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Identifying Teacher, School and District Characteristics Associated with Elementary Teachers' Use of Technology: A Multilevel Perspective

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Abstract

Over the past decade, investment in technology for schools has increased at a dramatic rate. Although policy makers are eager to understand the ways in which technology use in schools is affecting student learning, we believe that a critical preliminary step toward assessing the impacts of technology on teaching and learning requires the examination of the varied uses of technology in schools as well as the contexts that are likely to affect the use of technology in the classroom as a teaching and learning tool. Previous research examining technology use has focused on teacher characteristics and has neglected to explore the potentially alterable, organizational characteristics that may be affecting the adoption and use of technology in the classroom. In light of this argument and using survey data collected from 1490 *elementary* classroom teachers in 96 schools in 22 Massachusetts districts,

this research examines how technology is being used by elementary school teachers, and examines the school and district organizational characteristics that are associated with increased use of technology as a teaching and learning tool. In addition to examining technology-use as a multi-faceted construct, using multilevel regression techniques this study provides evidence that schools' organizational characteristics are associated with teachers' use of technology in the classroom. Organizational characteristics such as districts' and schools' leadership practices and emphasis on technology, the type and amount of technology-related professional development available to teachers, as well as the amount of technology-related restrictive policies in place were found to be associated with the four measures of teachers' use of technology examined in this study. Individual teacher characteristics such as constructivist beliefs, higher confidence using technology and positive beliefs about the efficacy of technology were each found to be associated with increased use of technology in the classroom.

Introduction

In a society that has become increasingly reliant on technology, it is not surprising that technology has become part of the permanent landscape in our schools and classrooms. In recent years, federal initiatives for which spending on educational technology increased from \$21 million in 1995 to \$729 million in 2001, have served to decrease the student-to-computer ratio from 9:1 to 4:1 over the same period (Glennan & Melmed, 1996; Market Data Retrieval, 1999, 2001). Both teachers and students report using technology at unprecedented levels; in 2001, the U.S. Census Bureau's Current Population Survey reported that American children between ages 9-17 use computers more than any other reported subgroup of the American population (92.6 percent) (A Nation Online, 2002). Similarly, data from NAEP reveals that 85 percent and 78 percent of teachers report using a computer to create instructional materials at home and at school, respectively, and that about half of all teachers use computers for administrative record keeping at school as well as at home (U.S. Department of Education, 2000). Additionally, NCES reports that about half of all teachers use email to "communicate with colleagues" and about a quarter of teachers communicate with parents via email (2000).

Despite these large expenditures, this increased access, and almost universal use by school-age children and their teachers, several observers have questioned the extent to which technology is affecting teaching and learning. In particular, some argue that there is insufficient evidence that access to educational technology has increased test scores (Oppenheimer, 1997; McNabb, Hawkes & Rouk, 1999), has had a positive impact on instruction (Stoll, 1999; Healey, 1998), or is being used effectively as an instructional tool (Cuban, 2001). While there is, understandably, a strong desire among policy makers to examine the impact of technology on student learning, we believe that as a critical preliminary step, it is first necessary to understand *how* technology is being used and *the contexts* that are likely to affect the adoption and use of technology in the classroom as a teaching and learning tool. Similarly, in order to effect policy changes, we believe that it is necessary to generate an understanding of the organizational characteristics that are associated with the use of technology in the classroom. Since technology-related decisions that can impact practices within the classroom are typically made *outside* of the classroom, it is important to examine potential technology-related policy levers that exist at the school and district level. Overall, examining the characteristics of

schools and districts associated with increased technology-use has the potential to lead to a greater understanding of the organizational practices, policy differences, and differences in student populations that explain teacher-to-teacher and school-to-school differences in how technology is being used as a teaching and learning tool.

In light of this argument, this research examines how technology is being used by elementary school teachers, and examines the school and district characteristics that are associated with the use of technology in the classroom. We begin by discussing previous research that examines technology use among teachers, and the methodological as well as substantive advantages to examining the ways in which organizational characteristics potentially impact technology-related classroom practices.

Prior Research Examining Types of Technology Use and Teacher Characteristics

In recent years, seminal work by Becker, Anderson, Ravitz, and Wong (1998, 1999) and work by Mathews (1996, 2000) have helped define types of “technology use” in classrooms and schools. Research by Becker and his colleagues found that teachers’ and students’ use of technology is both varied and widespread (Ravitz, Wong, and Becker, 1998; 1999; 2000). For example, in their nationally representative sample, 71 percent of teachers in Grades 4 through 12 reported requiring their students to use a computer at least once in some way at some point during the 1997-1998 school year. Their work also found that almost 75 percent of the teachers who reported not using technology *with* their students, reported using technology themselves for non-instructional purposes. In fact, the most frequent use of technology across all subject areas was not instructional use, but “professional uses of technology related to their day-to-day needs” (Becker, 1999, p. 31) such as preparing handouts for class at least weekly (66 percent of all teachers). Other frequent non-instructional uses of technology included use for record keeping and student grading, with almost half of all teachers reporting this type of use on a weekly basis.

Although the work by Becker et al. found “technology use” to be a multi-faceted phenomenon, the majority of their research focused on teachers’ use of technology to deliver instruction. In their study, Becker and his colleagues (2000) found that “constructivist-oriented teachers use computers in more varied ways, have greater technical expertise in the use of computers, use computers frequently with students, and use them in more powerful ways” (p. 55) and that teachers who reported feeling comfortable with technology and had a positive philosophy toward computers made more frequent use of computers both in their own work and with their students.

Becker et al. also examined the relationship between technology use and other teacher characteristics. These characteristics included teachers’ subject area, teachers’ access to technology, scheduling practices, as well as measures of teachers’ perceptions about school culture. Becker et al. found that academic teachers who work in secondary schools that schedule longer blocks of time (e.g., 90-120 minutes) for classes “were somewhat more likely to report frequent student computer use during class (19 percent vs. 15 percent), even though they met with their classes on perhaps half the number of days as teachers who taught traditional 50-minute periods” (Becker & Anderson, 2001, p. 3). School environment was measured in a number of ways including the extent to which teachers reported feeling pressured (either self-imposed or externally imposed) to cover large amounts of curriculum. Here Becker found that those teachers who do not try to teach a large number of separate topics but “a small number of topics in great depth” are twice as likely to have

their students use computers in class (29 percent vs. 14 percent, respectively) as are those teachers who report pressure to cover a large amount of curriculum.

Similarly, Mathews' study (1996, 2000) which examined 3,500 K-12 survey responses from teachers in Idaho found that "technology use" is not a singular concept. Mathews' research examined teachers' use of technology for the preparation of class materials, for reporting attendance, for word processing, for tutorials that explain concepts/methods, and for drill and practice. Using ordinary least squares regression to examine technology use, Mathews found that predictors varied in their ability to predict the many different technology uses that were observed among teachers, confirming the hypothesis that there is no single, generic definition of "technology use". For example, Mathews found teachers' level of education to be a powerful predictor of teachers' use of technology to prepare instructional materials, record attendance, and perform word processing, while the number of students in the class was a strong predictor of technology use to record and calculate grades, and for drill and practice. Mathews' work was the first to use regression models to predict deconstructed measures of how teachers use technology as a professional tool.

