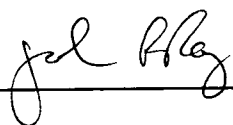


To the Graduate Council:

I am submitting herewith a dissertation written by Donald Lynnwood Belvin entitled "Access to Educational Technology in Tennessee Schools: A Descriptive Study of the Current Status." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Education.


E. Dale Doak, Major Professor

We have read this dissertation
and recommend its acceptance:





Accepted for the Council:


Associate Vice Chancellor and
Dean of The Graduate School

Access to Educational Technology in Tennessee Schools
A Descriptive Study of the Current Status

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

D. Lynnwood Belvin

December, 1997

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Special appreciation is extended to my late father, my mother, and my sisters. They were always supportive of my educational pursuits and provided constant encouragement and love.

ABSTRACT

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

A questionnaire was sent to technology coordinators representing the 139 county and special school districts in the State of Tennessee. The seventy nine respondents were a representative sample of the population. Equal distributions were found in the areas of school size, school spending, and geographic location.

The majority of the 21st Century Classroom computers were located in self-contained classrooms (67%). More 21st Century Classroom computers were placed in the Kindergarten - Eighth grades.

The participants reported over 52,000 computers in schools for instructional use. Measurements of access were student to computer (9:1), student to multimedia (20:1), student to the Internet (60:1), student to local area network (21:1), student to older computers (16:1) and student to newer

computers (23:1). Per pupil expenditures for a school system did not appear to influence student to computer ratios.

The average percent of technology budget dollars spent on teacher training was 6%. Seventeen school systems reported no money in the technology budget for teacher training. The most common teacher training activity was local training on software packages.

The average percentage of the technology budget allocated to computer repair and replacement was 8%. Fourteen percent of the districts reported no money in the technology budget for the repair and replacement of computers.

Examples of policy for the replacement and repair of computers included full-time technicians, the practice of moving older computers to lower grades, maintenance contracts, and manufacturer's warranties. The most common long range plan was to network all schools and to provide Internet access to all classrooms. Nineteen percent of the respondents reported no long range plan.

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CHAPTER I

DESCRIPTION OF THE STUDY

Introduction

The presence and utilization of computers has become a fact of American life. Computers and telecommunications networks have had a tremendous influence on how we live, work, learn, and play. New technologies have been essential tools for doing business and were quickly becoming a primary means for people to acquire information. The nation's schools, in recognizing their responsibility to prepare students to live and work in this technological society, had enlisted as resources computers and telecommunication networks. It was estimated that every year in the past decade, school systems had added between 300,000 to 400,000 computers to their schools (Office of Technology Assessment (OTA), 1995).

Current technological advances have made computing power more available and affordable than ever before. Software to support computer operations made it possible for children to build their own curriculum materials in hypermedia formats and collect and analyze data much as practicing scientists would. Sophisticated technology had rapidly become more affordable. Cases have existed where technology and school reform have been successful partners in telling us that the marriage could be a productive one (Sheingold & Tucker 1990; Stearns et al. 1991; Zorfass 1991).

There have also been many cases where school districts invested in technology that turned out not to be well used such as, computers gathering dust in the corner of a classroom, or to be used in ways that merely perpetuated the status quo (Oakes & Schneider 1984). From the "successes" we learned that technology often produced unexpected benefits for students and teachers (Stearns et al. 1991). From the failures we learned that implementation without adequate policy, thoughtful planning or sustained support was nearly always futile (Office of Educational Research and Improvement (OERI), 1993).

With available technologies, teachers were able to solve a range of educational problems, meet a variety of learning goals in all curriculum areas, and serve varying age levels of student populations. In addition, technologies offered teachers tools for accomplishing a variety of administrative tasks and for enhancing their own professional development (Office of Technology Assessment (OTA), 1995). Before teachers and students could have used technology for these ends they must have had access to hardware that was operational and able to take advantage of current software requirements.

The federal government, in an effort to bolster technology in schools, offered such incentives as *Goals 2000: Educate America Act* (P.L. 103-277), *Improving America's Schools - Technology for Education Act* (P.L. 103-382), and *Eisenhower Professional Development Program* (P.L.103-382). Each act

had a provision for the inclusion of technology in the classroom as well some provision to foster teacher development. Goals 2000 specifically required that technology plans be developed by states as a condition of participation. The Technology for Education Act carried the requirement that state and local governments that receive part of the funding must have provided for ongoing professional development to integrate technology in classrooms (OTA, 1995).

Some states developed specific plans and programs for the placement of technology in schools. Eight states in the southeastern United States had plans for educational technology in place (Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Texas, Virginia, and West Virginia). The majority of these plans had the effective use of technology to improve learning as the primary goal. A majority of the states in this region also planned to use technology to overcome access and equity problems. Common elements in southeastern state plans included the development of statewide electronic data networks (nine states) and statewide distant learning capability (five states). A less desirable parallel among this group of states was the low level of funding for staff development and the absence of provisions to deal with the upgrading and maintenance of equipment (Jones, 1994).

The State of Tennessee's major initiative to bring 21st-century technology to K-12 public schools was the Tennessee Education Network (TEN). TEN was comprised of four integrated areas of development and

deployment. Those areas were: training for technology, administrative information systems, the 21st Century Classroom Project, and a statewide telecommunications network. In fiscal year 1994, Tennessee allocated a total of \$78.1 million for educational technology with \$53.9 million earmarked for the 21st Century Classroom Project.

The 21st Century Classroom Project had distributed funding, as of April 1995, for some 3,710 Twenty-first Century Classrooms of the 4,142 funded by the General Assembly. The initial appropriation of \$53.9 million in 1994 was followed with an additional \$10 million for each of the fiscal years 1995 and 1996 (OEA, 1995). The appropriation was reduced to \$7 million in fiscal year 1997. The 21st Century Classroom Project was removed from the budget proposal for fiscal year 1998.

Specific guidelines were established for a prototype classroom costing \$20,000 (\$18,000 for hardware & \$2000 for software). Minimum instructional requirements included a fully-equipped multimedia teacher workstation, a number of networkable student workstations, and educational software. An additional requirement was completion of a comprehensive training program for teachers (Office of Education Accountability (OEA), 1995).

Local Education Agencies (LEA's) were required to provide matching funds as a condition of receiving 21st Century Classroom funds. The state contribution was 75% and the local contribution was roughly 25% of the cost

of the classroom. An adjustment was made on a county by county basis to the local contribution using a fiscal capacity index (FCI).

Fiscal capacity was defined as the potential ability of local governments to fund education from their own taxable sources, relative to the cost of their service responsibility (TACIR, 1995). The Tennessee Advisory Commission on Intergovernmental Relations (TACIR) determined the fiscal capacity for each of the 95 counties in Tennessee each year. This index was based on a set of averages using a multiple regression analysis on such factors as: fiscal effort, tax capacity based on sales and property, ability to pay based on per capita income, tax burden, and service responsibility on school population as a percentage of the total population for a particular county (TACIR, 1995). Highest capacity districts received amounts that were only 82% of the average district, while lowest capacity districts received amounts that were 172% of the state average. Based on a single 21st Century Classroom model, the state average for the local responsibility was \$5000 (25% of \$20,000). When this model was used, a highest capacity school district's responsibility would have been \$5900 while a lowest capacity school district's responsibility would have been \$1400 (TACIR, 1995).

The Tennessee Department of Education maintained a detailed report on what was spent by individual school systems on each 21st Century Classroom in the form of a budget plan that was required as a condition of funding. A report on how computers in 21st Century Classroom Project were

distributed within a particular school system, the platform of computer purchased, regional trends in subject area placement, local area networking, and connectivity to telecommunication networks was not available at the time of this study. A similar report identifying the age and quality of technology inventories prior to TEN, networking connectivity (local-area-networks and telecommunication networks), practices concerning teacher training and provisions to repair and replace technology inventories that was unique to Tennessee was also not available.

Problem

Current literature stressed the need for policy that addresses the issue of the access to computers in schools by students and teachers and the quality of that access. Studies such as the International Association for the Evaluation of Educational Attainment 1992 *Computers in Education Study* (Anderson, 1993); the National Education Association 1993 *Survey of Member Teachers* (NEA-Princeton Survey Research, 1993); the Market Data Retrieval *Education and Technology: A Survey of the K-12 Market* (MDR, 1993 - 1997); the Computer Consulting Association *Consulting Studies* (CCA, 1995); and the Quality Education Data *Technology in Public Schools Report* (Quality Education Data (QED), 1992 - 1997) provided such data as the number of computers in classrooms and some type of student-to-computer ratio. Very few studies defined the quality of the technology in place, connectivity

practices, programs for the training of staff, and practices that related to the repair and replacement of previously acquired computers.

According to the Office of Technology Assessment, a study that can provide a basis for the formulation and implementation of policy to address the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of the technology, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories was needed (OTA, 1995).

Purpose

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

This study examined these factors:

1. The placement (grade level and/or Curricular content area) of 21st Century Classroom computers;
2. The quality of existing classroom technology inventory (as determined by processor type and multimedia configuration);

3. The networking of classroom computer systems to local area networks;
4. The availability of Internet access for classroom instruction;
5. The presence of on-going staff development programs in the area of instructional technology,
6. The presence of policy and funding for the maintenance and replacement of existing classroom technology inventories, and;
7. The long range plans that school systems in Tennessee are developing.

Importance of the study

The writing of Cuban (1986), Cohen (1988), and others suggested that unless the school staff started out with an instructional goal, technology was most likely to be used to reinforce the status quo. Piele (1989) argued that this was exactly what happened with computers in most schools, where they became a drain on resources. Market data studies that reported the number of computers in classrooms and calculated student-to-computer ratios were available. A study that addressed the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of the technology, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of computers in Tennessee did not exist. Current data would be useful in shaping policy for technology. Such a study could provide baseline data to those involved in the planning, implementation, and continued support of technology. A description of the current conditions would provide a basis for the formulation of policies and procedures to encourage effective technology

utilization in Tennessee schools and insure that future planning of technology was equitable and not merely a reinforcement of existing practices.

A document unique to the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of the technology, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of computers had not been published. This study provided a description of the current conditions as a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee schools.

Assumptions

Assumptions of this study included:

1. Technology coordinators were the best source of data related to classroom technology access, teacher training programs in instructional technology, and policy for repair and replacement of technology inventories.
2. Those technology coordinators surveyed would have responded with accuracy and integrity.
3. The demographic data as published in "The 21st Century School Report Card" was both accurate and current.
4. The per pupil expenditure for education of a county, as determined by the Tennessee Department of Finance and Administration was an accurate estimation of a county's ability to locally fund education.

5. Analysis of current trends and the resulting policy suggestions would have been beneficial to both long range planning and current technology assessment.

Limitations

The study's focus was on the number and type of technology in place. It did not seek to establish for what purpose the technology was used in the classroom or the effect on student gains that may have been determined by such use. The sample was limited to Technology Coordinators as the source of school system technology data.

Delimitation's

This study was restricted by the following:

1. The study did not seek to evaluate the instructional use of technology in Tennessee classrooms, it's purpose was to describe current conditions and placement of computers.
2. The study did not seek to determine the value that technology may have added to a particular instructional area and/or grade level.
3. The study did not address the amount, placement, cost, or type of software found in classrooms.
3. The number of units, dollars allocated for upkeep, and future purchase plans for administrative computers were not collected. The study described those computers used for instructional purposes.

Definition of Terms

For the purpose of this study, the following terms were defined as:

Access - The state or quality of technology equipment being placed in a school so that it is convenient to both students and teachers for instructional usage.

ASCII (American Standard Code for Information Interchange) Text File - A text file in ASCII format reduces it to essential elements--upper- and lower-case letters, numbers, punctuation, and some control characters but no graphics characters or printer codes--and eases the process of sharing it with other computers.

CD-ROM (Compact disc-read only memory) - An optical storage system for computers that permits data to be randomly accessed from a disc.

Download- To copy a file, e-mail, or other information from a central computer to a personal computer.

Electronic mail (e-mail) - A computer application for exchanging information over a distance using either a network connection or modem and a computer. E-mail can be addressed to an individual, as well as to groups of people.

E-mail address - A specific, locatable, electronic address that designates a person or service at a specific network site. Electronic mail addresses include a user name (which can be a title or function, such as "info"), the symbol "@," and a domain name (e.g., teacher@school.edu).

File server - The personal computer that provides access to files for all workstations in a local area network.

Internet - International collection of interconnected electronic networks that support a common set of data communication protocols--Transmission Control Protocol (TCP) and Internet Protocol (IP).

Internet Access - a physical connection to the Internet either by way of a network connection or individual modem.

Local-Area-Network (LAN) - A network connecting computers in close proximity, LANs facilitate communication and sharing of both information and computer resources (such as printers or storage by the members of a group). An electronic device to share printing resources only was NOT considered a LAN for this study.

Modem - A device that allows two computers to communicate over telephone lines. It converts digital computer signals into analog format for transmission.

Multimedia - Any combination of video, sound, text, animation, and graphic images in a computer-based environment. Often includes technology such as

CD-ROM, videodiscs, videocassette recorders, television, video cameras, and software.

Network - A shared communications system that supports digital communication among connected computers.

Summary

A document unique to the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories had not been published.

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

CHAPTER II

REVIEW OF LITERATURE

Introduction

America's schools had invested heavily in technology over the past decade. Most of that expenditure had gone for the purchase of computers and software. Numerous studies defined the artifacts of technology. Studies sought to define the placement of computers in the school, the age and quality of that inventory, the connectivity of computers, provisions for teacher training, and programs in place to maintain and replace the installed inventory.

This review identified technology diffusion research, findings of national studies, state and regional studies, studies that examined provisions for the training of teachers, and research on practices in technology maintenance.

Technology Diffusion Research

Research on diffusion of educational technology had been dominated by descriptive survey research (Holloway, 1994). The federal government had been the primary source of longitudinal studies (Atkenson & Jackson, 1992). The main sources of longitudinal data were agencies that served as suppliers of educational research to Congress. Agencies identified included the General

Accounting Office (GAO), the Congressional Budget Office (CBO), the Office of Technology Assessment (OTA), and the Congressional Research Service (CRS). Examples of significant studies published by the federal government were the National Center of Educational Statistics (NCES) reports, *Schools and Staffing in the United States: A Statistical Profile* (NCES, 1992), *Education Indicators: An International Perspective* (NCES, 1996), *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1995* (NCES, 1995), *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1996* (NCES, 1996); *Teachers and Technology: Making the Connection* (OTA, 1995); and a government grant supported study *Telecommunications and K-12 Educators: Findings from a National Survey*" (Honey & Hernriques, 1993).

Technology acquisition and implementation had not usually been discussed by educators as a market activity. Holloway (1994) contended that reasons educators did not describe acquisition as a market activity may have been due to factors such as ignorance of markets and feelings that studies should learning centered. Market studies often included a projection of financial profit which was not appropriate to education. Since most studies of diffusion and implementations resembled market research, a credible case for education as a market was justified. Education as a market was also supported in that the most current and comprehensive studies, including those used by the federal government, were done by private commercial

marketing research corporations which included the Rand Corporation, Quality Educational Data (QED), Market Data Retrieval (MDR), CCA Consulting (CCA), and the Software Publishers Association (SPA).

Major nationwide surveys of schools, teachers, and students by non-government associations have been conducted in the United States. Examples included: the U.S. portion of the 1992 *Computers in Education Study of the International Association for the Evaluation of Educational Achievement* (Anderson, 1994), the 1991 *National Study of School Uses of Television and Video* conducted by the Corporation for Public Broadcasting (CPB- Andrew L. Russell and Thomas R. Curtin, 1993), and the 1993 *Communications Survey of Member Teachers of the National Education Association* (NEA- Princeton Survey Research, 1993). Although these were nationally representative data sources, they still provided a rough estimate of how accessible instructional technology was in schools. Reported data in these studies was also lacking regarding classroom access to local area networks, multimedia and telecommunication networks.

Regional, state, and local school system studies that identified diffusion practices have been conducted. The common research design was in the form of a descriptive report that was derived from some type of mailed survey instrument. Specific examples of such reports were: "*Statewide Technology Survey of New Hampshire Schools - 1994-95*" (Center for Research Management, 1995), *The Utah Educational Technology Initiative*

Year Two Evaluation" (Mergendoller, 1993), *Computers In Education: A Survey of Computer Technology In The Westchester/Putnam Schools* (Flank, 1992); *Bits, Bytes, and Barriers: Tennessee Teachers' Use of Technology* (Appalachia Educational Laboratory and Tennessee Education Association (AEL/TEA), 1991) and *Survey of 21st Century Classroom Teachers* (Office of Education Accountability (OEA), 1995).

Results of National Studies

Available survey data provided a picture of which technologies schools own and how much the average school had. Of their total expenditures to date for technology, schools had spent the most on computers. Over the past decade, schools had spent roughly \$500 million on new computers. Between 1989 and 1992, schools added 1.1 million computers, increasing their inventory by nearly 50 percent, from 2.4 million to 3.5 million (Anderson, 1994). At the end of the 1995 - 1996 school year, 5.82 million computers had been installed (QED, 1996). Market Data Retrieval estimated the number of computers in schools to have been 6.3 million at the end of the 1996 - 1997 school year (MDR, 1997).

Student to Computer Ratios

Student to computer ratios were a popular means of determining access as demonstrated by such ratios being found in most national studies. Quality Education Data (QED) determined that in the early 80's the ratio of students to computer was 125:1. By 1988-89 that number dropped to 25:1 and

by 1994-95, the ratio had changed to 10.5:1 (QED, 1995). CCA Consulting and Market Data Retrieval calculated 1994-95 student to computer ratios of 10:1 (CCA, 1995) and 11:1 (MDR, 1995). The National Center of Educational Statistics (NCES) report for that same time calculated a student to computer ratio of 15:1 (NCES, 1996). Quality Education Data calculated a 1995-96 student to computer ratio of 9:1 (QED, 1996). For the 1996-97 school year Quality Education Data estimated the student to computer ratio to have been 8.1:1 (QED, 1997). Market Data Retrieval reported a ratio of 7.3:1 for 1996-97 school year (MDR, 1997)

By international standards, the U.S. was ahead of other countries in the area of school spending on technology (NCES, 1996). At the primary level, each computer was used by an average of 23 students in the United States, more students per computer than Japan, about the same as France, but fewer students per computer than any of the other countries. The 15:1 student to computer ratio at the secondary level in the United States was lower than in all other countries including Japan (32:1), France (26:1) and Germany (48:1) (NCES, 1996).

Effect of Per Pupil Expenditure on Student to Computer Ratio

District ability to pay as determined by per pupil expenditure did not appear to have a strong effect on the student to computer ratios in a district. A Rand Corporation study *Fostering the Use of Educational Technology: Elements of A National Strategy* (Rand, 1995) found when the student to

computer ratios of the top three states in per pupil expenditure spending were compared to the student to computer ratios of the bottom three states in per pupil expenditure spending, the student to computer ratios were either the same or different by a factor of two.

Decisions that technology was important to education could lead states and school districts to allocate increased proportions of resources to technology (Rand, 1995). Smaller schools tended to have higher student to computer ratios than larger schools and states with lower per pupil expenditures tend to have been rural with smaller schools (QED, 1995).

Placement of Computers in School Systems

Placement practices of computers in schools was reported by Quality Education Data (QED) and in the CCA Consulting (CCA). The typical high school in 1992 had an average of 54 computers and the typical elementary or middle school had about 25 (QED, 1993). The CCA study described similar placement practices with the average high school having 60 computers, middle school having 26 computers, and elementary school having 22 computers (CCA, 1995).

Location of Computers in Schools

Computer labs were the most likely place computers were found within schools (CCA, 1995). Software Publishers Association reported a steady migration of computers from labs to classrooms (SPA, 1995). Of the entire

installed base of instructional computers, 48% were found in computer labs and 24% in individual classrooms. The remaining 28% were found in either designated classrooms, other types of labs, or mobile carts (CCA, 1995). A trend in moving computers from labs to classrooms was detected in the 19906-97 *Technology Purchasing Forecast* (QED, 1996). This report noted that 40% of the computers were in labs and 35% in individual classrooms (QED, 1996).

