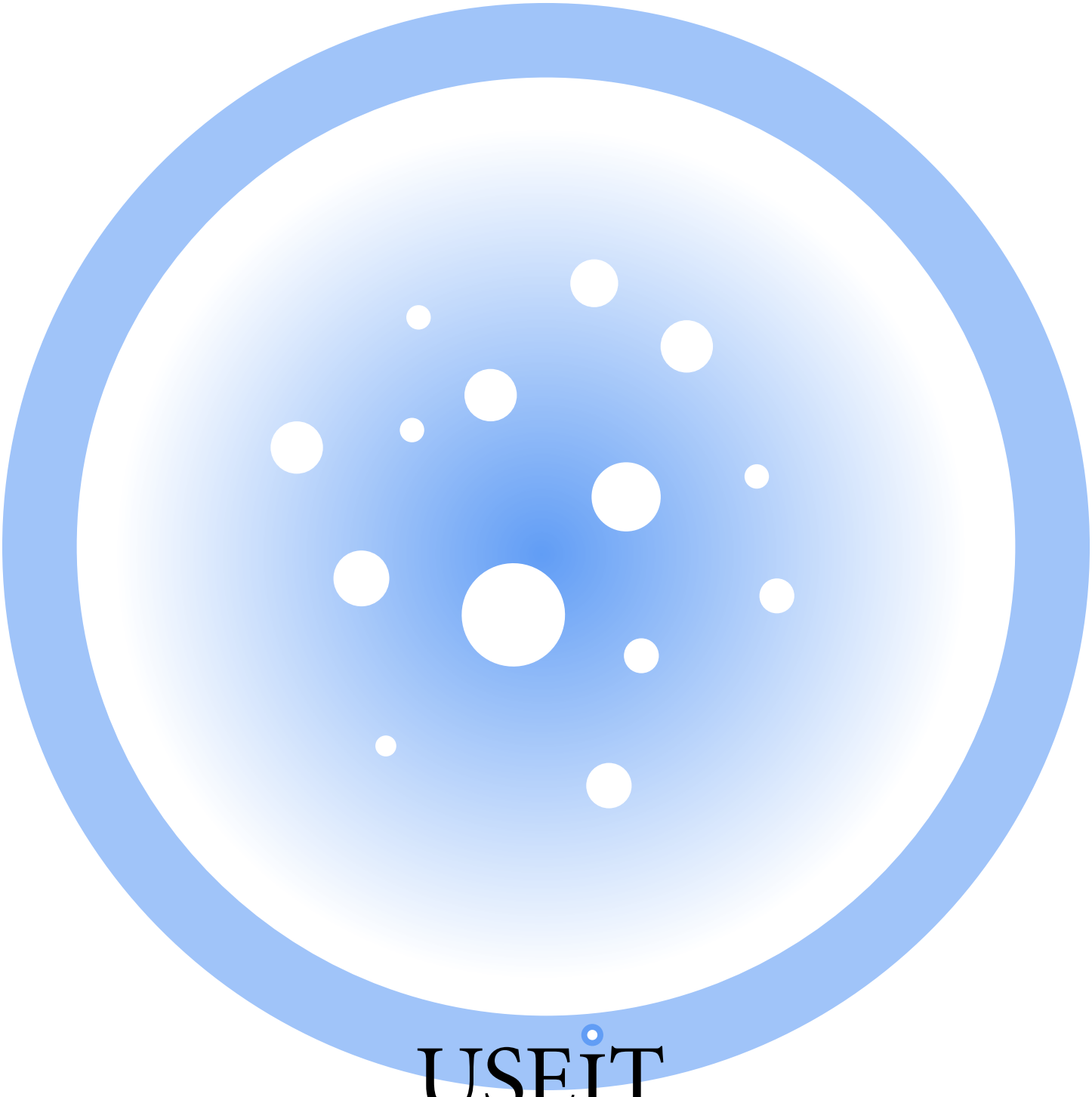

USEIT

Use,
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Technology
Study

report twelve

Measuring Teachers Technology Uses: Why Multiple-Measures Are More Revealing

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Measuring Teachers' Technology Uses: Why Multiple-Measures Are More Revealing

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Published by inTASC – June 2004

Preferred Citing:

Bebell, D., Russell, M., and O'Dwyer, L. (2004). *Measuring teachers' technology uses: Why multiple-measures are more revealing.* Boston, MA: Technology and Assessment Study Collaborative, Boston College.

Available for download at http://www.intasc.org/PDF/useit_r12.pdf

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Supported under the Field Initiated Study Grant Program, PR/Award Number R305T010065, as administered by the Office of Educational Research and Improvement, U.S. Department of Education.

The findings and opinions expressed in this report do not reflect the positions or policies of the Office of Educational Research and Improvement or the U.S. Department of Education.

USEIT

Use, Support, and Effect of Instructional Technology Study

Use, Support, and Effect of Instructional Technology (USEIT)

Report 12

Measuring Teachers' Technology Uses: Why Multiple Measures Are More Revealing

Introduction

Over the last 20 years, substantial investments have been made in educational technology. Not surprisingly, in today's zeitgeist of educational accountability there have been increasing calls for empirical, research-based evidence that these massive investments are effecting the lives of teachers and students (McNabb, Hawkes, & Rouk, 1999). While there is a strong desire to examine the effect of technology on student learning, effects on learning must be placed in the context of teacher and student use. In other words, before the outcomes of technology integration can be studied there must first be a clear understanding of how teachers and students are using technology.

Currently, what is meant by *teachers' use of technology* varies widely. In some cases, teachers' use of technology is specific to their use while delivering instruction in the classroom. In other cases, teachers require students to use technology to develop products or to facilitate learning. In still other cases, teachers' use includes emailing, lesson preparation, and record keeping, as well as personal use. Despite the many ways in which teachers may use technology to support their teaching, research on technology often lacks a clear definition of what is meant by teachers' use of technology. In turn, a variety of approaches to measuring teachers' use have been employed, most of which group together different uses into a single dimension. While defining technology use as a unitary dimension may simplify analyses, it complicates efforts by researchers and school leaders to do the following:

- provide a valid measure of technology use,
- interpret findings about the extent to which technology is used, and
- understand how to increase technology use.

In this paper, we review the several ways in which technology use has been measured over the past two decades and then present data that demonstrate the utility of employing multiple-measures of teachers' technology use.

Literature Review

The first large-scale investigation of educational technology occurred in 1986 when Congress asked the federal Office of Technology Assessment (OTA) to compile an assessment of technology use in American schools. Through a series of reports (OTA, 1988; 1989; 1995), national patterns of technology integration and use were documented. In addition, a primary finding suggested that the extent to which technology is used is left largely to the teacher's discretion.