Both Becker et al. and Mathews' work demonstrate the refinement of measurement that is possible in assessing teachers' use of technology, and their statistical models show that context variables differ in terms of their relationship to each of the defined technology uses. A commonality across the work of Becker et al. and Mathews is the absence of contextual or organizational measures taken at the school or district level. Their research focuses on the teacher characteristics that potentially influence technology use, but neither study includes other potentially alterable variables measured at the school or district level that may be affecting the adoption of technology in the classroom by teachers. Although Becker and his colleagues' work does include some measures of school culture, these are measures taken at the teacher level and were not aggregated to create school or district averages. The research presented here seeks to extend the work of Mathews and Becker et al. by including organizational characteristics measured at the school and district level in models to predict four common uses of technology. Knowing that teachers are influenced by the structure of the system in which they work, we seek to examine technology use using a multilevel or hierarchical approach.

Examining Teachers' Use of Technology Using a Hierarchical Approach

Over the past two decades, researchers have become increasingly aware of the pitfalls of examining organizational data using traditional analyses such as ordinary least squares analysis or analysis of variance, and of the need to analyze education-related processes using a hierarchical or nested approach (Robinson, 1950; Cronbach, 1976; Haney, 1980; Burstein, 1980; Bryk & Raudenbush, 1992; Kreft & de Leeuw, 1998). As far back as 1976, Cronbach wrote the following:

The majority of studies of educational effects – whether classroom experiments, or evaluations of programs, or surveys – have collected and analyzed data in ways that conceal more than they reveal. The established methods have generated false conclusions in many studies (1976, p.1)

A hierarchical approach is recommended because education systems are typically organized in a hierarchical fashion; students are nested within classrooms, classrooms within schools, and schools within districts. At each level in an educational system's hierarchy, events take place and decisions are made that potentially impede or assist the events that occur at the next level. For example,

decisions made at the district level may have profound effects on the technology resources available for teaching and learning in the classroom.

Given that decisions to make technology available in classrooms are typically made at the school or district level, it is important to examine the school system as a hierarchical organization within which technology use occurs, and to identify alterable characteristics at the school or district levels that could positively affect the use of technology as a teaching and learning tool in the classroom. A hierarchical approach to analyzing the factors that are associated with increased technology use requires the analysis of individuals within groups, and groups within larger organizations, and has a number of advantages over more traditional approaches. The advantages of the hierarchical approach include the following (Bryk & Raudenbush, 1992; Goldstein, 1995; Kreft & de Leeuw, 1998):

- the approach allows the examination of technology use as a function of classroom, teacher, school and district characteristics;
- the approach allows the relationship between characteristics such as school socioeconomic status or the availability of technology-related professional development, and technology use to vary across schools;
- the approach “borrows strength” from the relationship between structural characteristics and technology use in other schools in order to create a better understanding of the processes that impact technology use;
- differences among teachers within schools and differences between schools can be explored at the same time therefore producing a more accurate representation of how organizational characteristics are associated with technology use in the classroom.

Recognizing this importance, the purpose of this study is to examine elementary teachers’ use of technology from a multilevel perspective. Using data collected as part of the Use, Support, and Effect of Instructional Technology (USEIT) Study, this research applies hierarchical linear modeling techniques to examine the ways in which elementary teachers’ use of technology is influenced by the characteristics of their schools and districts. Using a two-level model, this research examines technology use as a function of teacher characteristics at level-1, and as a function of school and district leadership characteristics, and technology-related policies at level-2. Based on these findings, implications for school and district technology-related policies and practices are explored. Prior to examining these issues, we provide a brief overview of the USEIT study and the measures used in the hierarchical models. Throughout the present work, the term technology refers specifically to computer-based technologies and includes personal computers, LCD projectors, and Palm Pilots.

USEIT Study Data

Data from the USEIT study were analyzed to examine the organizational characteristics that are associated with technology use. The USEIT study, which was conducted in 22 school districts in Massachusetts, was designed to examine how educational technologies are being used by teachers and students, which factors influence these uses, and how these uses affect student learning. In the spring of 2002, surveys were administered to gather data about district technology programs, teacher and student use of technology both in and out of the classroom, as well as information about the factors that influence these uses. In total, survey responses were obtained from 120 district-level

administrators, 122 principals, 4,400 teachers, and 14,200 students in elementary, middle, and high school.¹ The USEIT sample design allows students, teachers, principals and district-level administrators to be linked to each other.

This paper presents analyses based on survey responses from 1,490 elementary classroom teachers in 96 schools from grades kindergarten through Grade 6. Special education teachers were not included in the sample. Approximately 86 percent (1,276) of the elementary teachers included in the sample reported teaching all subjects, and the remaining 14 percent reported teaching English, mathematics, science, or social studies in some combination. Ninety-three percent of the sample was female. The majority of teachers surveyed were veteran teachers with approximately 58 percent reporting that they had been teaching for more than 10 years at the time the survey was administered. Only 3 percent of the elementary teachers reported having been teaching for less than one year. Approximately 83 percent (1,236) of the teachers surveyed reported having internet access in their classrooms, and 38 percent reported having access to three or more desktop computers in their classrooms. Less than 14 percent of the teachers reported that they do not have access to desktop computers in their classrooms, and of this percentage about half have access to computers in either a lab/media center or in the library. Only about 4 percent of the sample reported not having access to either desktop computers or laptop computers in their classrooms, lab/media centers, or libraries.

The USEIT study was designed to focus on a broad range of issues related to teacher and student use of technology, and included several survey items that focused specifically on the ways in which teachers are currently using technology and the factors that influence these uses. In the analyses presented here, a subset of survey items from the student, teacher, school principal, and district technology director were used to provide insight into the policies and practices that influence the adoption of technology as a teaching and learning tool in the classroom.

Outcome Measures: Defining Teacher Technology Use

Despite a substantial body of research focusing on teachers' use of technology, definitions of "technology use" vary widely. In-depth studies such as those conducted by Becker and his colleagues and Mathews focus on a number of refined uses of technology, but many discussions centering on technology use in schools employ a generic definition of "teachers' technology use". The array of use definitions was identified as early as 1995 in the Office of Technology Assessment (OTA) report *Teachers and Technology: Making the Connection* which notes that previous efforts to examine teachers' use of technology employ different categorizations and definitions of what constituted technology use in the classroom. The report points out that a 1992 survey conducted by the International Association for the Evaluation of Educational Achievement (IEA), defined a "computer-using teacher" as someone who "sometimes" used computers with students. In 1994, Becker constructed a more sophisticated classification to identify computer-using teachers. Comparing the two measures, the OTA found that while the IEA study classified 75 percent of teachers as "computer-using teachers", Becker's measure classified only 25 percent of teachers this way. In recent years, the expansion of the internet and email access, the universal availability of software programs that

¹ For a complete description of the study design, response rates, sample demographics, and survey instruments see www.INTASC.org.

are easier to use, and the growth of an entire industry dedicated to the production of educational software has further confounded the definition of “technology use”.

