

Quality Technology Support: What is it? Who has it? and What difference does it make?

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Abstract: Using the recommendations of the CEO Forum report on Professional Development, we operationalized "quality technology support" as consisting of (1) access to one-on-one personal guidance and help, (2) frequent teacher participation in technology-oriented professional support among teacher peers, (3) professional development content focused on instruction and integration, and (4) access to resources. Using the 1998 TLC national survey of teachers, we empirically confirmed that the frequency, variety, and increased use of technology in the classroom are associated with the availability of quality technology support. These results suggest that if technology leaders hope teachers will integrate technology they should attend to the instructional aspects of technology support, such as professional development opportunities and learning environments, as well as its technical components.

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Quality Technology Support: What is it? Who has it? and What difference does it make?

The failures of and difficulties encountered in so many K12 technology implementations have taught us that teachers need support in order to use educational technology in the classroom. Nearly all case studies of teachers' integration efforts emphasize that teachers need ready access to hardware, technical support, training, and instructional support (Blomeyer, 1991; Collis & Carleer, 1992; Diem, 1986; Garner & Gillingham, 1996; Ginsberg & McCormick, 1998; Kirby, 1998; Means & Olson, 1995; Pisapia, 1993; Ruopp, Gal, Drayton & Pfister, 1993; Sandholtz, Ringstaff & Dwyer, 1997; Schofield, 1995; Smith & Pohland, 1991; Stake, 1991; Strudler, 1991), occasionally varying only in their relative emphasis on these elements. Prominent reports by policymakers (U.S. Congress, Office of Technology Assessment, 1995; President's Committee of Advisors on Science and Technology & Panel on Educational Technology, 1997) and commentary from technology experts (Carter, 2000; McKenzie, 2001; Means, 2001) have echoed these findings, describing a lack of support as one of the biggest roadblocks to successful integration. Yet, little work has been done to date to conceptualize what an effective technology support environment might look like.

The CEO Forum, a group of business executives and school leaders concerned with the use of technology in America's schools, is an exception and an important attempt in this direction. They released a report (1999) detailing the key elements a school should aim for when developing high quality technology professional development programs for teachers. They describe both the professional development program and the general school environment that are necessary to support teachers' use of technology in the classroom. This includes that there is widespread participation among the teachers and that there is an emphasis on helping teachers how to integrate, not just learn to operate, educational technology. They also suggest that such offerings are either regularly scheduled or, ideally, is available to teachers on a "just in time" basis, as one-on-one learning opportunities. In addition, they suggest that teachers have access to follow-up help and preferably from individuals with classroom and curriculum experience. They also suggest that teachers should have ample access to educational technology resources near or in their work areas.

This paper offers a definition of quality technology support, which was guided by the CEO Forum professional development framework. While there are some descriptive data on different models of technology professional development (e.g., Anderson, 1998, 2001; DeWert & Cory, 1998; Milone, 1998), there is little data to date on the prevalence of quality technology support and its component parts, the factors that predict its presence, and its correlation with teachers' uses of technology. This national survey provides this important, heretofore unknown data.

Sample

The information gathered by the Teaching, Learning and Computing survey (TLC 1998) was derived from a national stratified, random 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. The QED supplied "universe" of schools was stratified by school size and the amount of technology in the school. Size was

determined by the number of full-time teachers at the school (grade 4 and above); amount of technology was established vis-à-vis an index of ten different types of technology present on a per-capita basis. The ten types of technology were selected in order to maximize the differences among the schools in the amount of technology present overall. It should be noted that by stratifying on school size and technology presence, the sample was not less representative but more representative of United States schools, and sampling errors were reduced.

Within sampled schools, probability methods were also used for sampling teachers. 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. 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. Using this information we gave teachers using computers and using projects a higher chance of selection in the sample. 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). In order to adjust for the school stratification by size and technology, weights were calculated by taking the inverse of the probability of selection of each school. Teacher weights were calculated by using both the school weight and the inverse of the teacher's probability of selection.

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.

Measurement

Definition and Prevalence of High-Quality Technology Support

The CEO Forum's 1999 report provides guidelines for schools developing high quality technology professional development and support programs, and includes an index, called the STaR Chart, for assessing the 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; these development opportunities are to include help from individuals with classroom and curriculum experience. Third, it suggests the need for teachers to have access to technology resources convenient to their classrooms. And finally, the CEO Forum's report also notes that attempts must be made to involve most of the teachers in the school in the technology professional development program. 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 in American schools, we applied these criteria to questions from our teacher and technology coordinator surveys. 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 STaR 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 technology support 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 70th percentile.

Frequent teacher participation in technology-oriented professional support among teacher peers.

The second dimension reflects the degree of teacher participation in school-wide technology professional development activities. This indicator, teacher participation, 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 1 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. "

Table 1

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%

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 2

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 quantitative, more "objective" index, we also developed a more subjective measure. 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 higher the overall quality rating, the more likely teachers were to give their technology-support environment a high score. This relationship holds true for schools receiving a lower 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 sizes¹ 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 3.

