Technology Support: Its Depth, Breadth and Impact in America's Schools

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Teaching, Learning, and Computing: 1998 National Survey

Report #5

Center for Research on Information Technology and Organizations
University of California, Irvine

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INTRODUCTION

Research has shown that teachers lack adequate support for the use of information and communication technologies (ICT). This has created serious obstacles to effective student learning with the aid of technology (U.S. Congress, Office of Technology Assessment, 1995; President's Committee of Advisors on Science and Technology & Panel on Educational Technology, 1997). The argument that the effective use of technology in the classroom is dependent upon the availability of teacher technology support has been noted in numerous studies of school-wide and classroom-based technology implementations (Blomeyer 1991; Collis & Carleer 1992; Diem 1986; Garner & Gillingham 1996; Ginsberg & McCormick 1998; Means & Olson 1995; Pisapia 1993; Ruopp et al. 1993; Sandholtz et al. 1997; Schofield 1995; Smith & Pohland 1991; Stake 1991; Strudler 1991).

In this report, we use the term "support" in its broadest sense, so that it encompasses a wide range of resources for teachers. These resources include, but are not limited to, facilities, presence of a support staff, personal help and guidance, professional development, and professional incentives. While the term "support" is generally understood in the literature, the more specific term "technology support" is much less apparent. This is due to the fact that it has come to refer to a variety of things. The inconsistency with which the term has been used is problematic, in that it is not always clear which dimensions of technology support teachers are lacking. This report aims to rectify this problem by providing a framework for defining the various dimensions of technology support. To begin, we utilize data from school administrators, technology coordinators, and teachers to examine the presence of each of these dimensions in American primary and secondary schools. Using the CEO Forum's (1999) professional development framework, we then elaborate on our definition for technology support to identify high-quality technology support. Finally, we correlate the presence of high-quality technology support with teachers' uses of educational technology.

SAMPLE

The information gathered by the Teaching, Learning and Computing survey (TLC 1998) was derived from a national probability sample of principals, technology coordinators and teachers in U.S. elementary and secondary schools. Initial contact letters were sent to 1,215 public, private, and parochial school principals who were selected from a national database of 109,000 schools. The database was supplied by Quality of Education Data (QED) of Denver, Co., a marketing information division of Scholastic Corporation. Schools were sampled according to their size and the amount of ICT they possessed. Size was determined by the number of full-time teachers at the school (grade 4 and above); amount of ICT was established vis-à-vis an index of ten different measures of per-capita technology presence.

Through probability sampling methods, we drew a sample of 3 elementary or 5 middle and high school teachers at each of the 898 selected schools. We sent a teacher roster form to the school principal as the first major mailing to the school (following an introductory letter). The form asked the principal to roster either 10 (elementary) or 15 (secondary) teachers of grades 4 or higher, starting with teachers with last names beginning with a randomly selected letter of the alphabet and proceeding alphabetically. In order to assign sampling weights, the roster form asked for additional pieces of information about the teachers such as subject taught, use of computers, and use of projects in teaching. In addition to asking the principals to select teachers, we also asked them to identify one person in the school who was most familiar with the technology in the school (i.e., the technology coordinator).

The overall response rate was 75%. The sample database includes data from 488 principals, 467 technology coordinators and 2,251 teachers. Principals, technology coordinators and teachers from sampled schools were questioned about the goals of technology and teaching, as well as the current implementation of technology within their schools. Data are presented at two levels in this report. First, school level data are based on information from principals and technology coordinators. Second, data are reported at the level of teachers. See the appendix for a description of how indicators in this report were constructed.

DEFINITION OF TECHNOLOGY SUPPORT

Technology support in schools can be categorized according to its content and the method by which it is delivered. For the purposes of this report, we make a distinction between instructional and technical content. The former is concerned with pedagogies, instructional strategies, and implementation of different teaching methods. The latter, however, encompasses all aspects of the technology, such as the operation and troubleshooting of hardware and software, which are generally not related to a specific instructional method. Knowledge of both content areas is of paramount importance for teachers intending to use technology effectively in the classroom; they must have the ability to operate ICT and use it as a pedagogical tool, one which supports both instruction and assessment. For instance, teachers need to know where to click the mouse and which menu commands to select. They must also be knowledgeable about how technology can allow students to access data, process them, and communicate their understandings. This knowledge must then be adapted and applied to the teacher's specific classroom context and levels of technology access. In sum, teachers are expected to develop a complex set of skills and reasoning processes, requiring considerable support.

The other dimension of technology support concerns the methods, or types of resources, used to deliver technology support services. These services include not only facilities and support staff, but also professional development, one-on-one consulting, and incentives. Each cell in Table 1 shows an example of how these types of support services differ for instructional and technical content.

TABLE 1: TECHNOLOGY SUPPORT CONTENT BY RESOURCE TYPE USED TO DELIVER TECHNOLOGY SERVICES TO TEACHERS

	Facilities	**Staff for assistance and necessary services**	**One-on-one, personal guidance, help**	**Professional Development, (scheduled sessions)**	**Incentives**
Instructional Content	Content-area specific software, communications access to pedagogical expertise	Instructional expertise and background of people providing support	Guided practice, consultation for curriculum integration	Pedagogy, models; implementation strategies	Release time for support focusing on instructional content
Technical Content	Network and Internet access; hardware, software	Technical support; help desk; network services	Computer experts for troubleshooting	Operating equipment, general software, etc.	Release time; free hardware, software and network access; anticipation of expert status

Developing a technology support environment that encompasses all the resources depicted in Table 1 requires considerable effort and expense. What is the payoff of providing more opportunities for teachers to learn about the necessary technical and instructional aspects of instructional technology? What might school leaders hope to achieve by offering ongoing technical support, including sufficient access to hardware? While there are some descriptive data on different models of technology professional development (cf. Anderson 1998; DeWert & Cory 1998; Milone 1998), there is an absence of specific descriptive or impact data. The TLC 1998 survey provides this important descriptive data on technology support elements in America's schools, and reports its impact on teachers' uses of technology.

FINDINGS

1. Availability of Technology Support

Educational Technology Facilities

The most basic form of technology support for teachers is the availability of educational technology resources. Given that a previous report (Report 2) described in detail the presence of technology facilities in schools (Anderson & Ronnkvist 1999), only a brief summary of these findings will be presented here. The survey results show that the average student-to-computer ratio in 1998 was 6 students for every computer, with roughly 90% of schools having some type of Internet access. Yet only 57% of schools had relatively high-speed access to the Internet. While these statistics place the United States among the nations with the highest ICT access per student, the range is very wide. Some schools have more computers than students (Pelgrum & Anderson 1999), whereas others have only 1 computer for 2,000 students.

In addition to collecting data at the school level on technology facilities, we also surveyed teachers about the resources they felt were available for use in their work area. Table 2 shows the percentage of teachers who had various technology resources available to them. Given that most teachers would likely report that paper-based assignments were a regular occurrence in their classrooms, it is to be expected that photocopying was the resource to which most teachers (91%) had easy access. More than three-fourths of the teachers had a computer printer close at hand and access to a fax machine, while at least half of the teachers had access to electronic mail at school. Close to 40% of teachers had either a modem or high-speed connection to the Internet from their classroom. In addition, the findings indicate that some teachers have been provided technology resources for use at home: e.g., desktop computers (28%), network access (12%), and laptop computers (11%).

Our measure of the level of facilities support for teachers is the sum of the number of these different resources that were provided to them.[1]

TABLE 2: PERCENTAGE OF TEACHERS WHO HAD RESOURCE AVAILABLE FOR USE

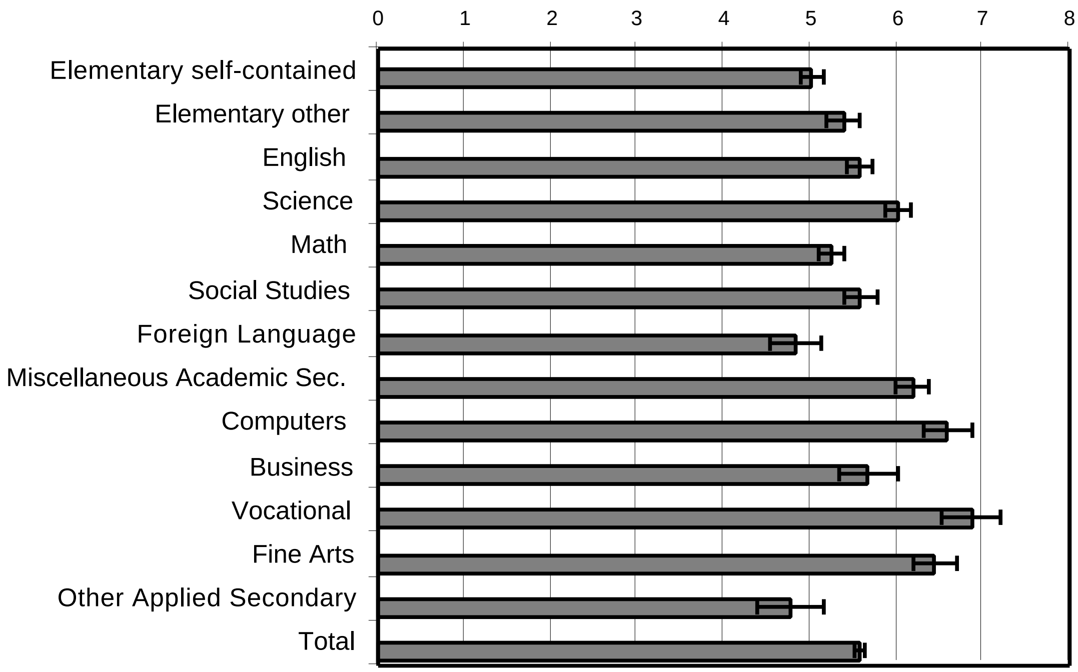
Resource	%
Easy access to photocopying with reasonable limits regarding cost-free use	91%
A computer printer in your room or nearby	78%
Easy access to a fax machine	70%
A desktop computer for your own use while at school	62%
Access to electronic mail from your classroom, lounge, or office	52%
Access to computers in the teachers' lounge or department office	51%
A telephone in your room	34%
Modem access to the Internet from your classroom	31%
High speed access to the Internet from your classroom	28%
A computer to borrow on occasion to use at home	28%
Access to the Internet from home through a district Internet connection	19%
Access to the school's computer network from home	12%
A laptop computer for using both at work and home	11%

On average, teachers reported access to at least 5 of these resources. While this number was consistent across elementary and secondary school levels, the number of resources available to teachers appeared to vary across subject areas. Figure 1 shows that teachers in Science, Computers, Vocational, and Fine Arts

[1] The number of classroom computers is not included in this measure. Instead, the measure reflects the level of facilities support for the computers which the teacher does have.

reported greater availability of technology resources than teachers in other subject areas, such as Foreign Language and other applied secondary subjects.