In order to tap into the multidimensional construct that is technology use and using many of the survey items developed by Becker et al., the USEIT surveys were designed to measure a large number of variables that relate to technology use. Building upon the theory-driven design of the surveys, teacher responses were analyzed and combined into composite variables to create refined measures of technology use. Using principal component analysis, a number of scales representing specific categories of technology use were created by combining a subset of survey items that were closely related to each other. For example, some survey items focused on the use of a specific type of technology, such as an LCD projector or the use of technology for communication with parents, colleagues, and administrators, while other items focused on the many ways in which teachers ask students to use technology for writing papers, conducting research, using spreadsheets, or for creating web pages. Other survey items focused on teachers’ use of technology such as for creating quizzes and tests, preparing lessons, or accommodating lessons. In this paper, four specific uses of technology were examined. These are as follows:

1. Teachers’ use of technology for delivering instruction;
2. Teacher-directed student use of technology during classtime;
3. Teacher-directed student use of technology to create products; and
4. Teachers’ use of technology for class preparation.

Table 1 presents the individual items used to create the four technology use scales, and the reliability of each of the scales for the elementary school teachers. Use of technology for delivering instruction is measured using a single item and each of the other outcomes is made up of a linear combination of at least 3 items.² Each scale was created to have a mean of zero and a standard deviation of 1. In the multilevel regression models, these four outcome measures are modeled as a function of teacher, school, and district characteristics.

Presenting a deconstructed view of technology use does not imply that these measures are completely independent. In fact, *Table 2* shows that these uses are moderately and positively correlated with each other, indicating that on average, teachers who use technology for one purpose are also likely to use technology for other purposes. The strongest relationship exists between teacher-directed student use of technology during class time and teacher-directed student use of technology to create products (0.590).

² Extensive exploratory data analysis was conducted in order to identify other variables that could be used in conjunction with the measure of technology use for delivery to create a composite, but this item consistently appeared to be measuring a different construct. This item was standardized to have a mean of zero and a standard deviation of 1.

Table 1
Outcome Scales, Constituent Items, and Reliability for Elementary Teachers

Outcome Measure	Constituent Items
Teachers' use of technology for delivering instruction	How often do you use a computer to deliver instruction to your class?
Teacher-directed student use of technology during classtime Cronbach's alpha = 0.84	During classtime how often did students work individually using computers this year? During classtime how often did students work in groups using computers this year? During classtime how often did students do research using the internet or CD-ROM this year?
Teacher-directed student use of technology to create products Cronbach's alpha = 0.72	During classtime how often did students use computers to solve problems this year?
Teachers' use of technology for class preparation	During classtime how often did students present information to the class/ using a computer this year?
Cronbach's alpha = 0.79	During classtime, how often did students use a computer or portable writing device for writing this year? How often did you ask students to produce multimedia projects using technology? How often did you ask students to produce web pages, websites or other web-based publications using technology? How often did you ask students to produce pictures or artwork using technology? How often did you ask students to produce graphs or charts using technology? How often did you ask students to produce videos or movies using technology? How often did you make handouts for students using a computer? How often did you create a test, quiz or assignment using a computer? How often did you perform research and lesson planning using the internet?

Table 2
Correlation Table of Technology Use Measures for Elementary Teachers

	Teacher use of technology for delivering instruction	Teacher-directed student technology use during class time	Teacher-directed student technology use to create products	Teachers use of technology for class preparation
Teacher use of technology for delivering instruction	1			
Teacher-directed student technology use during classtime	.486	1		
Teacher-directed student technology use to create products	.362	.590	1	
Teachers' use of technology for class preparation	.265	.300	.284	1

All correlations are significant at the 0.01 level (2-tailed).

To provide a sense of the degree to which teachers employ technology for each of these four uses, Figure 1 contains the average score across each of the items that comprise the four use scales on a scale which ranges from low to high use.

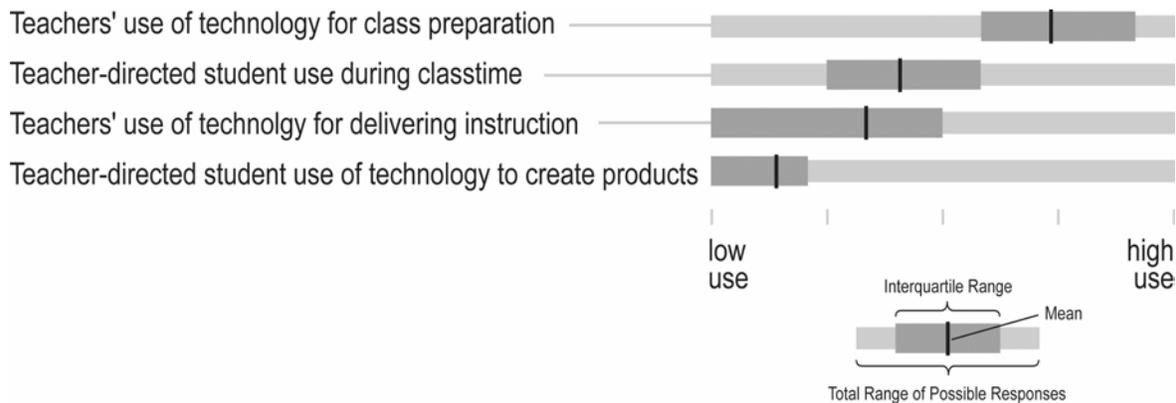


Figure 1. Frequency of elementary teacher technology uses.

The figure shows that teachers use technology most frequently for preparation purposes and least frequently for directing their students to create products using technology. These data support Cuban's (2001) argument that teachers tend not to use technology in the classroom very frequently.

Methods

The analyses presented in this research were conducted using a two-level hierarchical linear regression model. In this model, teacher use of technology was modeled at level-1 as a function of teacher characteristics and beliefs, and at level-2 by school and district characteristics. The general hierarchical model assumes a random sample of i teachers within J schools, such that Y_{ij} is the outcome variable (technology use in this case) for teacher i in school j (Bryk & Raudenbush, 1992). The level-1 or teacher model is expressed as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j}X_{1ij} + \beta_{2j}X_{2ij} + \dots + \beta_{kj}X_{kij} + r_{ij}$$

In this model, the teacher outcome, Y_{ij} , is modeled as a function of a linear combination of aggregate classroom and teacher level predictors, X_{kij} . This model states that the predicted outcome is composed of a unique intercept β_{0j} , and slope for each school β_{kj} , as well as a random student effect, r_{ij} . The intercept represents the base technology use in each school and the random teacher effect is assumed to be normally distributed with a mean of zero and variance, σ^2 . The chief difference between this model and an ordinary least squares model is that level-1 predictors may vary across schools (Bryk & Raudenbush, 1992). In the models used in this research, only mean technology use is allowed to vary between schools.

