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HOW TEACHERS' USES OF TECHNOLOGY VARY BY TENURE AND LONGEVITY

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ABSTRACT

In spite of large expenditures on and increased access to educational technologies, a concern remains that computer-based technologies are not being integrated into regular instructional practices. While there is evidence to support the hypothesis that newer teachers' familiarity with technology leads to increased technology integration, a question remains about whether technology use is not only related to the number of years they have been in the teaching professional, but also the number of years they have been teaching at their current school. To examine this issue, this research presents the findings from the analysis of survey data collected from the 2,864 teachers. The data show that the relationship between technology use, the amount of time teachers have been teaching throughout their career, and the number of years they have been at their current school varies according to the ways in which technology use is defined. This article discusses the variety of relationships that were observed in the data and their implications for pre-service and in-service teacher training.

Over the past decade, expenditures on, access to, and use of computer-based technologies by teachers and students have increased sharply. Between 1995 and 2001, federal expenditures on educational technology increased from $21 to

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$729 million while the student to computer ratio has decreased from 9:1 to the current estimate of 4:1 (Glennan & Melmed, 1996; Market Data Retrieval, 1999, 2001; Bausell & Klemick, 2007). Between 1997 and 2003, the percentage of classrooms connected to the Internet more than tripled from 27% to 93%. In 1997, 50% of schools were using a dial-up connection to connect to the Internet and only 45% had a dedicated high-speed Internet line. By 2003, less than 5% of schools were still using dial-up connections and 95% had broadband access. In 2003, two-thirds of schools had also established wireless connections to the Internet. More recent data on schools that received funds through the Enhancing Education Through Technology program (EETT), the federal grants program designed to improve student achievement through the use of technology in elementary and secondary schools, indicates that over 50% of teachers use technology to develop materials, prepare lessons, and/or create tests and quizzes. Forty percent of teachers reported using technology while delivering lessons, while more than half of students reported using technology in school to conduct research, to practice or review classroom content, to take tests or quizzes, or to produce assignments (Bakia, Mitchell, & Yang, 2007).

Despite these large expenditures, this increased access, and nearly universal computer use by school-age children and their teachers, several observers have questioned the extent to which technology is impacting teaching and learning (Cuban, 2001; Healy, 1998; Stoll, 1999). Specifically, Cuban argues that despite widespread use of computers by teachers outside of the classroom, instructional practices and school culture have not incorporated computer-based technologies into regular instructional practices. From Cuban's perspective, the problem is two-fold. First, teachers lack an understanding of how technology can be integrated into regular classroom instructional practices. This notion is supported by a 1999 U.S. Department of Education Survey in which only one-third of teachers reported feeling either well-prepared or very well prepared to use computers and the Internet for classroom instruction (U.S. Department of Education, 2000). Second, school systems have not been restructured to fully support the integration of technology during instruction. As a result, computer-use during class time is often treated as a special event or an add-on to the traditional curriculum.

In response to the first problem, many educational leaders have assumed that as new generations of teachers who have grown up in a technology-rich environment enter the profession, their comfort and skill with technology will lead to increased use of computers for instruction (U.S. Department of Education, 2000). However, other advocates for educational technology argue that "teacher-training programs do not provide future teachers with the kinds of experiences necessary to prepare them to use technology in their classrooms" and that pre-service teachers must be exposed to ways of teaching with technology during formal teacher preparation programs (Milken Exchange on Education Technology, 1999, p. i).

Similarly, several advocates for educational technology have emphasized the need to provide in-service teachers with better preparation on how to integrate

technology into their teaching practices. In a 2000 report, the U.S. Department of Education stated that "teachers' preparation and training to use educational technology is a key factor to consider when examining their use of computers and Internet for instructional purposes" (U.S. Department of Education, 2000, p. 4). In response to this need, the *No Child Left Behind Act of 2001* (Public Law No: 107-110) requires all recipients of federal technology grants to invest a minimum of 25% of the awarded funds in professional development related to technology integration.

To investigate the widespread belief that new teachers who have grown up with technology will use educational technology more often than veteran teachers, Russell, Bebell, O'Dwyer, and O'Connor analyzed survey data from 2,864 K-12 teachers collected as part of the Use, Support, and Effect of Instructional Technology (USEIT) Study (2003). In that study, patterns of technology use for teachers who had been teaching throughout their careers for varying lengths of time were explored. Both new and veteran teacher data were examined across the four different types of technology use scales presented in Table 1: teachers' use of technology for delivering instruction (Delivery Use); teachers' use of e-mail for professional purposes (E-mail Use); teachers' use of technology for preparation (Preparation Use); and teacher-directed student use of technology during class time (Teacher-Directed Student Use) (Russell, Bebell, O'Dwyer, & O'Connor, 2003). (Both the USEIT study and the measurement of teachers' technology use are discussed later in this article.) Table 1 displays the mean standardized technology use scale score for three groups of teachers based on the number of years they had been teaching across four categories of technology use.