FIGURE 1. AVERAGE NUMBER OF TEACHER-REPORTED RESOURCES BY SUBJECT AREA TAUGHT



Error Bars represent +/- one Standard Error of the Mean for each bar.

Technology Staffing

In addition to having access to hardware and software, teachers also need "peopleware" to support these technology resources. Eighty-seven percent of the schools surveyed indicated that someone served in the role of technology coordinator. However, only 19% of these technology coordinators reported working full-time (i.e., 35 hours or more per week) in that capacity. Recently, *Education Week's* modest survey[2] (1999) found a slightly larger number of schools with full-time coordinators: 30%. Even by their results, it appears that over two-thirds of American schools remain without a full-time technology coordinator (Jerald & Orlofsky 1999).

Elementary and secondary schools are almost equally likely to have a technology coordinator. However, high schools are twice as likely to have full-time coordinators; i.e., 33% compared to 16% of middle and elementary schools.

[2] The Education Week survey, however, had under a 10% response rate.

TABLE 3: TECHNOLOGY COORDINATOR PRESENCE ACROSS SCHOOL LEVEL

School Level	% with Technology Coordinator	% with Full-time Coordinator
Elementary	85%	16%
Middle	90%	16%
High School	89%	33%
All Levels	87%	19%

Nearly 90% of the schools surveyed had assigned someone to serve as technology coordinator. In order to estimate the potential impact they may have in a school, we must first understand the range of duties they perform and the amount of time they spend on them.

Technology coordinators indicated that they performed a wide variety of jobs, many of which were unrelated to supporting technology. Table 4 shows that close to half of the schools had technology coordinators who were also classroom instructors. Just over one-quarter of the schools had technology coordinators who also provided network coordination. About 16% of technology coordinators reported they also fulfilled a media specialist job role. In addition to supporting technology, respondents also performed administrative tasks, such as grant writer or assistant principal, curriculum or staff development tasks, and were responsible for technology or other hardware related problems such as phone repair or computer maintenance. Lastly, 13% of the schools had technology specialists who described themselves as neither technology nor network coordinators. Technology coordinators who serve in multiple job roles and support a large number of teachers are likely hard-pressed to provide the regular, systematic technology support that is often reported as a prerequisite to teachers' technology use. Part-time coordinators may lack the time and attention it takes to attend to routine maintenance or software upgrades; they may also be unable to offer professional development training on the operation and integration of software.

TABLE 4: ADDITIONAL JOB ROLES HELD BY TECHNOLOGY COORDINATORS

Additional Job Role	% with Additional Role
Classroom Instructor	45%
Network Coordinator	26%
Media Specialist	16%
Other	13%

In addition to their other roles, technology coordinators can be differentiated by the number of hours they spend per week on various technology coordination tasks. Figure 2 displays the weekly hours full-time and part-time technology coordinators reported spending on several job tasks: supervising and assisting computer use by classes of other teachers; installing, troubleshooting, and maintaining equipment, networks, operating systems, and software; selecting and acquiring computer-related hardware, software, and support materials for the school; planning and running staff development workshops; writing lesson plans and units with other teachers that integrate computer activities with curriculum; and other support tasks. Full-time coordinators spent the greatest amount of time on supervising classes, closely followed by installing and troubleshooting. However, part-time coordinators tended to spend more time installing and troubleshooting than supervising classes.

Whether teachers are at schools with full-time or part-time technology coordinators, they receive little assistance integrating technology into their curriculum. Full-time coordinators spent roughly 2 hours per week on this task, while part-time coordinators spent even less; i.e., only 1 hour per week. While the technical support that teachers receive is arguably helpful to them, one would expect them to benefit from additional help with integrating technology into their curriculum.

FIGURE 2: AVERAGE WEEKLY HOURS SPENT BY TECHNOLOGY COORDINATOR ON DESIGNATED JOB TASKS

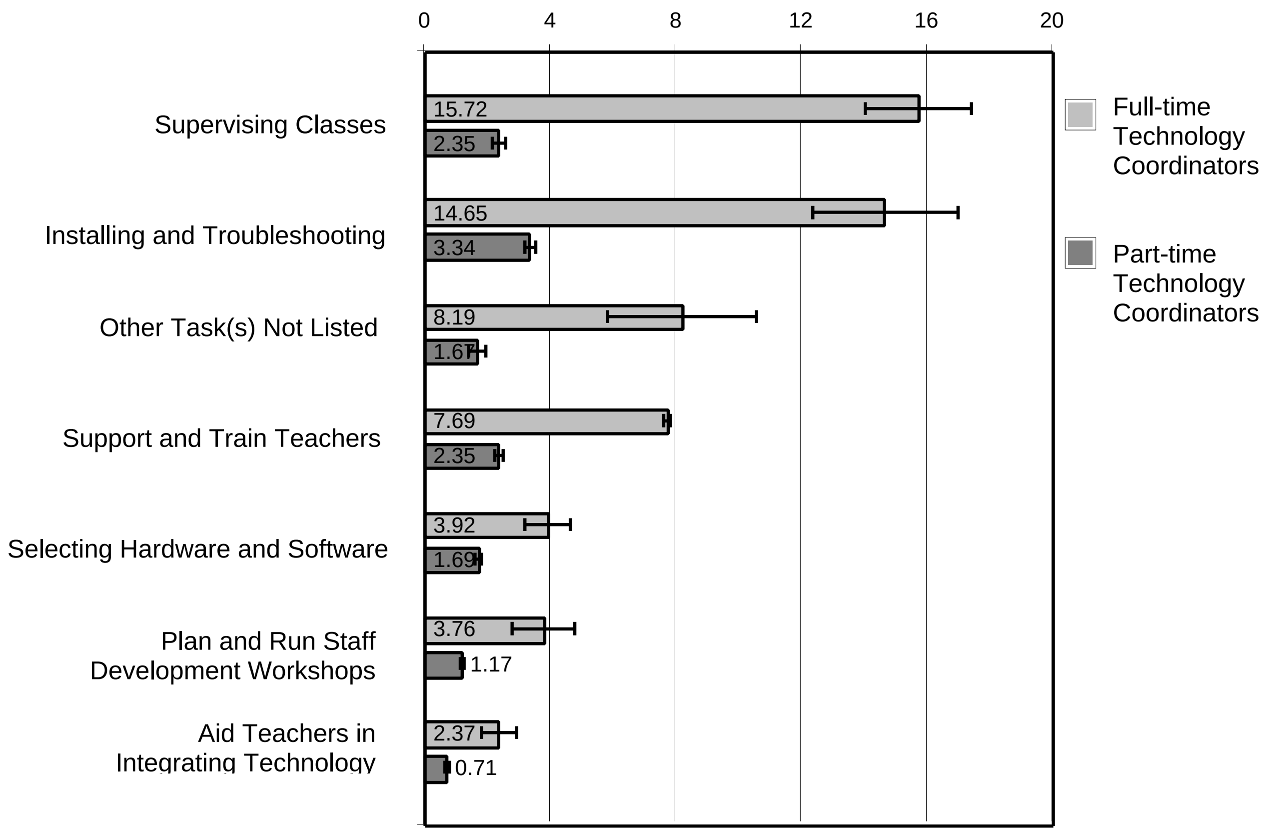
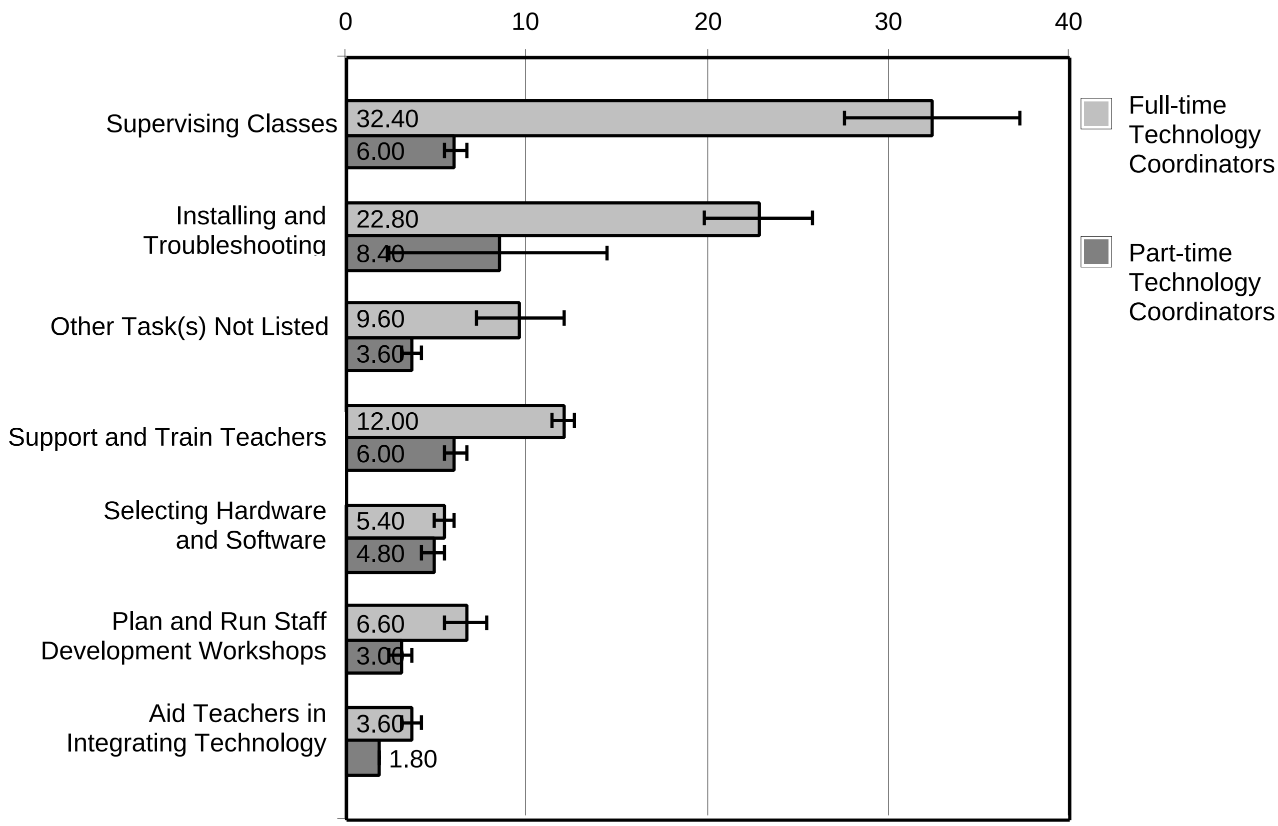