The variation in the level-1 predictors across schools is modeled at the second level; the level-1 predictors are modeled as outcomes at level-2. The level-2 model is expressed as follows:

$$\beta_{kj} = \gamma_{0k} + \gamma_{1k}W_{1j} + \gamma_{2k}W_{2j} + \dots + \gamma_{P-1k}W_{P-1j} + u_{kj}$$

Each β_{kj} is modeled as a function of a combination of school- or district-level predictors, W_{pj} , and each γ_{pk} represents the effect of the predictors on the outcome. Each school has a unique random effect, u_{kj} , which is assumed to be normally distributed with a mean of zero and variance τ_{kk} for any k .

These models allowed the total variability in each of the four technology use measures to be partitioned into its within-school and between-school variance components, and allow predictors to be added at each level that explain a proportion of both the within-school and between-school variance available. Although it might be considered more appropriate to model technology use as varying within-schools, between-schools within-districts, and between-districts, it is not possible to reliably do so with this data. In order to be able to examine differences between schools within districts independently of the differences between districts, more districts than are available in the USEIT study would be required. For this reason, the between-school variability will be confounded with the between-district variability in the models presented in this research. At the district/school level, both district and school characteristics will be included in the models in order to explain differences among schools/districts.

The hierarchical regression analyses were carried out in three stages. When conducting the hierarchical analysis, the first step required the examination of the amount of variability in the outcome, technology use in this case, that existed within and between schools/districts. In order to accomplish this, unconditional models, in which no predictors other than teachers' school

membership were known, were formulated. To develop a better understanding of the organizational factors that were associated with increased technology use, the second stage of the analysis involved extensive theory-driven, exploratory data analysis to identify variables observed to be associated with each of the four technology uses. These variables included: grade level, number of years teaching, access to technology, type and availability of professional development, perceived need for technology-related professional development, pressure to use technology, the level of technology-support available, teachers' pedagogical beliefs, as well as teachers' comfort level with technology, and beliefs about the efficacy of technology. For many predictors, teacher measures were aggregated to the school level in order to create a measure of average school characteristics. Guided by past research and theory, exploratory multilevel models were formulated.

Each of the predictor variables and composites measured at the teacher, school, or district level (X_{kij} and W_{pj}) were standardized to have a mean of zero and standard deviation of 1. Principal components analysis was again used to validate the existence of measurement scales and to create standardized scale scores, and reliability coefficients were calculated. The variables and composites included in the exploratory phase are listed in Table 3 and a complete description, including scale reliability is included in Appendix A.

In the final stage of the analysis, variables identified during the exploratory stage were combined into more parsimonious models to predict each of the four technology use outcome measures. In this way, each of the four uses are predicted by a different set of independent variables. In each model, an indicator of school socioeconomic status is included to examine whether school socioeconomic status contributes to differences among schools in terms of technology use. The index was created from three separate measures: school-mean number of books in students' homes, school-mean amount of technology available in students' homes, and percent of students in a school not receiving free or reduced lunch. Principal components analysis was used to confirm that these three variables were measuring the same construct; one component with an eigenvalue greater than 1 was extracted which accounted for 87 percent of the variance. The factor loadings for the three variables were each greater than .90.

Table 3
Variables and Composites Included in Exploratory Analysis Phase

Measures taken at the teacher level

Perceived importance of technology for the school/district
 Characteristics that shape technology use in your classroom
 Leadership emphasis on technology items
 Teachers' need for professional development for basic skills
 Teachers' need for professional development relating technology integration
 Student characteristics obstruct technology use
 Leadership and teacher input issues obstruct technology use
 Access obstructs technology use
 Quality of computers obstructs use
 Poor professional development obstructs technology use
 Problems incorporating technology obstruct use
 Problems getting technology to work obstructs technology use
 District success implementing the technology program
 Importance of computers for teaching
 Teacher confidence using technology
 Pressure to use technology
 Community support for change
 Support for growth
 Relationship with principal
 Support for innovation
 Computers harm student learning
 Beliefs about teacher-directed instruction
 Belief that computers help students
 Constructivist beliefs

Measures taken at the district level

Number of restrictive policies scale
 Line item funding for technology
 Leaders discuss technology
 Evaluations consider technology
 Principal's technology decision
 Variety of technology-related professional development
 The extent to which professional development focuses on technology integration

Results

Table 4 presents the unconditional variance components for each of the four technology uses. The results indicate that although the majority of variability in each use exists among-teachers within-schools, a significant proportion of the variability lies between schools. The largest school-to-school differences occur for the measure concerned with how often teachers direct students to use technology during classtime; 16 percent of the total variability for this type of technology use lies between schools. It appears that the smallest between school differences occur for the use of technology for preparation measure. It is interesting to recall that *Figure 1* indicated that use for preparation was the most frequently occurring type of technology use among elementary teachers.

Table 4
Unconditional Variance Components for Four Technology Uses

	Teacher use of technology for delivering instruction	Teacher-directed student technology use during class time	Teacher-directed student technology use to create products	Teachers use of technology for class preparation
Percent of variance within schools	86%	84%	89%	94%
Percent of variance between schools	14% [‡]	16% [‡]	11% [‡]	6% [‡]

[‡]The amount of variability between schools is significant for $p < .001$.

Table 5 presents the standardized regression coefficients and their associated standard errors for the variables that combine to produce the best prediction models for each of the four types of technology use. Hierarchical linear regression modeling is a generalization of ordinary least squares analysis in which each level in the hierarchy is represented by a separate regression equation. For this reason, the multilevel regression coefficients refer to specific levels in the hierarchical structure of the data and are interpreted in the same way as traditional regression coefficients. The results of the analyses are presented in two ways. First, each model is discussed independently in order to understand the processes associated with each of the four uses. Second, the strength of the associations are compared across models.

Comparisons Within Models

Teacher use of technology for delivering instruction

The strongest predictors of school-to-school differences among teachers' use of technology for delivering instruction are school-mean perceived pressure to use technology (0.371) and, not surprisingly, school-mean availability of technology (0.375). At the school-level, mean perception regarding inadequate professional development (-0.193) has a negative relationship with technology use for delivering instruction. Conversely, increased variety in the types of technology-related professional development reported to be available to teachers within a school appears to have a small positive effect on teachers' use of technology for delivering instruction (0.067). The teacher-

level model indicates that teachers who possess higher levels of confidence using technology (0.129) and more positive beliefs about technology (0.114) are more likely to use technology for delivering instruction. Not surprising, teachers who report having difficulty integrating technology into the curriculum are less likely to use technology for delivery.

Teacher-directed student use of technology during classtime

In addition to their importance for predicting teachers' use of technology for delivery, school-mean perceived pressure to use technology (0.321) and school-mean availability of technology (0.265) are also highly, positively related to the rate at which teachers direct their students to use technology during classtime. The extent to which professional development focuses on the integration of technology (0.303) is also a strong between-school predictor for this type of use. The importance of being prepared to integrate technology is also mirrored at the teacher-level; teachers who report experiencing problems integrating technology into the curriculum (-0.106) are significantly less likely to direct their students to use technology during classtime. At the teacher level, beliefs about student-centered instruction (0.069) and about the positive impacts of computers on students (0.188) are positive predictors of teacher-directed student use of technology during class time.