The results show that teachers who had been teaching for 6-15 years reported the highest use of e-mail for professional purposes. As many observers had assumed, teachers who entered the teaching profession within the previous five years used technology significantly more for preparation than teachers who have taught for 15 or more years. However, new teachers used technology for delivering instruction less frequently than teachers who have been teaching six or more years. Interestingly, there are no significant differences among the three groups in terms of technology use to deliver instruction. New teachers were also found to be assigning their students to use technology during class time significantly less frequently than teachers who have taught for six or more years. As Table 1 shows, the results of the analysis do not fully support the belief that new teachers' perceived comfort with technology results in more frequent technology use than their older colleagues.

Revisiting the same teacher data in 2005, Russell, Bebell, and O'Dwyer reexamined the interesting patterns between the number of years a teacher reported teaching and their patterns of technology use. The analyses showed that teachers who had only been in the profession for two years or fewer, had higher levels of comfort with technology than the other teachers in the sample. In terms of technology use, these teachers reported using technology for preparation more

Table 1. Teachers' Use of Technology for Preparation, E-mail, Delivery of Instruction and Teacher-Directed Student Use Across the Number of Years Teaching

	Preparation use[a]		E-mail use[a]		Delivery use		Teacher-directed student use[a]	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
1-5 years (A)	0.30	0.80	0.05	1.02	–0.07	0.99	–0.12	0.96
6-15 years (B)	0.21*	0.87	1.15	1.02	0.03	0.99	0.03*	0.97
> 15 years (C)	–0.22†‡	1.07	–0.08†‡	0.98	0.01	0.99	0.05†	1.03

[a]Indicates ANOVA was significant at the .01 level.
*Indicates a significant difference at the .01 level between Group A and Group B.
†Indicates a significant difference at the .01 level between Group A and Group C.
‡Indicates a significant difference at the .01 level between Group B and Group C.

often than other teachers; however, they reported lower levels of use during class time for both delivering instruction and assigning activities that require students to use technology (Russell, Bebell, & O'Dwyer, 2005).

While these previous findings have been eye-opening for many observers, they have also led some to question why these patterns might occur. These observers questioned whether the technology use patterns that were observed were the result of teachers being new to their school as opposed to being new to the teaching profession. The idea behind this question is that teachers who are new to a school may need time to develop familiarity with the school's curriculum, social norms, student skills, and technology resources. Collectively, the need to develop familiarity and comfort with these factors may have a temporary negative effect on teachers' use of technology during instruction. This question underlies the present inquiry where we focus on whether teachers' use of technology varies by the amount of time they have been teaching throughout their career versus the amount of time they have taught at their current school. Given the recent emphasis on the need for pre-service preparation programs to prepare new teachers to use technology as an instructional tool, the answer to this question has implications for how we assess the impact pre-service programs have on technology use by new teachers and whether schools should do more to familiarize any teacher who is new to the school with the technology resources available to support instruction.

To address this issue, the current article presents findings from the analysis of data collected from the 2,864 Massachusetts teachers who were previously used to examine the relationship between the length of time teachers have been teaching and their technology uses (Russell, Bebell, O'Dwyer, & O'Connor, 2003). For the analyses presented here, additional information about the amount of time teachers have taught in their current school is employed. This additional information allows us to examine the relationship between teacher tenure, teacher longevity within a school, and their technology uses. Before examining these issues, we provide a brief overview of the USEIT Study and the data used to examine these issues.

THE USEIT STUDY

Working with 22 school districts located throughout Massachusetts, the USEIT Study was designed to examine how educational technologies are being used by teachers and students, what factors influence these uses, and how these uses affect student learning. The three-year study began during the Spring of 2001 and was divided into two phases. During the first phase (2001-2002 school year), information about district technology programs, teacher and student use of technology in and out of the classroom, and factors that influence these uses were collected through site visits, interviews, and surveys. In total, survey responses were obtained from 120 district level administrators, 122 principals, 4,400 teachers, and 14,200 students (Russell, Bebell, & O'Dwyer, 2003).

Specifically, across the 22 districts participating in the USEIT Study, all teachers in each school were asked to complete the teacher survey. In the vast majority of schools, teacher surveys were completed by all teachers attending a faculty meeting. Given that attendance at faculty meetings is likely unrelated to teachers' technology use, we believe non-response by teachers who were not present to complete the survey did not bias the survey data.

