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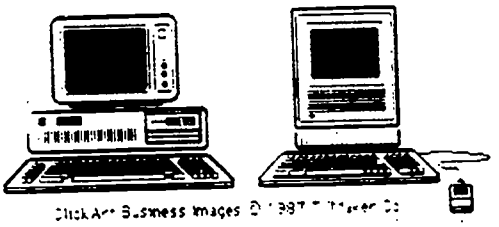
ABSTRACT

Technology is a powerful and important support tool for restructuring the school's teaching and learning environment. This document examines the rate of historical acquisition, level of access, and degree of use of technology within New York State public schools. The number of microcomputers in the schools has more than doubled in the past 8 years, to more than 214,000. The state's ratio of microcomputers to students is 12.2 to 1 overall. To reach the goal of the State Education Department's long-range plan, a ratio of approximately 5 to 1 will be necessary. Most of the computers in New York schools are older models that are not capable of running the most powerful, user-engaging applications. Capital funds are needed to ensure up-to-date technology for the state's students. At present New York schools rank well behind leading states in terms of the number of technology resources. There are many cutting-edge applications of educational technology in New York, but there are also many inequalities in the access and use of technology relative to the minority status of students. Two graphs and seven tables present information on computer use in New York schools. (SLD)

Technology In New York State Public Schools

What Schools Have and How They are Using It



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Technology in New York State Public Schools

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ABSTRACT

Technolcgy is a powerful and important support tool for restructuring the school's teaching and learning environment. This document examines the rate of historical acquisition, level of access and degree of use of technology within New York State Public schools.

There are four major points which the data in this report highlight.

- Technology acquisition, access and use has continued to grow over the past 8 years.
- A large percentage of the existing hardware base is rapidly becoming obsolete.
- New York State is losing its leadership position in a number of technology access and use categories.
- There are serious inequalities in the level of technology access and use in our schools.

Why is Technology Important?

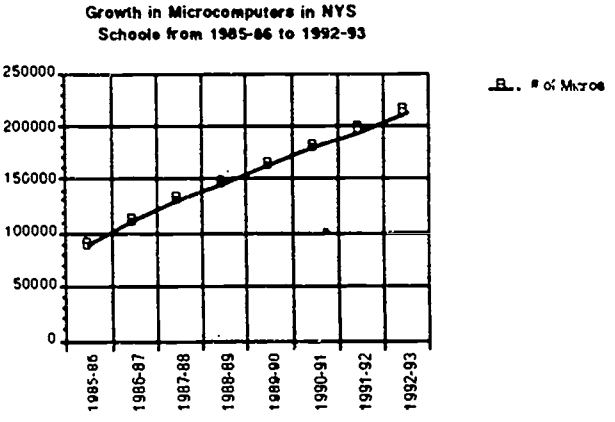
The responsibility of schools is to prepare today's students for life in the 21st century. All students who graduate from our schools must be prepared to access, analyze, apply and communicate information effectively so that they can be successful, contributing members of the changing, information-based, global society in which we are now living. If the workforce of tomorrow is to be internationally competitive, our future citizenry must be able to function with technological literacy in this information society that is evolving. Students, as adults, will be part of an ubiquitous electronic learning environment in which they must be proficient. Workers will be expected to be continual, "life-long learners", particularly through technology-based systems.

Clearly then, technology is important for our schools and our students. Our society has come to expect that students will use technology. Consistent with this expectation, the US. Department of Labor has identified two essential workplace competencies related to technology. The first is the use of information and the second is the ability to use technology tools. Technology can also significantly increase student learning, enhance the teaching process, and improve the management of schools. Technology tools clearly can empower learners and increase the amount of active, collaborative learning.

Schools must take advantage of technology to develop technology skills, to support teaching and learning, and to improve the management of programs. To be truly successful, schools must offer the training and support necessary for teachers to integrate these technology tools into day-to-day instruction. To take advantage of technology's power requires access at the point of learning.

What kind of access to computers do our students have?

The first graph (Graph 1) shows the growth in the total number of microcomputers in public schools over the past 8 years (1985-86 school year to 1992-93 school year). As shown, the number of microcomputers has more than doubled (89,136 to 214,074) during the 8 year period.



Graph 1

What is the distribution of computers and other technology across schools?