Teachers direct students to create products using technology

Preparation to integrate technology through professional development (0.206) as well as pressure to use technology (0.307) are strong, positive predictors of school-to-school differences in the frequency with which teachers direct students to create products using technology. Teacher beliefs about the positive impacts of technology (0.157) and constructivist beliefs (0.109) are positively related to increased use at the teacher level. Conversely, perceived problems integrating technology into the curriculum is associated with less frequent use.

Teachers use technology for preparation

Although the extent to which professional development focuses on integration (0.134) and the variety of technology-related professional development available to teachers (0.068) are significant, the availability of technology (0.233) is the strongest, positive predictor of technology use for preparation at the school level. At the individual level, beliefs about student-centered instruction (0.066), and positive beliefs about the effects of technology (0.067) are both associated with increased use of technology for preparation. Higher teacher confidence is associated with the largest increase in the use of technology for preparation (0.270).

Comparisons Across Models

The regression coefficients in Table 5 indicate that for all four technology use measures, the predictor effects between schools are larger than the effects within schools. It is also clear that school and district characteristics differ in their ability to predict the four uses of technology defined here. At the school level, the extent to which professional development focuses on technology integration is associated with teachers' increased use of technology for class preparation (0.134) and increased use by students both during class time (0.303) and to create products (0.206).

Interestingly, according to the model, this predictor is not associated with teachers' use of technology for delivering instruction (0.000).

The models show that increased availability of technology is likely to result in increased use of technology for delivering instruction (0.375), increased teacher-directed use of technology by students during class time (0.265), and increased use by teachers for class preparation (0.233). Given that products created using technology are typically done outside of the classroom, availability of technology is not as strongly related to technology use for this purpose (0.131) as it is for the other three purposes.

School-mean teachers' perceived pressure to use technology is positively associated with each of the four uses. The observed relationship shows that teachers are more likely to use technology for delivering instruction (0.371), to have their students use technology during class time (0.321) and to create products using technology (0.307), and to a lesser degree, use technology for class preparation (0.123) when, on average, teachers in their school feel pressure to use technology.

Across the four models, the variety of available technology-related professional development is positively related to each of the four technology uses. The amount of restrictive policies for using technology that are in place within a school or district is negatively associated with the frequency with which teachers' direct students to use technology during classtime (-0.052) and direct students to create products using technology (-0.033). Very restrictive policies may be discouraging teachers from directing their students to use technology.

At the individual or teacher level, teachers who report problems incorporating technology into the curriculum appear less likely to use technology to deliver instruction (-0.099), less likely to have their students use technology during class time (-0.106) or to create products using technology (-0.071), and are less likely to use technology themselves for class preparation (-0.022). It is interesting to note that neither the quality of the available technology nor issues relating to student characteristics in the classroom appear to be strongly associated with any of the four uses; although the relationship is negative, the regression coefficients are weak and non-significant.

Similar to previous research (Ravitz, Becker, & Wong, 2000), pedagogical beliefs and beliefs about the positive impacts of technology are positively related to each of the four technology uses. The strongest positive predictor of whether a teacher will use technology to deliver instruction (0.114), have their students use technology during classtime (0.188), and have their students create products using technology (0.157) is a teacher's belief about the positive impacts of technology for students. As would be expected, teacher beliefs about technology's impact on students is not as strong a predictor of whether they themselves use technology for class preparation (0.067). Higher teacher confidence using technology is associated with increased use for delivering instruction (0.129) and in particular, increased use for class preparation (0.270). Consistent with Becker's findings, teachers who hold constructivist beliefs are more likely to have their students use technology during classtime (0.069) and to create products (0.109), and are more likely to use technology themselves for class preparation (0.066).

It is interesting to note that socioeconomic status is not a significant predictor of the differences among schools for any of the four uses. Perceptions about inadequate professional development are associated with decreased use of technology for delivering instruction (-0.193) and for class preparation (-0.126).

Variance Explained

When context variables were added at each of the two levels, a portion of the available variance at each level was explained. However, the percentages in *Table 6* indicate that the regression models were not powerful for explaining differences in use among teachers within schools; the models each only explained less than 10% of the available variance within schools. At the school-level, the models explain a larger proportion of the available variance, but because the amount of available variance between schools was small to begin with, the total amount of variance explained by the models remained small.

Despite the relatively small amount of total variability in use explained by the models, the findings at the school level demonstrate the importance of examining technology use as a phenomenon that may be influenced by characteristics at different levels in a school system's hierarchy. Importantly, the ability of a school or district to manipulate or alter all of the factors related to technology use at the school level suggests that school and district policies, practices, and leadership can influence the ways in which, and extent to which teachers use technology for a variety of purposes. However, the small amount of variance explained at the teacher (or within school) level indicates although we are moving toward a greater understanding of the differences in use among schools, we have much to learn about the processes that impact use within schools.

Table 5
Multilevel regression models for predicting teachers' use of technology

	Teacher use of technology for delivering instruction	Teacher- directed student use of technology during class time	Teachers direct students to create products using technology	Teachers use technology for preparation
	Coefficient (s.e.)	Coefficient (s.e.)	Coefficient (s.e.)	Coefficient (s.e.)
District/School Model				
Teachers report that poor professional development is an obstacle (school mean)	-0.193 (.09)			-0.126 (.10)
Variety of available technology-related professional development (district mean)	0.067 (.03)	0.067 (.03)	0.012 (.03)	0.068 (.03)
Socioeconomic status index (school mean)	-0.022 (.04)	0.040 (.04)	0.011 (.05)	0.028 (.03)
Principal's professional use of email with teachers	-0.002 (.06)			
Teachers report that professional development focuses on technology integration (school mean)	0.000 (.07)	0.303 (.08)	0.206 (.07)	0.134 (.05)
Teachers report that access is an obstacle (school mean)	0.037 (.10)			
Line item funding for technology (district mean)	0.037 (.14)			
Principal's discretion related to technology decisions	0.037 (.07)	-0.025 (.08)		
Teacher perception of superintendent's emphasis on technology (school mean)	0.042 (.04)	0.072 (.03)	0.042 (.04)	-0.020 (.03)
Teachers report pressure to use technology (school mean)	0.371 (.07)	0.321 (.07)	0.307 (.06)	0.123 (.06)
Teachers report on the availability of technology (school mean)	0.375 (.09)	0.265 (.09)	0.131 (.09)	0.233 (.06)
Amount of restrictive policies for using technology		-0.052 (.02)	-0.033 (.03)	
Evaluations consider technology (district mean)			0.020 (.04)	
Teachers report that technology quality is an obstacle (school mean)				-0.087 (.05)
Teacher Model				
Problems incorporating technology into the curriculum obstruct use	-0.098 (.04)	-0.106 (.04)	-0.071 (.03)	-0.022 (.04)
Issues with the quality of technology obstruct use	-0.007 (.04)	-0.005 (.04)	0.008 (.04)	-0.027 (.04)
Issues with students obstruct technology use	-0.008 (.03)	0.005 (.04)	0.011 (.03)	0.015 (.03)
Teacher believes in student-centered instruction	0.021 (.03)	0.069 (.03)	0.109 (.03)	0.066 (.03)
Teacher believes that computers help students	0.114 (.03)	0.188 (.03)	0.157 (.03)	0.067 (.03)
Teacher confidence using technology	0.129 (.03)	0.055 (.04)	0.055 (.03)	0.270 (.04)