The analyses presented in this article are based on survey responses from the K-12 mathematics, English/language arts, science, social studies, and elementary classroom teachers, yielding a total of 2,868 surveys. Special education teachers were not included in the sample. The sample includes a broad range of teachers across grade levels, with first through twelfth grade each represented by at least 230 teachers. In addition, each of the primary subject areas (English/ Language arts, science, social studies, mathematics) are represented by at least 475 teachers while 1,279 teachers indicated that they teach in self-contained classrooms in which three or more of the subjects are taught (e.g., elementary school classrooms).

Table 2 presents the number and percentage of teachers in each category of the "number of years taught throughout career" and the "number of years at current school" variables. The numbers and percentages show that the USEIT teacher sample represented a range of experience. In Massachusetts, as across the nation, there has been much concern recently over the number of retirement-age teachers (Darling-Hammond, 1997). Thus, it is interesting to note that 46% of the sample had taught more than 15 years throughout their careers. Conversely, about 26% of teachers were relatively new to the field (five or fewer years of experience). Table 2 also shows that in terms of the number of years teachers had been at their current school, the largest percentage was represented by teachers who had been teaching at their current school for more than 15 years (approximately 28%).

MEASURING TEACHER USES OF TECHNOLOGY

Over the past two decades, a substantial body of research has focused on teachers' use of computer-based technology. Across this body of research, what is meant by "technology use" varies widely. In some cases, technology use is specific to the use of computer-based technologies to deliver instruction. For example, a teacher may use graphical software on a computer connected to an LCD projector to demonstrate the principles of geometry to the class. In other cases, teachers require students to use technology to develop products or to facilitate learning. A teacher might ask students to use Microsoft PowerPoint™ to create a presentation or to use the Internet to conduct research. In still other cases, teacher technology use includes e-mailing, preparing lessons, and maintaining records, as well as personal use. Yet, despite the increasing variety of uses of

Table 2. Number of Years Teaching v. Number of Years at Current School for the USEIT Sample

Years taught throughout career	Years taught at current school (number of teachers and percent of total sample)						
	< 1 year	1-2 years	3-5 years	6-10 years	11-15 years	> 15 years	Total
< 1 year	123 (4.3%)						123 (4.3%)
1-2 years	85 (3.0%)	114 (4.0%)					199 (6.9%)
3-5 years	98 (3.4%)	109 (3.8%)	231 (8.1%)				438 (15.3%)
6-10 years	90 (3.1%)	72 (2.5%)	175 (6.1%)	170 (5.9%)			507 (17.7%)
11-15 years	23 (0.8%)	30 (1.0%)	58 (2.0%)	93 (3.2%)	75 (2.6%)		279 (9.7%)
> 15 years	34 (1.2%)	55 (1.9%)	93 (3.2%)	146 (5.1%)	179 (6.3%)	811 (28.3%)	1318 (46.0%)
Total	453 (15.8%)	380 (13.3%)	557 (19.4%)	409 (14.3%)	254 (8.9%)	811 (28.3%)	2864 (100.0%)

Note: Twenty-two (0.8%) teachers did not report the number of years they had been teaching throughout their careers and 18 (0.6%) did not report the number of years they had taught at their current school.

technology, teachers' use of technology is often discussed as a generic and unidimensional practice.

In order to examine whether the many different technology uses reported by teachers are unidimensional, Bebell, Russell, and O'Dwyer (2004) performed principal component analyses of 45 USEIT teacher survey items, each of which focused on a specific use of technology. In some cases, the survey items focused on teachers' use of a specific type of technology, such as using an LCD projector or e-mailing. Other items focused on specific ways in which teachers ask students to use technology such as for writing papers, conducting research, using spreadsheets, or for creating Web pages. In still other cases, items focused on teacher use of technology for specific purposes like creating quizzes and tests, preparing lessons, or for providing students with accommodations during lessons.

If the individual technology uses together represent a single category of generic technology use, then it would be expected that the initial principal component analysis would identify one major component that united a substantial number of these items into a single construct. As Bebell, Russell, and O'Dwyer (2004) reported, this turned out not to be the case. Instead, analyses yielded seven distinct factors (or categories) of teacher technology use. For each category, a separate measure of technology use was formed. These categories included teachers' use of technology for preparation, teachers' use of technology for delivering instruction, teacher-directed student use of technology during class time, teacher-directed student use of technology for creating products, teachers' use of technology for special education and accommodation, teachers' use of e-mail for professional purposes, and teachers' use of technology for recording grades.

When considering teachers' use of technology, whether from the perspective of teacher preparation or research, it is important to recognize that there are many different types of technology use related to instruction. Some of these uses occur outside of the classroom, particularly preparation and professional communication via e-mail. Other uses clearly occur in the classroom and directly involve students. When attempting to examine technology use or isolate ways for *influencing* teachers' technology use, it is important to address each specific type of use rather than simply focusing on teachers' use of technology in general. This article focuses on a subset of the technology uses listed above to examine whether teachers' uses of technology vary according to their tenure as a teacher and the length of time they have been at their current school.