The following table (Table 1) shows the number and percentage of schools which have at least

one or more of a particular technology resource. As described below, total microcomputers are divided into two groups, old and new. The old group reflects first generation, low powered machines, while the new group reflects more powerful computers with graphical interfaces.

The two sub-categories of "Old Micros" and "New Micros" under the total statewide count of microcomputers reflects the number of microcomputers that fall into two broad classes of machines--those which are first and second generation computers (the old technology), and the newer, more recently acquired workstations (the new). This distinction is made because it is only the newer computers which have the capability to support evolving multimedia software, and it is only those machines which can typically be networked easily for high capacity access to other resources such as CD-ROM's and wide area telecommunications links such as those to the Internet.

Table 1
Technology Resources in K-12 Public Schools (N=3,906)

	# of Schools	% of Schools
Microcomputers	**********	**********
Old	3,796	97%
New	3,176	81%
Any	3,895	99%
Laser Printers	1,990	51%
CD-ROM's	1,545	40%
VCR's	3,709	95%
TV's	3,860	99%
Cable TV	2,802	72%
Public TV	3,371	86%
Satellite	101	3%
Distance Learning	400	10%

The actual statewide counts of technology resources and the ratio of students to each resource is presented in Table 2. Only those technology resources that make sense on a per student basis are included in Table 1.

What is the ratio of students to technology resources in our schools?

Building level access to certain technology resources such as public television, cable TV and satellite are reflected in the prior chart because they are a shared building resource, not an individual student resource. Table 2 presents the actual count of technology resources and the ratio of students to resource. Note that the count of physical books in the school libraries is provided in this chart as a point of reference. The ratios are based on the 2,615,852 public school students in New York State during the 1992-93 school year.

Table 2
Technology Resources in Schools
Count and Ratio of Students to Resource

RESOURCE	STATEWIDE COUNT	RATIO OF STUDENTS
Microcomputers	**********	**********
Old	131,446	19.9 TO 1
New	56,049	46.7 TO 1
Total	214,074	12.2 TO 1
Laser Printers	4,774	547.9 TO 1
CD-ROM's	2,919	896.1 TO 1
VCR's	28,088	93.1 TO 1
TV's	42,516	61.5 TO 1
Books	42,248,995	1 TO 16.2

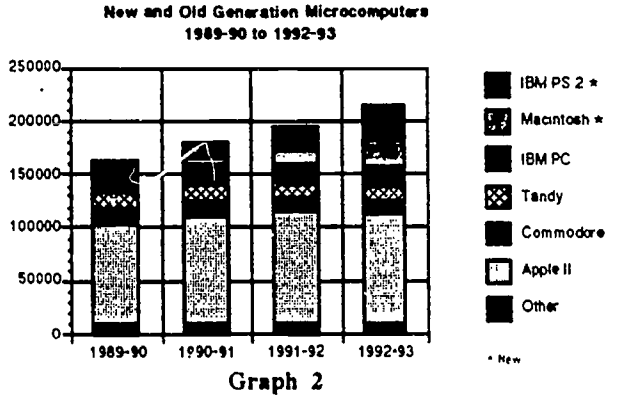
This ratio of 12.2 to 1 for all microcomputers is a significant improvement over the 24:1 ratio which was reflected in the 1985-86 school year. The Department's *Long Range Plan for Technology in Elementary and Secondary Education* recommends an optimum level of 4-6 computers in each classroom. This would mean a ratio of approximately 5 students to 1 microcomputer. Without additional resources, the present trend of acquisition shown in the Graph 1 suggests it will take approximately 6 more years to arrive at this student to computer ratio of 5:1.

In terms of other technology resources which can either be shared electronically via local area networks (e.g. laser printers or CD-ROM's) or can be utilized in small and large groups (e.g. TV's, VCR's and videodisks), the ideal and practical ratio is clearly greater than 1:1.

How many "newer" type computers are available to our students?

Graph 2 displays the distribution of specific types of "old" and "new" microcomputers over the past four year period--the only time period for which comparable data exist. As discussed in the prior analysis, new microcomputers included IBM PS/2 and Macintosh, while old microcomputers included the remainder, with Apple II and Commodore comprising the major portion of the "old" category. The most current year of data displayed in this graph (1992-93) indicates that there were 56,049 new microcomputers (IBM PS/2's and Macintoshes) and 131,446 old microcomputers. The "other" category was not classified into either "new" or "old" computers. Thus in terms of the total number of microcomputers in the State (214,074) only 26% of those machines were new technology.

