Considerations on Technology and Teachers
The Best of JRTE
Edited by Lynne Schrum

Considerations on Technology and Teachers is a collection of the best research articles from the Journal of Research on Technology in Education (JRTE) over the past six years.

In the introduction, editor Lynne Schrum explains why it was important to publish this collection. She also gives background on the educational research landscape and discusses where educational research needs to be in the future. Following the introduction is an excerpt of Chapter 3, “Measuring Teachers’ Technology Uses: Why Multiple Measures Are More Revealing.” It provides an example of the type of research articles presented in this book as well as the author updates that conclude each chapter.
INTRODUCTION

Revisioning a Proactive Approach to an Educational Technology Research Agenda

Lynne Schrum | George Mason University

In 2005, five educational technology editors and researchers (Bull, Knezek, Roblyer, Schrum, & Thompson) wrote an editorial that was designed both as a call for educational researchers to identify the pressures toward one model of research methodology, and as a call for the joint creation of an agenda that respected the way schools work, the challenges of learning technology, and the impact of pressure to demonstrate academic achievement directly tied to the use of technology. This introduction is designed to revive the conversation, and also to expand the agenda in new ways.

During the past 30 years, technological advances have exceeded even the most optimistic expectations. The steady advance in speed and capacity has produced powerful computers available at modest prices, along with a wide variety of handheld technologies that can accomplish remarkable tasks. This wider accessibility has resulted in wider usage. A recent Pew study found that 93% of teens ages 12–17 now use the Internet, up from 73% in 2000 (Pew Internet & American Life Project, 2007). Additionally, this study found that 69% of online Americans have used “cloud computing” applications (basically Web 2.0 tools) (Jones & Fox, 2009).
Those of us who have committed our professional lives to investigating this educational arena have anticipated that the advances in technological capacity would be matched by parallel enhancements in learning. Recently, we have witnessed a remarkable expansion of Web 2.0 tools and their uses in educational settings. And research on teaching and learning is blending activities inside and beyond the classroom in innovative uses of technology, such as the “Innovative Digital Media and Learning Projects” (The MacArthur Foundation, www.macfound.org/att/cf/%7Bb0386ce3-8b29-4162-8098-e466fb856794%7D/DMLCOMP2009-PR-090416.PDF).

Technology has had a positive impact on education, even if it has not yet resulted in wholesale educational transformation. However, there are larger issues that have not yet been addressed: for example, disparities in educational outcomes still exist, too many of our youth still drop out of school and do not reach their potential, and students are often disengaged from content and learning. Perhaps our research is unable to answer the questions, or perhaps we are asking the wrong questions. It appears that our conversations are not yet as broad, deep, or inclusive as they will need to be for us to see the type of transformation we desire. An effective return on future investments in educational technology is more likely to be realized to the extent that research captures past impact and provides directions for future use. Best approaches to educational research have been the focus of a major emphasis by the U.S. Department of Education. There is no area in which well-conceived and effectively implemented research could be of greater value than in the area of technological innovation. Our research is about technology; we now must let others see how it is about learners of all ages, teaching, and the future of our democracy.

Challenges for Educational Technology Research

A review of educational technology journals provides an opportunity to survey the landscape of the published research in this area. It raises a concern about our efforts to mentor the next generation of researchers. For example, in 2009 approximately 85% of submissions to the Journal of Research on Technology in Education (JRTE) were ultimately rejected for two main reasons. The primary reason was related to quality, methods, and focus. But many were rejected because they did not deepen, expand, or push the envelope on our literature base, nor did they help develop new knowledge that added to what we already know.

Every researcher undertakes a study with the hope of making a substantive contribution to the field. Each of the submissions represents months or years of effort and
commitment on the part of one or more authors. A publication process that results in inefficiencies of 80% or more clearly cries out for improvement.

We stand at a crossroads as the U.S. Department of Education is beginning to recognize that not all randomized studies are valuable, and that other types of studies may offer insights and knowledge worth having. At the same time, the funding will still go only to educational researchers who offer strong and worthwhile research designs that are based on sound background literature, theoretical constructs, deep and important research questions, and accepted methods of data collection and analysis.