METHODOLOGY

As described in greater detail in Russell, Bebell, and O'Dwyer (2004), several survey items were combined through principal components analyses to form individual scales that measure teachers' use of technology for a variety of

educational purposes. To facilitate comparison among scales, each scale was standardized so that it has a mean of 0 and a standard deviation of 1. This article focuses on a subset of the technology uses listed above to examine whether teachers' uses of technology vary according to the amount of time they have been in the profession versus the amount of time they have worked at their current school. Presented along with their associated reliability estimates (Cronbach's alpha), these are:

- Teachers direct students to create products using technology (0.84)
- Teachers direct students to use technology during class time (0.73)
- Teachers' use of e-mail for professional purposes (0.86)
- Teachers' use of technology for preparation (0.80)
- Teachers' use of technology for delivering technology (single item)

With the exception of the teachers' use of technology for delivering instruction which was measured with a single item, the reliabilities of the scales were high (i.e., > 0.70). For each of these dependent measures, the mean score for the teachers in each category in Table 2 were calculated. To focus on teachers who have had a reasonable amount of time to develop experience as a classroom teacher, only those teachers that had been teaching throughout their career for three or more years were included in the analyses. Specifically, factorial ANOVAs were calculated to examine technology use among teachers who had been teaching throughout their careers for three or more years as it related to the length of time they had been teaching at their current school. The factorial ANOVAs allowed us to examine the main effects for each of the two independent variables (length of time teaching throughout career and number of years at current school) and the interaction between the two.

Subsequent to each factorial ANOVA, we examined the simple effects using one-way ANOVAs. These one-way designs embedded in the factorial design allowed us to test the differences between the means on the dependent technology use measures across the number of years that teachers had been at their current school within each category for the length of time teaching throughout career variable. To adjust for looking at the variation in scores along only one-dimension in a two-dimensional design, the error term used for examining the simple effects was the within-groups mean square from the original between-subjects factorial analysis (Keppel & Wickens, 2004). Bonferroni post hoc tests were used to adjust the type I error rate in both the factorial and simple effects ANOVAs.

RESULTS

For each dependent variable, the factorial and simple effects ANOVA results are discussed in turn.

Teachers Direct Students to Create Products Using Technology

Table 3 shows that higher mean technology use for directing their students to create products using technology was observed for newer teachers. Teachers who had been teaching for three to five years, 6-10 years, and 11-15 years and had been at their current school for three to five years had the highest mean technology use for this purpose (0.23, 0.11, and 0.23, respectively). Veteran teachers who had been teaching throughout their career for 11-15 years but who had been at their current school for less than one year had the lowest mean (–0.57) out of any teacher group.

To examine whether a) the number of years a teacher has been in the profession, b) the number of years they have taught in their current school, and c) the interaction between these two variables relate to the frequency with which teachers direct their students to create products using technology, a factorial ANOVA was conducted. Table 3 (bottom panel) shows that the interaction between the two independent variables was not statistically significant ($F(10, 2394) = 1.44$, $p = .158$), and the main effect for both the number of years that a teacher had been at their current school ($F(5, 2394) = 2.78$, $p < .05$) and the number of years taught throughout their career variable ($F(3, 2394) = 3.68$, $p < .05$) were both statistically significant. These findings indicate that the two independent factors were independently related with the frequency of teacher directed students use of technology to create products, but that they did not have a joint effect.

To identify where the significant differences occurred among teachers who have been in their current school for varying periods of time and to identify differences among teachers who have been in the profession for varying periods of time, Bonferroni post hoc tests were conducted. The post hoc tests indicated that there were significant differences between technology use for teachers who had been teaching at their current school for three to five years and those who had been teaching at their current schools for 11-15 years ($p < .001$) and more than 15 years ($p < .01$). Similarly, the post hoc tests showed that there were significant differences between technology use for teachers who had been teaching throughout their careers for 3-5 years and those who had been teaching for 11-15 years ($p < .001$) and more than 15 years ($p < .01$).