Ten years later Congress requested OTA "to revisit the issue of teachers and technology in K–12 schools in depth" (OTA, 1995). In a 1995 OTA report, the authors noted that previous research on teachers' use of technology employed different definitions of what constituted technology use. In turn, these different definitions led to confusing and sometimes contradictory findings regarding teachers' use of technology. For example, a 1992 International Association for the Evaluation of Educational Achievement (IEA) survey defined a "computer-using teacher" as someone who "sometimes" used computers with students. A year later, Becker (1994) employed a more explicit definition of a computer using teacher for which at least 90% of the teachers' students were required to use a computer in their class in some way during the year. Thus, the IEA defined use of technology in terms of the teachers' use for instructional delivery while Becker defined use in terms of the students' use of technology during class time. Not surprisingly, these two different definitions of a "computer-using teacher" yielded different impressions of the technology use. In 1992, the IEA study classified 75% of U.S. teachers as "computer-using teachers" while Becker's criteria yielded about one third of that (approximately 25%) (OTA, 1995). This confusion and inconsistency led the OTA to remark: "Thus, the percentage of teachers classified as computer-using teachers is quite variable and becomes smaller as definitions of use become more stringent" (p. 103).

During the mid 1990s, several advances in computer-based technologies came together and allowed teachers to use technology to support their teaching in an increasing variety of ways. Whereas instructional uses of computers had been limited largely to word processing and computer programming, teachers were now able to perform multi-media presentations and computer-based simulations. With the introduction of the Internet into the classroom, teachers were also able to incorporate activities that tapped the World Wide Web. Outside of class time, software for record keeping and test development provided teachers with new ways of using computers to support their teaching. In addition, the Internet allowed teachers access to additional resources when planning lessons (Becker, 1999) and allowed teachers to use email to communicate with their colleagues, administrative leaders, students, and parents (Lerman, 1998). Naturally, as the variety of ways in which teachers could use technology increased1, defining a technology-using teacher became more complicated.

Quantifying Teachers' Modern Technology Use (1994–2002)

Since 1994, the National Center for Educational Statistics (NCES) has conducted a series of surveys on public school teachers' access to and use of computers and the Internet. In a 2000 report, the NCES differentiate among types of teachers' technology uses and report that, although the vast majority of teachers were using technology for some aspects of their professional activities, non-instructive technology uses were pervasive. For example, the NCES reports that:

- 85% of teachers use a computer to create instructional materials at home and 78% do so at school,
- approximately half of all teachers use computers for administrative record keeping at school and at home,
- approximately half of all teachers use email to "communicate with colleagues" and about a quarter of teachers communicate with parents via email, and
- approximately 20% of teachers post homework and assignments on the Internet.

Recognizing instructional use as a separate facet of technology use, the NCES also reported that 53% of all public school teachers who have a computer at school are using it for instruction during regular class time. In a summary report of the 2000 NCES document, Cassandra Rowand (2000) articulated several facets of teacher technology usage which were measured by the NCES survey. These facets included the teacher using technology to/for the following (in order of frequency of use):

- creating instructional materials,
- keeping administrative records,
- communicating with colleagues,
- gathering information for planning lessons,
- presenting multimedia classroom presentations,
- accessing research and best practices for teaching,
- communicating with parents or students, and
- accessing model lesson plans.

Besides the work by the NCES, perhaps the largest recent study of teachers' technology practices was the Teaching, Learning and Computing (TLC) survey which was conducted in 1998 and has generated nine full reports which detail the practices and beliefs of a representative sample of United States teachers (Becker, 1999; Ravitz, Wong, & Becker, 1998, 1999, 2000; Ravitz & Wong, 2000). Like the NCES, Becker and his colleagues documented that teachers' and students' use of computers was becoming more varied and more widespread. For example, 71% of Grade 4–12 teachers reported that they had their students use a computer at least once in some way during the 1997–1998 school year. Of those teachers who reported that they do not use technology with their students, three-fourths reported that they do use technology themselves for non-instructional purposes. In fact, the most frequent uses 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). One of the most frequent uses of technology reported by teachers was making handouts for class (66% of all teachers reported making handouts at least weekly). In addition, almost half of the teachers reported using a computer at least weekly for record keeping and student

grading, two-thirds reported using the Internet for lesson planning, and 68% reported using email for communication. In short, the 1998 TLC survey data indicated that the majority of teachers were using technology to support their teaching, but much of this use occurred outside of class time.

This finding was echoed by Cuban (2001) whose book *Oversold and Underused* has led many to question the impact of limited numbers of computers in classrooms on teaching and learning. It is important to note that when making the connection between technology use and teaching, Cuban separated technology use during class time and outside of class time. Despite repeated efforts to distinguish between uses of technology during and outside of class time, when making the argument that computers are underused as instructional tools, Cuban employs a definition of technology use that is exclusive of technology for communication, lesson planning and preparation, grading and record keeping. In other words, Cuban addresses the impacts (or lack thereof) of technology on instructional practices using a less than complete measure of what constitutes teachers' technology use.

It is clear, both in theoretical and investigative research, that defining and measuring teachers' use of technology has increased in complexity as technology has become more advanced, varied, and pervasive in the educational system. In actuality, very little has changed since the mid 1990s when the U.S. Department of Education raised concern about the different ways in which technology use was being defined and measured. Today, several researchers and organizations have developed their own definitions and measures of technology use to examine the extent of technology use and to assess the impact of technology use on teaching and learning. Without question, instruments such as those developed by the CEO Forum and the International Society for Technology in Education (ISTE) appear to be effective in spurring reflection among school leaders and discussion regarding technology's impact in schools. Frequently these instruments collect information on a variety of different types of teachers' technology use and then collapse the data into a single generic "technology use" variable. Unfortunately, the amalgamated measure may be inadequate both for understanding the extent to which technology is being used by teachers and for assessing the impact of technology on learning outcomes. Moreover, there is a strong likelihood that the school leaders who rely upon this information for decision-making will interpret findings in a number of different ways. For example, some may interpret one measure of teachers' technology use solely as teachers' use of technology for delivery, while others may view it as a generic measure of the collected technology skills and uses of a teacher.

Recognizing the importance of how technology use is both defined and measured, the remainder of this paper uses data collected as part of the Use, Support, and Effect of Instructional Technology (USEIT) study, to describe efforts to develop multiple measures of teachers' technology use and to provide examples of how a multi-faceted approach to measuring teachers' technology use holds the potential to provide deeper insight into how technology use varies across settings. Based upon the findings described here, implications for future definitions and measurement of technology use are discussed. Throughout the present work, the term *technology* refers specifically to computer-based technologies and includes personal computers, LCD projectors, and Palm Pilots. Prior to examining technology use, we provide a brief overview of the USEIT study sample and design.