The critical point to be made from this data is that the majority of microcomputers used by students are not capable of running the most powerful, user-engaging applications. These graphical, interactive, multimedia applications require fast processors, high amounts of memory and extensive disk storage--something the "old" machines, and in fact some of those classified as "new" cannot deliver. This is not to say that these older machines are not of any value. They do, however, reflect an aging technological resource that will increasingly be unable to run the newer software applications which commercial vendors are producing. Given the rapidly aging computers in schools, and given the 5-6 year cycle to double the number of computers in schools (assuming present linear growth trends), it would take approximately 12 years to replace all the old hardware in schools and move toward a more ideal ratio of 5 students to one computer. During this 12 year period, technology evolution will not stand still. Unless sufficient capital funds are available to shorten this cycle to the point where all hardware is replaced every 5-6 years, few students will have access to the most current technologies in schools.



Graph 2

How do New York State schools compare with other schools across the nation in terms of access to technology resources?

A recent article in *Electronic Learning* (October, 1993) provided state-by-state technology data collected by Market Data Retrieval, or MDR (a commercial information service). The statistics in this article a part of a large report which presents a comparative perspective on technology access across the nation. Though not all the categories of technological resources examined at the national level match up with data we collect at the state level data through the Basic Educational Data System (BEDS), there are some interesting reference points.

The next table (Table 3) presents MDR data from this same *Electronic Learning* article showing the percentage of districts nationally that had various technologies in 1992-93.

Table 3

Technology Resources Nationally Available At District Level

TECHNOLOGY RESOURCE	% OF DISTRICTS NATIONALLY WITH RESOURCE
Local Area Networks (LAN's)	68%
Integrated Learning Systems (ILS)	30%
CD-ROM	73%
Video Disk	54%
Modems	74%
Satellite	50%
Cable TV	78%

Source Market Data Retrieval--Electronic Learning. October 1993

Table 4 also presents data from Market Data Retrieval, but the unit of analysis is the school building rather than the district. This table displays the percentage of all buildings with each resource nationally, the percentage of New York State buildings with the resource, and the ranking of New York State relative to the other states and the District of Columbia in terms of

the percentage of buildings with each technology resource. The last two columns of this second table show the lowest percentage of each resource in a state and the highest percentage. Because there is a higher percentage of districts than school buildings nationally with a particular set of technology resources, the figures in the first table of national statistics (district level) are higher for each resource than the second table (building level).

Based on these figures, New York State schools appear to lag behind the national percentage, and are ranked considerably back from the leading technology states in terms of a number of technology resources.

Table 4

Technology Resources Across Nation Including New York State Ranking

TECHNOLOGY RESOURCE	% Buildings in Nation	% Buildings in NYS	NYS Ranking	Lowest- Highest % States
Local Area Networks (LAN's)	49%	48%	26	12%-89%
Integrated Learning Systems (ILS)	20%	17%	25	2%-61%
CD-ROM	43%	52%	14	17%-76%
Video Disk	39%	45%	17	6%-100%
Modems	63%	66%	20	24%-100%
Satellite	17%	3%	47	0%-97%
Cable TV	76%	52%	48	42%-100%

Source Market Data Retrieval--Electronic Learning, October, 1993

How do New York State schools compare with other schools across the nation on planning for technology?

One Market Data Retrieval (MDR) statistic at the national level which we can compare with a New York State statistic is the percentage of districts which have a technology plan. MDR indicates that there are 64% of the districts in the nation which have a technology plan, and 67% of the schools. Data collected by the Education Department in June of 1993 indicated that 75% of New York State districts have read the Department's *Long Range Plan for Technology*, and 76% of those who have read it are implementing the plan in their district. That would mean that 57% of the districts are implementing the State's *Plan*. In addition, 73.4% of the districts indicated that they have some sort of district level technology plan, and 52.9% of the district respondents who had read the *Long Range Plan* noted that they had developed school building-level technology plans. Like the comparative data on technology resources in schools, New York State districts and buildings are slightly behind the nation in terms of technology planning. It is important to note that technology planning, as part of an overall district and building level restructuring process, is an important prerequisite to successful technology use.

How are computers implemented in schools?