Some of the reasons for the ongoing challenge, presented when the editorial first was published, are still useful and unfortunately, operational, so they are repeated here:

_Unrealistic expectations for technology-based reform._ Technologies brought about such high-profile reforms in other areas of society that many educators and researchers came to expect similarly widespread impact in education. Other areas of society faced similar challenges. For example, researchers were not able to capture any relationship between investments in technology and increases in productivity throughout the 1980s. Business continued to invest, and eventually the investment in technology was associated with gains in productivity in the 1990s. Education represents an unparalleled set of problems and complexities. In retrospect, it seems apparent that expectations should be based on a more realistic, theory-based appraisal of specific learning problems for which technology applications might be a good solution. Research should have focused on confirming that these applications were instructional strategies of choice and on providing guidelines for conditions under which this was true.

_Lack of consensus on research questions and methodologies._ For the first 20 years, educational technology research focused on the question: “Is a technology-based method better than a non-technology-based one?” Eventually, this approach was deemed ill-conceived and unproductive. Yet no more useful paradigm has emerged to take its place. Future research must focus on yet-to-be-articulated research questions.

_Diminished role of research in school reform._ Even published studies do not typically result in any change in educational practice. Some educators have argued that this is due in no small part to a “disconnect” between the interests of researchers and the needs of teachers and schools. A more practical, focused research agenda is an essential need, as are strategies for coordinating research efforts and findings across researchers and research centers. (Bull et al., 2005, pp. 218–219)
A New Challenge for Our Design-Based and Collaborative Research

Since this original editorial was written, new Web 2.0 tools, which offer greater potential to increase interactivity and perhaps better address the digital divide, have become commonplace, and almost all use of these tools is voluntary (Alexander, 2008; Solomon & Schrum, 2010). Now we are tasked with investigating their purposeful educational uses and identifying ways these new tools may affect student engagement and academic achievement; the hope is that we have learned about creating a unified research agenda to help guide us.

We are beginning to see research that examines a new type of activity, epistemic games; they are “explicitly based on theory of learning in the digital age and are designed to allow learners to develop domain-specific expertise under realistic constraints” (Rupp et al., 2009, p. 4). The goal is to have learners experience what it is like to really think and act like “journalists, artists, business managers, or engineers by using digital learning technologies to solve realistic complex performance tasks” (p. 4). We might consider this somewhat analogous to an authentic practicum or internship, and these models have been created in a variety of content areas, including history (Johnson & Levine, 2008; Squire, DeVane, & Durga, 2008) with research suggesting powerful and positive results in engaging learners. Research on these tools offers an opportunity to be both formative as well as design based, because reflection on the data leads to modification of the tools. If, as Barab, Thomas, Dodge, Carteaux, and Tuzun suggest, these types of activities sit at the “intersection of education, entertainment, and social commitment” (2005, p. 86), then what are the implications for our research? Annetta (2008) suggests, “These educational games commonly require the use of logic, memory, problem-solving, critical thinking skills, visualization, and discovery” (p. 261). What requirements are placed on researchers to examine the constructs in and out of school? Squire, Giovanetto, DeVane, and Durga (2005) posit, “To date, we actually know relatively little about the consequences of game play on the cognition of those who play them” (p. 35).

More importantly, some research has begun to show that students are really learning in this environment. Hickey, Ingram-Goble, and Jameson (2009), for example, have seen this in their research. In two studies of Quest Atlantis, they found sixth grade students making “larger gains in understanding and achievement” than in classes that used expository text to learn the same concepts and skills (p. 187). In a study of a similar type of project, Ketelhut (2007) found that her results “suggest that embedding science inquiry curricula in novel platforms like a MUVE might act as a catalyst for change in students’ self-efficacy and learning processes” (p. 99). Kyza (2009) conducted a multiple-case study looking at middle school students’ reasoning in an investigation of data-rich,
scientific problems scaffolded by software, the task, and the teacher. Although she found statistically significant growth in learning and that the scaffolding contributed to the inquiry, she also found that they required “epistemologically targeted discourse alongside guided inquiry experiences” to be able to really understand alternative hypotheses and to support their scientific reasoning processes (p. 377).