Bolded values represent statistical significance for $p < .05$

Table 6
Variance Explained by the Four Models

		Teacher use of technology for delivering instruction	Teacher-directed student technology use during classtime	Teacher-directed student technology use to create products	Teachers use of technology for class preparation
Percent of Variance Available	Within schools	86%	84%	89%	94%
	Between schools	14% [‡]	16% [‡]	11% [‡]	6% [‡]
Percent of Level Specific Variance Predicted by Model	Within schools	5%	6%	5%	9%
	Between schools	66%	69%	52%	67%
Percent of Total Variance Predicted by Variables		13%	16%	10%	12%

[‡] The amount of variability between schools is significant for $p < .001$.

Discussion

Over the past decade, school districts have invested heavily in technology and, in turn, the national average student-to-computer ratio has decreased to 4:1. At the same time, the variety of ways in which technology is used to support teaching and learning both in and out of the classroom has increased rapidly. The increased access and variety of technology tools available has complicated the way in which teacher technology use is defined. As educational technology and its use in the classroom continue to evolve it is vital that we continue to remain informed about the variety of ways in which technology is actually used and the policies and practices that promote the use of technology as a teaching and learning tool.

Although an informative body of research has examined factors that influence the extent to which individual teachers use technology, primarily for instructional purposes, little empirical research has focused on the role of schools and districts in shaping teacher use of technology.

Without question, researchers, policy makers, and technology advocates acknowledge the role that schools and districts play in shaping teacher technology use. For several years, the US Department of Education has emphasized the importance of preparing teachers to use technology through pre-service and in-service training. Similarly, the Milken-Exchange on Educational Technology has identified several conditions under which technology use is believed to increase. Among the conditions are: strong leadership, professional preparation, and the technological capacity of the system (Lemke & Coughlin, 1998). While it may seem intuitive that each of these factors may influence technology use, there is little empirical research that examines the magnitude with which these school and district-level factors impact uses of technology by individual teachers.

From a methodological perspective, the analyses presented above demonstrate the advantages of examining factors that influence technology use from a multi-level perspective. As shown in *Table 4*, a significant amount of the variability in each of the teachers' uses of technology occurs due to differences that exist at the school and district level. The results in *Table 6* show that a substantial percentage of variability between schools is explained by school and district characteristics. While some of the within-school variance is explained by individual teacher factors (such as pedagogical beliefs, confidence using technology, and beliefs about the benefits of technology for students) and even more variance remains unexplained by any of the factors included in our models, the multi-level modeling techniques identify several characteristics that reside above the classroom level over which schools and districts have control. These factors include: the extent to which professional development focuses on technology integration, the variety of technology-related professional development that is available to teachers, emphasis (e.g., pressure) placed on technology use by school leaders, the availability of technology within schools, and the type of policies that exist regarding student use of technology in schools.

The analyses also demonstrate the utility of examining technology use from a multi-faceted, rather than a singular, perspective. Although several teacher- and school-level variables were significant predictors of more than one category of technology use, only one variable (beliefs about positive impact of computers on students) was a significant predictor across all four models. Similarly, several variables, such as the amount of restrictive policies, superintendent's emphasis on technology, poor professional development, and teacher confidence using technology, were significant predictors for only one or two types of use.

For schools and districts that are interested in increasing the extent to which teachers use technology, these two methodological benefits provide insight into the specific types of factors that they can focus on, at the teacher level and at the school level, in order to positively influence specific uses of technology. As an example, the models presented in this research suggest that a school that aims to increase student use of technology during class might shift the focus of professional development to technology integration, increase pressure by the principal and superintendent to use technology, increase the availability of technology within the school, and limit the amount of restrictive policies relating to technology use. In contrast, a school that is interested in increasing use of technology for delivery would be less inclined to alter the focus of its professional development or consider the restrictiveness of its policies regarding technology. Similarly, the models presented here indicate that positive beliefs about technology have a positive effect on all four types of uses. As we have documented elsewhere, exposing teachers to a variety of technologies and a variety of instructional uses of those technologies can increase the value teachers place in those technologies (Russell, Bebell, O'Dwyer, & O'Connor, 2003). A similar strategy that focuses on exposing teachers to the positive effects of technology use on students may also increase

the positive beliefs teachers have about technology. In turn, the models presented here suggest that such an increase in teachers' positive beliefs about technology will translate into increased use of technology across all four categories of use.

Despite gaining a richer empirical understanding of the factors that influence a variety of technology uses by elementary school teachers, the analyses present several challenges for future research efforts. First, although the multilevel modeling techniques provide more precise estimates of the effects of school- and district-level factors on each type of technology use, there is a substantial amount of variability in use that remains unexplained by each model. This unexplained variance may result in part from error in the measures included in the models. However, given the relatively high reliability coefficients for the outcome and predictor measures, it is more likely that additional variables that are not included in the models contribute to teachers' technology use. As an example, separate analyses performed with the USEIT study teacher survey data indicate that technology use varies by the length of time the teacher has been teaching (Russell, Bebell, O'Dwyer, & O'Connor, 2003). Specifically, new teachers use technology for preparation more often than do teachers who have been in the profession for several years. Yet, these more tenured teachers report using technology more frequently with students than do newer teachers. Similarly, teachers' technology use varies according to the grade level taught. Undoubtedly, including these variables in the models would increase the amount of variance explained by the models. However, we chose to exclude these variables since a school or district cannot manipulate them. Nonetheless, there are likely to be other variables which were not included in the models but which can be influenced by school and district policies that may account for a meaningful portion of the variance in teacher technology use.

Second, the research presented here focuses on four general categories of technology use. While the survey was developed such that the items included a wide variety of specific and more general uses of technology in and out of the classroom, the range of technology uses was by no means exhaustive. As an example, sufficient information was not available to create scales that represent use of technology in the classroom to develop basic skills or to develop higher order skills. Instead, the outcome measure which we term teacher-directed student use of technology during class time incorporates both purposes. Similarly, although a limited number of items focused on the use of technology to create pictures, the inclusion of additional survey items might have allowed for the creation of scales that distinguish between the use of technology to explore visual concepts in art, mathematics, and/or science. In other words, despite our effort to consider technology use as multi-faceted, the variety of uses could be defined in an even more sophisticated manner.