The same New York State Education Department (SED) survey of districts (June 1993) indicated that 33% of the districts had implemented an integrated learning system (ILS). This compares with the MDR figure of 30% nationally. School building level data are not available from the Department. In the same SED survey, 94.9% of the respondents indicated they use computer labs for instruction, and 67.4% of these indicated that all (100%) of their buildings were equipped with computer labs.

The Long Range Plan for Technology argued for the inclusion of computers in the classroom, and data from the June survey show that 41.3% of the districts statewide provided teachers with access to

telecommunications and network services **within** the classroom. When asked about student access to telecommunications and network services **within** the classroom, 41.2% of the districts indicated that they provided this access.

The Department's Office of Elementary, Middle and Secondary Education has negotiated over $17.5 million of technology partnerships with corporations such as Apple Computer, IBM, Microsoft and NYNEX. These partnerships have helped to establish technology rich learning environments and to substantially expand student and teacher access to computers. There are 91 districts participating in partnerships, encompassing 146 schools. These technology partnership sites cover the entire State, and include 25 rural schools, 79 urban schools and 42 suburban schools. The technology partnerships established with Apple Computer and IBM, for example, have implemented building-wide networks with 4-6 workstations in every classroom, multimedia capability, and access to the outside world through a connection to the wide area network. These technology-rich environments reflect practical implementations of the "Vision of the Future" for technology defined in *The Long Range Plan for Technology*. A key aspect of this vision is the availability of computers and other technology tools in the classroom where students "work." Clearly the majority of schools have not yet implemented technology widely in their classrooms.

To what extent are teachers trained in the use of technology?

With respect to the percentage of teachers in the district that had been trained in the use of computer software tools for use within an instructional program, 59.7% of New York State districts indicated that they had teachers trained with nearly half the districts indicating that 50 or fewer teachers in each district had been trained. It is likely that a large portion of these teachers were trained through the Model Schools Program staff development model. Model Schools Program training is offered through BOCES and some Teacher Centers. Because of the critical importance of staff development in the successful use of technology, additional data need to be collected on the nature and extent of teacher training taking place. With respect to the source of a wide variety of instructional technology services (including, but not limited to Model Schools), 75.1% of districts indicated that BOCES provides some instructional technology service to their district.

How much are computers and television used in the classroom?

The actual use of technology in the classroom can vary a great deal depending on the level of access in the school, how the teacher and the school perceive the role of technology in the teaching learning process, and the level of training teachers receive in the technology use. The annual Basic Education Data Systems (BEDS) survey asks about the use of computers and television. The most recent summary results (1992-93) indicate that 2,615,852 public school students (69.4%) use computers regularly. This reflects a slight increase from 68.4% of students using computers in 1990-91. There were 78,915 teachers (47%) who were using computers during the 1992-93 school year. In terms of non-computer resources, statewide survey data from 1992-93 indicate that 48% of public school teachers use television in the classroom regularly or occasionally.

Note that regular computer use is defined as direct interaction with a computer as part of a planned sequence of instructional activities, regular television use is defined as viewing 75% of a series in a classroom, and occasional use is defined as viewing a program once a month or at least ten programs per year.

How much are networks used?

The use of networking by teachers as a means to access information resources and to enhance communications between teachers and students is a relatively new phenomenon, compared with other technology such as the television and computers. Schools which have local area networks (LAN's) have the opportunity not only to share printers and other resources such as CD-ROM's, but also to network with each other within the building. Local area networks also can provide all network workstations with a link to other networks outside the school building. Wide area networking links via modems and other communications connections widen the potential for communications, and allow both teachers and students to access information resources and expertise (people) across the district, the state, the nation, and the world. Information is not available to determine how frequently LAN's are used for these purposes. The Apple and IBM partnership sites which provide multiple workstations in each classroom, with local area network links between all computers, and connections to wide area networks such as Technology Network Ties and the Internet model this vision of connectivity flowing from the classroom to the building to the wide area network. As such, these sites, exhibit substantially greater network activity, and have become pioneers in the use of network technology for instruction.