Figure 2 does not take into account the size of the school population that is being served. That is, it may be more useful to examine how much time is spent on a weekly basis in terms of the number of teachers within the school. shows the average amount of time per teacher that technology coordinators spend on job tasks. The findings show that, when accounting for the number of teachers within a school, the proportion of time spent on each task is similar to what was illustrated in Figure 2. However, the gap between the time spent on each activity between the full-time and part-time coordinators is a bit smaller. For example, full-time coordinators spent about five times as much on supervising classes, between two to three times as much on installing and troubleshooting, and about the same on selecting hardware and software as part-time coordinators.

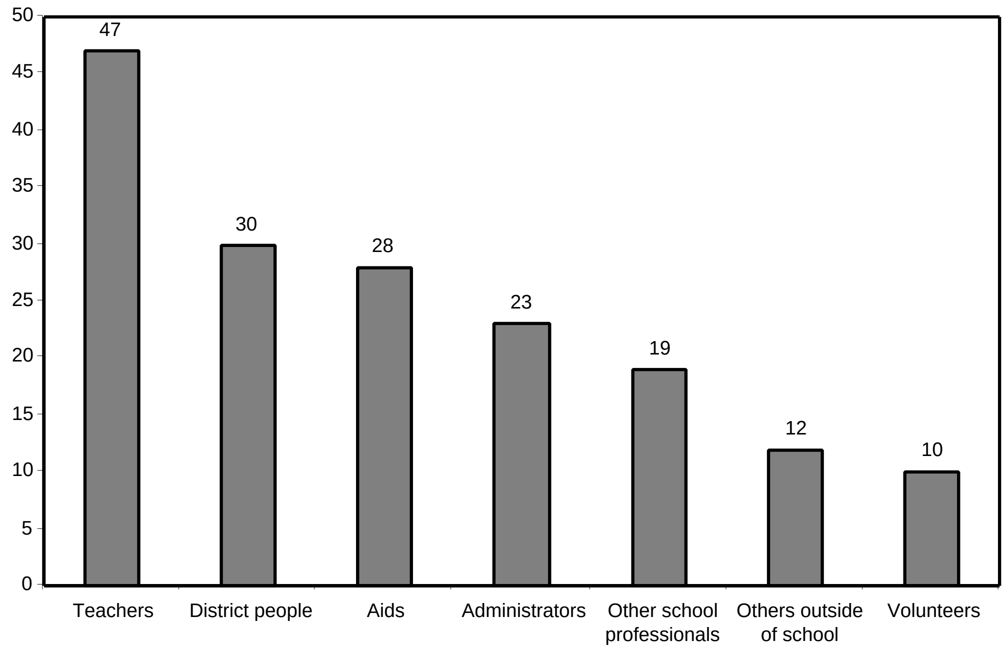
Figure 3 also reinforces the finding that teachers receive more technical than instructional help. On a weekly basis, full-time technology coordinators spent only 3 to 4 minutes per teacher assisting them with integrating technology into the curriculum, whereas part-time coordinators spent just 1 to 2 minutes per teacher. Technical support is clearly more prevalent than instructional support for teachers integrating educational technology. While supervising classes is indeed a type of instructional support, it suggests that, in this capacity, the technology coordinator replaces rather than supplements the role of the teacher.

FIGURE 3: AVERAGE MINUTES SPENT PER WEEK BY TECHNOLOGY COORDINATOR ON JOB TASKS PER TEACHER



In addition to detailing time spent on different support tasks, technology coordinators indicated whether there were other adults, internal or external to the school, who also provided technology support. On average, technology coordinators had 2 to 3 additional adults providing help, totaling nearly 16 more hours of support per week. Figure 4 shows the percentage of technology coordinators reporting additional support from other people such as teachers, district employees, aids, administrators, other school professionals, and others outside of the school. Close to half of technology coordinators (47%) receive assistance from teachers.

FIGURE 4: PERCENTAGE OF TECHNOLOGY COORDINATORS REPORTING ADDITIONAL SUPPORT FROM OTHERS



About one-fourth of technology coordinators reported involving students to support teachers' use of computers. In the schools where such student participation was reported, typically 2 to 5 students were involved in each of the following activities: troubleshooting hardware and operating systems, instructing teachers, developing a school web site, and working as a computer lab assistant for various classes. The significance of student assistance should not be underestimated, for if each student contributes 5 hours per week (one class period per day), schools could add the equivalent of more than an extra full-time person in staff support to the adult staffing that they already have.[3]

Personal, One-on-One Help

Another important type of support technology coordinators can provide is individualized, personal, one-on-one support to teachers on a regular basis. Technology coordinators were asked the amount of time they spent supporting or training individual teachers to use computers, including impromptu help. On average, they spent 3 to 4 hours per week providing this type of assistance, comprising about 22% of their total technology support time each week. This differs slightly when comparing full-time and part-time technology coordinators. In a given week, a full-time technology coordinator spent about 14% of their time giving individualized assistance, while part-time coordinators spent about 24% of their technology support time.

Many teachers were provided with opportunities to receive formal computer technology training and support through one-on-one or small group tutoring/training sessions. Table 5 demonstrates that, on average, technology coordinators provided one-on-one opportunities in their schools on 19 occasions throughout the school year; i.e., about twice a month. This average increases slightly when selecting only the schools that identified at least one training opportunity (about 79% of schools). Put in terms of the

[3] Calculation: The schools that reported student support in at least one area averaged about 9 to 10 student workers in total across the four areas. If each student worked 4 to 5 hours per week, that is slightly more than 1 FTE of time.

number of teachers in a school, each teacher received about 7.6 of these personalized help sessions in a given academic year.

Professional Development

In addition to impromptu, one-on-one help, technology coordinators also helped provide technology-related professional development workshops or in-service training. Table 5 shows the number of formal computer technology training, tutoring, or support occasions offered over the 1997-1998 academic year. Technology coordinators reported that, on average, school-presented workshops were offered to teachers only about twice a year. District workshops were offered three times over an academic year. However, when only schools that offered at least one type of occasion were selected, these averages roughly doubled. That is, among schools that had any school-presented workshops, there were an average of 4 technology workshops per year. Likewise, those having a district workshop had an average of 7 per year.

A majority of schools (92%) offered at least one opportunity for professional development. On average, schools offering one or more development occasions reported that 29 opportunities were provided during the 1997-1998 academic year.

TABLE 5: MEAN NUMBER OF TECHNOLOGY DEVELOPMENT OCCASIONS AND NUMBER OF TEACHERS SERVED OVER 1997-1998 ACADEMIC YEAR[1]

	Average # of Development Occasions			**Average # of Teachers Served**			**Average Teacher Development Occasions[2]**		
Type of Occasion	**All Schools**	**% with 1 or more occ.**	**Schools with 1 or more occ.**	**All Schools**	**% with 1 or more served**	**Schools with 1 or more served**	**All Schools**	**% with 1 or more occ.**	**Schools with 1 or more occ.**
One-on-one or small group tutoring or training sessions about technology	19.1 (59.5)[3]	78.6%	24.3 (66.2)	1.1[4] (1.2)	78.9%	2.0[4] (1.0)	23.9[4] (76.3)	76.6%	30.7[4] (85.9)
District/Diocese presented technology in-service workshops	3.1 (9.9)	42.7%	7.3 (14.1)	12.6 (62.9)	41.2%	30.6 (95.2)	149.3 (1578.4)	40.2%	370.0 (2472.6)
School-presented technology in-service workshops	2.2 (4.8)	61.2%	3.7 (5.7)	15.5 (26.6)	61.2%	25.4 (30.1)	53.3 (144.7)	60.7%	87.7 (177.5)
State or regionally sponsored workshops or technology conferences	1.3 (2.9)	43.5%	2.9 (3.8)	13.9 (103.3)	40.6%	34.1 (159.9)	21.7 (153.7)	40.0%	53.9 (239.4)
Commercially presented workshops or courses on technology	0.5 (1.3)	24.4%	2.2 (1.8)	2.1 (19.4)	23.2%	9.2 (39.5)	7.2 (93.3)	22.9%	31.2 (193.6)
College or university courses on technology	0.9 (4.6)	22.3%	3.9 (9.1)	0.3[4] (0.7)	20.6%	1.7[4] (1.0)	1.7[4] (6.3)	19.8%	8.3[4] (12.1)
All Types of Training	27.1 (63.7)	92.1%	29.4 (65.8)						

[1] Table 5 is based on survey information which asks the technology coordinator to estimate the number of occasions teachers had in the 1997-1998 school year to receive formal computer training, direct tutoring or support; in addition, they were asked to estimate the average number of teachers per occasion. A total of 388 schools provided data for this table.