Sample and Methodology

To explore the utility of a multi-dimensional definition of technology use, the analyses use data collected as part of the USEIT Study. Working with 22 school districts located throughout Massachusetts, the USEIT Study examines the use of educational technologies by teachers and students, the factors that influence these uses, and the effect of these uses on student learning. The 3-year study began during the spring of 2001 and included survey responses from 2,894 K–12 mathematics, English/language arts, science, social studies, and elementary school classroom teachers from schools across 22 districts. As described in greater detail by Bebell, Russell, & O'Dwyer (2003), the sample includes a broad spectrum of teachers across grade levels and school types (elementary, middle, and high school), with each grade level represented by at least 230 teachers. The sample also includes at least 470 teachers from each of the four main subject areas as well as 1,279 self-contained elementary school classroom teachers who reported teaching multiple subject areas.

The USEIT teacher survey was developed based upon current literature, was designed to focus on a broad range of issues related to teacher and student use of technology, and included 45 items that focused on uses of technology both in and outside of the classroom by both teachers and their students. Twelve of these items asked teachers about the frequency with which they used a specific piece of hardware such as a desktop computer in their classroom, shared laptops, an LCD projector, or a scanner. Since these survey items did not specify whether it was the teachers or their students using the devices, they are excluded from the analyses presented below. Thus, the analyses presented below began by focusing on the remaining 33 items, 21 of which were ultimately used to form seven separate scales of technology use.

Defining Technology Use as Multi-Dimensional

One of two approaches are often used to represent teacher technology use: a) a composite measure that represents an index of general technology use is calculated, or b) multiple measures each of which represents a specific category or type of technology use are generated. The first approach creates a single aggregate measure that represents the frequency with which a teacher uses technology for a variety of purposes. Since an increased value in a teacher's response to each survey item corresponds to more frequent use, the items are summed to generate a composite measure that represents the frequency of technology use.

A histogram of the summed composite measure of technology use for the sample of 2,628 teachers is displayed in Figure 1. As seen in Figure 1 (shown on the following page), the composite technology use measure is approximately normally distributed (skewness = -.04) with the majority of respondents clustered in the middle of the distribution and with a fairly equal number of respondents at the respective ends of the distribution.

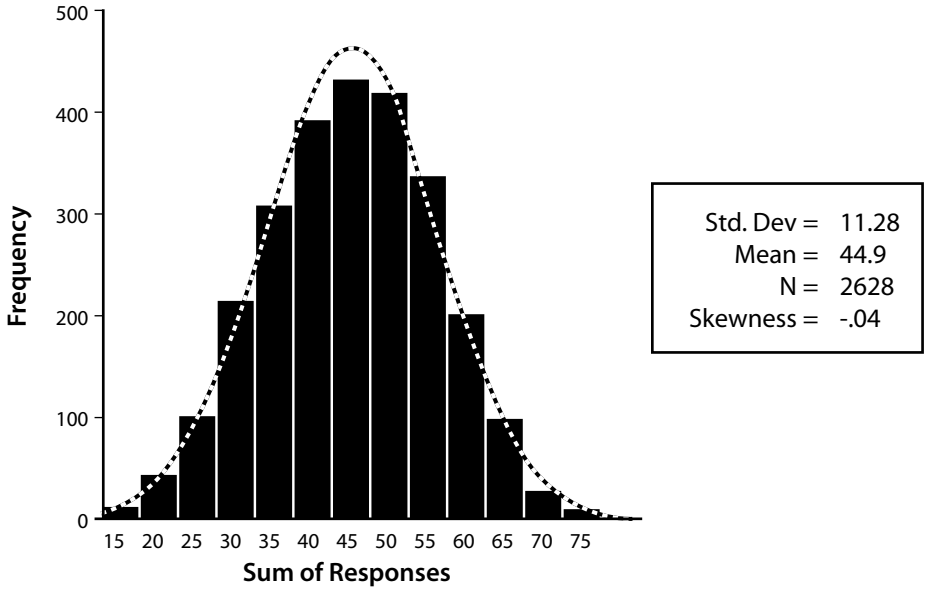

Figure 1: Single composite measurement of teacher technology use

The second approach to measuring teacher technology use involves examining the specific ways in which teachers make use of technology. In this case, multiple measures (i.e. scales) for the specific ways that teachers use technology are constructed from related survey items. As documented in Bebell, O'Dwyer, Russell, & Miranda (2003), principal component analyses were used to develop seven separate scales that measure teachers' technology use. These seven scales include the following:

- Teachers' use of technology for class preparation (Preparation)
- Teachers' professional email use (Professional Email)
- Teachers' use of technology for delivering instruction (Delivering Instruction)
- Teachers' use of technology for accommodation (Accommodation)
- Teacher-directed student use of technology during class time (Student Use)
- Teacher-directed student use of technology to create products (Student Products)
- Teachers' use of technology for grading (Grading)

These seven categories of teacher technology use are displayed in Figure 2 along with the distribution and mean response for each of the items used to form each of the seven scales.

As seen in Figure 2, the number of items used to form each category of use ranges from one to five items. Also note that the distribution of responses and mean response varies considerably across the individual items. For example, the distribution of responses for the item that asks teachers how often they make handouts for students using computers is negatively skewed, with the vast majority of teachers reporting that they do this several times a week or several times a month. For this item, the mean response indicates that, on average, teachers use computers often to make handouts. In contrast, the distribution of responses for the item that asks teachers how often they have students perform research using the Internet or CD-ROMs during class time has a relatively normal distribution with a mean that is just below the mid-point of the

scale. In further contrast, the item that asks teachers how often they ask students to produce multimedia projects has a large positive skew with most teachers responding that they never have students create these type of projects.