Although over 2,200 school buildings are linked to Technology Network Ties (TNT), the major focus of use up until recently has been on management

applications. The statewide survey of districts (June, 1993) provided information about the instructional use of the Technology Network Ties (TNT) network in schools. In that survey 5.4% of districts indicated that they had students using the TNT network for electronic mail and 12.3% indicated they had teachers using the network for electronic mail. When asked about student and teacher use of TNT for BITNET mail and listservers, 1.4% of the districts indicated they had students involved and 4% of the districts indicated they had teachers involved. In terms of Internet access via TNT, 4.8% of the districts indicate they have students using the Internet and 8% of the districts indicated they have teachers using the Internet. The actual numbers of students and teachers using these TNT network services vary a great deal from district to district.

In addition to Internet connections via the TNT--NYSERNet connection, some schools have established their own direct connections to the Internet through NYSERNet. The most recent listing of NYSERNet affiliates (October, 1993) shows the following K-12 School sites with dedicated connections to the Internet:

Bronx High School of Science
Erie I BOCES
Livingston-Steuben-Wyoming BOCES
New York City Board of Education
Onondaga-Cortland-Madison BOCES
Putnam-Northern Westchester BOCES
Ralph Bunche School (New York City)
Stuyvesant High School (New York City)

Since both the Erie I BOCES and the Onondaga BOCES sites are part of an expanded TNT network pilot, that leaves only 6 of these school sites with full, dedicated access to the Internet (via NYSERNet). In addition to these sites, NYSERNet reports that 44 K-12 sites have dial access to Internet services. The number of direct connections or dial links to the Internet may increase over the next year as the TNT Internet service is expanded and as new service providers such as America On-Line, Prodigy, MCI, Sprint and others start to offer full Internet access to schools, as well as individuals. It should also be noted that teachers and students may gain access to Internet resources through the many NYSERNet connections in universities and libraries. Systematically tracking the connections and use of the Internet is not possible, given the many means of access outside the school setting.

One of the most rapidly growing classroom applications of networking is the Internet. The Internet is a diffused, network of networks which is becoming as important to K-12 educators as it has been for researchers and individuals in higher education. While it is impossible to track network usage on the Internet, a comparative indicator of use has recently become available through the National Aeronautics and Space Administration (NASA). NASA provides one of the most widely known and utilized Internet resources for schools, known as NASA SpaceLink. NASA keeps a count, by state of the K-12 individuals who have accessed SpaceLink during the past 90 days. The November, 1993 SpaceLink report provides the following count for the top ten K-12 subscriptions, by state. As Table 5 shows, New York was 7th in terms of use, with the top state, California, having over 150% more use. In lieu of more detailed statistics, this count of SpaceLink subscribers probably provides one of the best relative indicators of the network use by teachers in the state because of the excellent resources available and the widespread publicity on the service itself. This table also provides a good point of comparison of New York State teachers with those around the country.

Table 5

NASA SpaceLink Subscribers
November 1993

State Level Subscribers	Number of K-12 Users
California	2,062
Texas	1,880
Michigan	1,382
Florida	1,197
Ohio	1,051
Virginia	913
New York	887
Alabama	819
Illinois	790
Pennsylvania	691

While it is difficult to track specific users and application use within the Internet, there is no question that the demand for Internet services, and other network resources, is increasing astronomically, based on network traffic studies. Over time, better measures will have to be identified for tracking K-12 demand and usage of these network resources and services.

How equitable is access to the technology in our schools?

Examining the ratio of students to total microcomputers in a school, based on the percentage of

minority students in a school, we find a range from 10.3 students per computer in the lowest minority percentage buildings (0-20% minority) to a high of 17.2 students per computer in the highest percentage minority buildings (81-100% minority). Clearly these differences point out significant inequities in the level of access that students have to technology. The following table (Table 6) illustrates the disparity between low and high minority schools in the State, and provides additional detail on the specific resource disparity.

Table 6

Relationship of % Minority and Computer Access

Percent Minority	Ratio of Students to Old Micros	Ratio of Students to New Micros	Ratio of Students to CD-ROM's	Percent of Students Using Computer	Percent of Teachers Using Computer
0-20%	16.1 to 1	40.0 to 1	686 to 1	76.2%	58.6%
21-40%	19.4 to 1	44.4 to 1	952 to 1	75.7%	52.5%
41-60%	22.2 to 1	49.4 to 1	1052 to 1	68.3%	43.1%
61-80%	25.8 to 1	43.1 to 1	959 to 1	68.8%	42.3%
81-100%	30.3 to 1	70.2 to 1	1715 to 1	57.0%	25.6%

It appears that across the State there are significant differences between the lowest minority and the highest minority schools relative to all technology resources. The highest minority schools have significantly fewer computers and particularly fewer new computers that are capable of running the most sophisticated software than do schools with low percentages of minority students. The highest minority schools also have fewer CD-ROM's, an important peripheral devise for accessing information resources. In addition, both student and teacher use of computers is significantly lower, due in part to the more limited access and the more obsolete hardware.