[2] Average teacher development occasions is calculated by multiplying # of occasions by average # of teachers served for each school and then averaging across all schools.

[3] The number in parentheses are standard deviations. Unless marked by a "%", all remaining numbers in the table are means.

[4] This estimate was adjusted in order to aid in resolving differences in the way respondents interpreted the item. In some cases, technology coordinators gave the total number of teachers served overall instead of the total number of teachers served per occasion.

Technology coordinators estimated spending an average of 1 to 2 hours per week on training and assistance to ensure that staff could use the technology. This constituted about 9% of the hours spent on technology support per week. Full-time coordinators (those who work 35 hours or more per week) spent twice as much time, 3 to 4 hours a week, on planning and running staff development workshops compared to part-time coordinators.

Another important aspect of professional development is implementing and integrating computers into instruction. Technology coordinators reported spending an average of only one hour per week on helping teachers to write lesson plans and units that integrate computer activities into the curriculum. Part-time coordinators spent an hour or less on providing this type of assistance, compared to full-time coordinators' 2 to 3 hours per week.

Teachers were asked about the content of the formal staff development sessions in which they had participated since June of 1997. Four of the topics specifically addressed technology issues; these are shown in Table 6. Three of these topics were related to technical content: understanding the mechanics of using computer technology and software, enabling students to create multimedia activities, and using the Internet or other on-line activities. The remaining topic was related more to instructional content: integrating computers into instructional activities in your subject area. The topics most often rated as "central" at staff development sessions attended by teachers were "the mechanics of using computer technology and software" (41%), and "integrating computers into instructional activities in your subject area" (33%). "How to use the Internet or other on-line activities in your subject area" was a central topic 30% of the time. Only 12% of these teachers received instruction on "how to enable students to create multimedia presentations."

TABLE 6: PERCENTAGE OF TEACHERS REPORTING
PROFESSIONAL DEVELOPMENT SESSION TOPICS AND DEGREE OF EMPHASIS

	Central Topic
Mechanics of using computer technology and software.	41
Integrating computers into instructional activities in your subject area.	33
How to use Internet or other on-line activities.	30
How to enable students to create multimedia activities.	12

The breadth of the professional development programs available to teachers is indicated by the number of technology-focused sessions that they were able to attend. Only 7% of teachers attended professional development workshops where all four of these topics were the central focus. But twice that number (14%) reported that they attended sessions where one, two or three of these topics were central. Half of the teachers (50%) said none of these topics was central. In other words, none of the professional development sessions they had attended all year had a technology focus. Given that teachers reported attending only 4 to 5 scheduled professional development days or half-days per year, it should come as no surprise that teachers were unable to learn about all of these technology topics.

Incentives

Although determining what incentives schools offered teachers for developing technology skills was not an objective of this survey, teachers reported the availability of two items which could be interpreted as incentives: school-provided Internet access and computers they could take home. As reported in Table 2, only a small number of teachers have access to these incentives. Nearly one-fifth (19%) of the teachers surveyed indicated that they had access to the Internet from home through a district connection, whereas only half as many (11%) had access to a laptop which they can use at home or school.

Summary of Technology Support and Teachers' Perceptions of Its Availability

To summarize across the five elements of technology support identified in Table 1, the majority of American teachers have access to key educational technology resources like computers, printers, and faxes. Most schools have some technology support personnel; the amount of person hours devoted to technology support, and the background they bring to that role, varies widely. Often, this variation is the result of specific conditions at the school site. Technology coordinators tend to provide assistance in a one-on-one format, but teachers' access to this method of service delivery varies depending on the number of staff the technology coordinator must serve. Technology coordinators and others offer professional development programs on technology topics. However, the overall amount of time spent on professional development is limited, and technology topics comprise only one part of this programming. If the prevalence of teachers' access at home to equipment and the Internet is any indication, there are few incentives provided by schools to encourage teachers to learn to use technology. Overall, while most teachers have some access to technology support, the amount available to them varies widely; and technical support is always more prevalent than instructional support for technology use.

The TLC survey asked teachers to comment on the availability of each type of technology support. We found that teachers' impressions correspond greatly with these descriptive measures. Table 7 shows about one-quarter of the teachers surveyed indicated that technical support was available to them most of the time or almost always; one-fifth of the sample (21%) felt similarly about instructional support. Less than half (41%) of the teachers believed that both technical and instructional support were available to them at least some of the times they needed it. For about 10% of the teachers, technical help was not available at all; and twice that number (20%) indicated they had no instructional help available to them.

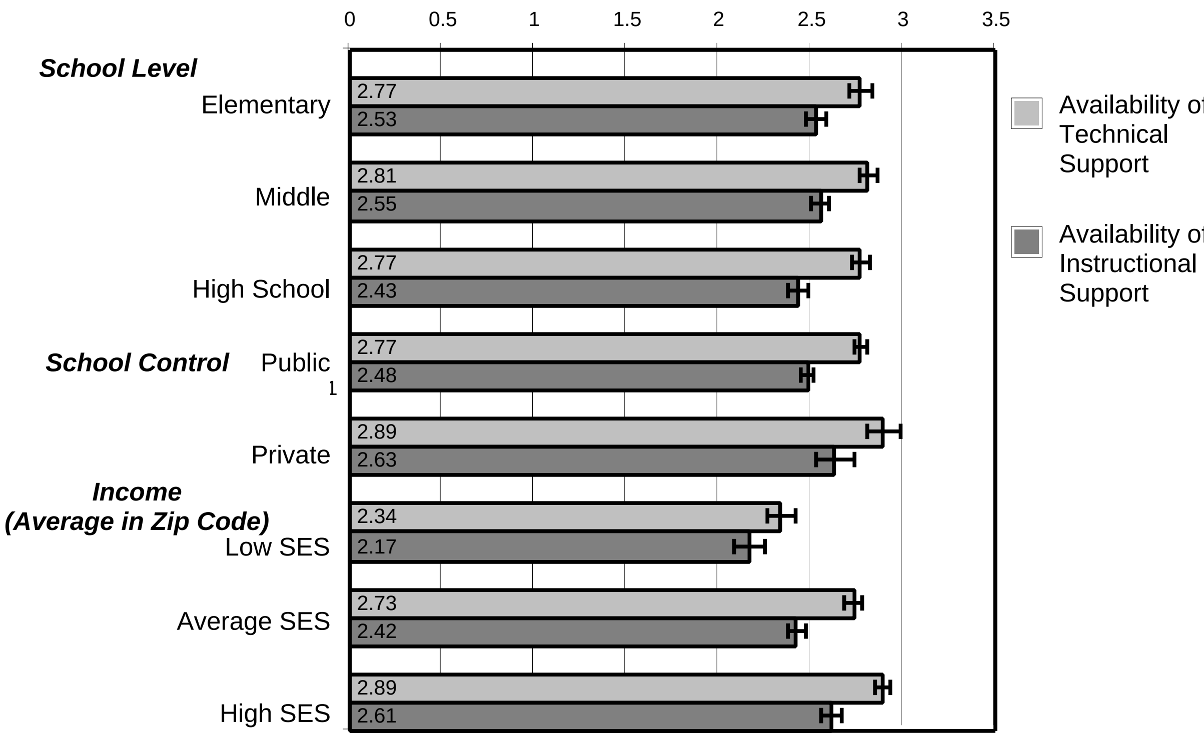
TABLE 7: PERCENTAGE OF TEACHERS REPORTING FREQUENCY OF AVAILABILITY FOR TECHNOLOGY SUPPORT

	Technical Help	Instructional Help
"Not available"	10	20
"Sometimes"	41	41
"Frequently"	24	18
"Mostly"	11	10
"Almost always"	14	11

Teachers' perceptions of availability of technology support varies across different school characteristics.[4] Figure 5 shows that high school teachers reported that instructional support was slightly less available to them than did elementary and middle school teachers. In contrast, perceptions of the availability of technical support were similar across all three levels. Teachers in private schools tended to report that instructional support was more available than did those in public schools. Teachers in schools located in low SES areas perceived both instructional and technical support as slightly less available than teachers located in schools in average or high SES areas. While differences by school level were not statistically significant (at $p \leq .05$), they were significant across school control and across income levels of the schools.

[4] School characteristics include school level (elementary, middle, high schools), school control (public or private) and SES (based on income level of zip code location of school). See the appendix for more details.

FIGURE 5: TEACHERS' RATINGS OF AVAILABILITY OF TECHNOLOGY SUPPORT



<u>2. Variations in Technology Support</u>

How do teachers' perceptions of availability fit with reports of technology support available? To explore this question we divided technology support into its component parts. Figures 6 through 9 present four of the different elements of support identified in Table 1: technical facilities or resources, individual attention, professional development opportunities, and professional development topics.