Quality and/or Age of Computers

Studies that sought to define the quality of equipment currently in use found the 8-bit Apple II computer, the most popular computer marketed to K-12 schools for use in instruction in the 1980s, comprised a large portion of school computer inventories even though it was no longer made and could not run newer software (Anderson, 1994). As of 1992, almost 50% of the computers used for instruction in the United States were 8-bit computers, primarily of the Apple II family. An additional 26% were somewhat more powerful but still comparatively limited computers with 16-bit processors and 8-bit transmission buses. An estimated amount of 60% of the outdated machines were found in the elementary school (QED, 1994). In 1992, over 40% of the elementary schools had no computers newer than the Apple II family (Anderson, 1994). Of the entire installed base of computers, Quality Education Data in 1994 estimated 22% were newer technology (32 bit), 28% mid-level (16 bit) and the remaining 50% 8 bit technology (QED, 1994). Of the

newer technology computers, the majority were found at the high school level (MDR, 1994). The Quality Education Report for 1996-97 showed a decline in the number of older computers in use. The number of Apple II family computers had decreased to 19% and DOS-only IBM compatibles had decreased to 11% (QED, 1997). In the same report Macintosh computers represented 41% of the computers used for instruction and Windows capable IBM compatible computers represented 29% (QED, 1997).

Vendor Share of Market

According to QED in 1995, most of the systems in use in schools were between three and six years old (QED, 1995). A significant percentage (44%) of the installed base of computers were purchased before 1989 (CCA, 1995). Due to the age and nature of existing inventories, Apple Computer had maintained the majority of the market share (59%) in all cited studies. If all Apple II family computers were removed from schools, the Apple Computer's market share would have declined to 26% (CCA, 1995). IBM compatible or MS-DOS/Windows based computers had shown a gain in market share. CCA estimated school purchases in the 1994-95 year were 57% IBM compatibles and 43% Macintosh (CCA, 1995). For the 1995-96 school year, QED estimated the percentage to have been 61% Macintosh computers and 39% IBM compatible computers (QED, 1996). The Market Data Retrieval study found 59% Macintosh computers and 41% IBM compatible computers (MDR, 1996). Market Data Retrieval reported Apple Computer's market share for the

1996 - 97 school year to have been 54.3% and IBM compatibles to have been 44.3% (MDR, 1997).

Current Operating Systems

Capability of running current generation operating systems was found in a majority of all installed computers newer than the Apple II family and early IBM compatible units (CCA, 1995). Sixty percent of the Apple Macintosh computers were running the System 7.x release of the operating system. Fifty-two percent of the IBM compatible computers were running the Windows operating system, and 40% were Windows95 ready (CCA, 1996). CCA Consulting's definition of Windows95 ready was a computer having a 386DX (or better) Intel processor, 4 megabytes of RAM, and a 200 megabyte hard drive. For the 1995-96 school year, Market Data Retrieval reported that 58% of the IBM compatible computers were using some version of the Microsoft Windows operating system (MDR, 1997).

Local Area Networks

The 1994 IEA study found Local Area Network (LAN) connections available on about 20% of all K-12 school computers. LANs were somewhat less prevalent in elementary schools than in high schools. Sixteen percent of elementary school computers were part of a LAN compared with 24% of high school computers (Anderson, 1994).

Quality Education Data reported LAN growth in percentage of districts with LAN's. The number of LAN-owning districts increased from 1,567 districts (10%) in 1988 to 8,478 districts (53%) in 1994 (QED, 1995). CCA Consulting reported 60% of all K-12 personal computers were connected to a LAN (CCA, 1995). The National Center for Education Statistics report *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1995* identified 45% of classrooms, 71% of computer labs, 64% of library/media centers, and 20% of teacher workrooms were connected to local area networks (NCES, 1995). Market Data Retrieval reported 62% of the computers in schools were connected to networks in 1995-96 (MDR, 1996) and the number of networked computers increased to 65% in the 1996-97 school year (MDR, 1997).

CD-ROM Access

In the 1992-93 school year, 44% of U.S. public schools had at least one computer equipped with CD-ROM, nearly triple the percentage found two years earlier. As with other computer technologies, high schools were more likely to have CD-ROM than elementary schools (MDR, 1993). CCA Consulting estimated the percentage of computers with CD-ROM drives to have been 50% of the installed base (CCA, 1995). Quality Education Data reported 91% of all school districts had CD-ROM in use (QED, 1995). Market Data Retrieval reported 92% of all schools had at least one CD-ROM device in the 1995-96 school year (MDR, 1996) and 93% had one or more CD-ROM

device in the 1996-97 school year (MDR, 1997). Market Data Retrieval noted a trend towards putting CD-ROM towers on network servers in the 1996-97 school year where some 22% of the schools reported having such hardware (MDR, 1997). In more recent studies, Quality Education Data described CD-ROM access in the form of multimedia computers in a school. The 1996-97 school year report found an average of 52 computers in each school were multimedia capable (QED, 1997).

Modem and Internet Access

Internet access was not defined or described in studies prior to 1996. In studies before 1996, the number of modems a school system had was reported. Quality Education Data reported the number of districts with modems increased from 18% in 1988 to 53% in 1994 (QED, 1995). Market Data Retrieval reported the percentage of schools with modems 64.8% (MDR, 1993). For that same period of time, Quality Education Data reported 23% of the schools had modems (QED, 1993). The National Center for Education Statistics report *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1995* identified 30% of classrooms, 41% of computer labs, 64% of library/media centers, and 10% of teacher workrooms had computers with modems. The same report identified 35% of classrooms, 41% of computer labs, 68% of library/media centers, and 14% of teacher workrooms were connected or had access to wide area networks (NCES, 1995).

The Market Data Retrieval report for the 1995-96 school year reported 70% of schools with Internet access (MDR, 1996) with more access found at the high school level. The National Center for Education Statistics report *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1996* reported 65% of all public schools had some form of Internet access in 1996. The same report found 61% of the elementary schools had access and 77% of the secondary schools had Internet access (NCES, 1996). Quality Education Data found 13 states in the 1996-97 school year had 90% or better of their schools connected to the Internet. In national rankings for 1996-97 school year, Tennessee was ranked sixth with 99% of the schools with some form in Internet access (QED, 1997).

State and Regional Studies

Studies that sought to collect and report data as it related to a specific state/region included: *Computers In Education: A Survey of Computer Technology In The Westchester/Putnam Schools* (Flank, 1992); *Bits, Bytes, and Barriers: Tennessee Teachers' Use of Technology* (Appalachia Educational Laboratory and Tennessee Education Association (AEL/TEA), 1991), *Statewide Technology Survey of New Hampshire Schools - 1994-95* (Center for Research Management, 1995), *The Utah Educational Technology Initiative Year Two Evaluation* (Mergendoller, 1993), and *Survey of 21st Century Classroom Teachers* (Office of Education Accountability (OEA), 1995).

Flank (Flank, 1992) found in the *Computers In Education: A Survey of Computer Technology In The Westchester/Putnam Schools* a student to computer ratio of 10.3 to 1 with the greatest number of computers found at the high school level (8.8 to 1). More IBM compatibles were found in high schools than in elementary schools with the average age of a computer in the district to have been five years (Flank, 1992). Long range technology plans were reported in 62% of the districts surveyed with the average time span of the plan being five years in length. The areas of teacher training seen as the most important were training teachers to integrate computers into the curriculum utilized (96%) and training teachers to use some type of application software package in the classroom (91%). Release time for teachers to obtain training was seen as a high priority in 57% of the districts (Flank, 1992).

The AEL/TEA study *Bits, Bytes, and Barriers: Tennessee Teachers' Use of Technology* (AEL/TEA, 1991) described the extent and forms of educational technology used by Tennessee teachers. Daily student use of computers in instruction was found by 43% of the respondents. Access to computers in labs was reported by 26% of those surveyed. Barriers to the effective use of technology were reported to have been a lack of funding (57%), teacher time to work with computers during the school day (30%) and the availability of training for teachers (13%). This study was distributed to a group of over 40,000 teachers with 449 surveys returned with usable data (AEL/TEA, 1991).

The Tennessee Department of Education's *Survey of 21st Century Classroom Teachers* (OEA, 1995) was distributed to over 700 teachers with 318 responding. Of those that responded to the survey, an average overall program rating of 1.8 on a scale of 4 was reported (1=Excellent, 2=Good, 3=Fair, 4=Poor). The responding teachers rated the state training as 14% excellent, 44% good, 28% fair, and 14% poor (OEA, 1995). The study identified additional training as a need by 85% of the responding teachers. Seventy five percent of the responding teachers indicated they wanted training on integrating the use of technology with the state's curriculum (OEA, 1995).

Findings of the New Hampshire Schools study found 38% of the schools had some type of technology plan and of the 21,704 computers reported, 58% were found in classrooms. New Hampshire's ratio of students to computer was 9.6:1 and 29% of the schools had some type of local area network(LAN). Thirty two percent of the schools had some type of Internet access. The study also found the most frequent opportunity for staff development was workshops (88%) and technology coordinators provided most of the technical support (Center for Resource Management, 1995).

The Utah Study found the student to computer ratio was 11:1 with the majority of computer in schools found in labs. It also reported more computers placed at the high school than elementary school. The predominate platform of computer in the elementary school was Apple (Apple II and Macintosh) and the predominate platform in both the middle

school and high school was IBM Compatible. The study found less than 20% of the teachers received any technology inservice training and most training was delivered on the local level by school system personnel. The technology budget allocated 6% for training. The average allocation for repair of computers by a school system was 6% of the technology budget. No formal plans for the scheduled replacement of computers were reported by the respondents (Mergendoller, 1993).

Research on Teacher Training

Available data suggested most teachers had very little technology training. The *Hardware Projections in K-12 Schools* study (Anderson, 1994) reported less than 50% of the American schools reported any type of introductory computer course for teachers (either in the district or at a local college) to have been available . Twenty seven percent of middle school teachers reported the availability of a introductory computer course compared to 51% of high schools and 43% of elementary school teachers (Anderson, 1994).

Data on expenditures for educational technology indicated far more resources had been allocated to hardware and software than to training or technical support. In the Market Data Retrieval, *Education and Technology, 1993: A Survey of the K-12 Market* study, district technology coordinators estimated training (programs and staff salaries) and support accounted for

15% of the total technology budget. The same report found 55% of the budget was devoted to hardware and the remaining 30% to software (MDR, 1993).

Technology-related training accounted for 4% of schools' technology budgets in 1995-96, according to Quality Education Data's *1995-96 Technology Purchasing Forecast* (QED, 1995). Of the average of \$82.05 spent on technology per student in 1994-95, 68% went toward hardware, 15% for software, 8% for supplies, 4% for training, and 5% for service (QED, 1995).

The Utah Educational Technology Initiative (1992-93) reported the average Utah elementary school received \$15,365 and spent 68% on hardware, 20% on software, 6% on repairs, and 6% on training. With a budget allocation of \$31,369, the average Utah secondary school allocated 75% to hardware, 15% to software, 6% to repairs, and 4% to training (Mergendoller, 1994).

The Florida legislature allocated \$55 million for educational technology and \$8.65 million for educational software in 1992-93. The appropriation required schools applying for these technology funds set aside at least 30% of the money for training (Anderson, 1994). The Texas Education Agency recommended districts allocate a substantial portion of their technology funds for staff development, suggesting districts just getting started allocate 30% of their technology funds to hardware, 30% to software, 30% to staff development, and 10% to maintenance (Mergendoller, 1994). The state of Washington spent about 40% of its \$4.5 million technology budget for the 1993-94 school year on teacher training activities (Anderson, 1994).

Alabama and the District of Columbia required all teachers to complete some form of inservice training in technology each year. The Alabama requirement was some of the mandated five inservice days include technology training. The District of Columbia required, as a condition of certification renewal, teachers complete sixty hours in technology training every five years (Anderson, 1994).

The National Education Association's *Status of the American Public School Teacher* study (NEA, 1991) identified 56% of those surveyed felt they needed training in how to use a personal computer. The same identified teachers needed training programs in standard computer software use (61%), multimedia software (62%), instructional videodiscs (67%), and on-line databases (72%). Less than 7% of the respondents saw that instruction in established technologies (videocassette recorders, television monitors, and instructional videotapes was necessary (NEA, 1991).

Identified training activities included basic literacy classes, self-paced video instruction, instruction in telecommunication programs, and the modeling of classroom implementation techniques (OTA, 1995). Examples of successful training programs included those which gave ample time and resources to the teacher (Griffith, 1993), provided appropriate technology resource personnel such as building level technology coordinators (Mergendoller, 1994), and involved the school administration in an active

role in both evaluation of technology using teachers and the use of technology themselves (Griffith, 1993).

Training and on-site assistance were often seen as the primary ingredients necessary to facilitate widespread technology use among teachers. Other factors which influenced whether teachers used technology resources included policies that encourage teacher experimentation and collaboration, allowing teachers to participate in the development of technology plans, the presence of incentives for teacher use of technology, and administrative leadership about technology (OTA, 1995).

According to the study, *Using Technology To Support Educational Reform* (Means, 1993), the two most critical factors affecting technology usage and adoption among teachers were having a vision and plan for using technology to meet instructional and professional goals, and evaluation and assessment policies which encouraged technology use. The *Teachers and Technology: Making the Connection* (OTA, 1995) report found ready access to equipment was a precondition for teacher training. Teachers expressed much frustration when they were trained to learn to use technology in a workshop, then returned to a classroom that did not have it.

In *A Cost Model: Implementing Technology in New York State Public Schools* (Radlick, 1994) it was suggested there should have been a substantial investment in human resources for every investment in hardware or software made. Examples of such resources included expenditures for

training, technical support, maintenance, and time to learn to use the technology (Radlick, 1994). The OTA study concluded most funding initiatives ignored the training aspects of funding components and focus on hardware and software (OTA, 1995).

A report on Los Angeles County schools identified teacher training as the core of a newly created technology initiative (Ingwerson, 1996). The report identified a train-the-trainer model which utilized teams of teachers. The teams role was to devise a series of teacher training sessions that were nine days in length. The training curriculum included working with multimedia, telecommunications, teacher productivity and learning resource management. For teachers to participate in the training team, a written plan on why they wanted to participate as well as an agreement to train 20 additional teachers was required. The study concluded training empowers teachers to discover opportunities so that their students get excited about learning (Ingwerson, 1996)

Research on Repair and Replacement of Computers

Examples of technical support issue studies that related directly to K-12 education were limited. The Market Data Retrieval, *Education and Technology, 1993: A Survey of the K-12 Market* and the Quality Education Data's 1995-96 *Technology Purchasing Forecast* (QED, 1995) studies collected information on computer repair and replacement practices as it related to K-12 schools. The Market Data Retrieval study chose to include in the

definition of teacher training the necessary staff to support the ongoing maintenance of computers and teacher support. The study reported that 15% of the total technology budget was for training and support (MDR, 1993). Quality Education Data found technology-related service accounted for 5% of most school districts technology budget in 1995-96 (QED, 1995).

Statewide studies identified examples of provisions for the ongoing support of computer inventories. The 1992 *Kentucky Master Plan for Educational Technology* provided funding for the ongoing maintenance and support of state and district level technology. The same plan school districts were responsible for all ongoing maintenance and support costs (KDE, 1992). The Utah Educational Technology Initiative (1992-93) reported the average Utah elementary and secondary school spent 6% percent of their technology expenditure on computer repair (Mergendoller, 1994).

The Texas Education Agency recommended districts allocate 10% of technology allocations to computer maintenance and repair (Mergendoller, 1994). In each study cited, the necessary funding to establish the suggested percentages were to come from local school budgets. Tennessee provided direct funding to school districts for technology support in providing a portion of the district level technology coordinator salary (Jones, 1994).

Provisions to manage computer inventories was seen as a major consideration in several reports. Of the reports cited, most were directed to business and higher education. The basic concepts that were found could be

applied to K-12 schools and offered many suggestions that had been tested and modified with success in both the business community and higher education.

In the study *Creating order from Chaos* (Wolfraim, 1996), three key areas for managing technology resources were mentioned. The first concept was the establishment of a district level set of standards for computer purchases. Minimum hardware requirements should have been developed with input from the various users and then published throughout the organization.

The second suggestion presented by Wolfraim was the creation of a fixed asset inventory that included detailed information on the equipment (Type of processor, amount of RAM, type of network card, etc.). With a current and dynamic inventory, the location of all computers in the organization was known as well as how close each unit was to obsolescence.

The final concept in this study was to develop a plan for the retirement of an inventory item. Technology purchases at one time were considered to have been usable for five years. The combined effects of escalating performance, reduced cost of new units, new software requirements, and rising expectations by users shortened this time span dramatically (Wolfraim, 1996). Organizations should project how long a computer will be useable as a "new item", as a mid-level item, and when it will reach obsolescence. Obsolescence will be reached before the computer fails to function. This concept helped explain the high percentage of older computers

that had a lack of current software available still being used by schools (QED, 1996).

Another source of computers for schools and a problem for schools was the practice of business, government, and individuals donating computers. In the Rand report *Surplus Federal Computers for Schools: An Assessment of the Early Implementation of E.O. 12999* (Rand, 1997), the problems with government and business donation of computers to schools were discussed. In Executive Order 12999, *Educational Technology: Ensuring Opportunity for All Children in the Next Century*, President Clinton promoted the transfer of unneeded federal government equipment to schools.

Of the 500,000 computers that would be available as surplus on an annual basis resulting from E.O. 12999, as few as 100,000 were usable and those were identified as IBM Compatibles with a 286 processor (Rand, 1997). In an interview with several school systems, it was found that most computers donated to schools were incompatible with district technology, needed maintenance, had additional costs associated with replacing missing components, and lacked any type of software (including operating systems). The study also found schools expressed a reluctance to turn down unwanted equipment for political reasons such as negative community relations and the discouragement of future donations (Rand, 1997).

The Rand report (Rand, 1997) found that even though older computers could be used for such applications as learning keyboarding skills and simple

text processing, as a rule the acceptance of this equipment should be discouraged. The study concluded with the suggestion that a school system have a clear sense of its technology needs and a strategy for meeting those needs. In the absence of such a plan, a school system could end up with computers it could not effectively use. Effective technology plans that guide the selection and use of equipment were seen as critical (Rand, 1997).

In *The Financial Mythology of Information Technology: Developing a New Game Plan* (Oberlin, 1996), the issue of recycling old technology was addressed. According to Oberlin, developing strategies to manage technology life cycles was a fundamental requirement of any financial plan. The study reported computers rarely wear out but they do become obsolete very fast.

The considerations of equity between schools (the school that gets the new technology and the school that gets the handed down computer), the increased support problems such a practice created, and some type of established plan for dealing with older technology were identified as a critical components of an effective management plan (Oberlin, 1996).

The additional operating costs for technical assistance, either school staff or in the form of a maintenance and service contracts, for teacher training in the educational applications of all the technologies, and for materials and supplies were rarely budgeted (Harvey, 1995). The cost of equipment, wiring, services and supplies could increase the per student cost of technology from the national average of between 0.75% and 1% to between

3% and 5% of total educational expenditures, or from \$45 to \$60 per student to between \$135 and \$300 per student (NCES, 1995).

It was reported in *Getting America's Students Ready for the 21st Century- Meeting the Technology Literacy Challenge A Report to the Nation on Technology and Education* (USDE, 1996) that the maintenance cost per computer for a school with single computers connected to the Internet was much less than the costs for a school with multiple networked PCs in every classroom and a high-speed connection to the Internet. In the single computer model, the costs per student were less than \$10 in one-time costs and less than \$15 in annual on-going costs. In the multiple networked PCs in every classroom and a high-speed connection to the Internet model, costs per student were more than \$250 in one-time costs, and exceeded \$42 in annual ongoing costs.