Table 7 presents the student to resource ratio of non-computer technology resources such as television and videocassette machines (VCR's), and clearly shows significant differences in the levels of access and use between low and high minority schools. Even in the case of cable television, which should be provided at no cost in the majority of service areas, high minority schools have a much lower percentage of access. Inequities extend to non-technology resources such as books, as illustrated Table 7.

Table 7

Relationship of % Minority and Technology Access

Percent Minority	Students to VCR's	Students to TV's	Percent of Teachers Using TV	Percent of Schools with Cable TV	Books per Student in School
0-20%	68.5 to 1	44.8 to 1	57.3%	87.2%	20.2
21-40%	78.6 to 1	52.1 to 1	54.4%	76.1%	18.1
41-60%	571.9 to 1	72.9 to 1	43.6%	66.1%	13.5
61-80%	135.3 to 1	98.0 to 1	39.5%	65.5%	12.7
81-100%	205.8 to 1	149.9 to 1	31.6%	25.2%	9.9

Although not shown here, the same discrepancy exists between the low and high minority schools with respect to their access to distance learning. Data indicate that 11.5% of the lowest minority schools (0-20% minority) are using distance learning, while only 6.4%

of the highest minority schools (81-100%) use this technology delivery system.

When the same technology resources are analyzed in terms of the percentage of families in a school living in poverty, similar patterns to those of the minority percentage are exhibited, although the ranges of difference between the low and high poverty schools, in terms of technology access and use, are not generally as great as those between the low and high minority schools. It appears that the greatest differences in terms of both the minority percentages and the poverty percentages exist in New York City.

No data exist on the equity of access to technology resource based on gender. In order to answer questions about gender access and use would require a substantial within building data collection effort. Collecting individual data, by teacher and student, would also be required to identify the specific manner of implementation which technology takes in a school.

What conclusions can we draw from these data?

Again, the four major points which the data in this report highlight are:

- Technology acquisition, access and use is growing across the State. There are many outstanding, cutting-edge technology implementations in New York State schools. The trend of computer acquisition (based on data since 1985-86) indicates a doubling of computers approximately every 6-7 years. This is a long period of time given the "life-cycle" of technology and the frequent introduction of increasingly powerful computers.

- A large percentage of the existing hardware base is rapidly becoming obsolete, and incapable of running the most current and powerful software. Over 75% of the computers in schools are simple first and second generation machines.

- Although New York State was an early leader in the acquisition and use of computers in schools, New York State is losing its leadership position and is beginning to lag behind other comparable states in a number of technology access and use categories.

- There are serious inequalities in the access and use of technology relative to the minority status of students. The highest minority percentage schools in the State have from 50-150% fewer technology resources than the lowest minority schools.

We must work to provide our students with the necessary access to information tools, and to ensure equity of access for all New York State students. To do this, legislative and regulatory barriers must be removed, and substantially more funding must be made available to support the implementation of technology and technology support systems in schools. This will take a concerted legislative effort and a grass roots coalition of the entire community, including parents, the business community and legislators at all levels.

The power of technology to restructure teaching and learning is tremendous. That is why technology plays such an important part in supporting the State's restructuring effort, called *The New Compact for Learning*. However, in order to take advantage of this power, students and teachers must have access to cutting-edge technology on a continual basis in their classrooms and their homes. Teachers must also have the training and support necessary to integrate technology tools into their instruction. In addition, all educators must have access to the national network infrastructure which will provide information and resources to support the learning process. Technology can only empower learners if and when it is available and used. Our task is to increase that access and use for all learners, rich and poor, in all areas of the State whether rural, urban or suburban.

Notes

1. The majority of data in this report are derived from the Basic Educational Data System (BEDS) school district and building surveys from the 1992-93 year. These data on technology are part of the larger BEDS Survey to which the State Education Department insures response from 100% of the school districts and buildings.

2. For additional information on BEDS or these data, contact:

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