Figure 6 reveals the variability of the technology resources provided to teachers. This was computed by summing the number of resources that teachers reported as available for their use (see Table 2 for a list of resources). The scores of teacher-reported resources vary from 0 to 13, where a score of 13 indicates that all of the listed resources were available.

Technology support helps individuals use and integrate technology in the classroom. Thus it is important to view technology support in terms of the amount available to each individual teacher. Figure 7 illustrates a measure of the one-on-one dimension of technology support; i.e., the ratio of support hours to each teacher at the school over one academic year[5]. The totals include support provided by the technology coordinator as well as others (see Figure 4 for a list of others who provided support). For example, a value

[5] This ratio was calculated at the school level and then weighted by the number of teachers.

of 25 indicates that an average teacher received about 25 hours of one-on-one support over the course of an academic year.
Figure 8 shows the total number of training opportunities, again taking into account the number of teachers in the school[6]. We calculated the total number of training opportunities by taking the sum of the training occasions, as indicated in Table 5, and dividing by the number of teachers in the school. Higher scores reflect a greater number of technology professional development opportunities per teacher.

A fourth element related to the professional development dimension is depicted in Figure 9: attending technology professional development sessions where technology topics were central. (See Table 6 for a list of the four possible technology topics.) A score of 4 would indicate that all four technology topics were central at the staff development sessions attended by teachers.

In each figure, the findings are presented in terms of school level (elementary, middle or high school), school control (public or private school) and SES (which was based on the income of the zip code the in which the school is located). See the appendix for detailed information on how these demographic variables were measured.

Findings for School Level

The data show that teachers in middle and high schools are provided with more technology resources (see Figure 6). Elementary and middle school teachers, however, received more temporal support. That is, they were provided with a greater number of support hours from either a technology coordinator or others who provided support (Figure 7). Middle schools had the fewest technology training opportunities available per teacher; elementary school teachers had twice as many opportunities (Figure 8). Overall, teachers across all three levels attended a similar number of workshops where technology topics were the central focus (Figure 9). Thus, even though the types of support available to teachers differed across school levels, teachers' perceptions of availability of technical and instructional support were about the same.

Findings for School Control

Public school teachers reported more technology resources (Figure 6) and a greater number of development occasions (Figure 8) than did teachers in private schools. They also attended more professional development sessions where technology topics were the central focus (Figure 8). In contrast, the number of support hours per teacher was slightly greater in private schools (Figure 7). While public school teachers had more resources and staff development focused on technology topics, private school teachers perceived technical and instructional support as more available. This may be due to the fact that, on average, private school teachers had more contact time with a technology coordinator or others providing support in their school. Looking across all of the support indicators, the average levels of support are quite similar in public and private schools.

Findings for SES

As might be expected, the data show teachers in high-income areas (based on zip code) reported more technology resources available for their use. Teachers in high SES schools were also more likely to attend workshops where technology topics were covered. This disparity does not extend to the number of support hours per teacher, which was similar across SES levels. Likewise, the number of training opportunities available per teacher was also similar across levels. The results suggest that teachers in high SES areas have a greater breadth of technology support available to them. Teachers at schools located in

[6] This ratio was calculated at the school level and then weighted by the number of teachers.

high or average SES communities tend to report both technical and instructional support as more available to them. Hence, teachers' perceptions seem to corroborate with actual technology support availability.

In summary, the results show that inequities exist in the availability of technology support across income levels. Furthermore, teachers seem to be aware of the availability of technology support. To push this finding a little further — teachers' awareness of the availability of technology support could suggest that they might actually be using the support. As teachers learn of different types of support available to them, perhaps they become more inclined to take advantage of that support — a step which could enhance how they use technology.

FIGURE 6: TEACHER-REPORTED RESOURCES

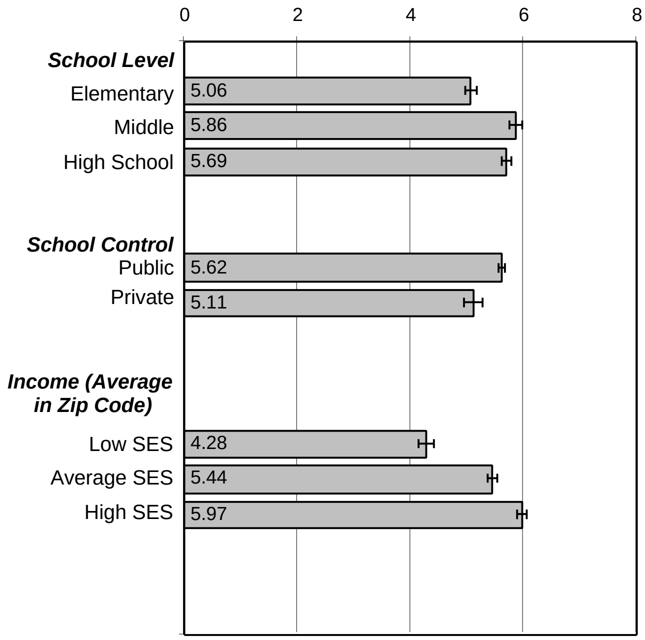


FIGURE 7: TOTAL SUPPORT HOURS PER TEACHER

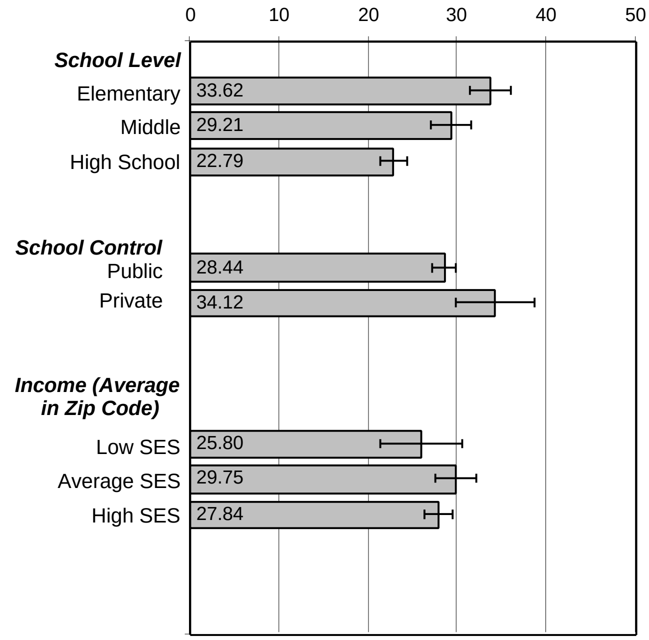


FIGURE 8: NUMBER OF DEVELOPMENT OCCASIONS PER TEACHER

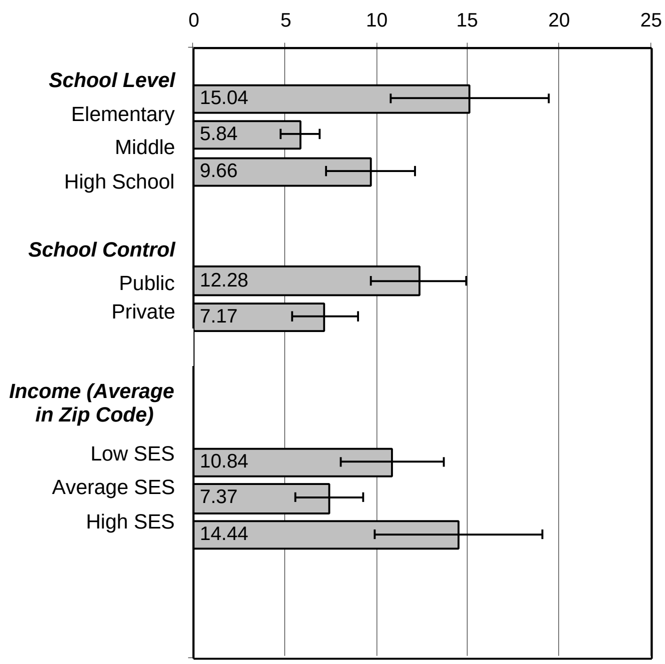
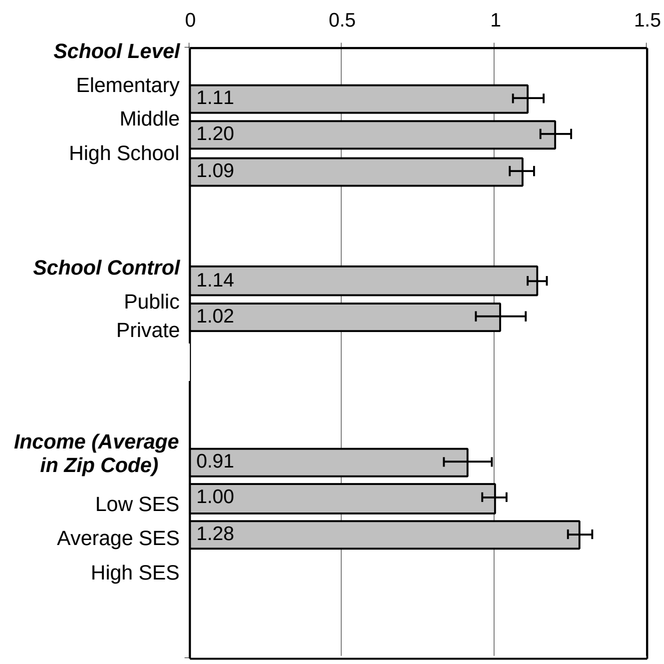


FIGURE 9: NUMBER OF COMPUTER TOPICS CENTRAL



Note: Figures 6-9. Availability of four components of technology support.