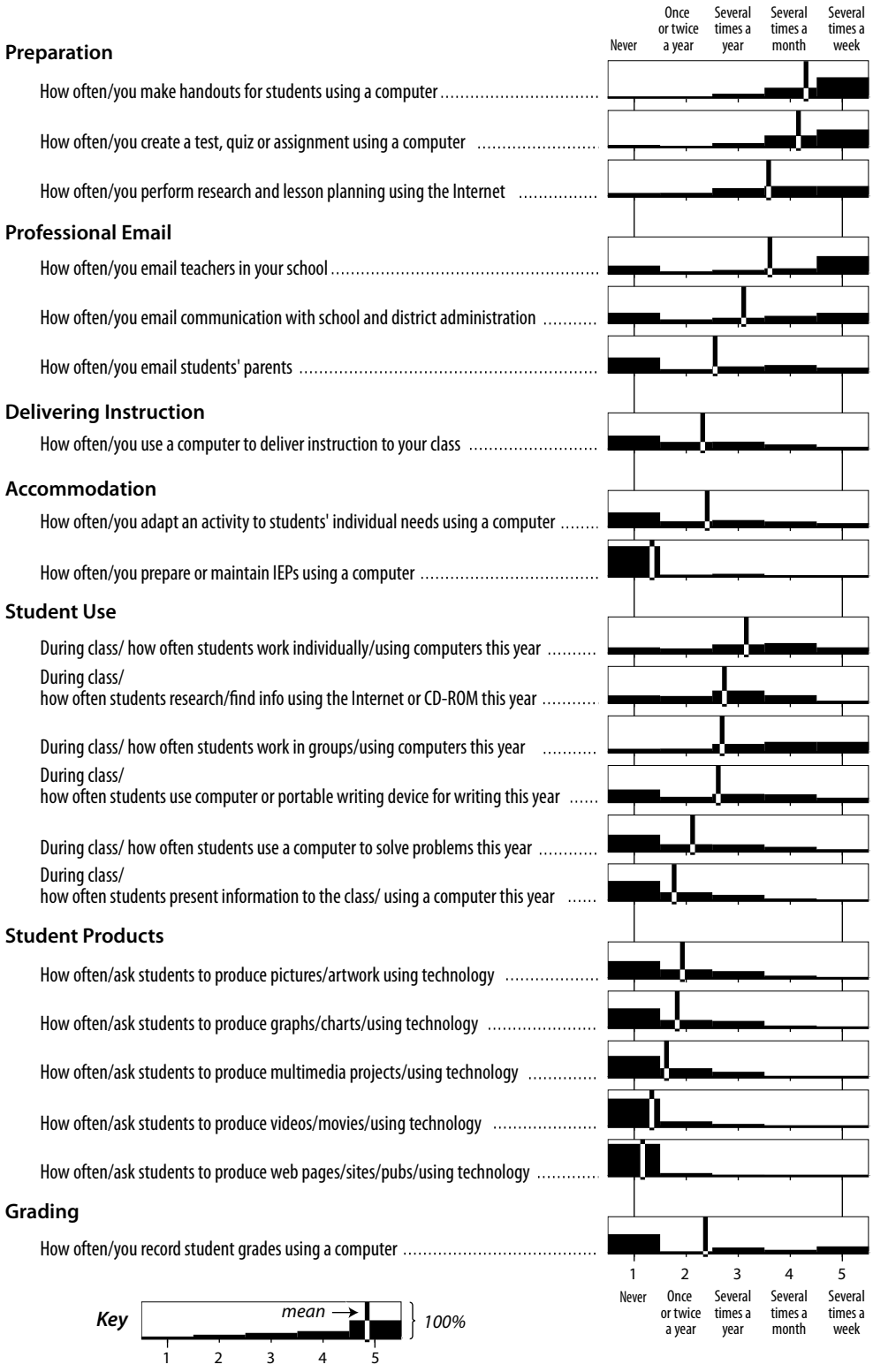

Figure 2: Distribution and mean frequency of use for items comprising the seven categories of teacher technology use

While examining teacher responses at the item level is informative and may reveal interesting patterns across items, patterns become easier to identify when items that focus on related uses of technology are combined into a single measure. As described above, principal component analyses were used to identify the items that have strong inter-correlations and thus can be combined to form a single measure that represents a specific category of technology use. Furthermore, since the same five-point response options, which correspond to the frequency of technology use, were used for all of the items that form the seven categories of technology use, an aggregate score for each category of use was calculated by summing each teacher's response across the survey items forming each category and then dividing by the number of items related to that category. The aggregate scores for each category of technology use are displayed in Figure 3.

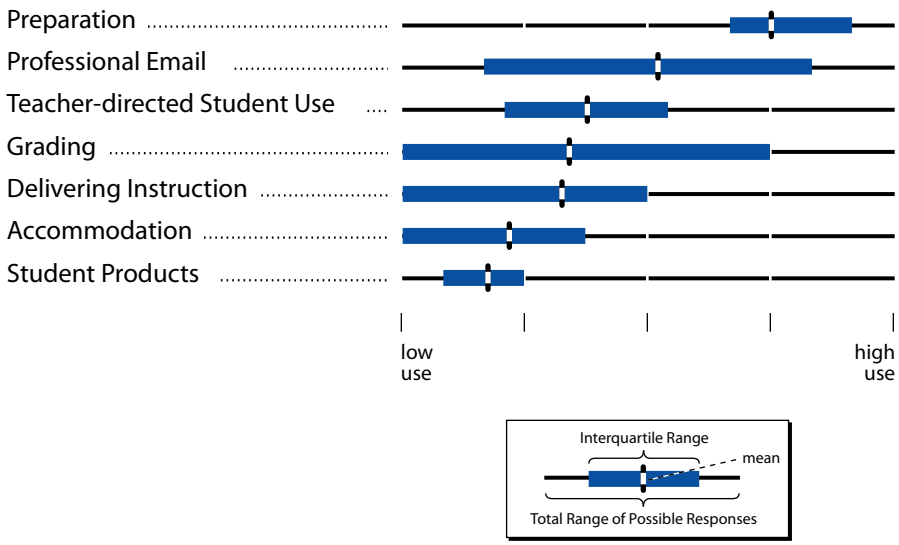

Figure 3: Degree of use for seven categories of technology use

As shown in Figure 3, teachers report that the extent of technology use is highest for preparation. The next most frequent use is for email, which is followed by teacher-directed student use of technology and the use of technology for grading. Note that with the exception of preparation, teachers (on average) report low to moderate levels of use for each category of use, with use for accommodation and for the creation of student products occurring least frequently. It is important to note, however, that the sample of teachers upon which these analyses are based excludes special education teachers who are perhaps most likely to develop accommodations for lessons.

While it is procedurally easier to form a single composite score by combining responses across all items than it is to form multiple categories of use, a richer understanding of how technology is and is not being used by teachers results when multiple categories of use are employed. As an example, recall that the USEIT sample of teachers was normally distributed on the generic measure of technology use (Figure 1). This normal distribution indicates that most teachers are making moderate use of technology and that relatively few teachers are using technology heavily or not all. The distribution of responses for the seven separate technology measures, however, suggest that the distribution of use varies dramatically across the separate categories of use. As shown in Figure 4, the distribution of teacher use of technology for instruction is positively skewed (skewness = 1.09) rather than normally distributed. This indicates

that the majority of the teachers in this sample do not use technology for instruction very often. In fact, nearly 900 teachers indicated that they never use technology to deliver instruction.