To examine whether the frequency with which teachers direct their students to create products using technology differs among teachers who have been at their current school for varying periods time but have taught for the same amount of time throughout their career, one-way ANOVAs and Bonferroni post hoc tests were conducted. These analyses indicate that among the teachers who had been teaching throughout their careers for 11-15 years, there were statistically significant differences for teachers who had been at their current school for less than one year (–0.57) and those teachers who had been at their current school for three to five years (0.23). Similarly, among this same group of teachers who had

Table 3. Teachers Direct Their Students to Create Products Using Technology

Years taught in career	Years taught at current school						
	< 1	1-2	3-5	6-10	11-15	> 15	Mean
3-5 years	0.12 (.10)	0.10 (.10)	0.23 (.07)				0.17 (.05)[b]
6-10 years	0.05 (.11)	–0.02 (.12)	0.11 (.08)	0.07 (.08)			0.06 (.05)
11-15 years	–0.57[†] (.22)	–0.18 (.19)	0.23[†‡] (.13)	–0.21[‡] (.11)	–0.10 (.12)		–0.11 (.05)[b]
> 15 years	–0.20 (.18)	0.07 (.14)	0.01 (.10)	0.04 (0.9)	–0.19 (.08)	–0.07 (.04)	–0.07 (.03)[b]
Mean	–0.01 (.07)	0.03 (.07)	0.15 (0.5)[a]	0.00 (.05)	–0.16 (.06)[a]	–0.07 (.04)[a]	

	Sum of squares	*df*	Mean square	*F*	Sig.
Years taught at current school	12.05	5, 2393	2.41	2.41	$p < .05$
Years taught throughout career	10.70	3, 2393	3.57	3.56	$p < .05$
Interaction	11.99	9, 2393	1.33	1.33	0.215

[a]Mean use of technology differed significantly for teachers who had been at their current school for between 3-5 years and either between 11-15 years (for $p < .001$) or more than 15 years (for $p < .01$).

[b]Mean use of technology differed significantly for teachers who had taught throughout their career for between 3-5 years and either between 11-15 years (for $p < .001$) or more than 15 years (for $p < .01$).

[†]Among teachers who had been teaching for between 11 and 15 years throughout their careers, the difference between mean use for teachers who had been at their current school for less than 1 year and those teachers who had been at their current school for between 3 and 5 years was statistically significant at $p < .01$.

[‡]Among teachers who had been teaching for between 11 and 15 years throughout their careers, the difference between mean use for teachers who had been at their current schools for between 3 and 5 years and those who had been at their current school between 6 and 10 years was significant at $p < .05$.

taught throughout their career for 11-15 years, there were significant differences for teachers who had been at their current schools for between three and five years (0.23) and those who had been at their current school 6-10 years (–0.21).

Teachers Direct Students to Use Technology During Class Time

Table 4 shows that regardless of how long teachers had been teaching throughout their career, teachers who had been at the current school for less than one year did not direct their students to use technology during class time very often. The lowest mean was observed for teachers who had been at their current school for less than one year, but had been teaching between 11 and 15 years throughout their careers (–0.93). Similar to the analyses presented above, teachers who had been teaching throughout their careers for 11-15 years and had been at their current school for three to five years most frequently directed their students to use technology during class time (0.25).

The factorial between-subjects ANOVA results in Table 4 (bottom panel) show that the interaction between the two independent variables was statistically significant ($F(9, 2334) = 2.42$, $p < .05$); that is, the effect of the number of years taught at the current school is not the same across of the number of years taught throughout a career. A significant main effect was found for the number of years that a teacher had been at their current school ($F(5, 2334) = 6.33$, $p < .001$) and a non-significant effect was found for the number of years taught throughout their career ($F(3, 2334) = 1.97$, $p = .116$). Since a main effect assesses the constant effect of the independent variable on the dependent variable that generalizes across all levels of the moderator variable, the interpretation of the significant main effect for the number of years teaching at their current school is problematic. The interpretation of simple effects in the case of a significant interaction remains unchanged (Winer, Brown, & Michels, 1991).

The simple effects ANOVA conducted for each category of years taught throughout career indicated the there were differences in technology use for teachers who had been at their current school for varying lengths of time. Among the teachers who had been teaching throughout their careers for between three and five years, Bonferroni post hoc tests showed that there were statistically significant differences between mean technology use for teachers who had been at their current school for less than one year (–0.21) and those teachers who had been at their current school for between three and five years (0.07). For the teachers who had been teaching throughout their career for between 11 and 15 years, there was a significant difference between mean technology use for teachers who had been at their current school less than one year (–0.93) and those who had been at their current school for three to five years (0.25), 6-10 years (0.02), and 11-15 years (0.16).