3. Definition and Prevalence of High-Quality Technology Support

The importance of professional development for schools with technology programs has been noted by the CEO Forum, a group of business executives and school leaders concerned with the use of technology in America's schools. Their 1999 report provides guidelines for schools developing high quality technology-support programs, and includes an index, called the STaR Chart, for assessing adequacy of school technology programs. It emphasizes four key elements of a successful technology program. First, the report stresses the importance of helping teachers to integrate, and not just operate, technology. Second, it calls for regularly scheduled technology-oriented development sessions, as well as for "just-in-time" and one-on-one learning opportunities; development opportunities include help from individuals with classroom and curriculum experience. Third, it suggests the need for teachers to have access to technology resources near their work place. And finally, the CEO Forum's professional development program also notes that attempts must be made to involve most of the teachers in the school. The CEO Forum's (1999) STaR Chart identifies and elaborates upon quality technology-support programs in other ways, but these criteria represent the essence of their framework.

To analyze the adequacy of teacher support programs, we applied these criteria to questions from our teacher survey. By relating specific indicators to each criterion we produced an index with which to measure the quality of technology support available to teachers. We included: (1) customized one-on-one help, (2) frequent teacher participation in on-going, technology-oriented professional support among teacher peers, (3) professional development content which emphasizes the instructional, and not just the technical, needs of teachers, and (4) access to a broad range of technology resources.

The first of these four quality aspects, "access to one-on-one help," was measured by data from school technology coordinators. All of the other indicators were based upon teacher reports. While our framework and the CEO Forum Chart are defined at the level of the school, our data is analyzed primarily at the level of the teacher. We used teacher-weighted data throughout, because the adequacy of support is best determined by the teachers themselves. Some groups of teachers may not be nearly as well supported as others and thus, asking teachers about their perceived support experiences is arguably more accurate than relying on an administrator's estimate. The aggregate teacher responses reported here give a profile of the adequacy of school technology-support programs overall. Before reporting the results of our quality index, we first provide more details on the four main indicators.

Access to One-on-One Personal Guidance and Help

The first dimension is based on the idea that quality technology support should provide teachers customized one-on-one help. Technology coordinators were asked about the number of occasions that teachers in their school received individualized attention during the 1997-1998 school year. Customized computer support includes technology instruction in the format of direct tutoring, as well as support in the form of one-on-one or small group sessions. In order to create a ratio representing the number of occasions per teacher, we simply divided the number of reported occasions by the total number of teachers in the school. This ratio was then re-coded into a dichotomous variable where a value of "1" indicates this ratio was .23 or greater; a value of "0" indicates the ratio was less than .23. This cut-off point denotes the 70^{th} percentile.

Frequent Teacher Participation in Technology-Oriented Professional Support Among Teacher Peers

The second dimension, teacher participation, reflects the degree of teacher participation in school-wide technology professional development activities. This indicator was created from information given by teachers about how frequently they discussed computers, software, or the Internet with other teachers at the school. Teacher participation was given a value of "1" if teachers said the discussions took place 1-3 times per week or almost daily; otherwise, a value of "0" was assigned. Thirty-three percent of the teachers indicated they had discussions with other teachers about computers, software or the Internet either daily or at least 1-3 times per week.

Professional Development Content Focused on Instruction and Integration

The third dimension of high quality technology support emphasizes the integration of computers into the classroom, as opposed to just their operation. This indicator concerns the content of the professional development activities attended by teachers. If teachers indicated that they had attended a professional development session where the integration of computers into instructional activities was a central topic, this indicator (content) was given a value of "1." Otherwise, content was coded as "0." Overall, about 32% of the teachers surveyed attended a professional development session where the central topic was how to integrate computers into instructional activities.

Access to Resources

The fourth dimension of high-quality technology support captures the argument that teachers should be provided with access to appropriate technology resources. Table 2 (see above) shows the percentage of teachers indicating which technology resources were available for their use. Full teacher access to technology resources was given a value of "1" if teachers had 7 or more of these resources available to them; otherwise they were given a value of "0. "

Overall Quality of Support

To create an overall index of a high-quality technology-support environment, the four dichotomous variables discussed above (one-on-one, teacher participation, content, and full access to technology resources) were summed. Teachers scoring either "3" or "4" were deemed to be in schools offering high-quality technology support. Those scoring "0" did not have any of the support dimensions present at a high enough level to receive a score in our index. Table 8 shows the frequency distribution of scores for the quality of technology support environment index. The table shows that only 13% of teachers are at schools having at least three support dimensions in place. Teachers indicating the presence of two or fewer (2, 1, or 0) dimensions in their schools are, for the most part, equally distributed; about 30% fall in each category.

TABLE 8: NUMBER OF QUALITY TECHNOLOGY SUPPORT DIMENSIONS

Number of Quality Technology Support Dimensions	% of Teachers
0	28%
1	34%
2	25%
3-4	13%

In addition to this "objective" index, we developed a more subjective measure as well. Teachers were asked to comment on the quality of the technology support they received. On a 5-point scale they indicated whether they received technical or instructional support and, if received, its quality, ranging from poor to excellent. While teachers' evaluations were distributed across the entire five-point scale for each of the four categories discussed above, there was a positive relationship between teachers' quality ratings and the overall quality index score. That is, the lower the overall quality rating, the more likely teachers were to give their technology-support environment a low score. This relationship holds true for schools receiving a higher index score as well.

We further analyzed the data to determine which of the four components of the support quality index was associated with higher subjective ratings of quality. For each component of quality technology support, we calculated the effect sizes[10] in terms of comparing teachers' subjective ratings of quality when each of the components of the quality index was and was not present. The results are presented in Table 9.

TABLE 9: EFFECT SIZES OF QUALITY SCORE COMPONENT ON TEACHERS' PERCEPTIONS OF THE QUALITY OF SUPPORT RECEIVED[7]

	Effect sizes of teachers' perceptions of overall quality of support received when each of four quality components was present:	
Quality Index Component	Technical Support	Instructional Support
-One-on-One Help	+0.20	+0.20
-Widespread Participation in Peer Support	+0.24	+0.16
-Instructional/Integrative Content of Professional Development	+0.44	+0.43
-Access to Diverse Technology Resources	+0.70	+0.55

Table 9 shows that, while all four of the components of support highlighted in the CEO Forum (1999) are important, access to resources and professional development focusing on instructional integration of technology content contribute the most to teachers' overall ratings of the quality of support received.

Next, we report factors that predict the presence of high-quality technology support.

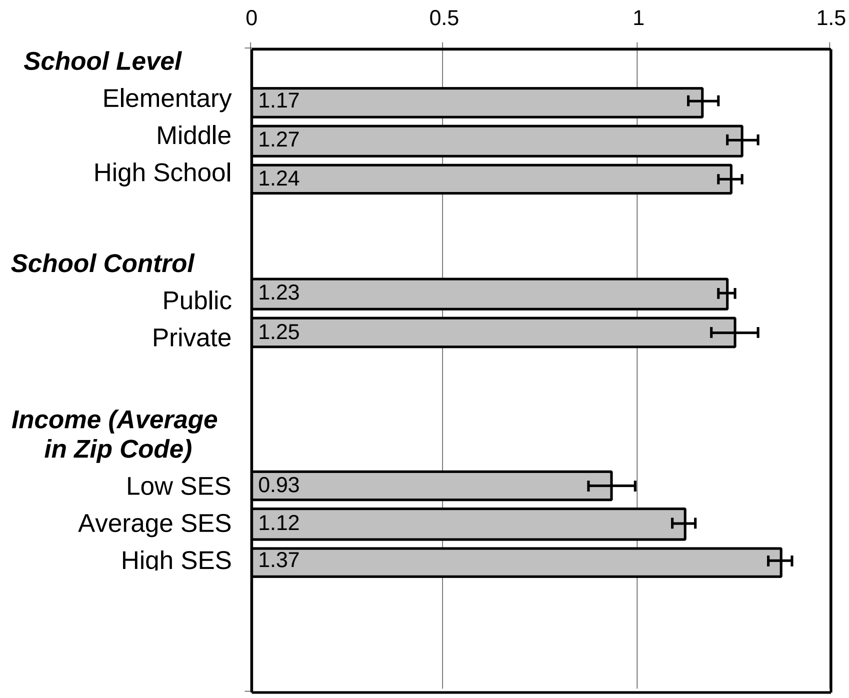
4. Variations in Quality Technology Support

Figure 10 compares the quality technology index (see Table 8) across school level (elementary, middle, and high), school control (public or private), and SES (based on zip code location of school). As noted above, the quality technology-support score ranges from "0" to "3," where "3" indicates the presence of either 3 or 4 quality dimensions.

The figure shows elementary school teachers reported slightly fewer dimensions of support in place than did their colleagues working in middle schools and high schools. Teachers in public and private schools have essentially the same number of dimensions in place. The most striking finding is that teachers in schools located in high SES areas have significantly higher quality technology support than those in average SES and low SES areas. In other words, teachers in schools located in higher SES areas are more likely to have a greater number of quality dimensions available to them.

[7] Effect sizes were calculated by subtracting the mean score of teachers' subjective ratings when the quality index component was not present from when it was present. The difference was then divided by a weighted average standard deviation of the two groups.