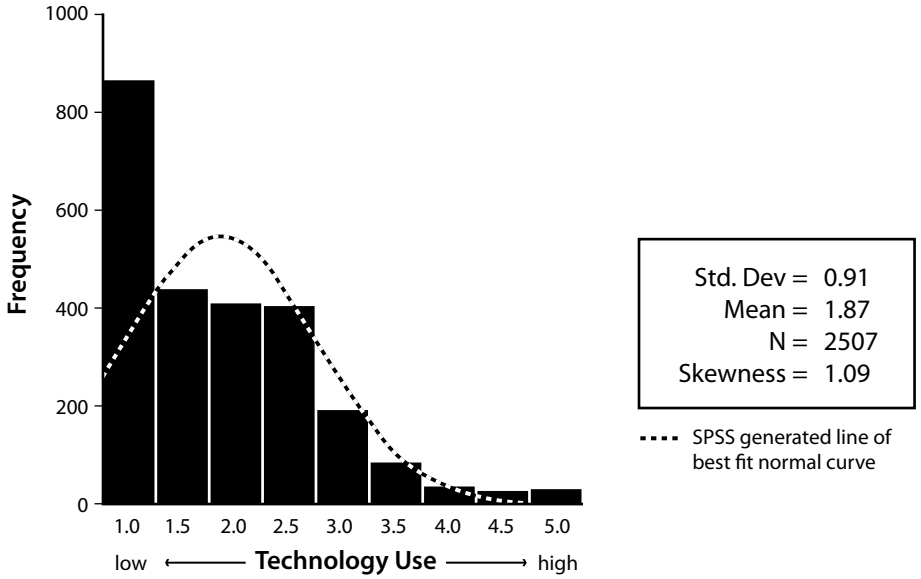

Figure 4: Histogram of teachers' use of technology for Delivering Instruction

In contrast, Figure 5 indicates that the use of technology for preparation is negatively skewed (skewness = -1.12), with most of the teachers reporting high frequency of preparation use.

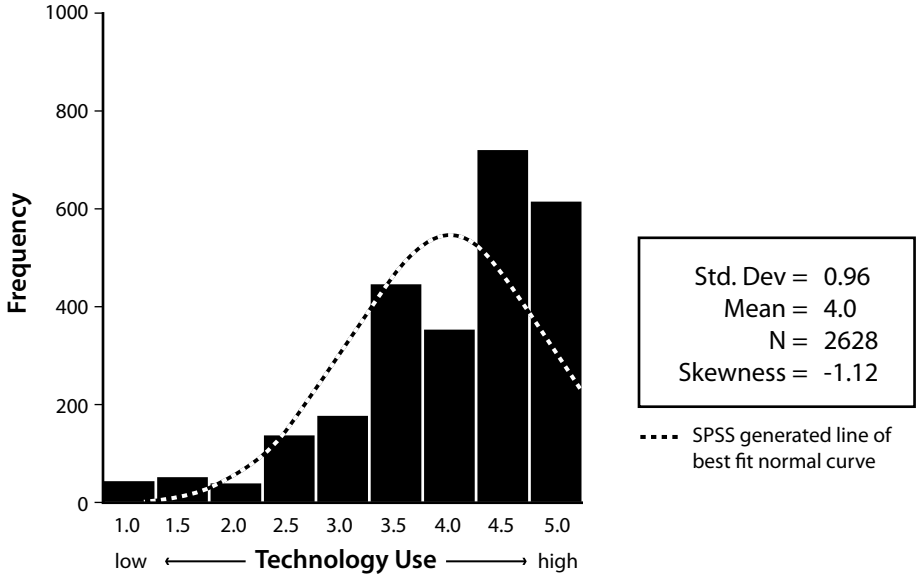

Figure 5: Histogram of teachers' use of technology for Preparation

Figure 6 displays the histograms for the five remaining technology use measures. Like Instructional Use, the distributions for Student Product use (1.15) and Accommodation (1.04) have large positive skews. Grading Use (0.60) also has a weak positive skew while Teacher-Directed Student Use during class time (0.11) is relatively normally distributed. Professional Email Use (skewness =-0.18), however, appears bimodal with a large percentage of teachers reporting frequent use and a large portion of the sample reporting no use.

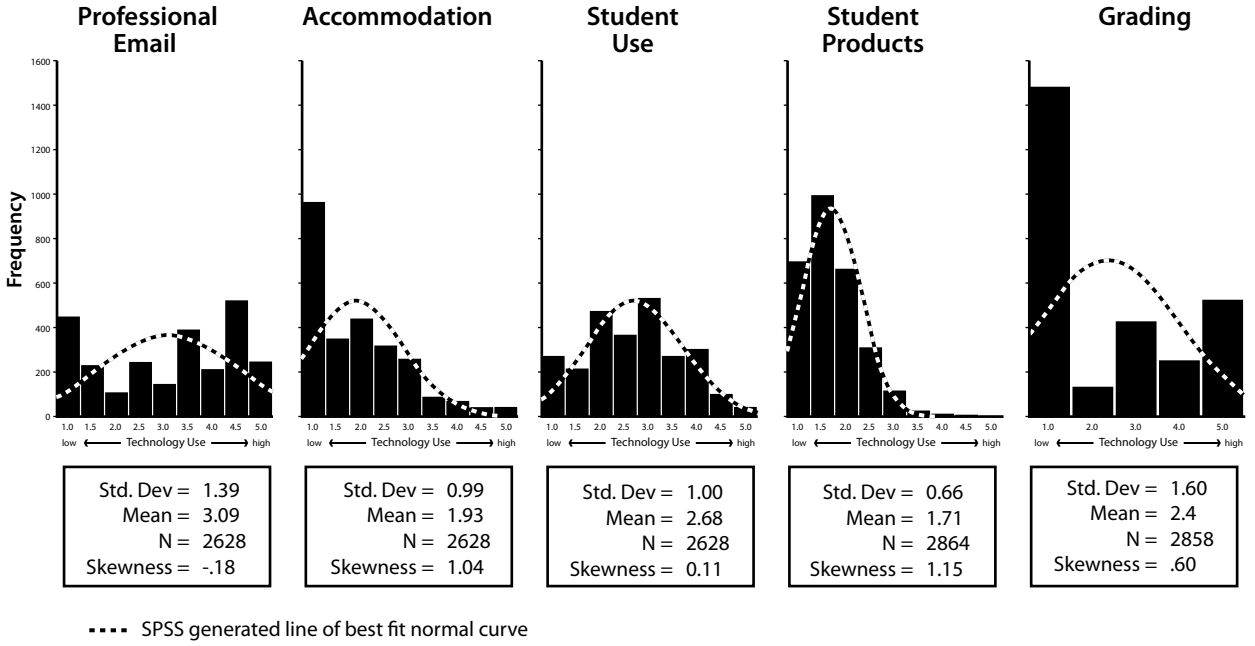

Figure 6: Histogram of the five remaining measures of teachers' technology use

In short, by measuring teachers' use of technology using specific measures we see important differences in the frequency with which teachers use technology for a specific use as well as differences in how these uses vary across teachers. When compared to a single generic measure of technology use, multiple measures of specific technology use offer a more nuanced understanding of how teachers are using technology and how these uses vary among teachers.

Correlation Among Technology Uses

By developing separate measures of teachers' technology use we are not inferring that each individual measure is unrelated to the other technology use measures. Indeed, it would be reasonable to assume that all of the measures have some degree of relation to each other. The strength of the relationships among the seven technology uses are examined via Pearson correlation coefficients which are presented in Table 1.