Table 4. Teachers Direct Their Students to Use Technology During Class Time

Years taught in career	Years taught at current school						
	< 1	1-2	3-5	6-10	11-15	> 15	Mean
3-5 years	–0.21† (.10)	–0.15 (.10)	0.07† (.07)				–0.05 (.05)
6-10 years	–0.13 (.11)	0.17 (.12)	–0.02 (.08)	0.11 (.08)			0.03 (0.4)
11-15 years	–0.93‡ (.23)	–0.19 (.19)	0.25‡ (.14)	0.02‡ (.11)	0.16‡ (.12)		0.02 (.06)
> 15 years	–0.25 (.18)	0.11 (.14)	0.24 (.11)	0.14 (.09)	–0.01 (.08)	0.04 (.04)	0.05 (.03)
Mean	–0.25 (.06)	–0.18 (.06)	0.09 (.04)	0.10 (.05)	0.04 (.07)	0.04 (.04)	

	Sum of squares	*df*	Mean square	*F*	Sig.
Years taught at current school	31.46	5, 2334	6.29	6.33	$p < .001$
Years taught throughout career	5.88	3, 2334	1.96	1.97	0.116
Interaction	21.61	9, 2334	2.40	2.42	$p < .05$

†Among teachers who had been teaching for between 3 and 5 years throughout their careers, the difference between mean use for teachers who had been at their current school for less than 1 year and those teachers who had been at their current school for between 3 and 5 years was statistically significant at $p < .05$.

‡Among teachers who had been teaching for between 11 and 15 years throughout their careers, the difference between mean use for teachers who had been at their current schools for less than 1 year and those who had been at their current school between 3 and 5 years, 6 and 10 years, and 11 and 15 years for $p < .01$.

Teachers' Use of e-Mail for Professional Purposes

Teachers who had been teaching between 6 and 10 years throughout their career and had been at their current school for between three and five years had the most frequent mean e-mail use for professional purposes of any group (0.25). Conversely, teachers who had been at the current school for less than one year but who had been teaching for between 11 and 15 years had the lowest mean professional use of e-mail (–0.36).

The results of the between-subjects factorial ANOVA in Table 5 (bottom panel) show that the interaction between the two independent variables was not statistically significant ($F(9, 2436) = 0.97$, $p = .465$). The main effect for the number of years that a teacher had been at their current school was also not statistically significant ($F(5, 2436) = 2.12$, $p = .061$) while the main effect for the number of years taught throughout their career variable was statistically significant ($F(3, 2436) = 7.76$, $p < .001$). Bonferroni post hoc tests indicated that there were significant differences between teachers' use of e-mail for professional purposes between teachers who had been teaching throughout their career for more than 15 years and teachers who had been teaching throughout their careers between three and five years ($p < .001$), between 6 and 10 years ($p < .001$), and between 11 and 15 years ($p < .01$).

The one-way ANOVAs used to examine the effects within each category of the years taught throughout career variable, indicated the there were no statistically significant differences in teachers' use of e-mail for teachers who had been at their current school for varying lengths of time.

Teachers' Use of Technology for Preparation

Table 6 shows that, teachers who had been teaching for between 6 and 10 years but who had only been at their current school for less than 1 year had the highest mean use of technology for preparation (0.42). Regardless of the number of years that teachers had been at their current school, Table 6 also indicates that teachers who had been teaching for more than 15 years throughout their career had lower means of use of technology for preparation than other groups of teachers. For example, within this group of veteran teachers, teachers who had only been at their current school for one to two years had the lowest mean use of technology for preparation (–0.43). With the exception of teachers who had been teaching for 11-15 years throughout their career but who had only been at their current school for less than one year (–0.08), teachers who had been teaching for 3-15 years had the higher mean use of technology for preparation as compared to teachers who taught more than 15 years in their career regardless of the number of years they had been at their current school.

The results of the between-subjects factorial ANOVA showed that the interaction between the two independent variables was not statistically significant ($F(9, 2432) = 0.87$, $p = .553$). While the main effect for the number of years that

Table 5. Teachers' Use of e-Mail for Professional Purposes

Years taught in career	Years taught at current school						
	< 1	1-2	3-5	6-10	11-15	> 15	Mean
3-5 years	0.12 (.10)	0.09 (.10)	0.19 (.07)				0.15 (.05)[a]
6-10 years	0.11 (.11)	0.13 (.12)	0.25 (.08)	0.07 (.08)			0.15 (.05)[a]
11-15 years	–0.36 (.22)	0.01 (.18)	0.11 (.13)	0.21 (.10)	0.23 (.12)		0.12 (.06)[a]
> 15 years	–0.21 (.17)	–0.40 (.14)	–0.01 (.10)	–0.13 (.08)	–0.06 (.08)	–0.12 (.03)	–0.12 (.03)[a]
Mean	0.03 (.07)	–0.01 (.06)	0.17 (.04)	0.03 (.05)	0.02 (.06)	–0.12 (.03)	

	Sum of squares	*df*	Mean square	*F*	Sig.
Years taught at current school	10.29	5, 2436	2.06	2.12	0.061
Years taught throughout career	22.65	3, 2436	7.55	7.76	< 0.001
Interaction	8.47	9, 2436	0.94	0.97	0.465

[a]For the main effect for Years Taught Throughout Career, the difference between the mean for teachers who had been teaching throughout their career for more than 15 years was statistically significantly different from the mean for teachers who had been teaching throughout their career for between 3 and 5 years (for $p < .001$), between 6-10 years (for $p < .001$), and between 11 and 15 years (for $p < .01$).