Estimates to install technology in every school in the nation were from \$12 to \$28 billion in one-time costs and from \$2 to \$5 billion in annual costs (USDE, 1996). An estimate for planning the cost of technology and it's support components to have been incurred at the school and district level was \$200 per student (USDE, 1996). This amount represented about 3% of the national per pupil expenditure and could be expressed as \$1 per day per student (USDE, 1996).

Summary

Research related to the diffusion of educational technology was descriptive in nature and in most cases utilized some form of mailed survey (Holloway, 1994). Reporting was most often in the form of some type of market data study that described conditions as well as made estimates for future purchases (Rand, 1994-97, QED 1992-97, MDR 1993-97, CCA 1995-96, SPA, 1996). Commercial studies were often the data source for contractor reports to government studies (Atkenson & Jackson, 1992). The most common method of reporting computer density was the student to computer ratio (Rand, 1994-97, QED 1992-97, MDR 1993-97, CCA 1995, SPA, 1995).

Technology Diffusion Research

The number of computers had increased each year in schools. It was estimated that as of 1997, 6.3 million computers had been installed (MDR, 1997 & QED, 1997). The estimated student to computer ratio ranged from 7.3:1 to 8.1:1 (MDR, 1997 & QED, 1997). Most computers were placed at the high school level and found in computer labs (CCA, 1995, QED, 1996, SPA, 1995).

District ability to pay as determined by per pupil expenditure did not appear to have a strong effect on the student to computer ratios in a district (Rand, 1995). When student to computer ratios of the top three states in per pupil expenditure spending were compared to the student to computer ratios of the bottom three states in per pupil expenditure spending, the student to

computer ratios were either the same or different by a factor of two.

Explanations given were technology was important to education and could lead states and school districts to allocate increased proportions of resources to technology (Rand, 1995) and states with lower per pupil expenditures tend to have been rural with smaller schools which tend to have higher student to computer ratios (QED, 1995).

Older technology not capable of running of current educational software was found in 50% of the schools in 1994 (QED, 1994) and 30% of the schools in 1997 (MDR, 1997). The computer platform most found in schools in 1997 was Apple Computer (Apple II and Macintosh) 54.3% and IBM Compatible 44.3% (MDR, 1997).

Apple Macintosh computers had 60% of the installed base running the System 7 version of the operating system (CCA, 1996). IBM compatible computers had 58% of the installed base running Windows with 40% Windows95 ready (CCA, 1996). The percentage of computers running the Apple II operating systems was estimated to have been 19% of all instructional computers and the number of IBM compatibles operating on some form of DOS-only (non-Windows) was reported to have been 11% of instructional computers (QED, 1997).

Local Area Networks (LANs) were more commonly found in secondary schools (Anderson, 1994). Research estimated the number of computers connected to LAN's in a school system increased each year. Recent

estimates were 65% of all computers were connected to some type of Local-Area-Network (MDR, 1997).

The percentage of schools that had access to CD-ROM drives had increased each year with 93% of all schools having such access (QED, 1997). An average of 52 computers per school were multimedia ready in 1997 (QED, 1997). CD-ROM tower devices on Local-Area-Networks as a were found in 22% of the schools (MDR, 1997).

The number of districts with modems had increased from 18% in 1988 to 53% in 1994 (QED, 1994). As many as 70% of all schools had Internet access in 1996 (MDR, 1996). Thirteen states had 90% or more schools with Internet access in 1997 (QED, 1997). Tennessee was ranked sixth nationwide with 99% of the schools connected to the Internet in 1997 (QED, 1997).

State and Regional Studies

The Westchester/Putnam School district of New York found a student to computer ratio of 10.3 to 1 with the greatest number of computers found at the high school level (8.8 to 1). Integrating computers into the was seen as the most important areas of teacher training (Flank, 1992).

A AEL/TEA study found daily student use of computers in instruction was found by 43% of the respondents and access to computers in labs was reported by 26% of those surveyed. Barriers to the effective use of technology were reported to have been a lack of funding (57%), teacher time to work with

computers during the school day (30%) and the availability of training for teachers (13%) (AEL/TEA, 1991).

The Tennessee Department of Education reported 21st Century Classroom Teachers rated the overall program 1.8 on a scale of 4. Eighty five percent of the responding teachers identified additional training and training on integrating the use of technology with the state's curriculum as a need (OEA, 1995).

Four percent of the schools technology budget in New Hampshire was for teacher training and 58% of the computers were found in classrooms. The student to computer ratio was 9.6 to 1, and 29% of the schools had local area networks (Center for Resource Management, 1995).

In Utah, the student to computer ratio as 11 to 1, the majority of computers were found in labs, the average percentage of the technology budget for training was 6% and the average amount of the local district technology expenditure allocated to repair was 6% (Mergendoller, 1993).

Research on Teacher Training

Expenditures for educational technology indicated far more resources had been allocated to hardware and software than to training or technical support. One report found that 15% of the technology budget was for training (programs and staff salaries)(MDR, 1993) and another found the percentage to had been 4% (QED, 1994).

Statewide studies reported an range of 6% of the school system level technology budget for teacher training in Utah (Mergendoller, 1994) to 40% of the statewide technology budget in the state of Washington (Anderson, 1994).

Technology inservice training was a requirement in Alabama and the District of Columbia and technology training was a requisite for teacher certification renewal in the District of Columbia (Anderson, 1994).

Identified training activities included basic literacy classes, self-paced video instruction, instruction in telecommunication programs, and the modeling of classroom implementation techniques (OTA, 1995).

Radlick (Radlick, 1994) reported a substantial investment in human resources for every investment in hardware or software made was necessary. Examples of such resources included expenditures for training, technical support, maintenance, and time to learn to use the technology .

The Office of Technology Assessment study (OTA, 1995) concluded that most funding initiatives ignored the training aspects of funding components and focus on hardware and software (OTA, 1995).

Critical factors that affected technology usage and adoption among teachers were having a vision and plan for using technology to meet instructional and professional goals, and evaluation and assessment policies that encouraged technology use (Means, 1993).

Ready access to equipment was a precondition for teacher training (OTA, 1995). The adjustment of current spending practices on teacher training, development of detailed plans for the training of teachers, utilization of the talents of the existing teachers, access to the technology for teachers, and active involvement of teachers in the development of plans was seen as critical (Radlick, 1994).

Research on Repair and Replacement of Computers

The Market Data Retrieval study reported that 15% of the total technology budget was for training (including staff salaries) and support (MDR, 1993). Quality Education Data found that technology-related service accounted for 5% of most school districts technology budget in 1995-96 (QED, 1995).

Statewide studies found that Kentucky (KDE, 1992) had provisions for the on-going maintenance of state equipment with no provisions for local school system technology equipment (KDE, 1992).

Utah schools on average, allocated 6% of technology budgets for repair and maintenance (Mergendoller, 1994). The recommended amount to have been allocated in Texas for maintenance and repair was 10% (Mergendoller, 1994).

Tennessee provided direct funding to school systems in the form of the 50% of the technology coordinator's salary (Jones, 1994).

Effective technology plans that guided the selection and use of equipment were critical. Three key areas for managing technology resources were: to establish a district level set of standards for computer purchases, creation of a fixed asset inventory that included specifics (Type of processor, amount of RAM, type of network card, etc.), and development of a plan for the retirement of an inventory item (Wolfrain, 1996).

A Rand report on the implementation of Executive Order 12999 (Rand, 1997) suggested that a school system have a clear sense of its technology needs and a strategy for addressing the issue of donated equipment. The absence of such a plan could result in a school system ending up with computers it cannot effectively use and the acceptance of donated equipment that does not fit established needs should be discouraged (Rand, 1997).

A time table or equipment life cycle chart to project the useable life of a computer was reported as a fundamental requirement of any technology plan. Specific issues that should be addressed were the equity of newer versus older computers, the increased maintenance cost for older computers, and the possible instructional usage of obsolete computers (Oberlin, 1996).

Maintenance cost estimates ranged from 1% to 5% of total educational expenditures (NCES, 1995). Maintenance cost per student for single computers connected the Internet were estimated to have been \$15 for ongoing costs and for multiple computers networked to a file server with a

high speed Internet connection, the cost was estimated to have been \$42 (USDE, 1996).

An estimate for the planning the cost of technology and it's support components to have been \$200 per student or 3% of the national per pupil expenditure (USDE, 1996).

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of equipment in the school, the connectivity of equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

The descriptive survey research method was the dominate type of research used in diffusion studies (Holloway, 1994). The common research design form used in statewide studies was a descriptive report derived from some type of mailed survey instrument. The descriptive data required for this study was collected using the survey method. A questionnaire, *Survey of Tennessee Technology Coordinators* (Appendix B), was administered to the technology coordinators of the 139 county and special school districts in the State of Tennessee. The published report, *21st Century Schools Program - State of Tennessee Report Card - 1996*, acted as the source of demographic data for individual school systems not collected using the survey instrument.

Demographics of Respondents

Questionnaires were sent to the technology coordinator in the 139 school districts in the State of Tennessee. A total of 79 surveys with useable data were returned for a response rate of 58%. The response rate to the electronic form of the survey was 19 of 139 technology coordinators (14%). The remaining 60 responses were from mailed surveys (44%). After the final return date for the mailed survey past, technology coordinators that did not return surveys were contacted by telephone conversation and asked to participate in the study. This solicitation resulted in 2 of the 60 returned mail surveys. Of the remaining technology coordinators contacted by telephone conversation, 51 of 139 technology coordinators responded they would not be able to participate (34%). The primary reason for non-participation related to lack of data necessary to complete Section 2 of the survey (Computers in Non-21st Century Classrooms). Classifying this group as respondents unable to participate, increased the response rate to 94% of those surveyed (130 of 139). The returned surveys were 24% electronic mail responses and 76% traditional mail responses.

A representative sample of the state was achieved as evidenced by the following analysis. Twenty nine percent of participants from school systems with a student population greater than or equal to 4,000 students (median + 1 standard deviation). Thirty nine percent of the participants were from school systems with a student population of 2,001 to 3,999 students (median range).

Thirty two percent of the participants were from school systems with 2,000 students or less (median - 1 standard deviation) (Figure 1).

The respondents from school systems with a per pupil expenditure greater than or equal to \$4,400 per student (median + 1 standard deviation) numbered 25 (32%), a per pupil expenditure greater than or equal to \$4,000 and less than \$4,400 per student were represented by 24 (30%) respondents, and school systems with a per pupil expenditure less than \$4,000 per student (median- 1 standard deviation) provided 30 (38%) of the responses (Figure 2).

For the purpose of the study, the state was divided into four geographic regions (Table 1). The survey respondents represented a balanced sample from the four regions identified. Region I (East Tennessee) had 18 (23%) responses, Region II (East Central Tennessee) had 22 (28%) responses, Region III (Middle Tennessee) provided 18 (23%) responses and Region IV (West Tennessee) provided 21 (26%) responses (Figure 3).

Questionnaire Data

The first part of the questionnaire was specific to the 21st Century Classroom Project. Data regarding placement of 21st Century Classroom computers by grade level, subject area, local area network access, and internet access was requested. The technology coordinator was asked to classify the specific platform information (Apple Macintosh or IBM Compatible) and report the number of units installed. All computers were required to be of a minimum processor quality and multimedia ready.

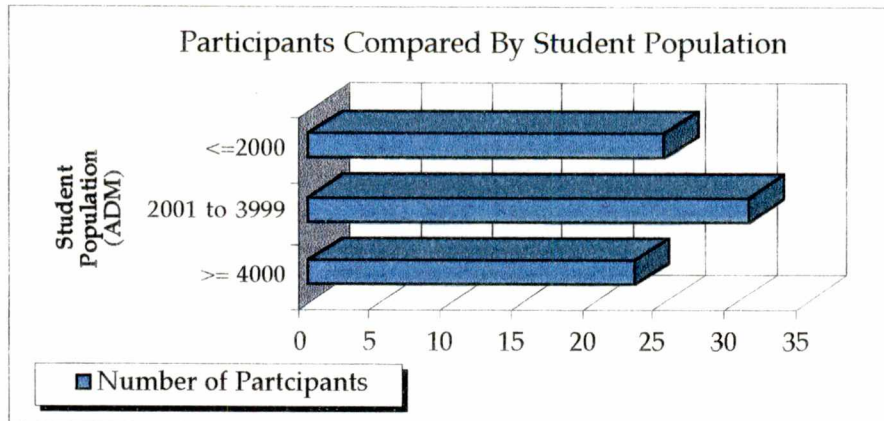


Figure 1: Participants Compared by Student Population

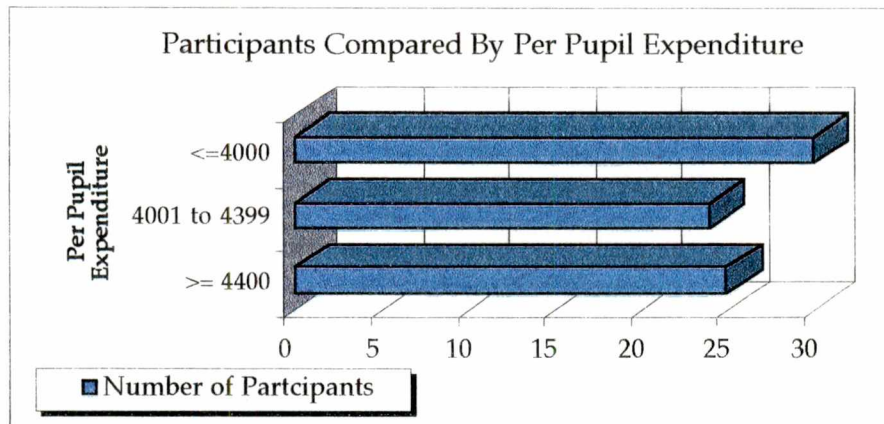


Figure 2: Participants Compared by Per Pupil Expenditure

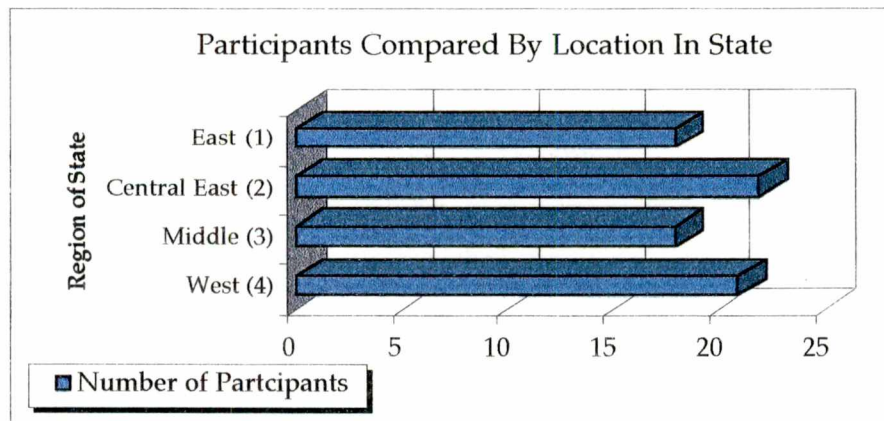


Figure 3: Participants Compared by Location in State

Table 1

Geographic Regions of Tennessee			
Region 1 <i>East</i>	Region 2 <i>East Central</i>	Region 3 <i>Middle</i>	Region 4 <i>West</i>
Anderson	Bledsoe	Bedford	Benton
Blount	Bradley	Cheatham	Carroll
Campbell	Cannon	Davidson	Chester
Carter	Clay	Dickson	Crockett
Clairborne	Coffee	Giles	Decatur
Cocke	Cumberland	Hickman	Dyer
Grainger	Dekalb	Houston	Fayette
Greene	Fentress	Humphreys	Gibson
Hamblin	Franklin	Lawrence	Hardeman
Hancock	Grundy	Lewis	Hardin
Hawkins	Hamilton	Lincoln	Haywood
Jefferson	Jackson	Macon	Henderson
Johnson	McMinn	Marshall	Henry
Knox	Marion	Maurry	Lake
Loudon	Meigs	Montgomery	Lauderdale
Monroe	Overton	Moore	McNairy
Morgan	Pickett	Perry	Madison
Roane	Polk	Robertson	Obion
Scott	Putnam	Rutherford	Shelby
Sevier	Rhea	Smith	Tipton
Sullivan	Sequatchie	Stewart	Weakley
Unicoi	VanBuren	Sumner	
Union	Warren	Trousdale	
Washington	White	Wayne	
		Williamson	
		Wilson	

The second section of the questionnaire collected data on all other classroom computers (non-21st Century Classroom computers). This section requested the specific numbers of computers in place by grade level. It was designed so that the number of computers by processor type were collected (i.e. Apple //e, Macintosh Classic, Power Macintosh, MS-DOS 286, MS-DOS Pentium, etc.). Data on capacity for multimedia operation (i.e. CD-ROM), connection to some type of Local Area Network (LAN), and access to the Internet was collected by grade level and processor type. Data collected in this section was used to report computer placement practices and to generate a student-to-computer ratio based on both the number and quality (processor type, multimedia capacity, network connectivity, and Internet access) of the computers reported.

The third section requested the percentage of funds allocated for the training of teachers to use technology and type of training activities offered. This section requested data in the form of percent of budget and data in the form of open-ended questions regarding the types of training programs in use.

The fourth and final section of the questionnaire requested the percentage of the local technology budget allocated for the repair and replacement of computers, if a local policy for the repair and replacement of computers existed, if the policy was funded, and examples of repair and replacement activities. This section also requested brief examples of long

range technology plans. The percentage of the technology budget was collected as quantitative data. The existence of a replacement policy, status of funding, types of repair and replacement activities and long range plans were collected in the form of open-ended responses.

Data from Other Sources

School system size (determined Average Daily Membership or ADM), and per-pupil expenditure were determined from the *21st Century Schools Program - State of Tennessee Report Card - October 1996*, published by the State of Tennessee - Department of Education (SDE, 1996).

Administration of the Questionnaire

A sample electronic questionnaire was developed and sent by way of electronic mail to five technology coordinators selected at random. The mechanics of receiving the document, accuracy of included directions, completion of the survey with test data, and return of the data as explained in the instructions were tested. The sample data was received and extracted as an ASCII text file, downloaded from the server to a local computer, imported into a spreadsheet program, and tested for accuracy. Those that participated at this level were asked to make suggestions for improvement. Suggestions for improvement made by the test group were implemented and the process was repeated. Upon a second successful test, the electronic mail survey instrument *Survey of Tennessee Technology Coordinators* (Appendix B) was completed.

The electronic questionnaire was administered to all technology coordinators in the State of Tennessee using electronic mail as the distribution and collection agent. The questionnaire process involved posting a cover letter to the listserv for technology coordinators (Ten-TC@ten.nash.ten.k12.tn.us) on April 2, 1996. The cover letter *Attention Tennessee Technology Coordinators* (Appendix A) was sent to notify the group as to the nature of the study, the exact type of data to be collected, and the importance of accuracy of the data reported.

On April 8, 1997, the survey was sent to all technology coordinators as an electronic mail document. The survey was sent to each individuals unique electronic mail address and not as a document posted to the technology coordinator's listserv. Specific instructions for returning the document were outlined in the document. The first mailing resulted in seven surveys being returned by the requested date (April 16, 1996).

A duplicate copy of the cover letter and survey was sent to each non-respondent's electronic mail address on April 23, 1996. This procedure resulted in the return of twelve additional electronic survey responses by the requested return date of April 30, 1996.

Following the utilization of electronic mail and the resulting low return rate, a paper copy which duplicated the electronic mail survey was created. This document was mailed to the non-responding technology coordinators on May 4, 1996. A deadline for completion and return was

indicated (May 20, 1996) and a self-addressed stamped envelope was included with the survey. This resulted in the return of 58 additional surveys. After a period of one week of the requested return date (May 28, 1996), the individuals that had not responded were contacted by telephone and requested to participate. Those that indicated an interest were sent an other copy of the paper version of the survey, along with a self-addressed stamped envelop. This resulted in 2 additional returned surveys. Following a two week period, non-respondents were contacted again by telephone (June 3 - 7, 1996). This process identified 51 technology coordinators (34%) that were unable to participate because they did not have access to the data required to complete the second section of the survey (Computers in Non-21st Century Classrooms). Nine technology coordinators (6%) were unable to be contacted and therefore classified as a non-response.

