic.
Most of the schools and districts surveyed had focused initial investments on Internet access, computer equipment, and networking. Many schools indicated that they had at least one multimedia computer per classroom; however schools varied greatly in their individual classroom access to the Internet. Surveys indicated that Internet access was not always reliable and that integration of technology and instruction was hindered by only one computer in the classroom. Teachers reported that one computer in the classroom limited student use to enrichment or independent study assignments.

Three of the six districts had installed two-way interactive videoconferencing equipment and classrooms. Two of the three districts using real-time videoconferencing were subsidized by their states for the equipment and direct costs. The third district provided the facility for a telehealth video site and received shared-use capabilities in return for the facility. The use of this particular technology varied from shared class instruction with other schools and/or districts, to guest speakers, to only meeting use by teaching and administrative staff. Each of these three districts had only one video classroom and reported that scheduling (both internal and external), cost, and technical support were problems with real-time video efforts.

Schools and districts surveyed varied greatly in the amount of technical support available to the teachers and staff. Most questionnaire participants indicated that they would like to have more technical support. Districts in this study ranged from supporting zero to six districtwide technical support employees. The number of districtwide technicians seemed to be influenced by district size and financial resources. In one district, teachers were given additional responsibilities for technical support in their individual schools. Survey results indicate that the availability of trained technical support staff could play an important role in the successful integration of technology in the classroom.

4. **Professional development.** As other studies have indicated, professional development for teachers is reported as critical if schools are to realize technology’s benefits for learning. Many teachers in this study indicated that they were still fearful of using technology and needed help in knowing how to use technology tools and how to adapt their pedagogical approach to accommodate the new tools. Although most teachers reported satisfaction with the professional development they received, the availability of professional development and training in the use of telecommunication technologies varied greatly between districts and came from a variety of sources. In many instances, teachers reported a “train-the-trainers” approach in which teachers were trained to provide professional development for other teachers. Several districts also reported the existence
of informal “learning communities” in which teachers trained teachers, teachers trained students, students trained teachers, and students trained students. Questionnaires also indicated that professional development and training were primarily hardware and software based, rather than focusing on the integration of technology in the learning process. Only two of the six districts reported “staff development for teachers to help students learn through the use of technology” as a goal.

Teachers who did have access to professional development opportunities noted that, while the training was of high quality, it was often sporadic and optional and provided little opportunity for practice, implementation, and follow-up. Surveys of teachers, school staffs, and district personnel indicated that, without mandatory and continual professional development concerning technology, and without school priorities (i.e., time) devoted to integrating technology into curriculum and instruction, the educational uses of telecommunication technology would likely remain sporadic.

5. **Evaluation.** Some districts surveyed in this study indicated that they had identified formal evaluation procedures in their technology plans, however implementation of the evaluation process appeared to be problematic. Several sites reported lack of clear district or local goals, and schools were collecting little data regarding telecommunication’s impact on student learning. Although telecommunication plans, required for federal E-Rate funds, were in place; little ongoing evaluation and assessment appeared to be occurring regarding the success of these plans. Some schools were able to define “success” in terms of increased computer and/or Internet access, yet there appeared to be no formal evaluation by the districts of whether the telecommunication effort had been beneficial to student learning. Documenting “best practices” in curriculum integration and professional development, amount of use, types of use, unique learning experiences, collaborative learning opportunities, parental involvement, and measurable student outcomes will be critical as school administrators attempt to justify future budgetary investments related to the ongoing costs of technology integration. In addition, this type of evaluation data will be essential for ensuring future investment of federal, state, and local public funds.
VI. CLOSING COMMENTS

Federal funding has played a significant role in introducing telecommunications technology into the K-12 educational environment. The use of telecommunications for educational purposes is still in its initial stages and its effectiveness is yet to be completely measured. Sustainability and assessment of what has been implemented are expected to require ongoing funding at the federal level. The experience of the school districts in this study suggests that future funding priorities should include professional development, telecommunication integration into the curriculum, research and evaluation of how telecommunication influences student achievement, and the deployment of emerging technologies. If schools continue to receive funding to acquire more and better hardware and software, the benefit to students increasingly will depend on the ability of some three million teachers to effectively use these new tools.