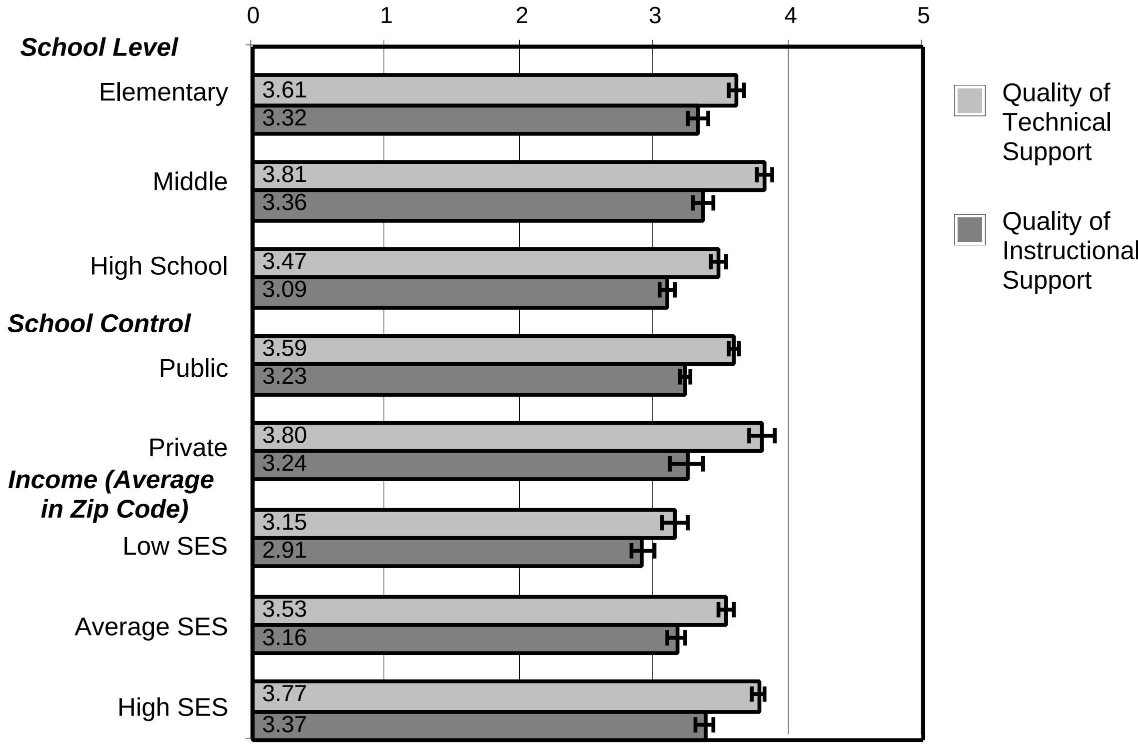
FIGURE 10: AVERAGE QUALITY TECHNOLOGY SUPPORT SCORE BROKEN OUT BY SCHOOL CHARACTERISTICS



Teachers' Perceptions of Quality Compared Across School Characteristics

Figure 11 compares teachers' perceptions of technical and instructional support across school level (elementary, middle, high school), school control (public or private), and school socioeconomic status (SES). The latter is based on the location of the school (identified by zip code).

FIGURE 11: TEACHERS' PERCEPTIONS OF QUALITY OF TECHNOLOGY SUPPORT BROKEN OUT BY SCHOOL CHARACTERISTICS.



High school teachers rated the quality of both technical and instructional support lower than middle and elementary school teachers did. Public school teachers rated the quality of technical support lower than did private school teachers. The disparities across school level and control are not nearly as profound as those observed across socioeconomic levels. Teachers in schools located in high SES areas rated the quality of both their technical and instructional support more highly that did teachers in schools located in lower SES areas. In other words, quality of technology support is lower in schools located in lower income communities.

In summary, the data show that access to quality support varies across certain types of schools. This includes both teachers' perceptions of quality and the actual presence of four dimensions of quality technology support. What remains unclear, however, is whether access to quality technology support leads to greater technology use by teachers. We address this question in the next section.

5. Quality Technology Support and Teachers' Uses of Educational Technology

Although many studies posit a link between technology support and the actual use of technology by teachers, there has been little empirical evidence to support such a claim. To address this gap, we have examined three aspects of technology use: frequency, variety, and change over time. Frequency is strictly a measure of how often teachers reported using computer technology with their students; higher scores indicate greater use. Variety refers to the different professional uses of computers by teachers. Examples include, but are not limited to, recording student grades, corresponding with parents, and exchanging computer files with other teachers. A high score indicates that, on a regular basis, teachers used technology in a variety of ways. We also examined how teachers have changed their technology use in the last five years. For example, teachers were queried about whether they used computers more now than five years ago to prepare for class or student assignments. Teachers using computers more often now scored higher on this indicator. The appendix provides additional information about the construction of the above indicators of teachers' use of technology.

To examine the impact of quality technology support on each of the three aspects of teachers' computer use, we employed multiple regression techniques. The same set of independent variables and controls were included in each model. The main independent variable was our objective index of quality technology support. We also included an indicator of the availability of technology support in the models, which was based on teachers' perceptions rather than the actual technology support available in a particular school.

In addition to quality and availability, we included several control variables in the multiple regression models (these are described fully in the appendix). In order to assess the relationship between computer use and skills, we controlled for the computer expertise of the teacher. We also controlled for the following school characteristics: school level (elementary, middle or high school), school control (public or private), and school socioeconomic status (SES).

Table 10 displays the correlation matrix of each of the three dependent variables (Y_1, Y_2, and Y_3) and the independent variables entered into each of the models. Note that the presence of quality technology support is positively correlated with each of the dependent variables.

TABLE 10: CORRELATION MATRIX OF VARIABLES ENTERED INTO MULTIPLE REGRESSION MODELS

	1	2	3	4	5	6	7	8	9
1. Frequency of Teacher Use With Students (Y_1)	1.000	.137	.368	.313	.157	.223	-.099	-.072	.047
2. Variety of Teacher Professional Use (Y_2)	.137	1.000	.389	.266	.087	.513	.144	-.049	.115
3. Change in Last 5 Years (Y_3)	.368	.389	1.000	.334	.215	.340	-.025	-.045	.039
4. Quality of Tech. Support (objective index)	.313	.266	.334	1.000	.271	.306	.025	.006	.159
5. Availability of Tech. Support (subjective perception)	.157	.087	.215	.271	1.000	.138	-.023	.037	.137
6. Teacher Computer Expertise	.223	.513	.340	.306	.138	1.000	.198	.030	.147
7. School Level	-.099	.144	-.025	.025	-.023	.198	1.000	-.104	-.012
8. School Control	-.072	-.049	-.045	.006	.037	.030	-.104	1.000	.167
9. School SES Location	.047	.115	.039	.159	.137	.147	-.012	.167	1.000

Using the same set of independent variables and controls, we ran three multiple regression models (one for each dependent variable). Table 11 shows the results of each of the model runs.

TABLE 11: REGRESSION MODEL RESULTS

	Model 1: Frequency of Teacher Use With Students (Y_1)				Model 2: Variety of Teacher Professional Use (Y_2)				Model 3: Change in Last 5 Years (Y_3)			
	b	se	Beta	p-value	b	se	Beta	p-value	b	se	Beta	p-value
Quality	0.48	0.05	0.25	.000	0.54	0.11	0.12	.000	0.74	0.12	0.23	.000
Availability	0.06	0.02	0.07	.006	-0.03	0.05	-0.01	.617	0.18	0.05	0.12	.000
Teacher Expertise	0.31	0.05	0.17	.000	1.99	0.10	0.47	.000	0.87	0.11	0.28	.000
School Level	-0.34	0.06	-0.15	.000	0.23	0.12	0.04	.059	-0.35	0.13	-0.09	.008
School Control	-0.57	0.15	-0.10	.000	-0.93	0.32	-0.07	.004	-0.63	0.34	-0.06	.068
SES Location	-0.04	0.07	-0.01	.609	0.27	0.15	0.04	.080	-0.22	0.16	-0.05	.177
	R^2 = 0.15, Adjusted R^2= 0.14				R^2 = 0.28, Adjusted R^2= 0.28				R^2 = 0.20, Adjusted R^2= 0.19			

Frequency of Teacher Use With Students (Y_1).

The first model demonstrates that, controlling for teacher expertise and school characteristics, both the quality and perceived availability of support are significant predictors of the frequency of teachers' use. Thus, teachers in schools with higher quality technology support are more likely to use technology with students than colleagues receiving lower quality support. Frequency of teacher use is dependent more upon quality of support, than perceived availability or teacher expertise.

Variety of Teacher Professional Use (Y_2).

The set of predictors in Model 2 explains twice the variance (28%) of those in Model 1 (14%). Again, quality is a significant predictor of teacher use. That is, teachers in schools with high quality technology support are more likely to engage in a variety of different professional uses of technology on a regular basis. However, availability is not a significant predictor of type of teacher use, indicating teachers' perceptions of technology support availability does not impact the type of teacher use.

Computer skills (expertise) are a strong, positive predictor of variety of use. Teachers with greater computer expertise are more likely to employ computer technologies in many different ways on a regular basis.

Change in Last 5 Years (Y_3).

In Model 3, the set of predictors accounts for 20% of the variance in teachers' changes in computer use over the last five years[8]. Both the quality of technology support and perceptions of its availability are significant predictors of teachers' changes in computer use.

As with the previous two models, teachers' expertise is also a significant predictor. That is, teachers with more computer expertise are more likely to increase their use of technology over time.

Table 12 summarizes the results of the three models. An asterisk (*) indicates the independent variable was a significant predictor of the teachers' use dimension. The quality of technology support has an impact on all three aspects of teachers' uses of technology. Specifically, teachers in schools with high quality technology support use technology more frequently with students and in a wider variety of ways professionally. Furthermore, quality technology support can influence teachers to increase their use of technology over time. These findings support previous claims of a link between the quality of technology support and the quantity and quality of actual use of technology by teachers.