Data Analysis

The basic treatment of the quantitative data collected was limited to arithmetic computations necessary to calculate frequencies, means, ranges and percentages. All computations were performed using the electronic spreadsheet program "Excel 5.0" by Microsoft Corporation. Findings were reported as tables and figures that described the responses.

Responses to open-ended items were listed and tallied. Responses were classified into like areas and sorted in order to group the data. Groups were tallied and reported by frequency of response.

Summary

The descriptive data required for this study were collected using the survey method. A questionnaire, *Survey of Tennessee Technology Coordinators* (Appendix B), was administered to technology coordinators representing the 139 county and special school districts in the State of Tennessee. The published report, *1996 - State of Tennessee Report Card*, acted as the source of demographic data for individual school systems that was not collected with the survey instrument.

Of the 79 returned surveys (58%), 19 were returned as electronic mail documents (24%) and the remaining 60 were returned as traditional mail documents(76%). Of the 60 remaining technology coordinators, 51 responded they were unable to participate(34%). The primary reason identified by this group was that they did not have the data to complete the section of the survey (Computers in Non-21st Century Classrooms).

The respondents were a representative sample of the population. Equal distributions of the respondents were found in the areas of school size based on average daily membership, school spending as measured by per pupil expenditure, and geographic location as measured by equal distribution in four regions of the state.

CHAPTER IV

ANALYSIS OF DATA

Introduction

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

The data were reported in four major sections: 21st Century Classrooms Information, Computers in Other Classrooms (non 21st Century), Teacher Training Information, and Provisions for Maintenance and Replacement.

21st Century Classroom Information

The first part of the survey collected data on the 21st Century Classroom Project. The four major sections were: Placement by Grade Level; Placement by Curricular Area; Connection to Local Area Networks (LANs) and; Connection to the Internet. Each section asked for platform specific and grade level specific responses.

Placement by Platform (Manufacturer)

Of the 3,905 computers, 2,030 computers were Macintosh (55%) and the remaining 1,875 computers were IBM Compatible computers (45%).

Breakdown by specific vendor of IBM Compatible computers (IBM, Compaq, Dell, etc.) was not requested in the survey.

Placement by Grade Level

A total of 808 computers were placed in the Kindergarten - Second Grades(21%) and 1,355 computers were placed in the Third - Fifth Grades (35%). A total of 1,003 computers were placed in the Sixth - Eighth grades (26%). The remaining 683 computers were placed in the Ninth - Twelfth Grades (18%). Overall, more computers were placed in the Kindergarten - Eighth grades.

Placement by Region

The Macintosh was the most frequent choice in Region One (East Tennessee), Region Three (Middle Tennessee), and Region Four (West Tennessee). Region Two (East Central Tennessee) had a higher placement of IBM compatible computers (Figure 4).

Placement by Curricular Area

Curricular area placement was balanced among subject areas (Math 246 (6%); Science 325 (8%); Language Arts 299 (8%); Social Studies 202 (5%); and Other 205 (5%)) (Table 2). The majority of the 21st Century Classroom computers

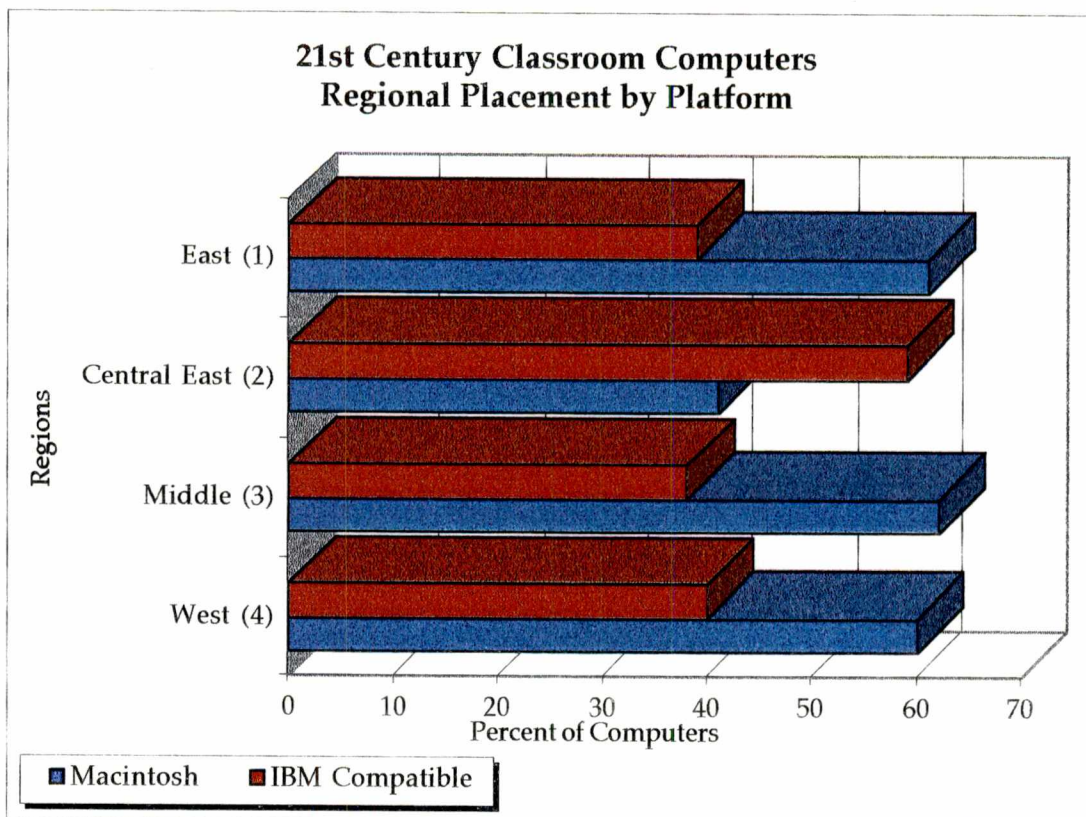


Figure 4: 21st Century Classroom Computers - Regional Placement by Platform

Table 2

21st Century Classroom Computers - Curricular Area Placement							
Platform	Math	Science	Language Arts	Social Studies	Other	Self Contained	Total
Macintosh	155	197	136	119	102	1321	2030
IBM Compatible	91	128	163	83	103	1307	1875
Total	246	325	299	202	205	2628	3905

were located in self-contained classrooms (67%). The distribution of Macintosh and IBM compatible computers was balanced in most all curricular areas. More Macintosh computers than IBM compatible computers were located in math and science classrooms.

Placement by State Region

Grade-level placement practices were balanced in Region Four (West Tennessee) with the remaining regions placing more computers in the Third - Eighth grades. Region One (East Tennessee) had the lowest number of 21st Century Classroom computers placed in the Ninth - Twelfth grades (12%). Region Two (East Central Tennessee) placed more computers in the Third - Fifth grades (43%) (Figure 5).

Local-Area-Network Information

Connection to Local-Area-Networks (LANs) was found on 2,757 computers (72%). The survey instructions stated that printer sharing only networks were NOT to be reported as a LAN. Third - Fifth grades had 1028 computers connected to a local area network (27%), more than any other grade level group (Table 3). More computers were connected to networks in Region Three (Middle Tennessee) (Figure 6). School systems with a student population over 4,400 had more computers connected to local area networks (Figure 7). The per pupil expenditure of a district did not appear to influence the number of networked computers (Figure 8).

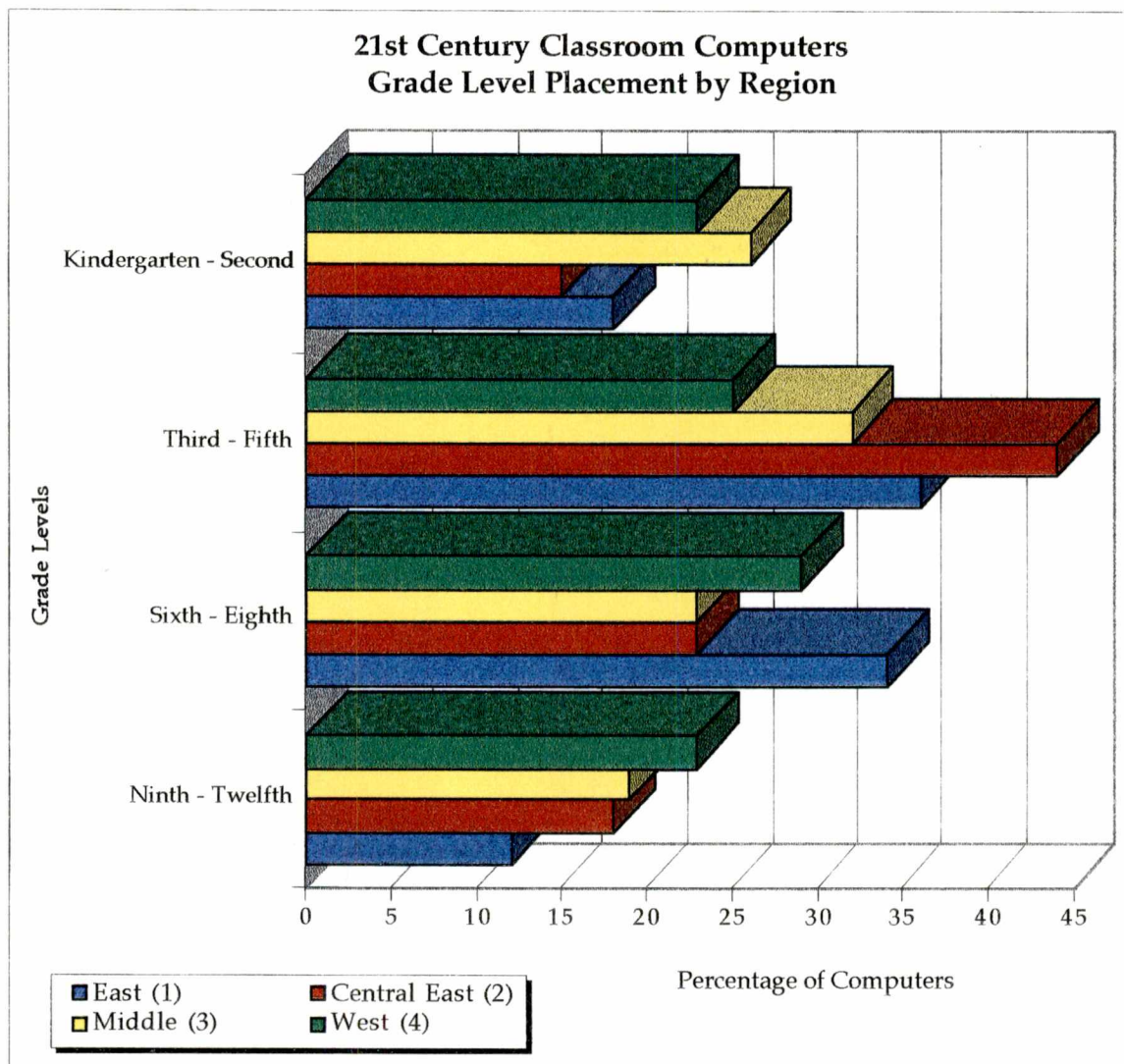


Figure 5: 21st Century Classroom Computers-Grade Level Placement by Region

Table 3

21st Century Classroom Computers - Connection to Local Area Network					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade - Twelfth Grade	Total
Macintosh	277	427	406	214	1324
IBM Compatible	266	601	259	307	1433
Total	543	1028	665	521	2757

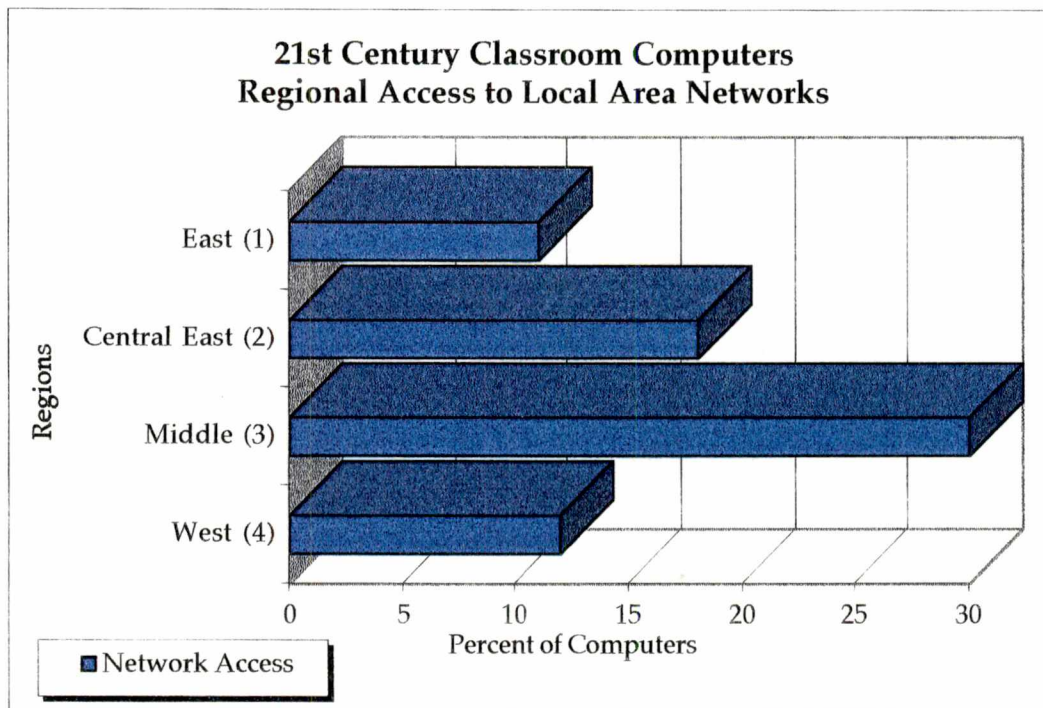


Figure 6: 21st Century Classroom Computers - Regional Access to Local Area Network

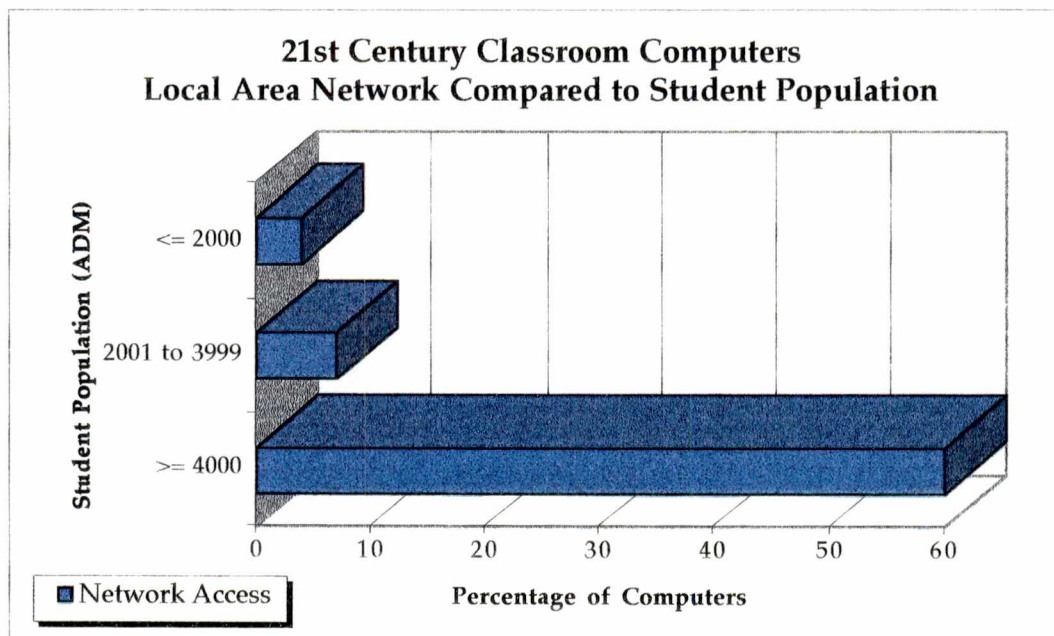


Figure 7: 21st Century Classroom Computers - Local Area Network Compared to Student Population

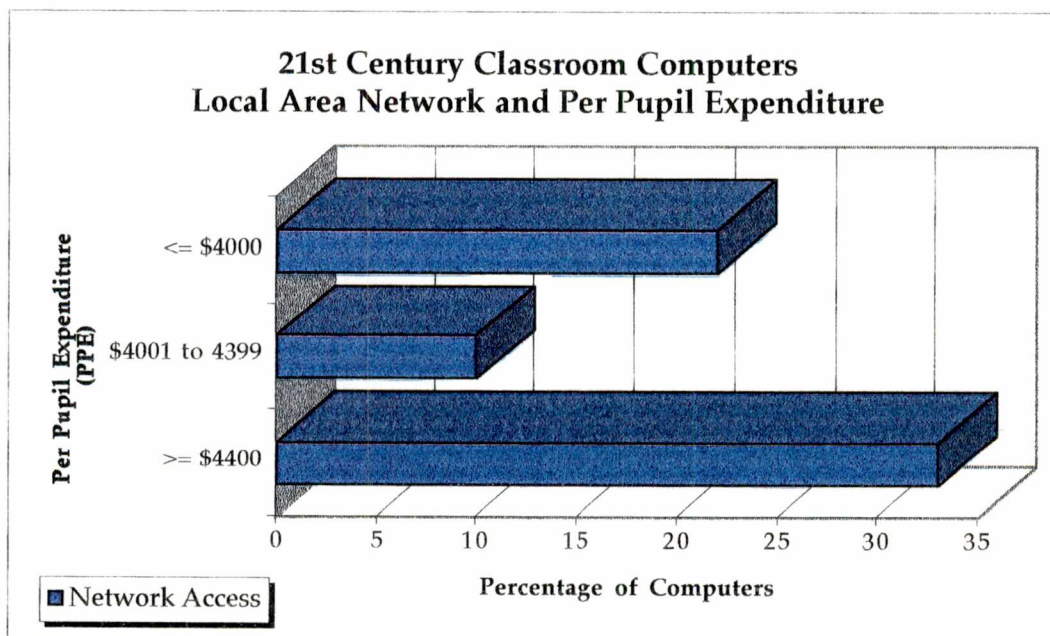


Figure 8: 21st Century Classroom Computers Local Area Network and Per Pupil Expenditure

Connection to Internet

Connection to the Internet in 21st Century Classrooms was reported on 1,462 computers (38%). The quality of the connection was not requested by the survey and therefore no breakdown as to the type of connection (network vs. dial-up modem) was determined. The greatest percentage of Internet connected computers was found in the Third - Eighth grades with 943 of the 1,462 computers (65%) having Internet access (Table 4). More computers had access to the Internet in Region Three (Middle Tennessee) (Figure 9). School systems with a student population over 4,400 had more computers connected to the Internet (Figure 10). The per pupil expenditure of a district did not appear to influence the number of computers with Internet access (Figure 11).

Computers in Other Classrooms (non-21st Century)

The second part of the survey requested information on computers in other classrooms (non- 21st Century Classroom Project). The data from this part were divided into sections by grade level placement. Each section requested the number and type of computer systems installed (Apple II, Macintosh, IBM compatible, and other). The Macintosh and IBM compatible information was divided into central processor unit groups (Macintosh 680x0 to Power Macintosh and Intel 8088 to Intel Pentium). The processor group information was necessary to determine the quality and age of the computer. Multimedia capacity, connection to a Local Area Network (LAN), and connection to the Internet was also asked.