Table 6. Teachers' Use of Technology for Preparation

Years taught in career	Years taught at current school						
	< 1	1-2	3-5	6-10	11-15	> 15	Mean
3-5 years	0.29 (.10)	0.17 (.09)	0.30 (0.6)				0.26 (.04)[a]
6-10 years	0.42 (.10)	0.15 (.11)	0.26 (.07)	0.08 (.08)			0.21 (.04)[a]
11-15 years	–0.08 (.21)	0.11 (.18)	0.24 (.13)	0.02 (.10)	0.04 (.11)		0.07 (.06)[a]
> 15 years	–0.06 (.17)	–0.43 (.13)	–0.11 (.10)	–0.16 (.08)	–0.39 (.07)	–0.30 (.04)	–0.28 (.03)[a]
Mean	0.25 (.05)	0.03 (.06)	0.21 (.04)	–0.02 (.05)	–0.26 (.07)	–0.30 (.04)	

	Sum of squares	*df*	Mean square	*F*	Sig.
Years taught at current school	8.44	5, 2432	1.69	1.75	0.120
Years taught throughout career	37.35	3, 2432	12.45	12.92	< 0.001
Interaction	7.53	9, 2432	0.84	0.87	0.553

[a]For the main effect for Years Taught Throughout Career, the difference between the mean for teachers who had been teaching throughout their career for more than 15 years was statistically significantly different from the mean for teachers who had been teaching throughout their career for between 3 and 5 years (for $p < .001$), between 6-10 years (for $p < .001$), and between 11 and 15 years (for $p < .001$).

a teacher had been at their current school was not statistically significant ($F(5, 2432) = 1.75$, $p = .120$), the main effect for the number of years taught throughout their career variable was statistically significant ($F(3, 2432) = 12.45$, $p < .001$). Bonferroni post hoc tests indicated that there were significant differences between technology use for teachers who had been teaching throughout their career for more than 15 years and teachers who had been teaching between three and five years ($p < .001$), 6 and 10 years ($p < .001$), and between 11 and 15 years ($p < .001$).

The analysis of the simple effects indicated that, similar to the previous analysis of teachers' use of e-mail for professional purposes, there were no statistically significant differences in teachers' use of technology for preparation for teachers who had been at their current school for varying lengths of time.

Teachers' Use of Technology for Delivering Instruction

Table 7 shows that teachers who had been teaching 11-15 years throughout their career and had been at their current school for three to five years had the highest mean technology use for delivering instruction (0.32). In general, teachers who had been teaching 3-10 years at their current school had consistently higher mean technology use for delivering instruction regardless of the number of years they had been teaching throughout their careers. Low technology use scores were observed for teachers who had been at their current school for less than one year despite having varied numbers of years teaching experience throughout their careers. For example, among the teachers who had been at their current school for less than one year, teachers who had been teaching between 11-15 years had the lowest technology use scale score (–0.52). Similarly, teachers who had been teaching 11-15 years throughout their career and had been at their current school 1-2 years had low mean scale scores (–0.35).

The results of the between-subjects factorial ANOVA in Table 7 (bottom panel) show that the interaction between the two independent variables was not statistically significant ($F(9, 2487) = 1.48$, $p = .150$). The main effect for the number of years that a teacher had been teaching throughout their career was not statistically significant ($F(3, 2487) = 0.95$, $p = .416$) while the main effect for the number of years taught at their current school was statistically significant ($F(5, 2487) = 6.21$, $p < .001$). Bonferroni post hoc tests indicated that there were significant differences between teachers' use of technology for delivering instruction among those teachers who had been teaching at their current school for three to five years and those who had been teaching at their current schools for less than one year ($p < .001$), one to two years ($p < .05$), and 11-15 years ($p < .05$). Similarly, there was a statistically significant difference between mean technology use for teachers who had been at their current school for less than one year and teachers who had been at their current school for 6-10 years ($p < . 01$).