Third, while the analyses provide important insight into school and district factors that influence technology use by elementary school teachers, the effect of these factors may not transfer to the middle and high school levels. Examining descriptive statistics from the USEIT study, we have found that the extent to which teachers at different grade levels use technology for a given purpose varies. Differences in the frequency with which elementary, middle and high school teachers engage in the four uses of technology discussed in this research may be due to such factors as the content of the courses they teach and the location of technology in the school (in the classroom versus in labs). In addition, since the administrative organization of high schools often differs from that of elementary schools, with the department heads often having influence over instructional practices, pressure from the school administration to use technology may play a different role in influencing teacher uses of technology. Clearly, to better understand the factors influencing technology uses, specific models for middle and high schools are needed.

Fourth, due to the limited number of districts (22) included in the analyses, it was not possible to separate the effect of district-level effects from school-level effects by creating a third level in our analyses. As a result, the effect of district policy decisions and practices are confounded with policies and practices enacted within individual schools that comprise the district. Given that many technology-related decisions, such as funding, professional development, and support structures, are developed at the district level and implemented at the school level, this confounding may be of little practical consequence. Nonetheless, further insight into the effect of school versus district-level factors would be gained by increasing the number of districts included in future studies.

Despite the shortcomings described above, the analyses presented here provide valuable insight into the factors that affect uses of technology by elementary school teachers. Although a large percentage of the variability in teachers' uses of technology results from factors that exist at the teacher level, the four models identify several factors that reside outside of the classroom that have a significant effect on technology uses. More importantly from a leadership perspective, these school and district level factors are alterable. While there is still much to learn with respect to how schools and districts can increase the uses of the expensive technologies in which they have invested, the findings presented here indicate that responsibility for increasing use does not reside solely on the shoulders of teachers. Instead, through strategic decisions regarding the focus and range of professional development opportunities, the ease with which technology is made available within schools, and the outward expression of the importance of technology use by principals, superintendents, and other school leaders, these analyses suggest that technology use by elementary school teachers will increase.

Note

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Appendix A

Teacher Items and Composites

Individual items and composites created from teacher survey responses:

<p>Perceived importance of technology for the school/district (teacher measure)</p>	
<p>How important is using technology to improve classroom instruction in your school/districts technology vision?</p> <p>How important is using technology to improve student performance in your school/districts technology vision?</p> <p>How important is student proficiency in teaming and collaboration in your school/districts technology vision?</p> <p>How important is student proficiency in data analysis in your school/districts technology vision?</p> <p>How important is increasingly teacher proficiency in the use of technology in your school/districts technology vision?</p> <p>How important is preparing students to take jobs in your school/districts technology vision?</p> <p>How important is improving student test scores in your school/districts technology vision?</p> <p>How important is promoting active learning strategies in your school/districts technology vision?</p> <p>How important is supporting instructional reform in your school/districts technology vision?</p> <p>How important is satisfying parents' and community interests in your school/districts technology vision?</p> <p>How important is improving student computer skills and abilities in your school/districts technology vision?</p> <p>How important is improving student proficiency in research in your school/districts technology vision?</p> <p>How important is improving productivity and efficiency in your school/districts technology vision?</p> <p>How important is target level of technology (i.e., student/computer ratio) in your school/districts technology vision?</p>	<p>Alpha = 0.95</p>
<p>Characteristics that shape technology use in your classroom (teacher measure)</p>	
<p>How important is using technology to improve classroom instruction in shaping computer use in your classroom?</p> <p>How important is using technology to improve student performance in shaping computer use in your own classroom?</p> <p>How important is student proficiency in teaming and collaboration in shaping computer use in your own classroom?</p> <p>How important is student proficiency in data analysis in shaping computer use in your own classroom?</p> <p>How important is increasingly teacher proficiency in the use of technology in shaping computer use in your own classroom?</p>	<p>Alpha = 0.94</p>

<p>How important is preparing students take jobs in shaping computer use in your own classroom?</p> <p>How important is improving student test scores in shaping computer use in your own classroom?</p> <p>How important is promoting active learning strategies in shaping computer use in your own classroom?</p> <p>How important is supporting instructional reform in shaping computer use in your own classroom?</p> <p>How important is satisfying parents' and community interests in shaping computer use in your own classroom?</p> <p>How important is improving student computer skills and abilities in shaping computer use in your own classroom?</p> <p>How important is improving student proficiency in research in shaping computer use in your own classroom?</p> <p>How important is improving productivity and efficiency in shaping computer use in your own classroom?</p> <p>How important is target level of technology (i.e., student/computer ratio) in shaping computer use in your own classroom?</p>	
<hr/>	
Leadership emphasis on technology items (teacher measures)	
<hr/>	
Superintendent's emphasis on technology (Single item)	
<hr/>	
Principal's emphasis on technology (Single item)	
<hr/>	
Teachers' need for professional development for basic skills (teacher measure)	
<p>Beneficial professional development: managing my computer desktop (opening programs, printing etc.)?</p> <p>Beneficial professional development: learning to utilize network services efficiently (e-mailed, saving to the server)?</p> <p>Beneficial professional development: learning about research sources on the Internet?</p> <p>Beneficial professional development: learning how to manipulate data and constructing graphs?</p> <p>Beneficial professional development: learning specific applications/software (Microsoft Word, PowerPoint)?</p>	Alpha = 0.78
<hr/>	
Teachers' need for professional development relating to the integration of technology (teacher measure)	
<hr/>	
<p>Beneficial professional development: integrating technology with student writing?</p> <p>Beneficial professional development: integrating technology into my classroom activities?</p>	Alpha = 0.80
<hr/>	
Student characteristics obstruct technology use (teacher measure)	
<hr/>	
<p>Are the lack of student's keyboarding skills an obstacle for you in making more effective use of technology?</p> <p>Does having too many students in your class act as an obstacle for you in making more effective use of technology?</p>	

<p>Are the lack of students' skills using a computer effectively an obstacle for you in making more effective use of technology? Does a wide variety of computer skills among the students in your classroom act as an obstacle for you in making more effective use of technology? Does a wide variety of academic skills among the students in your classroom act as an obstacle for you in making more effective use of technology?</p>	<p>Alpha = 0.76</p>
<p>Leadership and teacher input issues obstruct technology use (teacher measure)</p>	
<p>Does teachers' lack of input into technology decisions act as an obstacle for you in making more effective use of technology? Do difficulties connecting with the school technology specialist act as an obstacle for you in making more effective use of technology? Does lack of leadership related to technology act as an obstacle for you in making more effective use of technology? Does not knowing how the district wants you to use technology in the classroom act as an obstacle for you in making more effective use of technology? Does a lack of flexibility in deciding how to you use computers in your classroom act as an obstacle for you in making more effective use of technology?</p>	<p>Alpha = 0.77</p>
<p>Access obstructs technology use (teacher measure)</p>	
<p>Is the lack of computers in the classroom an obstacle for you in making more effective use of technology? Is the difficulty in accessing computers in labs and/or library an obstacle for you in making more effective use of technology? Is not having enough computers for all of your students an obstacle for you in making more effective use of technology?</p>	<p>Alpha = 0.78</p>
<p>Quality of computers obstructs use (teacher measure)</p>	
<p>Are unpredictable computers an obstacle for you in making more effective use of technology? Are outdated computers/software an obstacle for you in making more effective use of technology? Is increased speed and improved technology an obstacle for you in making more effective use of technology? Does a slow internet act as an obstacle for you in making more effective use of technology?</p>	<p>Alpha = 0.68</p>
<p>Poor professional development obstructs technology use (teacher measure)</p>	
<p>Is the unavailability of software that your professional development has trained you to use an obstacle for you in making more effective use of technology? Is the lack of practice with software that your professional development has trained you to use an obstacle for you in making more effective use of technology? Is insufficient or inadequate support on how to use technology in the classroom an obstacle for you in making more effective use of technology?</p>	<p>Alpha = 0.60</p>
<p>Problems incorporating technology obstruct use (teacher measure)</p>	