Table 4

21st Century Classroom Computers - Connection to Internet					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade - Twelfth Grade	Total
Macintosh	168	427	244	150	989
IBM Compatible	80	134	138	121	473
Total	248	561	382	271	1462

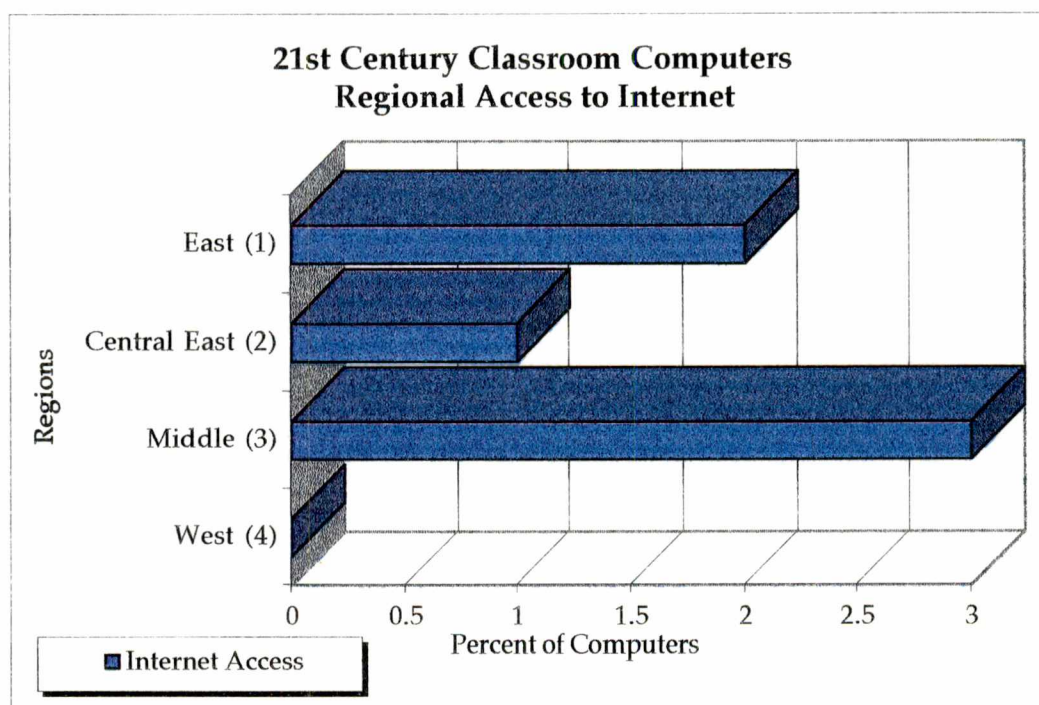


Figure 9: 21st Century Classroom Computers - Regional Access to Internet

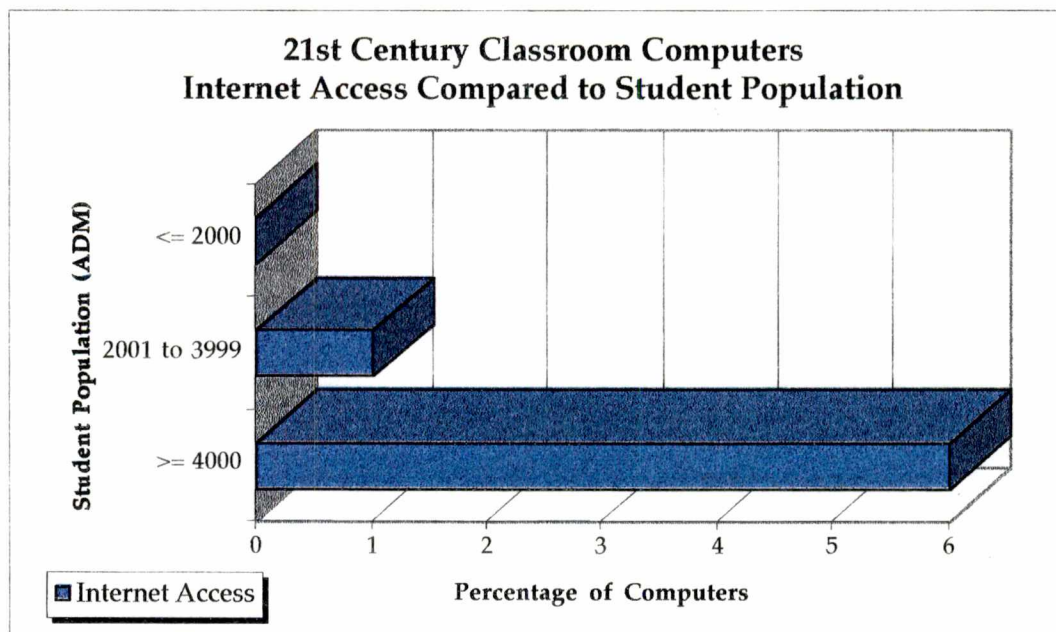


Figure 10: 21st Century Classroom Computers - Internet Access Compared to Student Population

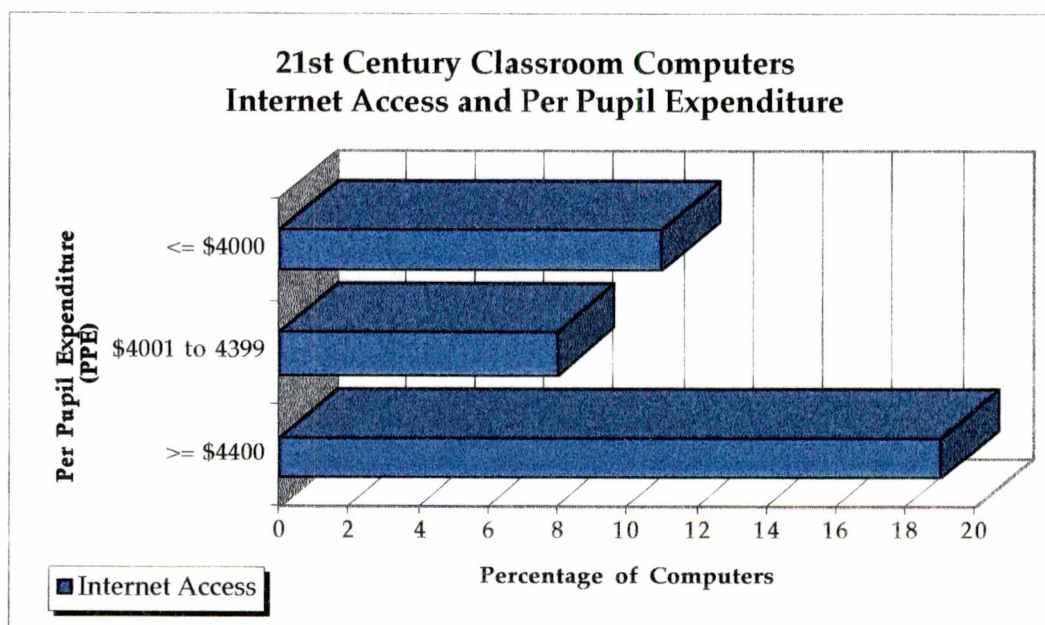


Figure 11: 21st Century Classroom Computers - Local Area Network and Per Pupil Expenditure

The study participants reported 48,867 computers. One school system left this section of the survey blank and responded that a fixed asset inventory for all computer equipment was not available.

Platform (Manufacturer) Information

Of the 48,867 reported computers, 11,617 were Apple II computers (24%), 17,996 Macintosh computers (37%), 18,824 IBM compatible computers (38%), and 430 reported as "other" computers (1%) (Figure 12).

Placement by Grade Level

In the Kindergarten - Second grades, 12,738 computers were reported (28%). Third - Fifth grades reported 11,601 computers (24%). Sixth - Eighth grades reported 10,139 computers (21%). The remaining 13,389 computers were found in the Ninth - Twelfth grades (27%). (Table 5)

Kindergarten - Eighth grades had 10,099 Apple II computers (28%), 13,799 Macintosh computers (39%), and 11,309 IBM compatible computers (32%). Ninth - Twelfth grades had 1,518 Apple II computers (11%), 4,197 Macintosh computers (31%), and 7,515 IBM compatible computers (56%).

Multimedia Ready Computers

Multimedia ready was defined as a computer having a CD-ROM device attached, a color display, and a some type of sound-card (IBM Compatibles only). Apple II computers could have been classified as multimedia ready when the Apple IIGS was considered. School systems that reported Apple II

Table 5

Other Computers - (Non 21st Century Classrooms)					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade- Twelfth Grade	Total
Apple // Family	3946	3525	2628	1518	11617
Macintosh 680020-30	1893	1135	854	850	4732
Macintosh 680040	2555	2567	2326	1934	9382
Power Macintosh	927	805	737	1413	3882
IBM Compatible 8088 - 80286	893	605	705	1432	3635
IBM Compatible 80386	1689	1371	1237	2532	6829
IBM Compatible 80486	1528	1391	1332	2946	7197
Pentium	186	152	220	605	1163
Other	121	50	100	159	430
Total	13738	11601	10139	13389	48867

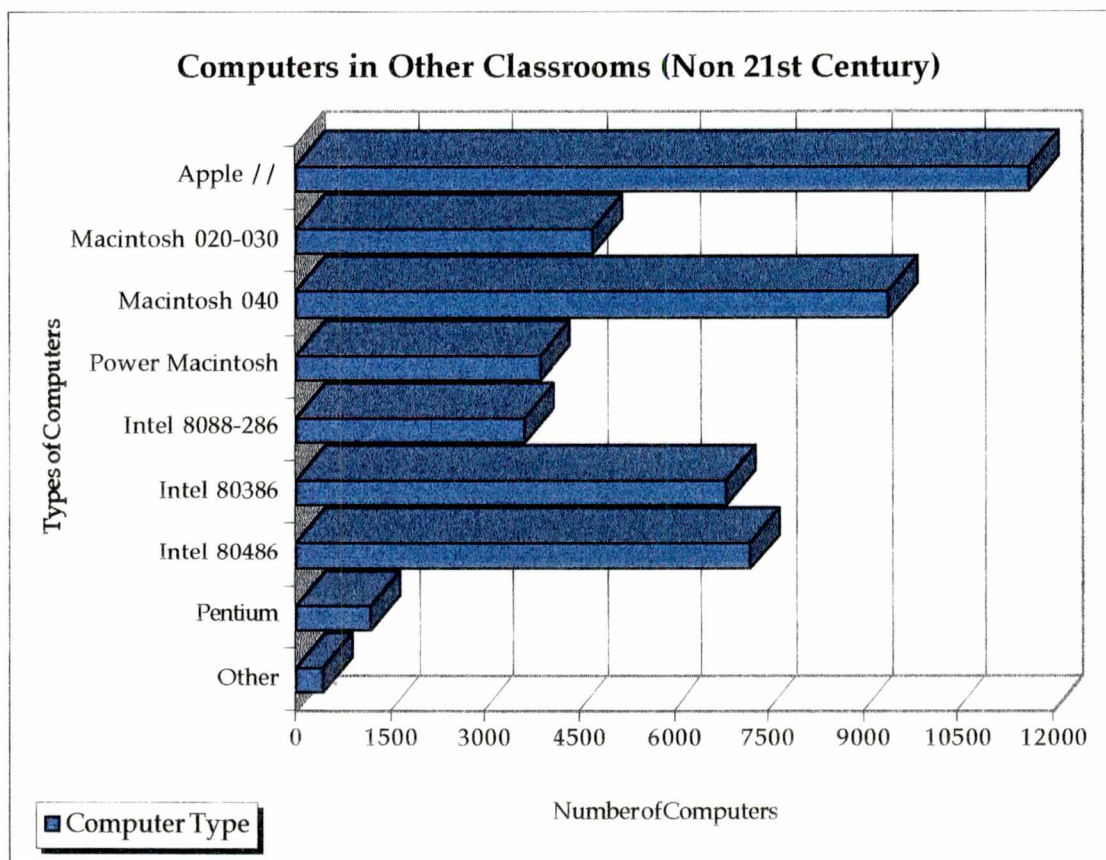


Figure 12: Computers in Other Classrooms (Non 21st Century)

computers as multimedia were contacted and asked to clarify their response. Of the 11,617 Apple II computers reported, 100 were identified as multimedia computers (0.8%). The 17,996 Macintosh computers had 12,533 reported as multimedia computers (70%). Of the 18,824 IBM compatible computers reported, 8,534 were multimedia computers (45%). The 430 computers identified as "other" had 271 reported as multimedia computers (63%). Forty five percent of all computers reported were multimedia computers.

A grade level analysis found 5,567 of the 13,738 computers in Kindergarten - Second grades were multimedia computers (41%). Of the 11,601 computers in Third - Fifth grades, 4,996 were multimedia computers (43%). The 10,139 computers in Sixth - Eighth grades had 4,321 as multimedia computers (43%). Of the 13,389 computers in Ninth - Twelfth grades, 6,554 were multimedia computers (49%) (Table 6).

For a computer to take advantage of current educational software, access to a CD-ROM device, a color monitor, and proper sound playback hardware was necessary. Of the multimedia computers, 100 were Apple II computers (1%), 12,538 Macintosh computers (58%), 8,534 IBM compatible computers (40%), and 271 "other" computers (1%) (Figure 13). The 100 Apple IIGS computers reported met the description test for a multimedia computer by having a color display, sound capability, and access to a CD-ROM drive.

Table 6

MultiMedia Ready - Existing Computers					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade- Twelfth Grade	Total
Apple // Family	100	0	0	0	100
Macintosh 680020-30	600	675	279	179	1733
Macintosh 680040	2146	2206	1775	1365	7492
Power Macintosh	777	653	571	1307	3308
IBM Compatible 8088 - 80286	40	30	150	512	732
IBM Compatible 80386	568	466	366	767	2167
IBM Compatible 80486	1162	819	869	1744	4594
Pentium	153	97	211	580	1041
Other	21	50	100	100	271
Total	5567	4996	4321	6554	21438

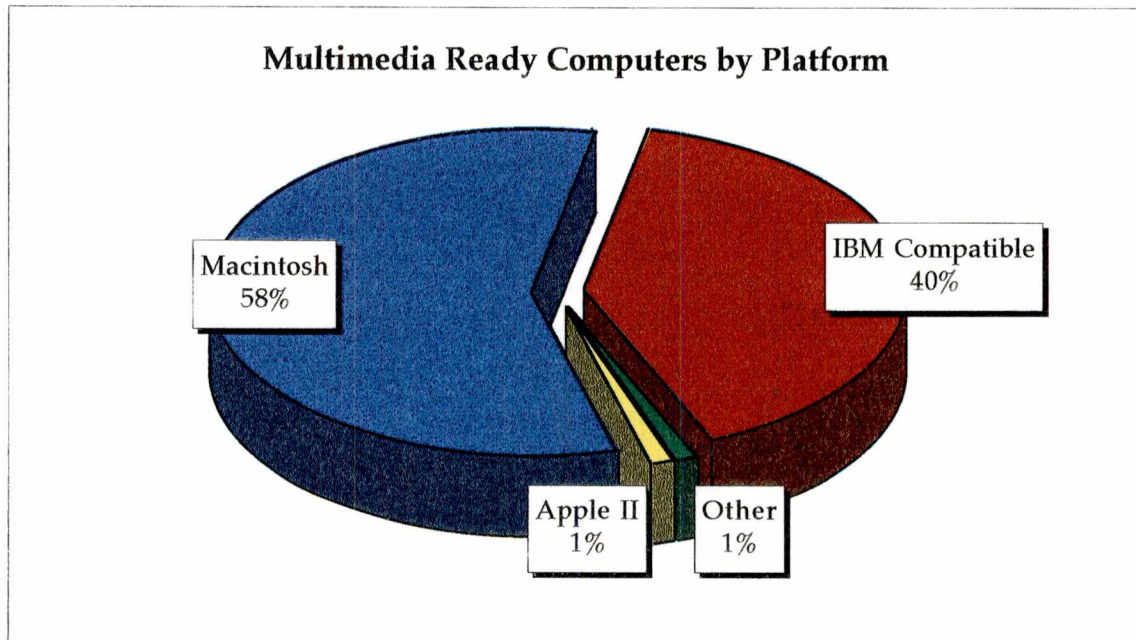


Figure 13: Multimedia Ready Computers by Platform

Connected to Internet

The number of computers with Internet access was low in comparison to other forms of student access. Three school systems reported Apple II computers (250 total) with Internet access. These school systems were contacted and asked to clarify their response. Since Internet access was not defined as being graphical in nature, it was possible for computers in this group to have dial-up text-only access. Of the 48,867 computers reported, 6,814 computers were connected to the Internet (14%). Kindergarten - Eighth grades reported 4,228 computers with Internet access (12%). Ninth - Twelfth grades reported 2,586 computers with Internet access (19%) (Table 7).

Connected to Local-Area-Network

A network was defined as some type of Local-Area-Network (LAN). Printer sharing types of networks were not to be identified as being a LAN. Connection to a local area network was found in 21,104 of the computers (43%). More computers were networked in the upper grades (Sixth - Twelfth grades) than in the lower grades. The largest percentage of networked computers was found in Ninth - Twelfth grades (49%) (Table 8).

Student to Computer Ratios

Student to computer ratios were often used as an indicator of the amount of access time a student could expect to receive. The overall student

Table 7

Local Area Network Access - Existing Computers					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade- Twelfth Grade	Total
Apple // Family	796	935	770	120	2621
Macintosh 680020-30	631	634	262	357	1884
Macintosh 680040	1448	1313	1316	947	5024
Power Macintosh	394	257	274	1015	1940
IBM Compatible 8088 - 80286	225	200	263	738	1426
IBM Compatible 80386	749	690	547	1159	3145
IBM Compatible 80486	782	904	825	1666	4177
Pentium	122	60	104	517	803
Other	0	0	20	64	84
Total	5147	4993	4381	6583	21104

Table 8

Internet Access - Existing Computers					
Platform	Kindergarten - Second Grade	Third Grade - Fifth Grade	Sixth Grade - Eighth Grade	Ninth Grade- Twelfth Grade	Total
Apple // Family	0	250	0	0	250
Macintosh 680020-30	322	516	118	66	1022
Macintosh 680040	542	461	288	481	1772
Power Macintosh	235	154	219	935	1543
IBM Compatible 8088 - 80286	26	60	83	230	399
IBM Compatible 80386	76	78	65	173	392
IBM Compatible 80486	58	215	208	432	913
Pentium	39	39	75	219	372
Other	26	25	50	50	151
Total	1324	1798	1106	2586	6814

to computer ratio for study participants was 9:1. This was derived from 499,007 students having access to 52,716 computers (all computers reported). Subtracting the number of 21st Century Classroom computers from the total number of computers reported increased the ratio to 10:1 (499,007 students and 48,867 computers).

Quality of Student Access

When consideration was given to the quality of the computer (age, processor power, multimedia, type of access) the 9:1 student to computer ratio changed dramatically. Figures 14 through 16 show various ways this access was examined.

Student access to multimedia computers on existing computers was 23:1 (499,007 students and 21,438 computers). Including 21st Century Classroom computers with the existing number of computers lowered the ratio to 20:1. Student access to the Internet was 73:1 on existing computers and decreased to 60:1 when 21st Century Classroom computers connected to the Internet were included. Student access to a local area network (LAN) was 24:1 (499,007 students to 21,104 networked computers) and decreased to 21:1 (499,007 students to 23,861 computers) when 21st Century Classroom computers connected to a LAN were included (Figure 14).