Table 1: Correlation Table of the Seven Specific Teacher Technology Measures

	Accommo-dation	Delivery	Prof. Email	Preparation	Student Use	Student Products	Grading
Accommodation	1.00						
Delivery	0.26	1.00					
Prof. Email	0.26	0.25	1.00				
Preparation	0.27	0.26	0.35	1.00			
Student Use	0.32	0.47	0.22	0.27	1.00		
Student Products	0.23	0.33	0.18	0.33	0.46	1.00	
Grading	0.11	0.17	0.15	0.24	0.07	0.00	1.00

Table 1 shows that the correlations among the seven teacher technology use measures are all positive, but generally indicate weak to moderate relationships. The positive inter-correlations suggest that teachers who use technology for one purpose are, on average, likely to use technology for other purposes. Likewise, a teacher who never uses one form of technology is likely to be an infrequent user of other technologies. However, the moderate to weak correlations also suggest that there is considerable variation between the extent to which teachers use technology for one purpose and the extent to which they use technology for another purpose.

Across the seven categories of technology use, the median correlation is 0.26. When examining the correlations between any two of the technology uses, two measures have inter-correlation coefficients that are larger than 0.4 (Delivery correlated with Student Use and Student Use correlated with Student Products). Aside from these relationships, there are four examples of correlations above 0.3 (Accommodation correlated with Student Use; Delivery correlated with Student Products; Preparation correlated with Professional Email; and Preparation correlated with Student Products). Again, it is logical that there is a positive relationship between these pairs of measures. Yet, the relatively weak to moderate correlations among each of the uses suggest that each teacher technology category does represent a separate aspect of technology use.

How Multiple Measures of Technology Use Improve Understanding

Although the seven teacher technology use measures are weakly to moderately related to each other, the analyses presented above provide evidence that a) each measure does represent a separate and distinct category of technology use, and b) the frequency and distribution of technology use varies considerably across the seven measures. In this section, we examine how the use of separate measures of technology use provide insight into the ways in which technology use varies across different groups of teachers. Specifically, we examine patterns of use for a) teachers who have been in the profession for different lengths of time, b) teachers who teach in different school types (i.e., elementary versus middle/high school), and c) teachers who teach different subject areas (English/language arts, mathematics, social studies/geography, and science). These analyses are presented to illustrate how our understanding of technology use changes when a single generic measure of use versus multiple specific measures are used.

Technology Use by Years Teaching

It is commonly believed that as new teachers, who have grown up with and are comfortable using technology, enter the teaching profession, technology use in schools will increase (U.S. Department of Education, 2000). When examining use of technology by teachers using a generic measure which comprises a variety of types of technology use, it appears that the frequency with which teachers use technology does not vary noticeably across the number of years in the profession. As seen in Figure 7, teachers who are brand new to the profession report almost the same amount of use as do teachers who have been in the profession for 11 or more years.

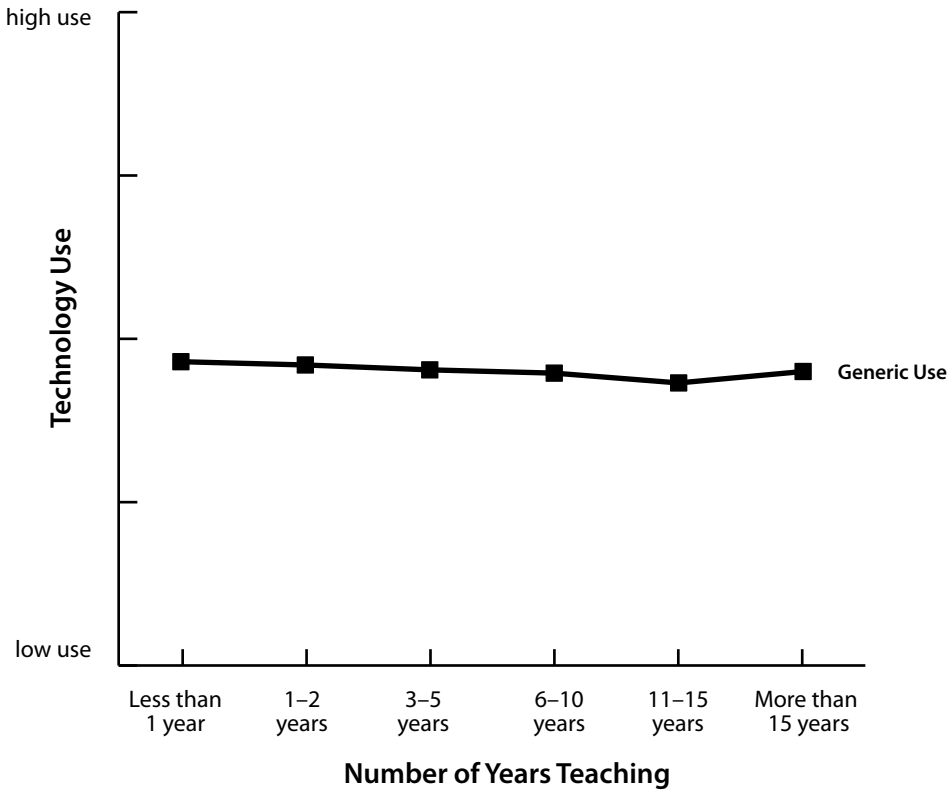

Figure 7: Comparison of generic technology use measure across the number of years teacher has taught

However, when multiple measures of technology use are employed, the pattern changes noticeably. As depicted in Figure 8, newer teachers report higher levels of technology use for preparation and slightly higher levels of use for accommodation than do more experienced teachers. Conversely, new teachers report less frequent use of technology for delivery and report asking students to use technology during class time less frequently than do their more experienced colleagues.