We hear a great deal about the preparation of teachers these days, and how many still are not changing their teaching to take advantage of technology. Recently some researchers have begun to reexamine the preparation and role of school leaders and their need for specific types of preparation to lead our 21st-century schools (Schrum, Galizio, & Ledesma, in press; Schrum & Levin, 2009). The reality is that without support, leadership, and commitment from all stakeholders in a school system, the type of learning we have often dreamed of may not be realized. The need then is for a comprehensive plan with complementary comprehensive research to document what we find.

Are these studies and efforts the beginning of a new research agenda? Are they perhaps the beginning of a new effort to demonstrate that in certain circumstances, under particular conditions, technology may assist in enhancing learning outcomes? Or will we again see that real systemic changes happen only with funding, and that well-designed projects are not scalable or applicable in other situations?

A Renewed Proposal for a Proactive Research Agenda

One editorial function is to serve as a nexus for quality control. However, being an editor also offers an opportunity to provide leadership, either implicitly by what is published, or explicitly by purposefully seeking important and thoughtful additions to our literature base. Discussions regarding the potential value of a proactive approach to research continue within this context. After many years as editor of JRTE, I consider it important to explicate the importance of what needs to be published, to explore ways to influence the conversation, and to encourage new scholars to join us; such discussion also allows us to courageously draw a deep line in the sand to only approve and accept rigorous and valuable research.

An effective conversation must include discourse among leading educational technology researchers. However, to be successful, it will be equally important to involve other stakeholders to ensure strong linkages between applied research and explicit connections and value to schools. It is also important to include input from corporate partners, the K–12 school community, developers, and policy makers in the questions we ask, in the research we conduct, and in the interpretations and policy that ensue.
Two further outcomes may emerge from this dialogue. The process of preparing doctoral students to design, conduct, and analyze good research is a nontrivial task, and yet we continue to see less funding, fewer full-time positions, and thus less time for faculty to devote to this important goal. If educational technology researchers and journal editors can proactively work toward a measure of consensus on productive directions for future research, it may be possible to increase the positive outcomes for our future colleagues.

Second, as previously addressed, the introduction of technology into our schools has not resulted in the expected educational reform. One reason for that may be the missing relationship between educators and their burning questions and the questions educational researchers choose to investigate. If we can assist in creating a dialogue, stronger collaboration, and recursive conversation between these two groups, that too would be an excellent outcome. After all, teaching and learning require support from the teacher in designing an educational environment, and technology must be embedded in thoughtfully planned ongoing instruction to be effective in supporting student outcomes. Educators and researchers have common goals, and synergy between them would benefit all.

Conclusions

The purpose of this compilation of research articles from JRTE is to provide a context and trail of where we have been and what our research base has established thus far. At present the technological capacity available to schools exceeds our ability to use it effectively to enhance learning. A proactive approach to establishing a research agenda can potentially provide guidance to future investigators. The substantial continuing cost of technology in schools makes it important to ensure that research produced is relevant. Providing researchers with context and guidelines will increase the likelihood that efforts are productively directed. Barab, Dodge, Thomas, Jackson, and Tuzun (2007) suggest that a larger purpose may result from the community of educational researchers, if they decide to work together to build true transformative materials and move theory into directions that take advantage of our collective knowledge. They state that a collective effort would be

significantly heightened if we as a community embrace the critical agendas that are central to so many discussions in anthropology, philosophy, or even curriculum development more generally. Instead of simply building an artifact to help individuals accomplish a particular task, or to meet a specific standard, the focus of critical design work is to develop sociotechnical structures that facilitate individuals in critiquing and improving themselves and the societies in which they function, and then we use our understanding of participation with these structures to advance theory. (p. 264)
A consensus on every point will not be reached, nor is that the intent. There will always be diverse perspectives within an academic community. However, the dialogue will encourage more sharply articulated research objectives and guidelines. The result should facilitate much needed research in this area.