Existing computer systems were classified as "newer" (Macintosh 680040, Power Macintosh, Intel 80486, and Pentium) and "older" (Apple II Family, Macintosh 680020-30, Intel 8088-80286, and Intel 80386). The study

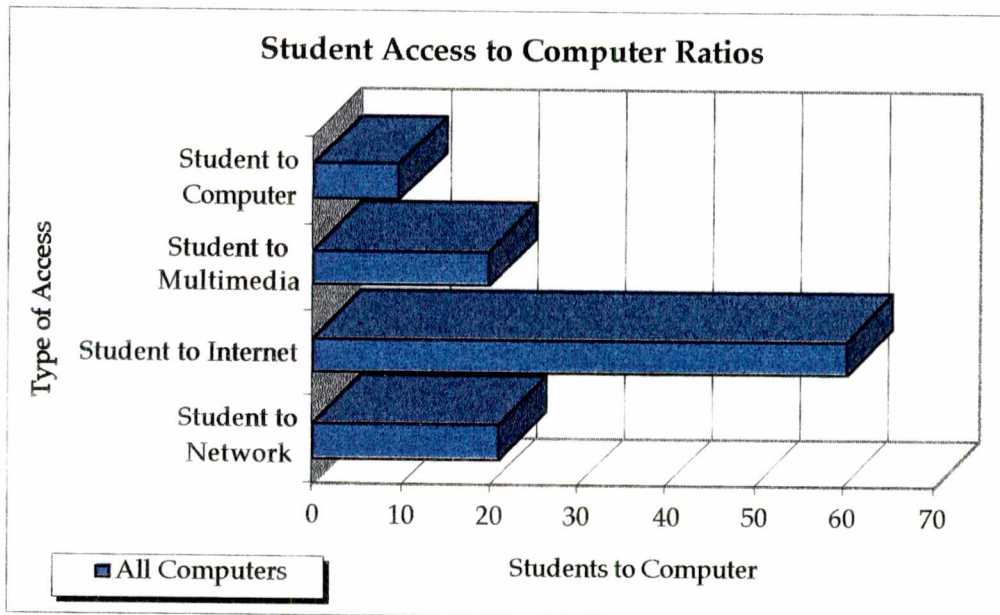


Figure 14: Student Access to Computer Ratios

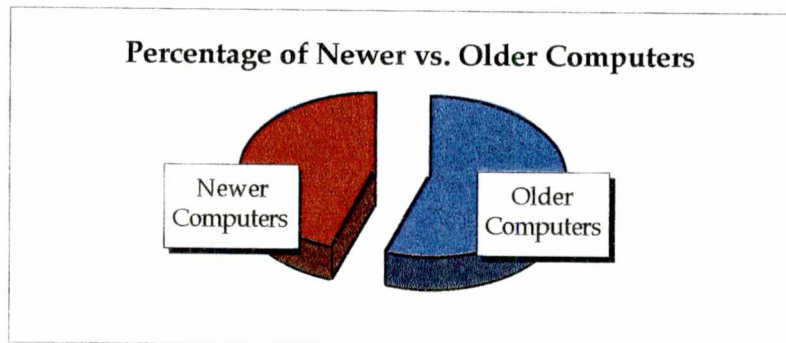


Figure 15: Percentage of Newer vs. Older Computers

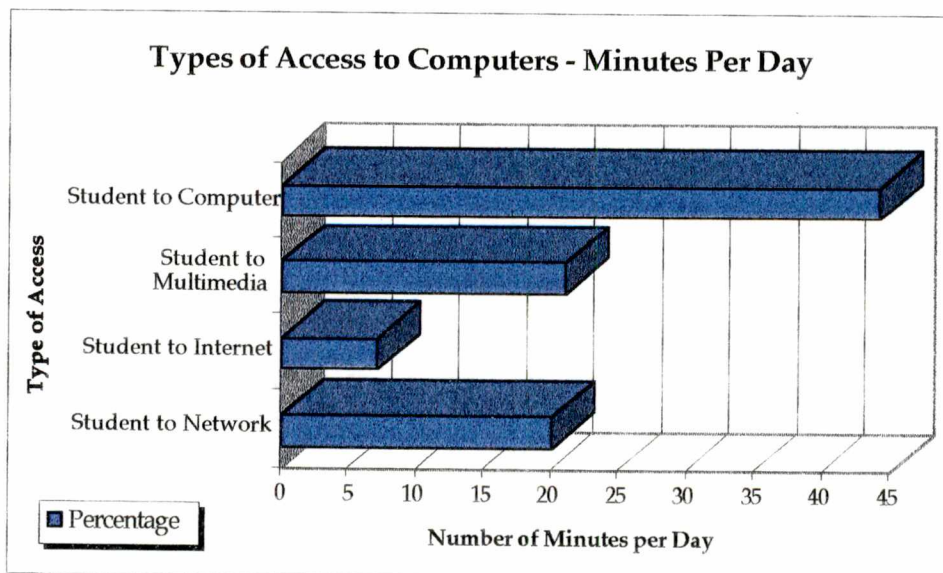


Figure 16: Types of Access to Computers - Minutes Per Day

classified 26,813 computers as older computers and 21,624 as newer computers (Figure 15). The student to computer ratio to older computers was 16:1 and the student to computer ratio to newer computers was 23:1.

Student Access Time

Schools were in session for 180 instructional days and the average school day was comprised of 420 minutes (7 hours per day). The total number of minutes a student would have access to computers was derived by multiplying the amount of time in a school day (420 minutes) by the number of computers and dividing the result by the number of students. Student population and number of computers were collected at the school system level. The number of minutes of computer access time per day calculation was performed on a system level. For example, 420 minutes multiplied by 52,716 computers equaled 22,140,720 minutes of computer time in one day (statewide). That amount was divided by 499,007 students and resulted in 44 minutes of computer time per student per day.

A student had 44 minutes of computer access time per day. Student access to a multimedia computer was 21 minutes per day. Student access to a networked computer was 20 minutes per day and student access to the Internet was 7 minutes a day (Figure 16). The amount of time a student had access to older technology was 22 minutes per day and access to newer technology was 18 minutes per day.

Economic Factors and Student To Computer Ratio

Per Pupil Expenditures of a school district had little statistical effect on the student to computer ratio. System student to computer ratios were calculated for each participating school system and compared to the per pupil expenditures for that school system. A Pearson correlation coefficient of $r=.034$ revealed little statistical significance.

The lack of a strong correlation of student to computer ratio to per pupil expenditure was not unique to this study. The Rand report *Fostering the Use of Educational Technology: Elements of A National Strategy* (Rand, 1995) and the Quality Education Data report *1995-96 Technology Purchasing Forecast* (QED, 1995) had similar findings. The student to computer ratio was compared to the three highest per pupil expenditure school systems and the three lowest per pupil expenditure systems that participated in the study (Figure 17). The findings were similar to a comparison of student to computer ratios of the top three states in per pupil expenditure to the bottom three states in per pupil expenditure (Figure 18). In both examples the per pupil expenditure of a state/school district did not appear to have a significant influence on the student to computer ratio.

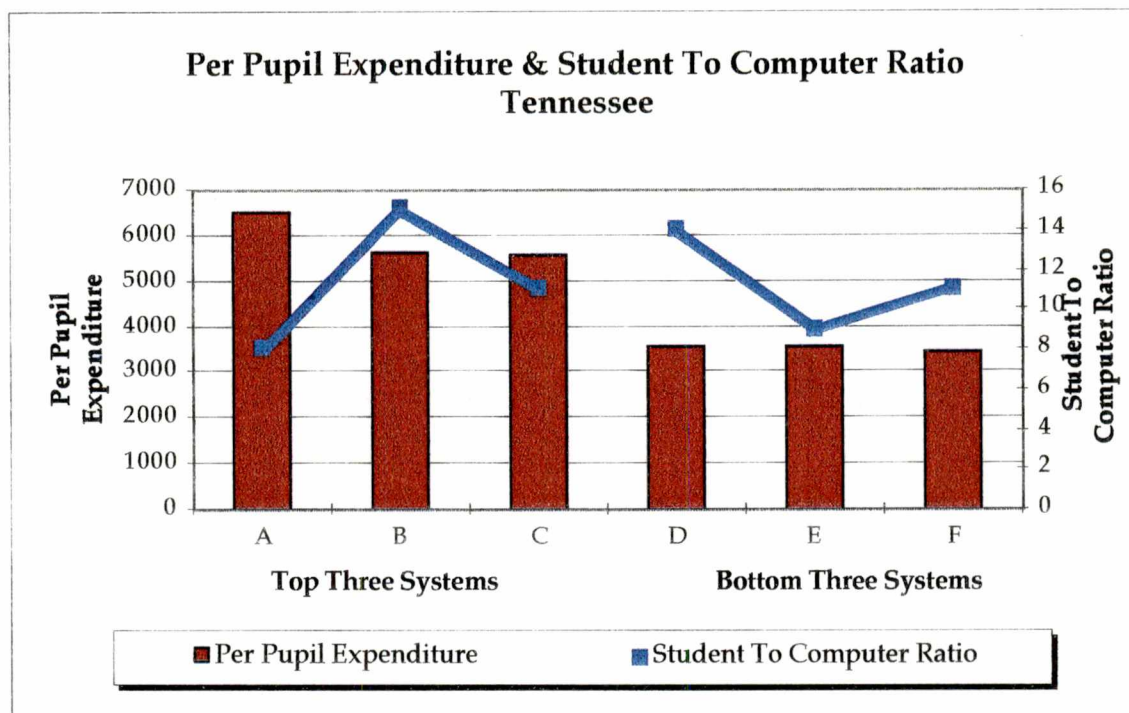


Figure 17: Per Pupil Expenditure & Student to Computer Ratio - Tennessee

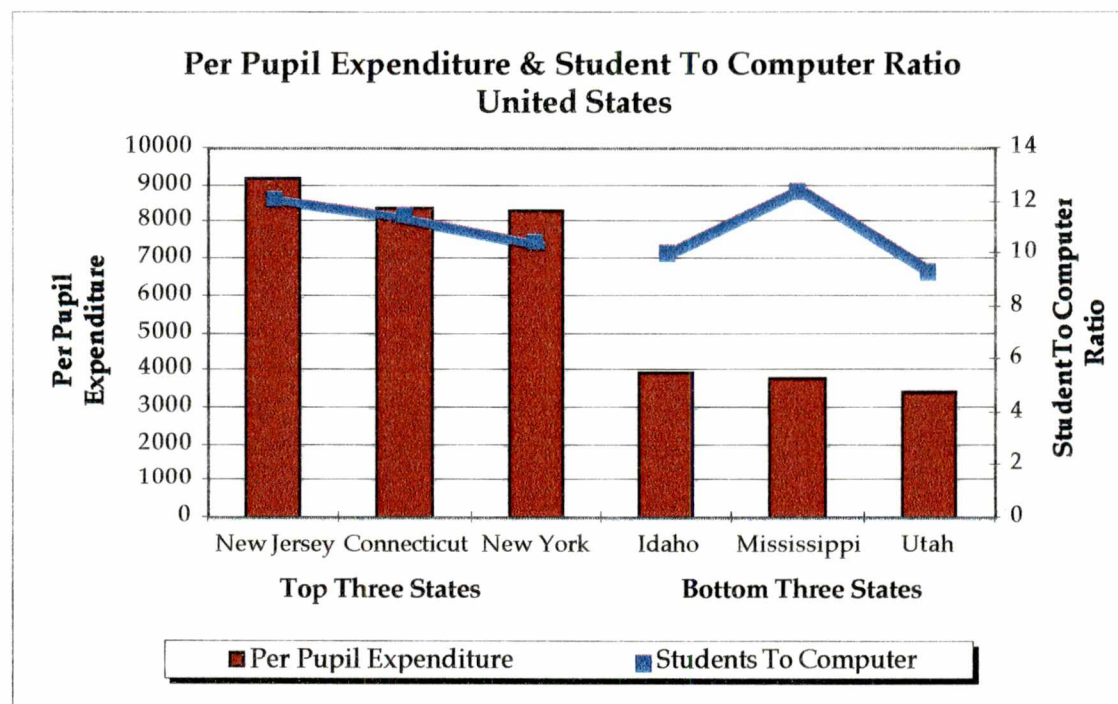


Figure 18: Per Pupil Expenditure & Student To Computer Ratio-United States

Teacher Training and Activities

The third section of the survey collected the percentage of the technology budget used for teacher training and requested a specific listing activities for teacher training. The specific types of activities were requested in the form of an open-ended response question with room to list up to three activities.

The average percent of technology dollars spent on teacher training was 6%. The most frequent amount reported was 5%. The highest reported percentage was 25% of the technology budget (2 systems). Seventeen school systems reported budgeting no money in the technology budget for teacher training. Regional comparisons determined that no particular region spent significantly more on teacher training than any other region (Table 9).

Categories of Low, Medium, and High were created based on the average (6%) plus or minus one standard deviation (3%). More school systems (73%) were low and medium levels of funding (Figure 19).

Regional comparisons of district technology expenditures for teacher training were much the same. Region 2 (East Central) and Region 3 (Middle) had school systems spending the highest percent of the technology budget on teacher training (25%). Region 2 (East Central) reported the highest number of school systems (7 of 22) spending no money from the technology budget

Table 9

Percentage of Technology Budget for Teacher Training by Region				
Percentage of Budget Range	Number of School Systems			
	Region 1 East	Region 2 East Central	Region 3 Middle	Region 4 West
Low ($\leq 3\%$)	6	12	7	8
Medium ($>3\%$ and $<9\%$)	6	6	4	8
High ($\geq 9\%$)	6	4	6	5
Total Systems Reporting	18	22	17	21

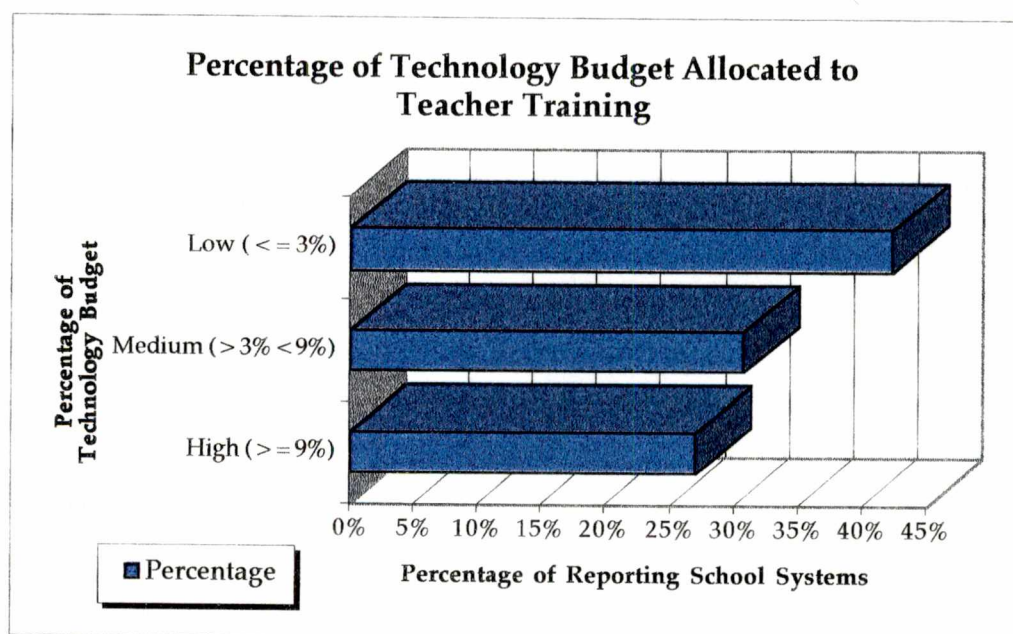


Figure 19: Percentage of Technology Budget Allocated to Teacher Training

for teacher training (Table 10).

Reporting systems identified numerous types of activities used for teacher training. Those reported were organized into similar categories. The most frequent reported activity was local training on specific software packages (33 of 78 systems - 42%). The next highest reported activity was state provided training (26 of 78 systems - 33%). Other activities ranged from computer literacy classes for teachers to vendor provided training (Figure 20). Participants were not asked to specify the location where any of the training took place (Training center, building lab, teacher's classroom, etc.).

Region 1 (East Tennessee) reported more cases of vendor provided training, peer tutoring, and inservice credit work-sessions than the other three regions. Region 3 (Middle Tennessee) provided more full-time staffing dedicated to teacher technology training than other regions. Region 4 (West Tennessee) had more systems that did not offer any type of teacher technology training activities. One school system reported using college courses as a means to accomplish technology training for teachers. Computer literacy classes for teachers were found in one of the reporting districts (Table 11).

Provisions for Maintenance and Replacement of Computers

In the final section of the survey, school systems were asked to report the percentage of the technology budget dedicated to maintenance and repair, the presence of a policy for the replacement and redistribution of existing

Table 10

Percentage of Technology Budget for Teacher Training				
	Percentage of Budget			
Percentages	Region 1 East	Region 2 East Central	Region 3 Middle	Region 4 West
Average Percent of Budget	7	5	6	5
Highest Percent of Budget	25	25	25	20
Lowest Percent of Budget	0	0	0	0
Most Common Percent of Budget	10	0	0	0

Table 11

Teacher Training Activities by Region					
	Number of Respondents				
Type of Activity	Region 1 East	Region 2 East Central	Region 3 Middle	Region 4 West	Total
Local Training (Software applications)	9	10	8	6	33
State training	6	8	7	5	26
None	1	2	1	6	10
Open labs (afterschool and night)	3	2	1	3	9
Other (local seminars, on-site visits, etc.)	0	1	3	3	7
Summer workshops	1	2	1	1	5
Vendor provided training	2	1	1	1	5
Fulltime trainer	1	0	2	1	4
Inservice credit worksessions	2	1	1	0	4
Internet	1	2	1	0	4
Peer tutoring	2	0	0	1	3
Conferences/Workshops	1	1	0	0	2
Beginner classes (literacy only)	0	1	0	0	1
College courses	0	0	0	1	1

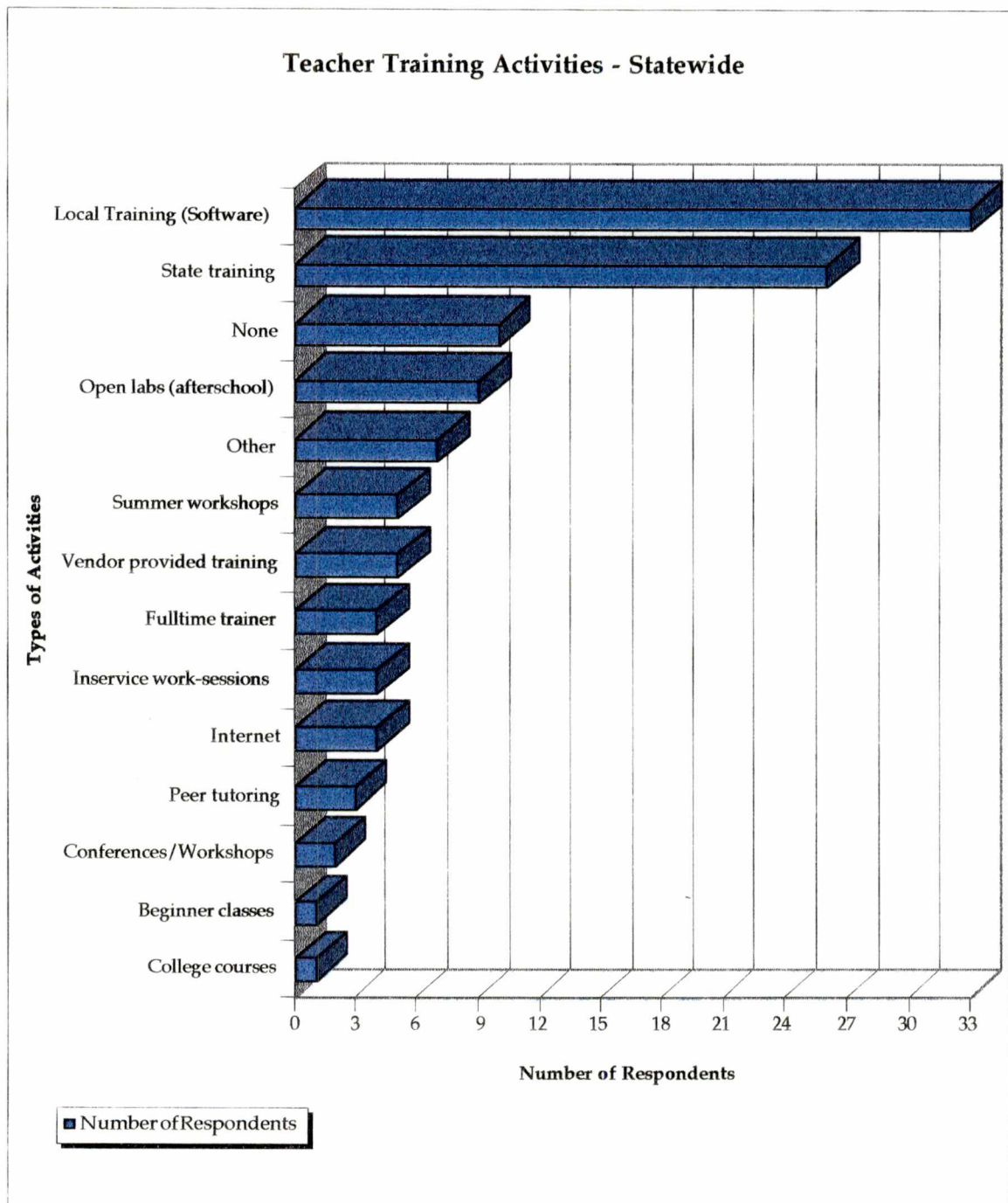


Figure 20: Teacher Training Activities - Statewide

inventory, specific examples of such a policy, and plans for technology growth. The questions on examples of policies and future plans were open-ended questions. The reported responses were organized into similar categories.