Table 3
Effect Sizes Of Quality Score Component On Teachers' Perceptions Of The Quality Of Support Received¹

Quality Index Component	Effect sizes of teachers' perceptions of overall quality of support received when each of four quality components was present:	
	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 3 shows that, while all four of the components of support highlighted in our CEO Forum-based (1999) quality support index 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 on who has quality technology support, including the factors that predict its presence and the difference it makes for teachers' uses of technology.

¹ 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.

Findings

Variations in quality technology support.

Figure 1 compares the quality technology index (see Table 2) 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 of the four dimensions in our quality index.

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.

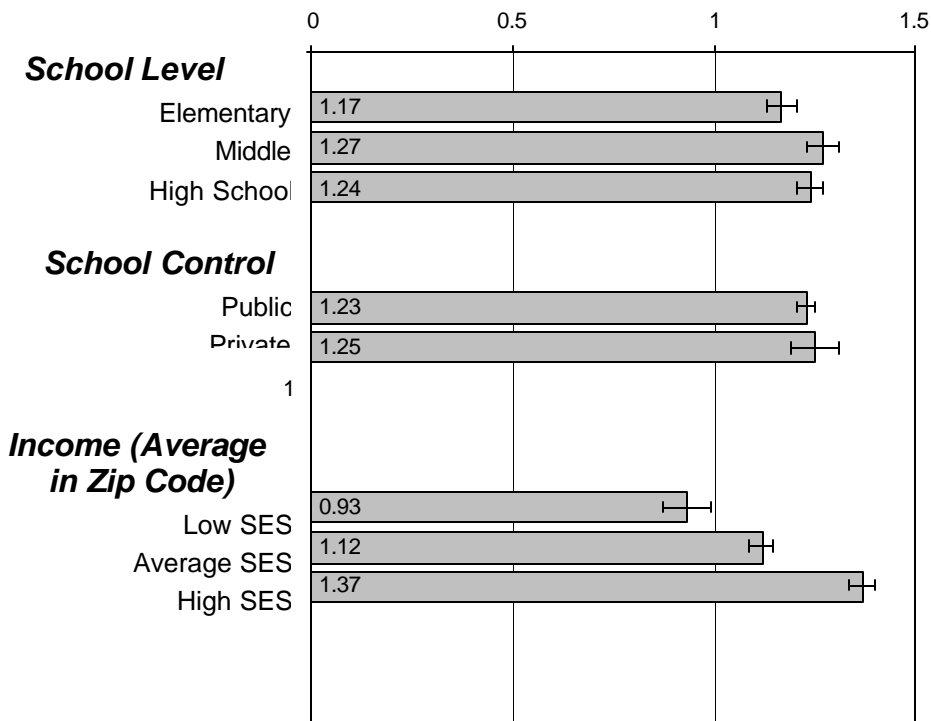


Figure 1: Average quality technology support score broken out by school characteristics.

Teachers’ perceptions of quality compared across school characteristics.

Figure 2 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).

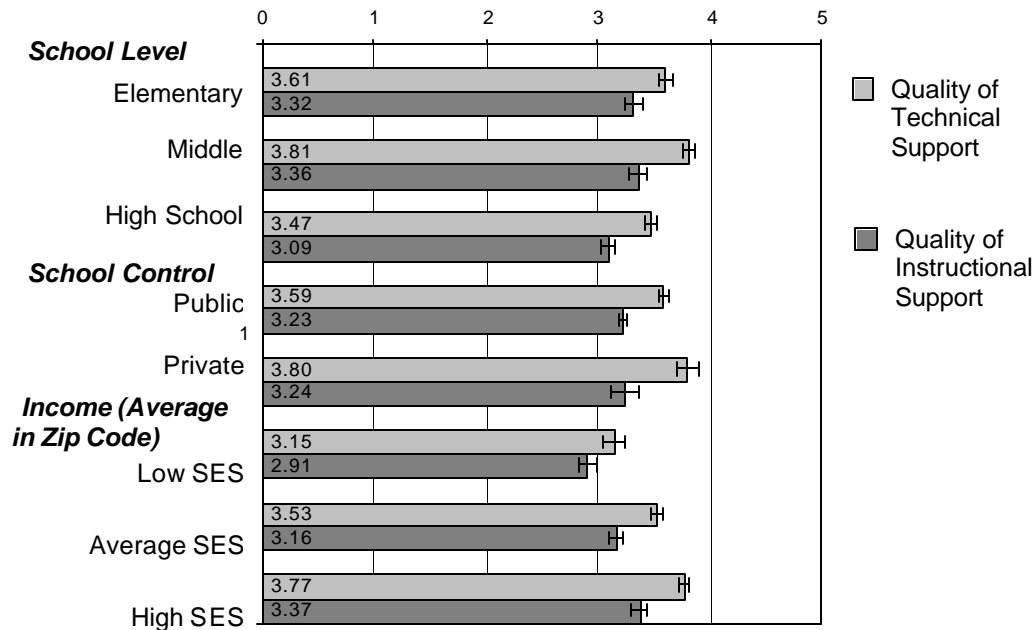


Figure 2: Teachers' perceptions of quality of technology support broken out by school characteristics.