TABLE 12: SUMMARY OF SIGNIFICANT PREDICTORS OF TEACHERS' USE

	Frequency of Teacher Use With Students (Y_1)	Variety of Teacher Professional Use (Y_2)	Change in Last 5 Years (Y_3)
Quality	*	*	*
Availability	*	-	*
Teacher Expertise	*	*	*
School Level	*	-	*
School Control	*	*	-
SES Location	-	-	-

Summary of Findings

Technology support in America's schools typically comprises access to equipment, dedicated staff, and professional development programming. This support is profoundly resource dependent, as evidenced by the wide range of roles adopted and number of hours worked by those involved with educational technology. Data from the Teaching, Learning and Computing survey in 1998 indicate that teachers' use of technology is positively related to support. Thus, we recommend that technology leaders plan carefully in order to provide a complete set of technology support services. This should include all of the dimensions from Table 1: facilities, staffing, personal assistance, professional development programming, and incentives.

When the technology support is designed with the instructional needs of teachers in mind—i.e., creating convenient access to necessary resources, providing individualized support, training teachers to integrate technology into the classroom, and providing resources as incentives—the effect on use is pronounced. This underscores the need for a systematic approach to creating support. Indeed, elements need to be provided and coordinated into a larger comprehensive view of what teachers need to make use of technology as an instructional tool.

[8] It is important to note that change is based on one measure of teachers' perceptions of change (see appendix), rather than the difference between ratings at two different time periods. Thus, the results should be interpreted with this in mind.

IMPLICATIONS AND CONCLUSION

Implications

Our findings confirm that the successful integration of technology into the classroom requires the availability of quality technology support. Support is multifaceted, comprising elements as general as routine maintenance and as specific as individualized training. Our demonstration that a quality support program requires the coordination of these elements highlights three issues of concern to technology leaders.

First, technology leaders need to be cognizant of the fact that technology support is not simply technical support. As noted above, technology support in an educational setting covers both the technical and instructional domains of support. By recognizing how each of these domains helps to facilitate the integration of technology into the classroom, technology leaders are able to identify how their decision-making and other leadership duties set the stage for creating high quality support programming.

Second, technology support programs are more effective when directed by well-trained technology coordinators. Recognizing that many schools have had to be creative and flexible in order to staff technology coordinator roles, we believe the elements of quality described above warrant specific training and qualifications. Schools, colleges, and departments of education could help to prepare such knowledgeable individuals by establishing or coordinating courses for technology support certification. In order to deal knowledgeably with the technical and instructional domains of support, technology coordinators must be trained to bridge technical ability with classroom teaching experience; their leadership and administrative capacities should be nurtured; and their aptitude for instructional design should be developed. While it is likely that the range of responsibilities for technology support exceeds the capabilities of any one person, schools need at least one individual with working knowledge of those areas. Under the direction of a qualified technology coordinator, faculty, staff, and students are able to provide adequate support.

Third, teachers must be provided with opportunities to learn about and use technology. This might be accomplished by adopting a systemic view that acknowledges teachers' dual role; i.e., they are both learners and instructional designers. Schools, then, are not simply workplaces in the traditional sense, but also places of learning for teachers. To begin, technology leaders must provide teachers with convenient access to educational technology resources and unfailing support for their use. Those who are unable to operate technology, or to use it effectively to leverage learning gains, must have opportunities to learn. Such training must fit into and be balanced with other work demands; they must also provide teachers with opportunities to socially construct understandings of these instructional tools. That is, teachers must first have access information. With experience they can incorporate their knowledge of technology into their pedagogy.

Conclusion

High quality technology support is comprehensive; it includes a variety of elements and careful planning to ensure their coordination. It is not simply "technical" support, such as undertaking routine maintenance and resolving software and hardware problems. Rather it is also "instructional" support, including individualized training, professional development activities, and professional development content that focuses on instruction and integration. Teachers report, and our descriptive data confirm, that they do not receive adequate instructional support to integrate technology into the classroom. These results suggest that if technology leaders hope to increase the frequency and variety of teachers' uses of technology, they should create professional development opportunities and learning environments that emphasize the instructional uses of educational technology.

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APPENDIX - DESCRIPTION OF INDICATORS ORDERED ALPHABETICALLY

Availability

Teachers on three versions of the questionnaires (1,3,4) were asked how available both technical and instructional support were when they needed it. Teachers based their answers on the following scale: '1' = not available; '2' = sometimes; '3' = frequently; '4' = mostly; '5'=almost always.

To create an overall availability measure, the original scale was recoded where '0' = not available; '1' = sometimes; '2' = frequently; '3' = mostly; '4'=almost always. Ratings of technical and instructional support availability were then summed. The result is an indicator of teachers' perceptions of overall availability which ranges in score from 0 to 8, where '8' indicates teachers perceived both technical and instructional support as available "almost always" when they needed it.

Change in Last 5 Years

Three versions of the teachers' questionnaires (2,3,4) asked teachers the following: compared to 5 years ago, are using computers more or less frequently in the following ways? (a) trying out new software or technologies; (b) using computers for class preparation (i.e., handouts, overheads); (c) using computers for non-work activities; (d) assigning students to use computers; (e) suggesting that students use computers in their projects. Teachers answered the question based on a four point scale where '1' = less frequently now, '2' = stayed the same, '3' = more frequently now, and '4' = much more now.

The change indicator was created by taking the sum of teachers' ratings across the five activities listed. Teachers who had less than 5 years of teaching experience were excluded from the analysis. Scores range from 0 to 20 where '20' indicates teachers said they performed all five activities much more now than they did 5 years ago.

Frequency of Technology Use With Students

The teacher computer use indicator represents how frequently teachers use computers with students. As illustrated in Table 13, a score of ‘0’ indicates the teacher does not use computers either professionally or with students; this is true for 7% of the teachers in our sample. If teachers use computers with students, they were to indicate whether this use occurred in the course in which they felt most satisfied with their teaching (the course where they accomplished their teaching goals most often). These questions included information on actual technology use with students. Thus, it was thought that responses related to the class in which teachers felt they accomplished their teaching goals most, would best represent the teacher’s beliefs and use. A score of ‘2’ indicates the teacher uses computers with students, but not in the class with which they are most satisfied. The highest score a teacher can receive on the teacher use indicator is a ‘6’ which indicates the teacher uses technology with students 41 times or more during a school year in the class with which they are most satisfied; about 16% of teachers in the sample received this score.

TABLE 13: DESCRIPTION OF TEACHER USE INDICATOR

Teacher Use Value	Description of Use	% of Teachers
0	Teacher does not use computers, either professionally or with students	7
1	Teacher uses computers only professionally	22
2	Teacher uses computers with students, but not in class with which they feel most satisfied	10
3	Teacher uses computers with students in the class with which they are most satisfied 1 to 10 times per school year	23
4	Teacher uses computers with students in the class with which they are most satisfied 11 to 20 times per school year	10
5	Teacher uses computers with students in the class with which they are most satisfied 21 to 40 times per school year (weekly)	12
6	Teacher uses computers with students in the class with which they are most satisfied 41 or more times per school year (bi-weekly)	16

School Level

School level represents the level of the school where ‘1’ is elementary schools, ‘2’ is middle schools and ‘3’ is high schools. This variable was created by examining the median grade of the school. Initially, school grade levels were from the sampling database, which was constructed from the QED database. This information was then updated with responses provided by the school principal. Elementary schools were those schools with median grade ranges of 5.5 or below; middle schools have median grade ranges of 5.6-9.4; and high schools are those having median grade ranges of 9.5 or above.

School Control

The type of school is based on information from the QED database. The original categories were ‘1’ = Public, ‘2’ = Catholic and ‘3’ = Other, where other includes other parochial besides Catholic, as well as non-sectarian private schools. This variable was collapsed into a dichotomous variable where ‘1’ = Public and ‘2’ = Private.

SES

School socio-economic status was obtained using QED data based on the income level of households within the schools’ zip code. The original variable was based on a five-point scale where '0' = not classified, '1' = low SES, '2' = low to average SES, '3' = average SES, '4' = average to high SES and '5' = high SES. These categories where then collapsed into a trichotomous variable where '1' indicates low SES, '2' indicates average SES, and '3' indicates ‘high SES’.

Teachers' Expertise

Because we recognized that a teacher's current level of skill and years of experience using technology might influence their need for technology support, we assigned all 2,251 respondents a skill level, ranging from 1 to 4, based on a self-report of their computer skills. The seven skills listed ranged from basic operating system skills, such as knowing how to "copy files from one disk to another" and "display the directory of a disk," to more complex skills, such as knowing how to "create a new database and establish fields and screen layouts," "imbed graphics into a word-processor document," "prepare a slide show using presentation software," "use a World Wide Web search engine" and "develop a multimedia document using HyperStudio or similar authoring software." Their responses that they either did, did not, or somewhat knew how to execute that skill were assigned a score. Their score on each of these seven items were averaged. The ranges of average score were then split into four divisions that fell along natural breaks and very roughly approximated quartiles.

TABLE 14: PERCENTAGE OF TEACHERS AT EACH SKILL LEVEL

Technical Skill Level	Percent of Total
Level 1	26
Level 2	31
Level 3	25
Level 4	18

Variety of Teacher Professional Use

Our variety of professional use measure was based on the following question answered by teachers: In which of the following ways do you use computers in preparing for your classes or in other professional activities? Eight types of activities were listed: record or calculate student grades; make handouts for students; correspond with parents; write lesson plans or related notes; get information or pictures from the Internet for use in lessons; use camcorders, digital cameras or scanners to prepare for class; exchange computer files with other teachers; and post student work, suggestions for resources, or ideas and opinions on the World Wide Web. Teachers answered the questions based on a four point scale where '1' = do not use, '2' = occasionally, '3' = weekly and '4' = more often.

The original scale was recoded so that '0' = do not use, '1' = occasionally, '2' = weekly and '3' = more often. The scores on all eight activities were summed to create an overall variety of use index. Scores range from 0 to 24 where '24' indicates all eight activities were done "more often" by teachers and a score of '0' indicates teachers had done none of the eight activities listed.