The average percentage of the technology budget allocated to repair and replacement was 8%. The most frequent percentage allocated was 5% and the highest reported percentage was 40%. The school district that reported 40% was contacted and verified the percentage reported was accurate. Of the 78 districts that participated in the study, 11 reported no money budgeted for the repair and replacement of computers (14%).

Regional budgeting trends for computer replacement and repair were balanced among regions with Region 4 (West Tennessee) showing the highest percentage allocated (40%). Region 2 (East Central Tennessee), Region 3 (Middle Tennessee), and Region 4 (West Tennessee) had school systems with no money in the technology budget for computer repair and replacement (Table 12).

Twenty four of the reporting school districts (31%) gave examples of policy that was in place for the replacement and redistribution of existing computers. Examples included full-time technicians, the practice of moving older computers to lower grades, maintenance contracts, and manufacturer's

Table 12

Percentage of Technology Budget for Repair and Replacement of Computers				
	Percentage of Technology Budget			
Percentages	Region 1 East	Region 2 East Central	Region 3 Middle	Region 4 West
Average Percent of Budget	8	8	9	8
Highest Percent of Budget	21	30	35	40
Lowest Percent of Budget	1	0	0	0
Most Common Percent of Budget	5	5	10	10

warranties (Table 13).

Of the 24 systems reporting examples of a replacement policy, 18 (75%) had funding in place to enact the policy. Eighteen (23%) of the total number of school systems (78) had a funded policy in place for equipment repair and replacement (Figure 21).

Region 3 (Middle Tennessee) had the highest percentage of school systems with a computer repair and replacement policy in place and Region 4 (West Tennessee) had the fewest number of school systems with a computer repair and replacement policy in place (Figure 22).

The final question on the survey requested information on the plan(s) the school system had for technology growth in the next two to three years. School systems were encouraged to provide multiple responses. Examples of planned activities were organized into similar categories (Table 14).

Table 13

Examples of Computer Repair & Replacement Plans		
Type of Activity	Number of Respondents*	Percentage of Total Responses*
Move older equipment down the grade level chain	4	17%
Repair as needed	4	17%
Manufacturer's warranty only	3	13%
Administrative decision	2	8%
Maintenance contract	2	8%
Part of 5 year technology plan	2	8%
On-staff technician / train teacher's repair basics	2	8%
Replace cpu's every 4 years / servers every 2 years	1	4%
Tech committee recommends / direct proposals	1	4%
Use of school system's reserve fund	1	4%
No repair for existing equipment	1	4%
Vocational labs only (Federal grant money)	1	4%
* Includes multiple responses from school systems		

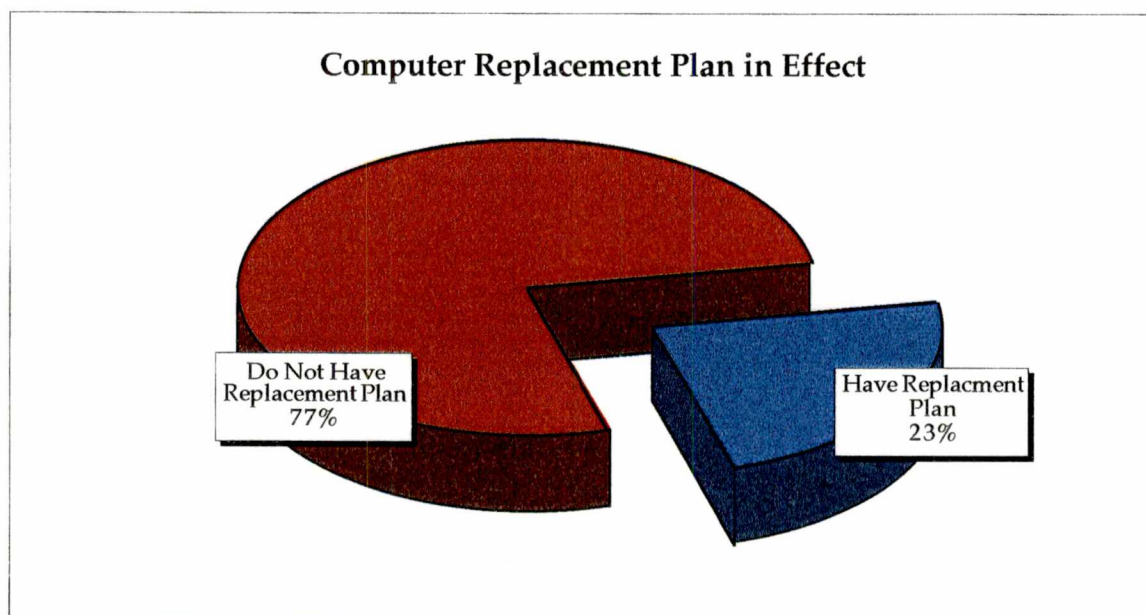


Figure 21: Computer Replacement Plan in Effect

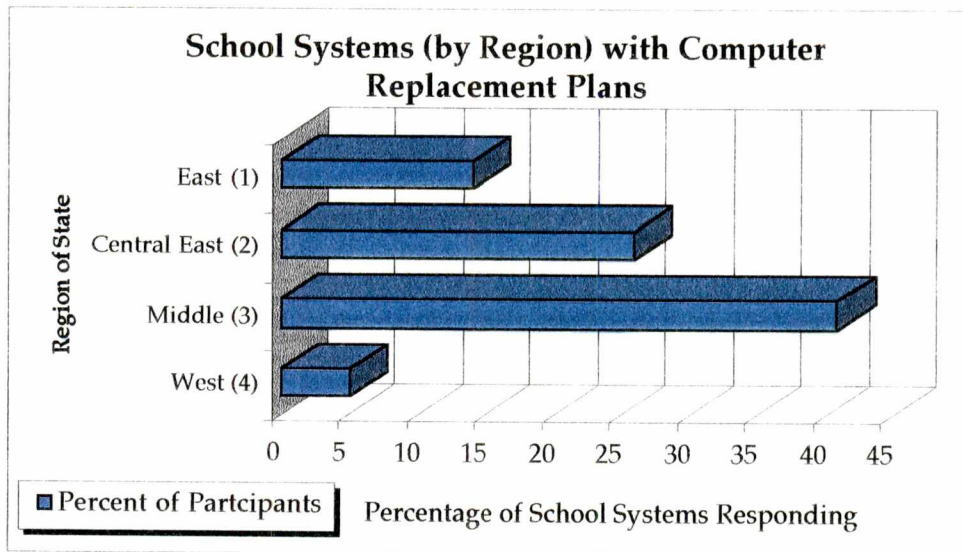


Figure 22: School Systems (by Region) with Computer Replacement Plans

Table 14

Examples of Long Range Plans		
Type of Activity	Respondents*	Total Responses*
Network all schools	24	31%
Internet access to all rooms	15	19%
No plan given	15	19%
Wide area network (create)	15	19%
21st century classrooms	11	14%
Computers for all teachers	10	13%
Computer labs	8	10%
Computers in all classrooms	5	6%
Teacher training programs	5	6%
Purchase new equipment	4	5%
Upgrade and replace equipment	4	5%
Technician (add to staff)	3	4%
Home access for students	2	3%
Trainer (add to staff)	2	3%
Distance education	1	1%
Increase repair funding	1	1%
Laptops for administrators	1	1%
Library automation	1	1%
Revise technology plan	1	1%
Takehome computers for students	1	1%
Technology learning center	1	1%
Universities (training projects)	1	1%

* Includes multiple responses from school systems

The most frequent response was to network all schools within the next three years stated by 31% of the respondents. Other responses included Internet access to all rooms (19%) and creation of Wide-Area-Networks (19%). Fifteen of the respondents (19%) reported no long range plan. Six percent of the systems identified teacher training as a long range plan (Table 15).

More schools in Region 1 (East Tennessee) reported plans to create wide area networks (28%). Region 2 (East Central Tennessee) reported the fewest number of school systems planning to add Internet access to all classrooms (9%). Region 3 (Middle Tennessee) had the greatest number of schools with continuance of the 21st Century Classroom project as a long range plan (29%). Region 4 (West Tennessee) had 33% percent of the schools reporting no long range plan.

Summary

21st Century Classroom Information

Of the 3,905 computers, 2,030 were Macintosh computers (55%) and the remaining 1,875 computers were IBM compatible computers(45%).

A total of 808 computers were placed in the Kindergarten - Second grades (21%) and 1,355 computers were placed in the Third - Fifth grades (35%). A total of 1,003 computers were placed in the Sixth - Eighth grades (26%). The remaining 683 computers were placed in the Ninth - Twelfth grades (18%).

Table 15

Examples of Long Range Plans by Region				
Type of Activity	Region 1 East	Region 2 East Central	Region 3 Middle	Region 4 West
21st century classrooms	2	2	5	2
Computer labs	2	1	3	2
Computers for all teachers	2	4	0	4
Computers in all classrooms	3	1	1	0
Distance education	0	0	1	0
Home access	0	1	1	0
Increase repair funding	1	0	0	0
Internet access to all rooms	4	2	3	6
Laptops for administrators	0	1	0	0
Library automation	0	0	1	0
Network all schools	6	8	4	6
None	4	2	2	0
Purchase new equipment	1	1	1	7
Revise technology plan	0	1	0	0
Takehome computers for students	0	0	0	1
Teacher training	2	1	2	0
Technician	2	1	0	0
Technology learning center	1	0	0	0
Trainer	1	1	0	0
Universities	0	0	1	0
Upgrade and replace equipment	1	2	1	0
Wide area network	5	4	3	3

The Macintosh computer was the most frequent choice in Region One (East Tennessee), Region Three (Middle Tennessee), and Region Four (West Tennessee).

The majority of the 21st Century Classroom computers were self-contained classrooms (67%). Overall, more computers were placed in the Kindergarten - Eighth grades.

Connection to Local-Area-Networks (LANs) was found on 2,757 computers (72%). School systems with a student population over 4,400 had more computers connected to local area networks. The per pupil expenditure of a district did not appear to influence the number of networked computers

Connection to the Internet in 21st Century Classrooms was reported on 1,462 computers (38%). The greatest percentage of Internet connected computers was found in the Third - Eighth grades.

Computers in Other Classrooms (non-21st Century)

Of the 48,867 reported computers, 11,617 were Apple II computers (24%), 17,996 Macintosh computers (37%), 18,824 IBM compatible computers (38%), and 430 "other" computers(1%).

In the Kindergarten - Second grades, 12,738 computers were reported (28%). Third - Fifth grades reported 11,601 computers (24%). Sixth - Eighth grades reported 10,139 computers (21%). The remaining 13,389 computers were found in the Ninth - Twelfth grades (27%).

Kindergarten - Eighth grades had 10099 Apple II computers (28%), 13,799 Macintosh computers (39%), and 11,309 IBM compatible computers (32%). Ninth - Twelfth grades had 1,518 Apple II computers (11%), 4,197 Macintosh computers (31%), and 7,515 IBM compatible computers (56%).

Of the multimedia ready computers, 100 were Apple II computers (1%), 12,538 Macintosh computers (58%), 8,534 IBM compatible computers (40%), and 271 "other" computers (1%). Forty five percent of all computers reported were multimedia computers.

Connection to a local area network was found in 21,104 of the computers (43%). More computers were networked in the upper grades (Sixth - Twelfth grades) than in the lower grades. The largest percentage of networked computers was found in Ninth - Twelfth grades (49%).

The overall student to computer ratio for study participants was 9:1. Subtracting the 21st Century Classroom computers from the total number of computers reported increased the ratio to 10:1.

Student access to multimedia computers on existing computers was 23:1. Including 21st Century Classroom computers with the existing number of computers lowered the ratio to 20:1.

Student access to the Internet was 73:1 on existing computers and decreased to 60:1 when 21st Century Classroom computers connected to the Internet were included.

Student access to a local area network was 24:1 and decreased to 21:1 when 21st Century Classroom computers connected to local area networks were included.

The student to computer ratio to older computers was 16:1 and the student to computer ratio to newer computers was 23:1.

A student had 44 minutes of computer access time per day. Student access to a multimedia computer was 21 minutes per day. Student access to a networked computer was 20 minutes per day and student access to the Internet was 7 minutes a day.

The amount of time a student had access to older computers was 22 minutes per day and access to newer computers was 18 minutes per day.

System student to computer ratios were calculated for each participating school system and compared to the per pupil expenditures for that school system. A Pearson correlation coefficient of $r=.034$ revealed little statistical significance. When states and districts with the highest and lowest per pupil expenditures were compared it was found that the per pupil expenditure of a state or school district did not appear to have a significant influence on the student to computer ratio.

Teacher Training and Activities

The average percent of technology budget dollars spent on teacher training was 6%. The most frequent amount reported was 5%. The highest

reported percentage was 25% of the technology budget (2 systems). Seventeen school systems reported budgeting no money in the technology budget for teacher training. Regional comparisons determined that no particular region spent significantly more on teacher training than any other region.

Numerous type of activities were used for teacher training. The most frequent reported activity was local training on specific software packages (33 of 78 systems - 42%). The next highest reported activity was state provided training (26 of 78 systems - 33%).

Provisions for Maintenance and Replacement of Computers

The average percentage of the technology budget allocated to computer repair and replacement was 8%. The most frequent percentage allocated was 5% and the highest reported percentage was 40%. Of the 78 districts that participated in the study, 14% reported no money in the technology budget for the repair and replacement of computers.

Twenty four of the reporting school districts (31%) gave examples of policy that was in place for the replacement and redistribution of existing computers. Examples included full-time technicians, the practice of moving older computers to lower grades, maintenance contracts, and manufacturer's warranties.

Of the 24 systems reporting examples of replacement policy, 75% had funding in place to enact the policy. Twenty three percent of the total number

of school systems had a funded policy in place for computer repair and replacement.

The most frequent long range plan was to network all schools within the next three years, as stated by 31% respondents. The next most common responses were Internet access to all rooms (19%) and creation of Wide-Area-Networks (19%). Nineteen percent of the respondents reported no long range plan. Six percent of the respondents identified teacher training as a long range plan.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

The presence and utilization of computers has become a fact of American life. Computers and telecommunications networks have had a tremendous influence on how we live, work, learn, and play. New technologies have been essential tools for doing business and were quickly becoming a primary means for people to acquire information. The nation's schools, in recognizing their responsibility to prepare students to live and work in this technological society, had enlisted as resources computers and telecommunication networks.

The purpose of this study was to provide a basis for the formulation of policies and procedures to encourage effective technology utilization in Tennessee Schools. This was accomplished by determining the type and quality of instructional technology equipment in use, the placement of that equipment in the school, the connectivity of that equipment, the status of technology training for teachers, and the provisions for the scheduled repair and replacement of technology inventories.

Summary of the Literature

A review of the literature revealed the quality and placement of

computers in schools, the connectivity of classroom computers, the provisions for the training of teachers to use technology and, examples of policy and funding practices for the repair and replacement of computers.

Quality and Placement of Computers in Schools

The number of computers had increased each year in schools. It was estimated 6.3 million computers had been installed. The student to computer ratio ranged from 7.3:1 to 8.1:1. Most computers were placed at the high school level and found in computer labs.

Older computers not capable of running current educational software were found in 30% of the schools. The computer platforms most found in schools were Apple Computer (Apple II and Macintosh) 54.3% and IBM Compatible 44.3%.

The percentage of schools with access to CD-ROM drives had increased each year with 93% of all schools having such access. An average of 52 computers per school were multimedia ready. District per pupil expenditure did not appear to have a strong effect on the student to computer ratio.

Connectivity of Classroom Computers

Local Area Networks (LANs) were more commonly found in secondary schools. The number of computers connected to local area networks had increased each year. Sixty five percent of all computers were connected to some type of local area network.

Seventy percent of all schools had Internet access. Thirteen states had 90% or more schools with Internet access. Tennessee was ranked sixth nationwide with 99% of the schools connected to the Internet.

On-going Instructional Technology Staff Development Programs

Expenditures for educational technology indicated far more resources had been allocated to hardware and software than to teacher training or technical support. An average of 8% of the school system technology budget was for teacher training (programs and staff salaries). Statewide studies reported a range of 6% of a local school system technology budget to 40% of a statewide technology budget for teacher training.

Identified training activities included basic literacy classes, self-paced video instruction, instruction in telecommunication programs, and the modeling of classroom implementation techniques. Ready access to equipment was a precondition for teacher training .

Critical factors that affected technology usage and adoption among teachers were having a vision and plan for using technology to meet instructional and professional goals, and evaluation and assessment policies that encouraged technology use.

Policy and Funding for the Maintenance and Replacement of Computers

The total percentage of the technology budget for the repair and replacement of computer equipment in national studies was an average of

10%. Statewide studies found an average of 8% of the technology budgets for repair and maintenance

Effective technology plans that guided the selection and use of equipment were found to be critical. Research suggested that a school system have a clear sense of its technology needs and a strategy for addressing the issue of donated equipment.

Three key areas for managing technology resources were the establishment of a district level set of standards for computer purchases, the creation of a fixed asset inventory that included specifics (Type of processor, amount of RAM, type of network card, etc.), and the development of a plan for the retirement of an inventory item.

A time table or equipment life cycle chart to project the useable life of a computer was reported as a fundamental requirement of any technology plan. An estimate for planning the cost of technology and it's support components was \$200 per student or 3% of the national per pupil expenditure.

Summary of the Procedures

The descriptive data required for this study were collected using the survey method. A questionnaire was sent to technology coordinators representing the 139 county and special school districts in the State of Tennessee.

Of the 79 returned surveys (58%), 19 were returned as electronic mail documents (24%) and the remaining 60 were returned as traditional mail documents (76%). Of the 60 remaining technology coordinators, 51 responded they were unable to participate (34%). The primary reason identified by this group was that they did not have the data to complete the second section of the survey (Computers in Non-21st Century Classrooms).

The respondents were a representative sample of the population. Equal distributions were found in the areas of school size based on average daily membership, school spending as measured by per pupil expenditure, and geographic location as measured by equal distribution in four regions of the state.

Summary of the Findings

The study examined these factors: the placement (grade level and/or Curricular content area) of 21st Century Classroom computers; the quality of existing classroom technology inventory (as determined by processor type and multimedia configuration); the networking of classroom computer systems to local area networks; the availability of Internet access for classroom instruction; the presence of on-going staff development programs in the area of instructional technology; the presence of policy and funding for the maintenance and replacement of existing classroom technology inventories, and; the long range plans that school systems in Tennessee are developing.