References


INTRODUCTION


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

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In the past 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 investments are affecting the lives of teachers and students. This paper examines the ways in which teachers use technology, with a specific emphasis on the measurement of teachers’ technology use. Specifically, the survey responses of approximately 3,000 K–12 teachers are analyzed to examine the multidimensional nature of teachers’ technology use. The findings provide insight into improved strategies for conceiving of and measuring teacher technology use.
Introduction

Over the past 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 affecting the lives of teachers and students (McNabb, Hawkes, & Rouk, 1999). Although 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 e-mailing, 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. Although 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 chapter, 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 the U.S. 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, whereas 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,” whereas 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 multimedia 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 e-mail to communicate with their colleagues, administrative leaders, students, and parents (Lerman, 1998). Naturally, as the variety of ways in which teachers could use technology increased, defining what was meant by technology-using teacher became more complicated. (For a complete review of the timeline of changes in the ways teachers use computers, see Becker’s Analysis and Trends of School Use of New Information Technologies, 1994.)


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 differentiated among types of teachers’ technology uses and reported that, although the vast majority of teachers were using technology for some aspects of their professional activities, noninstructive technology uses were pervasive. For example, the NCES reported 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 e-mail to “communicate with colleagues” and about a quarter of teachers communicate with parents by e-mail.
- 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, Rowand (2000) articulated several facets of teacher technology usage that were measured by the NCES survey. These facets included the teacher using technology to/for the following (in descending 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
- 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 that 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 noninstructional 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 e-mail 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 & 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 out 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, in both 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 on 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, whereas others may view it as a generic measure of the collected technology skills and uses of a teacher.

In recognition of the importance of how technology use is both defined and measured, the remainder of this chapter 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 multifaceted approach to measuring teachers’ technology use holds the potential to provide deeper insight into how technology use varies across settings. Based on 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. Before examining technology use, we provide a brief overview of the USEIT study sample and design.

Sample and Methodology

To explore the utility of a multidimensional definition of technology use, the analysis uses 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 three-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 Russell, Bebell, and 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 on 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. Because these survey items did not specify whether it was the teachers or their students using the devices, they...
Measuring Teachers' Technology Uses

CHAPTER 3

Defining Technology Use as Multidimensional

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. Because 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 3.1. As seen in Figure 3.1, the composite technology use measure is approximately normally distributed (skewness = –0.04) 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.

![Histogram of summed composite measure of teacher technology use](image)

**Figure 3.1 Single composite measurement of teacher technology use**

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STD. DEV = 11.28  
MEAN = 44.9  
N = 2,628  
SKEWNNESS = -.04
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 Russell, O’Dwyer, Bebell, and Miranda (2003), principal component analyses were used to develop seven separate scales that measure teachers’ technology use. These seven scales are as follows:

- Teachers’ use of technology for class preparation (Preparation)
- Teachers’ professional e-mail use (Professional E-mail)
- 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 3.2 along with the distribution and mean response for each of the items used to form each of the seven scales.

As seen in Figure 3.2, the number of items used to form each category of use ranges from one to five. 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 often use computers 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 CDs during class time has a relatively normal distribution with a mean that is just below the midpoint 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 3.2 Distribution and mean frequency of use for items comprised in the seven categories of teacher technology use
Although 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 previously, principal component analyses were used to identify the items that have strong intercorrelations and thus can be combined to form a single measure that represents a specific category of technology use. Furthermore, because the same 5-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 3.3.

![Figure 3.3 Degree of use for seven categories of technology use](image)

As shown in Figure 3.3, teachers reported that the extent of technology use is highest for preparation. The next most frequent use is for e-mail, 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, 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 on which these analyses are based excludes special education teachers, who are perhaps more likely to develop accommodations for lessons.
Although 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 3.1). This normal distribution indicates that most teachers are making moderate use of technology and that relatively few teachers are using technology heavily or not at 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 3.4, 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 3.4 Histogram of teachers' use of technology for Delivering Instruction](image)

In contrast, Figure 3.5 indicates that the use of technology for preparation is negatively skewed (skewness = –1.12), with most of the teachers reporting a high frequency of preparation use.
Figure 3.5 Histogram of teachers’ use of technology for Preparation

Figure 3.6 Histogram of the five remaining measures of teachers’ technology use

Figure 3.6 displays the histograms for the five remaining technology use measures. As with Delivering Instruction, the distributions for Student Products use (1.15) and Accommodation (1.04) have large positive skews. Grading use (0.60) also has a weak positive skew, whereas teacher-directed Student Use during class time (0.11) is relatively normally distributed. Professional E-mail 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.
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 implying 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 3.1.