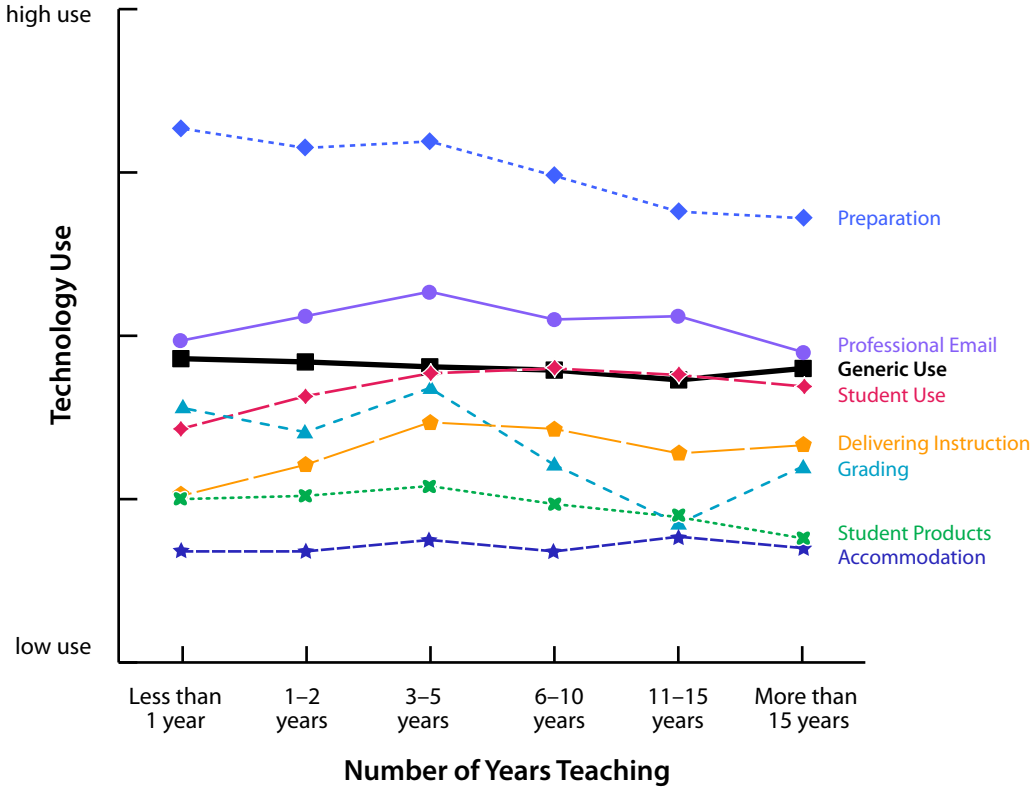

Figure 8: Comparison of multiple technology measures across the number of years teacher has taught.

A similar pattern occurs when examining the relationship between technology use and school type. As shown in Figure 9, the frequency with which teachers report using technology appears to be nearly identical in elementary and in middle/high schools based on a generic measure of technology use. However interesting differences appear when multiple measures of technology use are examined. Although teachers in both settings report about the same amount of use for Delivering Instruction, for Professional Email, and for Student Products, elementary teachers report using technology to accommodate lessons and asking their students to use technology during class time more frequently than do the middle/high school teachers. Conversely, the middle/high school teachers report using technology for preparation at a higher frequency than do the elementary school teachers. By far, however, the largest difference in use occurs for grading, which middle/high school teachers report occurring much more frequently than their elementary school counterparts.

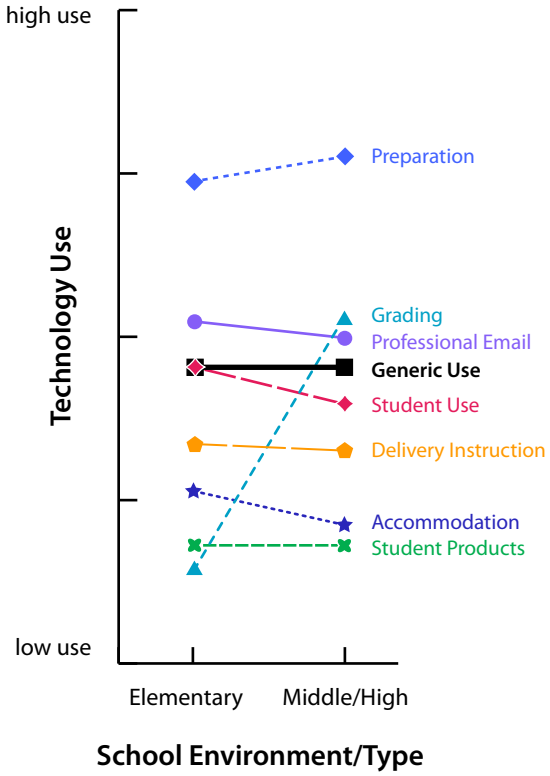

Figure 9: Comparison of different technology measures across school type

Although the differences are less dramatic across subject areas, the way in which technology use is defined also influences our perception of how technology use differs across subject areas. As seen in Figure 10, there appears to be little difference in the frequency of technology use across English/language arts, social studies/geography, and science teachers when technology use is defined with a generic measure. Using this generic measure, it also appears that mathematics teachers use technology less frequently than the other three groups of teachers. When employing multiple measures of technology use, we see a similar pattern for most uses, with mathematics teachers reporting the lowest levels of use for Preparation, Student Use during class time, and Student Products. For each of these uses, however, the difference in use between mathematics teachers and teachers of the other subjects is larger than it is for the generic use measure. However, mathematics teachers appear to use technology to deliver instruction about as frequently as any other group and report noticeably higher levels of use for grading. Although less dramatic, the way in which technology use differs between the other subject areas also changes when individual categories of use are examined. Perhaps most notably, whereas English, social studies and science teachers appear similar with respect to the generic measure, English teachers report using technology for grading less and use technology for accommodations more than teachers of the other two subject areas.

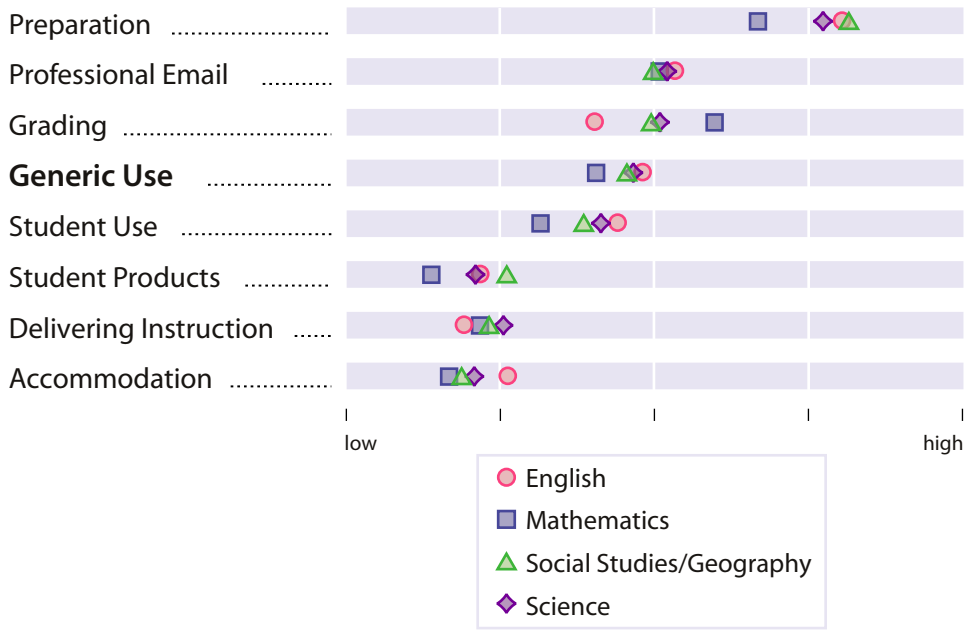

Figure 10: Comparison of different technology measures across school type

Although there are many possible reasons that may explain the differences in use noted above, our purpose here for examining patterns of use is to demonstrate how these patterns differ depending upon how one defines and measures technology use. Whereas there appears to be little difference in the frequency with which teachers use technology based on their years teaching, their school type, or across most subject areas (except mathematics) when a generic measure of technology use is employed, important differences appear when technology use is examined as a multi-dimensional construct.