Placement of 21st Century Classroom Computers

Of the 3,905 computers, 2,030 were Macintosh computers (55%) and the remaining 1,875 computers were IBM compatible computers(45%). A total of 808 computers were placed in the Kindergarten - Second grades (21%) and 1,355 computers were placed in the Third - Fifth grades (35%). A total of 1,003 computers were placed in the Sixth - Eighth grades (26%). The remaining 683 computers were placed in the Ninth - Twelfth grades (18%).

The majority of the 21st Century Classroom computers were self-contained classrooms (67%). Overall, more computers were placed in the Kindergarten - Eighth grades.

Connection to Local-Area-Networks (LANs) was found on 2,757 computers (72%). School systems with a student population over 4,400 had more computers connected to local area networks. The per pupil expenditure of a district did not appear to influence the number of networked computers

Connection to the Internet in 21st Century Classrooms was reported on 1,462 computers (38%). The greatest percentage of Internet connected computers was found in the Third - Eighth grades.

Quality of Existing Classroom Computers

Of the 48,867 reported computers, 11,617 were Apple II computers (24%), 17,996 Macintosh computers (37%), 18,824 IBM compatible computers (38%), and 430 "other" computers(1%). Kindergarten - Eighth grades had

10099 Apple II computers (28%), 13,799 Macintosh computers (39%), and 11,309 IBM compatible computers (32%). Ninth - Twelfth grades had 1,518 Apple II computers (11%), 4,197 Macintosh computers (31%), and 7,515 IBM compatible computers (56%).

Of the multimedia ready computers, 100 were Apple II computers (1%), 12,538 Macintosh computers (58%), 8,534 IBM compatible computers (40%), and 271 "other" computers (1%). Forty five percent of all computers reported were multimedia computers.

Quality of All Computers Reported (21st Century Classrooms and Existing)

The overall student to computer ratio for study participants was 9:1. Subtracting the 21st Century Classroom computers from the total number of computers reported increased the ratio to 10:1. Student access to multimedia computers was 23:1. Including 21st Century Classroom computers with the existing number of computers lowered the ratio to 20:1. Student access to the Internet was 73:1 on existing computers and decreased to 60:1 when 21st Century Classroom computers connected to the Internet were included. Student access to a local area network was 24:1 and decreased to 21:1 when 21st Century Classroom computers connected to local area networks were included. The student to computer ratio to older computers was 16:1 and the student to computer ratio to newer computers was 23:1.

Per pupil expenditures for a school system did not appear to influence student to computer ratios. When districts with the highest and lowest per

pupil expenditures were compared it was found that the student to computer ratios were the same or different by a factor of two.

Connection of Classroom Computers to Local Area Networks

Connection to a local area network was found in 21,104 of the computers (43%). More computers were networked in the upper grades (Sixth - Twelfth grades) than in the lower grades. The largest percentage of networked computers was found in Ninth - Twelfth grades (49%).

Availability of Internet Access for Classroom Instruction

Of the 48,867 computers reported, 6,814 computers were connected to the Internet (14%). Kindergarten - Eighth grades reported 4,228 computers with Internet access (12%). Ninth - Twelfth Grades reported 2,586 computers with Internet access (19%).

On-going Instructional Technology Staff Development Programs

The average percent of technology budget dollars spent on teacher training was 6%. Seventeen school systems reported no money in the technology budget for teacher training.

The most frequent reported activity was local training on specific software packages (33 of 78 systems - 42%). The next highest reported activity was state provided training (26 of 78 systems - 33%).

Policy and Funding for the Maintenance and Replacement of Computers

The average percentage of the technology budget allocated to computer repair and replacement was 8%. Fourteen percent of the districts reported no money in the technology budget for the repair and replacement of computers.

Twenty four of the reporting school districts (31%) gave examples of policy that was in place for the replacement and redistribution of existing computers. Examples included full-time technicians, the practice of moving older computers to lower grades, maintenance contracts, and manufacturer's warranties. Twenty three percent of the total number of school systems had a funded policy in place for computer repair and replacement.

Long Range Plans in Tennessee School Systems

The most frequent long range plan was to network all schools, as stated by 31% respondents. The next most common responses were Internet access to all rooms (19%) and the creation of Wide-Area-Networks (19%). Six percent of the respondents identified teacher training as a long range plan. Nineteen percent of the respondents reported no long range plan.

Recommendations

Quality of Student Access

A limited access to newer more powerful computers, multimedia computers, the Internet, and local-area-networks existed. Technology plans should be created and/or revised to insure that future purchases of computers meet minimum standards. Current grade level placement of computers should be examined for equity (age of computer, multimedia capacity, and connectivity) and corrected by way of goals and time lines stated in a technology plan.

Connectivity

School systems should add local area networks to all classrooms in order to access both shared network services and the Internet. Such a project would be beneficial in the effort to increase the quality of existing inventories. The demand that graphical Internet access places on computers and the fact that older computers are not capable of such access will require attention.

After the collection of data for this study, the State of Tennessee made provisions for the connection of all schools to the Internet by way of some type of high speed network connection (Connect TEN Project). Local school systems should expand access to the Internet to all classrooms by way of upgrading existing computers and installing local area networks.

Teacher Training

A greater commitment to budget money and time for the effective training of teachers is needed. School systems should establish a vision and plan for using technology to meet instructional and professional goals, and evaluation and assessment policies that encourage technology use.

Adjustments to current spending practices on teacher training, the development of detailed plans for the training of teachers, the utilization of the talents of existing teachers, ready access to technology for teachers, and the active involvement of teachers in technology planning is needed.

Tennessee schools have done a good job of placing computers in the hands of students and teachers. Additional effort is necessary to insure that adequate training programs are instituted and funded so that teachers are comfortable in the classroom use of computers and technology.

Maintenance and Replacement of Equipment

School districts should allocate both money and personnel to computer repair and technical support. Technology plans should be established that guide the selection and use of equipment. Such plans should include the establishment of a district level set of standards for computer purchases and the development of a plan for the retirement of an inventory item. Operational computers and on-going technology support are critical to the effective classroom use of technology.

Creation of Usable Inventory

School districts should not only count the number of computers they have in schools, they should collect specific information about each computer system (Type of processor, amount of RAM, type of network card, etc.). From this document, forecasting for replacement, estimating the cost of hardware and software upgrades, and analysis of the current status of computers in classrooms could be determined.

Creation of a Policy for Reassignment of Computers

Careful consideration should be given to the reassignment of older computers in a school system. The practice of moving older computers from one grade level to another should be examined. A time table or equipment life cycle chart to project the useable life of a computer and the possible instructional usage of older computers should be created. Such movement without a life cycle chart and stated instructional use is not recommended.

Creation of a Policy for Computer Donations

A school system should have a clear sense of its technology needs and a strategy for addressing the issue of donated equipment. The creation of district level standards for computer purchases, equipment life cycle charts, and published instructional usage for older computers would help in dealing with donated computers. The absence of such a plan could result in a school system ending up with computers that cannot effectively be used and add to

the existing burden of repair. The acceptance of donated equipment that does not fit established needs should be discouraged.

Future Research

A study of this type should be repeated on an annual basis. The rapid changes that are taking place in the area of technology in schools create the need for current data.

A study that investigates the instructional use of the computers and networks (local area networks and the Internet) would be beneficial. An examination of how computers and connectivity are used for classroom instruction in Tennessee schools is needed.

The study of administrative uses of computers in Tennessee schools would be beneficial in creating a total picture of educational technology usage and computer placement practices in a school system.

Intensive examination of the area of teacher training and support in educational technology is needed. A study of successful policies and programs for instructional technology support in Tennessee schools would be beneficial to other school systems as well as higher education agencies.

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APPENDIXES

APPENDIX A

Sample of Electronic Mail Cover Letter

Attention Tennessee Technology Coordinators

Greetings,

Within the next few days I will e-mail to you a survey. The purpose of the survey will be to create a descriptive study of the current access to educational technology in Tennessee schools. As technology coordinator of your school system, you will be asked to provide data that relates to the current number and types of instructional computer systems you have in place.

This survey is for a doctoral dissertation in Instructional Technology at The University of Tennessee. Your completion and return of the questionnaire constitutes consent to participate in the study

Your participation is very important as well as the accuracy of the data you report.

The survey instrument will have four major sections as described below:

Section One will request information on 21st Century Classrooms. You will need to report the number of units, platform chosen, grade level/ subject area placed, how many units are connected to a Local-area-network and how many units are connected to the Internet. [For the purpose of this study, printer sharing devices are NOT considered local-area-networks.]

Section Two will request similar information on all OTHER instructional computer systems in the school system. Specific processor information will be requested [Intel 80286, 386, etc. Mac 030, 040, etc.] as well as the number of units that are multimedia ready [CD-ROM, color display, sound-card, etc.], connected to networks, and with access to the Internet. Placement information [grade level / subject area] will also be requested.

Section Three will request the percentage of the local technology budget for teacher training in instructional technology and what types of programs you are currently providing.

Section Four will request the percentage of the total technology budget that is classified for the repair and replacement of existing instructional technologies inventories and if a local policy for the replacement of existing inventories of instructional technology exists.

Once the study is completed, the findings will be made available to you to download for your use. If you have any questions, please feel free to contact me at my e-mail address [belvinl@ten-nash.ten.k12.tn.us]

Thank you,

D. Lynnwood Belvin,
Technology Coordinator-Tullahoma City Schools
Graduate Researcher - University of Tennessee

APPENDIX B

Sample of Electronic Mail Questionnaire

Survey of Tennessee Technology Coordinators

This survey will, with your valued help, collect data that will be reported back in such a form that may be of value to you and your local school organization.

This survey is for a doctoral dissertation in Instructional Technology at The University of Tennessee. Your completion and return of the questionnaire constitutes consent to participate in the study

The numbers you provide will be only as composite data. The school system number you provide will be used only for classification purposes. Due to the nature of electronic data networks, confidentiality can not be assured.

The procedure to complete this electronic document is:

[E-mail] Upon receipt of this mail, at the MAIL> prompt, type the following:
MAIL> forward
at the TO: prompt type the following:
TO: belvinl
hit return to pass by the CC: prompt [if applicable] and
Subject: line prompt...
This will provide a copy of this document that you can then type your responses in. Upon completion of your responses, send the mail to me.
<CTRL>-Z
*exit

[PINE mail] Upon receipt and reading this mail, enter the command R for reply...
Answer the "Include copy" prompt with Y for yes.
This will provide a copy of this document that you can then type your responses in... upon completion of your responses, send the mail to me.
<CTRL>-X send? Y

Thank you for your help!

Lynnwood Belvin
Technology Coordinator - Tullahoma City Schools

-----Technology Coordinator Survey -----

School System Number:

////////////////////////////////////
 / SECTION I - 21ST CENTURY CLASSROOM INFORMATION ONLY! /
 / [ALL YEARS OF PROJECT] /
 //////////////////////////////////

+++++
 + Placement by Grade Level - 21st Century Classrooms +
 +++++

Computer Platform (Type)	Grade Level (K-2)	(3-5)	(6-8)	(9-12)
Macintosh				
IBM Comp.				

--- PLEASE USE NUMBERS ONLY ---

+++++
 + Placement by Curricular Area - 21st Century Classrooms +
 +++++

Computer Platform (Type)	Math	Science	Language Arts	Social Studies	Other Areas	Self Contained
Macintosh						
IBM Comp.						

--- PLEASE USE NUMBERS ONLY ---

+++++
 + Connected To Network (LAN) - 21st Century Classrooms +
 +++++

Computer Platform (Type)	Grade Level (K-2)	(3-5)	(6-8)	(9-12)
Macintosh				
IBM Comp.				

--- PLEASE USE NUMBERS ONLY ---

+++++
+ Connected To Internet (Direct or Modem)-21st Century Classrooms +
+++++

Computer Platform (Type)	Grade Level (K-2)	(3-5)	(6-8)	(9-12)
--------------------------	-------------------	-------	-------	--------

Macintosh
IBM Comp.

--- PLEASE USE NUMBERS ONLY ---

/////////
/ SECTION II - COMPUTERS IN OTHER CLASSROOMS (non-21st Century) /
/ [Do NOT include administrative computer systems] /
/////////

+++++
+ ELEMENTARY SCHOOLS (GRADES K-2) - NON 21ST CENTURY +
+++++

Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (#)
--------------------------	--------------	----------------------	---------------------	---------------

Apple II Family
Mac.[68000-20]
Mac. [68030-40]
Mac. [PowerPC]
IBM Comp.[8088-286]
IBM Comp.[80386]
IBM Comp.[80486]
IBM Comp.[Pentium]
Other

--- PLEASE USE NUMBERS ONLY ---

+++++
+ ELEMENTARY SCHOOLS (GRADES 3-5) - NON 21ST CENTURY +
+++++

Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (#)
--------------------------	--------------	----------------------	---------------------	---------------

Apple II Family
Mac.[68000-20]
Mac. [68030-40]
Mac. [PowerPC]
IBM Comp.[8088-286]
IBM Comp.[80386]
IBM Comp.[80486]
IBM Comp.[Pentium]
Other

--- PLEASE USE NUMBERS ONLY ---

+++++
+ MIDDLE SCHOOLS (GRADES 6-8) - NON 21ST CENTURY +
+++++

Computer Platform (type)	Total Number	Multimedia Ready(#)	Internet Access(#)	Networked (#)

Apple II Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

--- PLEASE USE NUMBERS ONLY ---

+++++
+ HIGH SCHOOLS (GRADES 9-12) - NON 21ST CENTURY +
+++++

Computer Platform (type)	Total Number	Multimedia Ready(#)	Internet Access(#)	Networked (#)

Apple II Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

--- PLEASE USE NUMBERS ONLY ---

////////////////////////////////////
/ SECTION III - LOCAL CLASSROOM HARDWARE FUNDING INFORMATION /
////////////////////////////////////

What is the percentage of local technology budget for the training
of teachers in the use technology for instruction?

Percentage only:

What are the types of programs currently being utilized for teacher
training in the use of technology for instruction?

- 1.
- 2.
- 3.
- etc.

////////////////////////////////////
/ SECTION IV - PROVISIONS FOR MAINTENANCE AND REPLACEMENT /
////////////////////////////////////

What percentage of the total technology budget is classified for the repair and replacement of existing instructional technology inventories?

Percentage only:

What type(s) of local policy exist for the replacement and/or redistribution of existing instructional technology inventories?
List brief examples:

- 1.
 - 2.
 - 3.
- etc.

Does funding exist to enact the above examples

Yes or No:

What plans do you have for the near future (2-3 years) for technology growth in your district?
List brief examples:

- 1.
 - 2.
 - 3.
- etc.

End of Survey - THANK YOU

APPENDIX C

Sample of Mailed Cover Letter and Survey

Survey of Tennessee Technology Coordinators

The purpose of the survey is to create a descriptive study of the current access to educational technology in Tennessee schools. Your participation in this study is very important as well as the accuracy of the data you report.

This survey is for a doctoral dissertation in Instructional Technology at The University of Tennessee - Knoxville. Your completion and return of this questionnaire constitutes consent to participate in the study. The numbers and other data you provide will be reported as composite data only. The state school system number is for classification purposes only.

The survey has four main sections as described below:

Section One is specific to the 21st Century Classroom Project. For the purpose of this study, printer sharing devices are NOT considered Local-Area-Networks

Section Two is specific to all OTHER instructional computer systems in your school system. Multimedia ready is defined as having a CD-ROM device attached, a color display, and sound-card (non-Macintosh). Printer sharing devices are not considered Local-Area-Networks for this section either.

Section Three is specific to efforts in teacher training in the areas of usage of technology for classroom instruction.

Section Four is specific to local policy and funding for the repair and replacement of existing instructional technology inventories.

The final results of this study will be made available to you as an electronic document (Adobe Acrobat file). The accuracy of the picture this study creates regarding the advancements made in Tennessee's classrooms is dependent on your active participation.

If you have questions regarding the study, you may contact me as follows:

D. Lynnwood Belvin, Technology Coordinator
Tullahoma City Schools
510 South Jackson Street
Tullahoma, TN 37388
email: belvinl@ten-nash.ten.k12.tn.us
Phone: 615-454-2652

Survey of Tennessee Technology Coordinators

State School System Number:

Section 1 - 21st Century Classroom Information Only

All Years of Project

Placement by Grade Level 21st Century Classrooms only

Computer Platform (type)	Grade Level			
	K-2	3-5	6-8	9-12
Macintosh				
IBM compatible				

Please use numbers only

Placement by Curricular Area 21st Century Classrooms only

Computer Platform (type)	Curricular Area					
	Math	Science	Language Arts	Social Studies	Other Areas	Self Contained
Macintosh						
IBM compatible						

Please use numbers only

Connected to Network (LAN) 21st Century Classrooms only

Computer Platform (type)	Grade Level			
	K-2	3-5	6-8	9-12
Macintosh				
IBM compatible				

Please use numbers only

Connected to Internet (direct or modem) 21st Century Classrooms only

Computer Platform (type)	Grade Level			
	K-2	3-5	6-8	9-12
Macintosh				
IBM compatible				

Please use numbers only

Section 2 - Computers in Other Classrooms (non-21st Century)

Do NOT include administrative computer systems

Elementary Schools (Grades K-2) - Non-21st Century				
Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (number)
Apple // Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

Please use numbers only

Elementary Schools (Grades 3-5) - Non-21st Century				
Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (number)
Apple // Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

Please use numbers only

Middle Schools (Grades 6-8) - Non-21st Century				
Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (number)
Apple // Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

Please use numbers only

High Schools (Grades 9-12) - Non-21st Century				
Computer Platform (type)	Total Number	Multimedia Ready (#)	Internet Access (#)	Networked (number)
Apple // Family				
Mac. [68000-20]				
Mac. [68030-40]				
Mac. [PowerPC]				
IBM Comp. [8088-286]				
IBM Comp. [80386]				
IBM Comp. [80486]				
IBM Comp. [Pentium]				
Other				

Please use numbers only

Section 3 - Teacher Training Information

What is the percentage of the local technology budget for the training of teachers in the use of technology for instruction?

Percentage only:

What are the types of programs currently being utilized for teacher training in the use of technology for instruction?

1. _____
2. _____
3. _____
- etc. _____

Section 4 - Provisions for Maintenance and Replacement

What percentage of the total technology budget is classified for the repair and replacement of existing instructional technology inventories?

Percentage only:

What type(s) of local policy exist for the replacement and/or redistribution of existing instructional technology inventories? (brief examples)

1. _____
2. _____
3. _____
- etc. _____

Does funding exist to enact the above examples?

Yes or No

What plans do you have for the near future (2-3 years) for technology growth in your district? (brief examples)

1. _____
2. _____
3. _____
- etc. _____

End of Survey

VITA

Donald Lynnwood Belvin was born in Chattanooga, Tennessee, on June 3, 1953. He attended elementary school and high school in Manchester, Tennessee. He received the Bachelor of Science degree in Music Education from Tennessee Technological University in 1975 and the Master of Arts degree in Educational Administration and Supervision from Tennessee Technological University in 1976.

He taught band, music, and computer science for the Tullahoma City School system from 1976 to 1992. During that period of time he also served as an adjunct faculty member at Motlow State Community College. He entered the doctoral program at The University of Tennessee, Knoxville in June of 1993 and served as a graduate assistant in the Curriculum Lab. Duties there included teaching graduate and undergraduate courses, teacher training workshops, and multimedia development for various research projects. He returned to the Tullahoma City School system in the Fall of 1994 as Technology Coordinator. He currently serves as Director of Instructional Technology for Tullahoma City Schools.

He has presented papers and workshops at regional, state, national and international conferences. He served on the Board of Directors of the Tennessee Educational Technology Association for four years and recently served as Vice-Chairman of the Board. He served as President of the Middle Tennessee Technology Coordinators Association from 1996 to 1997.