Is not being sure how to make technology relevant to your subject area act as an obstacle for you in making more effective use of technology? Do you have problems incorporating technology into lessons?	Alpha = 0.50
Problems getting technology to work obstructs technology use (teacher measure)	
Do you have problems getting the computer to work? Do you have problems getting the software to work? Do you have problems getting the printer to work? Do you have problems accessing network folders/files? Do you have problems connecting to the internet? Do you have problems emailing?	Alpha = 0.85
District success implementing the technology program (teacher measure)	
Rate the degree of success your district has had implementing technical professional development. Rate the degree of success your district has had integrating technology into the curriculum. Rate the degree of success your district has had implementing technical support. Rate the degree of success your district has had implementing access to hardware. Rate the degree of success your district has had implementing access to software. Rate the degree of success your district has had implementing network services.	Alpha = 0.85
Importance of computers for teaching (teacher measure)	
How important have computers been in your teaching this year? How important have computers been in your teaching three years ago? How important have computers been in your teaching five years ago?	Alpha = 0.79
Teacher confidence using technology (teacher measure)	
How confident have you been when using computers this year? How confident were you when you used computers three years ago? How confident were you when you used computers five years ago?	Alpha = 0.83
Pressure to use technology (teacher measure)	
Do you feel pressured to have students use computers? Do you feel pressured to have students use the Internet? Do you feel pressured to use technology in the same way as other teachers in your grade?	Alpha = 0.76
Community Support for change (teacher measure)	
Research and best practices are shared and discussed in my school/district. New ideas presented at in-services are discussed afterwards by teachers in this school. Most teachers here share my beliefs about what the central goals of the schools should be. Teachers in the school are continually learning and seeking new ideas. It is common for us to share samples of students' work.	Alpha = 0.80

Support for growth (teacher measure)	
If the teacher is not doing a good job, they are pressed by school leaders or colleagues to improve. Staff development activities are followed by support to help teachers implement new practices. Formal teacher mentoring actively occurs in my school	Alpha = 0.54
Relationship with principal (teacher measure)	
My principal's values and philosophy of education are similar to my own. I have a good working relationship with my principal.	Alpha = 0.72
Support for innovation (teacher measure)	
Teachers have a lot of input regarding innovations, projects, and changing practices. There are hindrances to implementing new ideas at my school. My school encourages experimentation.	Alpha = 0.57
Computers harm student learning (teacher measure)	
Computers have weakened students' research skills. Many students use computers to avoid doing more important schoolwork. Students' writing quality is worse when they use word processors. Computers encourage students to be lazy.	Alpha = 0.72
Beliefs about teacher-directed instruction (teacher measure)	
Teachers know a lot more than students; they shouldn't let students muddle around when they can just explain the answers directly. A quiet classroom is generally needed for effective learning. It is better when the teacher, not the students decides what activities are done.	Alpha = 0.64
Belief that computers help students (teacher measure)	
Students create better looking products with computers than with other traditional media. Students interact with each other more while working with computers. Computers help students grasp difficult curricular concepts. Students work harder at their assignments when they use computers. Students are more willing to do second drafts when using computer.	Alpha = 0.66
Constructivist beliefs (teacher measure)	
The role of the teacher is to be the facilitator vs. the instructor Students' interests/effort in academic work is more important than learning information from textbooks It is good to have different activities going on in the classroom vs. a whole class assignment Students take more initiative to learn when they can move around the classroom during class Students should help establish criteria on which they will be assessed	Alpha = 0.62

District Items and Composites

Number of restrictive policies scale	
Which of the following policies are implemented in your district: Students are not allowed to play games on the school computers Student access to the internet is screened by a firewall Which of the following policies are implemented in your district: Students are not allowed to send email from school computers Which of the following policies are implemented in your district: Students are not allowed to receive email from school computers Which of the following policies are implemented in your district: Students are not allowed to bring their own computers or Palms from home Which of the following policies are implemented in your district: Students are not allowed access to the server Which of the following policies are implemented in your district: Students are not allowed access to the server from home	Alpha = 0.45
Line item funding for technology	
Does your district budget have a line item for: Hardware Does your district budget have a line item for: Software Does your district budget have a line item for: Technology Support Staff Does your district budget have a line item for: Technology Curriculum Integration Staff Does your district budget have a line item for: Technology-related Professional Development Does your district budget have a line item for: Upgrades and replacement	Alpha = 0.89
Leaders discuss technology	
To what extent do you, as a district leader, raise issues about technology with the following people? : Parents To what extent do you, as a district leader, raise issues about technology with the following people?: School board To what extent do you, as a district leader, raise issues about technology with the following people? : With other district leaders To what extent do you, as a district leader, raise issues about technology with the following people? : Teachers To what extent do you, as a district leader, raise issues about technology with the following people? : Principals To what extent do you, as a district leader, raise issues about technology with the following people? : Your community	Alpha = 0.84
Evaluations consider technology	
To what extent is technology considered when evaluating the principals and curriculum leaders in your district?	Alpha =

To what extent is technology considered when evaluating the teachers in your district?	0.82
Principal's technology-related decision making	
How much discretion do individual principals in your district have about: Purchasing software	Alpha = 0.75
How much discretion do individual principals in your district have about: Purchasing hardware	
How much discretion do individual principals in your district have about: Allocation of technology in the schools	
How much discretion do individual principals in your district have about: Professional development activities	
Variety of technology-related professional development	
Workshops and seminars; run by outside source	Alpha = 0.93
Workshops and seminars; run by district personnel	
University or college course work	
Mentor/colleague	
Attending conferences	
District or school sponsored courses (over several weeks)	
Online or web-based professional development	
One-on-one or group training with technology staff	
Release time for department or grade level planning related to technology	
Release time for individual professional development related to technology	
The extent to which professional development focuses on technology integration	
Does your school focus on the mechanics of how to use a computer or more on how to integrate technology into the curriculum?	Alpha = 0.65
Which would be more useful to your staff: focusing on the mechanics or focusing on how to integrate technology	

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