Discussion

Investments in educational technology have sparked important questions about the impacts of technology on teaching and learning. In turn, leaders and researchers at the district, state, and national levels are making efforts to both increase use of technology by teachers and students and to examine technology's effects on student learning. In many cases, however, definitions of technology use vary substantially across settings and studies, and technology use is often examined in a generic fashion. The analyses presented here demonstrate the value of conceiving of technology use as multiple categories or types of use rather than a single generic construct. Using 21 survey items that focus on specific uses of technology, the analyses presented above demonstrate the following:

a) separate measures that represent distinct categories of technology use can be formed;

b) although these measures are correlated positively with each other, the strength of the relationships are weak enough to suggest that each category represents a separate and distinct type of use;

c) the use of distinct measures versus a generic measure provides a richer, more nuanced understanding of how technology use differs across factors such as teacher tenure, school type, and subject area taught.

The implications of this approach are especially applicable to the future development of surveys and other research instruments designed to measure teachers' use of technology. For example, a district interested in documenting the extent to which teachers are using technology or the extent to which teachers' use of technology changes in response to the acquisition of more resources or the provision of professional development are likely to develop a richer understanding by collecting information about the specific types of teachers' technology use rather than simply measuring its generic presence or absence.

Using a multi-faceted approach to measure teachers' use of technology also brings to bear the general issue of how complicated and varied technology use actually is in today's schools. In good faith, a principal can no longer evaluate a teacher based on whether the teacher is using technology or not, but rather the question should evolve to include how a teacher is making use of various technologies and for what purposes.

In fact, in keeping with previous research findings, our examination of educational technology use shows that the majority of teachers' use of technology goes on behind the scenes with lesson preparation, grading, and professional email use rather than instructional use or teacher-directed student use (Cuban, 2001; Becker, 1999; Bebell, Russell , O'Dwyer, & O'Connor, 2003). For this reason, the traditional methodological tool of classroom observations would fail to capture these activities in an evaluation or research study. Similarly, studies that focus entirely upon student reported data (Edwards, 2002) would also fail to capture the most frequent and pervasive teacher uses of technology.

This point is also directly relevant when examining the relationship between technology use and its impacts on student learning. Although several studies have documented positive effects of technology use on student learning when the technology is used directly by students (see Goldberg, Bebell, & Cook, 2003; Kulik, 1994; and Sivin-Kachala, 1998 for meta-analyses of nearly 700 studies), the analyses presented

above suggest that teacher-directed student use of technology during class time represents just one category of use. Moreover, teacher-directed student use during class time is reported to occur less frequently in comparison to teachers' use for preparation or communication. While it is unquestionably important to understand how student use of technology impacts student learning, it is equally important to examine the relationship between student learning and other uses of technology by teachers that directly support instruction. Clearly, this type of analysis can only be conducted if multiple measures of technology use are employed.

Finally, it is important to recognize that although we strongly advocate for multiple measures of technology use, we are not suggesting that the uses we have employed represent a definitive body of uses or that the items used to form each measure are exhaustive. To the contrary, we believe that as researchers and educators who are familiar with educational technology consider the full range of ways in which technology is currently being used additional categories of use will be identified. Similarly, as new technologies become available and as ubiquitous computing becomes more prominent in schools, specific uses of technology will emerge and categories of technology use will expand. While it may seem efficient to "borrow" surveys or items that have been used for other research or evaluations, doing so may fail to capture the full range in which teachers are using existing and recently acquired technologies for a variety of purposes. It is for these reasons that we encourage schools, districts, and researchers, who will be using surveys to document technology use, to begin by defining the categories or types of use of interest and to then develop items related to each category of use.

As an example, when developing the teacher survey for the USEIT Study, we theorized that teachers' technology use fell into four categories and developed several items related to each category. These theoretical categories included teachers' professional technology use outside of class time, teachers' use of technology during class time (including student directed uses), teachers assigning work that required students to use specific technology, and teachers' communication via e-mail. As described above, our analyses of the teachers' responses to the survey led us to identify seven specific and independent uses of technology by teachers. This expansion occurred because three uses, which originally were subsumed within another category of use, were found to be independent. As an example, we had originally believed that grading was part of professional use outside of the classroom and, thus, would be strongly related to creating tests, handouts, and using the Internet to prepare for lessons. Similarly, we believed that teachers' use of technology to deliver instruction and to make accommodations were components of technology use during class time. However, our analyses indicate that teachers' technology use for delivery and to accommodate lessons operated independently of teachers asking students to use technology during class time and that teachers' use of technology for grading operated independently of preparation. Having learned this, before conducting similar research in the future, we could increase the reliability of our measures and the amount of information provided about each category of use by developing additional items to measure the categories of use that have emerged from our analyses of the USEIT survey data.

In closing, over the past decades, a wide variety of computer-based technologies that can and are being used for educational purposes have emerged. Without question, the variety of technologies and the multiple ways in which some technologies can be used for educational purposes complicates efforts to document technology use and

the effect of these uses on teaching and learning. As we have shown using a limited number of survey items, simply conceiving of a variety of uses of technology as a single generic measure of technology use masks far more than it reveals.

Endnote

1 For a complete review of the timeline of changes in the ways teachers use computers, see Becker's (1994) *Analysis and Trends of School Use of New Information Technologies.*

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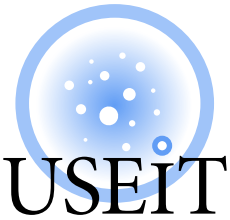
inTASC is a not-for-profit research group that works collaboratively with schools, educational agencies, and businesses to conduct research and development on a variety of issues related to technology and assessment. inTASC brings together researchers who have examined several aspects of technology and assessment in schools over the past decade to focus on new questions and issues that arise from the field. inTASC is unique in that it does not develop research studies and then seek schools to participate in research activities. Instead, schools, educational agencies, and businesses approach inTASC with their own ideas and/or questions that require systematic research to address. Research conducted by inTASC is developed, conducted, and often disseminated in collaboration with our educational and business partners.

inTASC believes that advances in educational technology and continuously emerging applications of those technologies coupled with growing demands to document impacts on teaching and learning requires a dual focus on instructional uses of technology and applications of technology to new forms of assessment. For this reason, inTASC collaborates on research that focuses on instructional uses of technology and on applications of computer-based technologies to the technology of testing and assessment. It is our hope that this dual focus will enable us to provide research-based information to schools and educational leaders about the impacts of educational technology, and to produce new forms of assessment that capitalize on the powers of computer-based technologies and that are more sensitive to the types of learning enabled by educational technologies.



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