Table 3.1 Correlation Table of the Seven Specific Teacher Technology Measures

<table>
<thead>
<tr>
<th></th>
<th>Accom.</th>
<th>Delivery</th>
<th>Prof. E-mail</th>
<th>Prep.</th>
<th>Student Use</th>
<th>Student Products</th>
<th>Grading</th>
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<tr>
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<td>1.00</td>
<td></td>
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<td>Preparation</td>
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<tr>
<td>Student Use</td>
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<td>0.47</td>
<td>0.22</td>
<td>0.27</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Products</td>
<td>0.23</td>
<td>0.33</td>
<td>0.18</td>
<td>0.33</td>
<td>0.46</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Grading</td>
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<td>0.17</td>
<td>0.15</td>
<td>0.24</td>
<td>0.07</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 3.1 shows that the correlations among the seven teacher technology use measures are all positive, but generally indicate weak to moderate relationships. The positive intercorrelations 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 intercorrelation 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 E-mail, 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 just presented 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 provides 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 is 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 (National Center for Education Statistics, 2000). When examining use of technology by teachers using a generic measure that 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 3.7, 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.
However, when multiple measures of technology use are employed, the pattern changes noticeably. As depicted in Figure 3.8, 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.
A similar pattern occurs when examining the relationship between technology use and school type. As shown in Figure 3.9, 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 E-mail, 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 do their elementary school counterparts.

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 3.10, 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.

Although there are many possible reasons that may explain the differences in use just noted, our purpose here for examining patterns of use is to demonstrate how these patterns differ depending on 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 multidimensional construct.
Figure 3.9  Comparison of different technology measures across school type

Figure 3.10  Comparison of different technology measures across subject areas
Discussion

Investments in educational technology have sparked important questions about the impact of technology on teaching and learning. In turn, leaders and researchers at the district, state, and national levels are making efforts both to 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 just presented demonstrate the following:

- Separate measures that represent distinct categories of technology use can be formed.
- Although these measures are correlated positively with each other, the relationships are weak enough to suggest that each category represents a separate and distinct type of use.
- 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 is 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 multifaceted 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 e-mail use rather than instructional use or teacher-directed student use (Becker, 1999; Cuban, 2001; Russell, Bebell, 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 on 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, Russell, & Cook, 2003; Kulik, 1994; and Sivin-Kachala, 1998, for meta-analyses of nearly 700 studies), the analyses presented here 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. Although it is unquestionably important to understand how student use of technology affects 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. Although 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 through e-mail. As described earlier, 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, during recent 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 complicate 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.

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Author Update

In an effort to better define and measure the ways teachers use technology to support teaching and learning, we examined survey responses from more than 2,500 teachers using factor analytic techniques. Our analyses demonstrated that defining and measuring multiple, distinct technology uses was more informative than using a more general “technology use” metric. Specifically, our analyses suggested that teachers’ use of technology is multifaceted and cannot be meaningfully collapsed into a single metric.

In the six years since the original 2004 JRTE publication, the possibilities for how teachers employ educational technology has only grown more nuanced (and complicated). Moreover, it’s important to consider that the data we used in this chapter to demonstrate the multifaceted nature of teachers’ technology use were collected in early 2001, from traditional K–12 learning environments. Indeed, since that time, the expectations of how (and why) teachers use technology has continued to evolve rapidly, as represented by the recent (2008) revisions to the ISTE National Educational Technology Standards for Teachers. Quite simply, the more types of educational technology infiltrate schools, the more potential ways there are for teachers to employ technology to support teaching and learning.

Similarly, the past decade has witnessed large increases in the number of schools that have adopted 1-to-1 technology access—providing environments where teachers can employ novel uses of technology with their students. Not surprisingly, one of the central themes to emerge from research into 1-to-1 settings has been the recognition of classroom teachers as critical gatekeepers to student technology use. Given this recognition of teachers and the importance of their technology-related practices in the classroom, it is vital that we, as researchers, find the best methods to recognize and measure the various ways in which teachers use technology.
References


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