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 (i.e. public, private) 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 than 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 the subjective measure, the teachers' perceptions of quality, and the more objective measure, the actual presence of the four dimensions of quality technology support as measured by the index. What remains unclear, however, is whether access to quality technology support matters. That is, does it lead to greater technology use by teachers? We address this question in the next section.

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 investigate it, 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 teachers' uses of technology.

To examine the impact of quality technology support on each of the three aspects of teachers' computer use, we employed multiple regression using the SPSS forward selection method. 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 of the actual technology support available to them in their 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 4 displays the correlation matrix of each of the three dependent variables (Y1, Y2, and Y3) 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 4
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 5 shows the results of each of the model runs.

Table 5
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 (Y₁).

The first model demonstrates that, controlling for teacher expertise and school characteristics, both the quality of support and its perceived availability are significant predictors of the frequency of teachers' assigning their students to use technology. 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 (Y₂).

The set of predictors in Model 2 explains twice the variance (28%) of those in Model 1 (14%). Again, our measure of 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 their use of technology to complete their professional work.

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 (Y₃).

In Model 3, the set of predictors accounts for 20% of the variance in teachers' changes in computer use over the last five years². Both the quality of technology support and perceptions of its availability are significant predictors of teachers' changes in computer use. As with the

² 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.

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.

Summary of Findings

Table 6 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 6
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	-	-	-

Even so, these models account for only up to 28% of the variance. Elements that we were not able to include in our models but other related research suggests impact teachers' uses of technology include teachers' instructional aims and purposes (Dexter, Anderson & Becker, 1999), their beliefs about instruction (Ravitz, Becker & Wong, 2000), their degree of professional involvement and collaboration (Becker & Riel, 2000; Ronnkvist & Anderson, 2000) and their principal's leadership for technology use (Anderson & Dexter, 2000).

Implications and Conclusion

Implications

Our findings confirm that teachers' frequency, variety, and progressive use of technology is positively correlated with the availability of quality technology support. Such support is multifaceted, comprising elements as general as access to equipment and as specific as individualized training. Our demonstration that a quality support program requires the provision and coordination of these elements highlights three issues of concern to technology leaders.

First, technology leaders need to be cognizant of the fact that to provide quality technology support they must go beyond the more prevalent technical aspects of support (Ronkvist, Dexter & Anderson, 2000) and also cover the instructional domain of support. Recognizing how each of these domains helps to facilitate teachers' integration of technology into the classroom should guide technology leaders in their decision-making and other leadership

duties so they allocate the resources, hire the staff, and support the policies and practices that work together to bolster high quality technology support.

Second, we believe the elements of quality described above warrant specific training and qualifications; thus, technology support programs will be more effective when directed by well-trained technology coordinators. Many schools have had to be creative and flexible in order to staff technology coordinator roles at all. Yet, 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. It is likely that the range of responsibilities for technology support exceeds the capabilities of any one person. Under the direction of a qualified technology coordinator, faculty, staff, and students could work together to provide high quality technology support. But, schools would benefit from at least one individual with working knowledge of those areas. Schools, colleges, and departments of education could help to prepare such knowledgeable individuals by establishing or coordinating courses for technology support certification.

Third, the instructional aspects of our quality index highlights that teachers should be provided with opportunities to learn to use technology and to integrate it into their classrooms. Focusing on the teacher as a learner and as an instructional designer suggests what the school setting must provide teachers both as a workplace and as a place of learning. If technology leaders want teachers to design instruction that utilizes educational technology, putting it into students' hands as a powerful tool, then their workplace should provide convenient access to educational technology resources and unfailing support for their use. If teachers do not yet recognize how to operate technology and use it to leverage learning gains, they should have opportunities to learn to do so. These learning opportunities should fit into and be balanced with their other work demands and allow for them to socially construct understandings of these instructional tools. That is, teachers should have access to information and experiences that allow them to process it into personal understandings that they make a part of their pedagogy. This would support their applying, in their own instructional style, educational technology to their classroom situation and trusting that they are making sound decisions about the use of students' precious learning time when they do so.

Conclusion

When technology support is designed with the instructional needs of teachers in mind---such as creating classroom-convenient access to necessary resources, providing teachers with one-on-one support, teaching them about integrating educational technology, and encouraging professional collaboration---the effects on teachers' uses are pronounced. Quality technology support is associated with teachers' increased uses of technology, correlating with greater frequency and variety of use as well as increased use over time.

Teachers report, and our data confirm, that they do not receive adequate instructional support to integrate technology into the classroom. These results suggest that technology leaders should plan carefully for a set of coordinated technology support services, i.e. support that includes professional development opportunities and learning environments that emphasize the instructional uses of educational technology. This suggests a need for a systematic approach to creating support, so that all elements are not only provided for, but also coordinated into a larger comprehensive view of what teachers need to make use of technology as an instructional tool.

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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 7, 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 7: 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 were 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," "embed 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 8: 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.