Table 7. Teachers' Use of Technology for Delivering Instruction

Years taught in career	Years taught at current school						
	< 1	1-2	3-5	6-10	11-15	> 15	Mean
3-5 years	–0.17 (.10)†	–0.22 (.10)†	0.18 (.07)†				0.00 (.05)
6-10 years	–0.15 (.11)	0.10 (.12)	0.08 (.08)	0.06 (.08)			0.03 (.04)
11-15 years	–0.52 (.21)‡	–0.35 (.18)‡	0.32 (.13)‡	0.04 (.10)	–0.03 (.12)		–0.01 (.06)
> 15 years	–0.22 (.17)	0.08 (.14)	0.17 (.10)	0.12 (.08)	–0.08 (.08)	0.01 (.04)	0.02 (.03)
Mean	–0.20 (.06)[a,b]	–0.09 (.06)[b]	0.16 (.04)[b]	0.09 (.05)[a]	–0.70 (.06)	0.01 (.04)[b]	

	Sum of squares	*df*	Mean square	*F*	Sig.
Years taught at current school	30.62	5, 2487	6.12	6.21	< 0.001
Years taught throughout career	2.81	3, 2487	0.936	0.95	0.416
Interaction	13.13	9, 2487	1.46	1.48	0.150

[a]For the main effect for Years Taught Throughout Career, the difference between the mean for teachers who had been at their current school for between 3 and 5 years were statistically significantly different from the mean for teachers who had been at their current school for less than 1 year (for $p < .001$), between 1 and 2 years (for $p < .001$), and for more than 15 years (for $p < .01$).

[b]For the main effect for Years Taught at Current School, the difference between the mean for teachers who had been at their current school for between 6 and 10 years were statistically significantly different from the mean for teachers who had been at their current school for less than 1 year (for $p < .01$).

†Among teachers who had been teaching for between 3 and 5 years throughout their careers, the difference between mean use for teachers who had been at their current school for between 3 and 5 years and those teachers who had been at their current school for less than 1 year ($p < .01$) and between 1 and 2 years ($p < .01$) was statistically significant.

‡Among teachers who had been teaching for between 11 and 15 years throughout their careers, the difference between technology use for teachers who had been at their current schools for between 3 and 5 years and those teachers who had been at their current school for less than 1 year ($p < .01$) and between 1 and 2 years ($p < .05$) was statistically significant.

The one-way ANOVAs used to examine the effects within each category of years taught throughout career indicated that there were differences in teachers' use of technology for delivering instruction among teachers who had been at their current school for varying lengths of time. For example, among the teachers who had been teaching throughout their careers for three to five years, Bonferroni post hoc tests showed that there were statistically significant differences between mean technology use for teachers who had been at their current school for three to five years (0.18) and those teachers who had been at their current school for less than one year (–0.17) and one to two years (–0.22). Similarly, among the teachers who had been teaching for 11-15 years throughout their careers, mean technology use for teachers who had been at their current school for three to five years (0.32) and those teachers who had been at their current school for less than one year (–0.52) and one to two years (–0.35).

DISCUSSION

Over the past decade, schools have invested heavily in acquiring computer-based technologies. At the same time, critics have raised concerns that teachers generally are making little use of these technologies, which in turn, minimizes the impact of technology on students and their learning (Cuban, 2001; Healy, 1998; Stoll, 1999). Some proponents, however, have countered these concerns by arguing that as new teachers, who have grown up with technology, enter the profession, use of technology will increase and impacts on students will follow (U.S. Department of Education, 2000). As a follow up to previous work that examined whether teachers' technology use varied according to how long teachers had been teaching throughout their career, the analyses reported in this research were undertaken to examine relationships between teachers' uses of technology and: 1) the length of time they have been in the profession; and 2) the length of time they have taught at their current school. In addition, the interaction between the length of a teacher's career and the length of time they had been at their current school was examined to explore whether moving to a new school impacted teachers' technology uses. The aim of these analyses was to examine the extent to which the amount of time a teacher has taught in a school or across his/her career is related to their use of technology.

Summary of Findings

In general, teachers who had been teaching for longer periods of time reported less frequent use of technology. For example, teachers with more than 10 years experience had students create products with technology less frequently than teachers with less than 10 years experience and teachers who had taught for more than 15 years reported less frequent use of technology to prepare for lessons and to e-mail their colleagues. Conversely, teachers with three to five years

experience reported that they had students create products using technology more frequently than teachers with six or more years experience throughout their careers. Similarly, teachers who had been teaching for 3-10 years reported the most frequent use of technology for preparation. However, the frequency with which teachers had students use technology during class time did not differ noticeably based on the number of years teachers' were in the profession.

Focusing on the amount of time teachers had taught at their current school, the patterns differed depending upon the specific use of technology being examined. For some uses, teachers who had been at their current school for longer periods of time reported less frequent use of technology. In other cases, teachers who were both new to the school or had been at the school for longer periods of time reported lower use of technology. And yet in other cases, teachers who were new to a school reported the lowest amount of use. For example comparing technology use across the various categories of number of years at current school, teachers who were at their current school for more than 10 years reported less frequent use of technology for preparation; teachers who had been at their school for less than one year or for more than 10 years reported they had their students use technology to create products least frequently; for use during class time, teachers who had been at their current school for two years or less reported the least frequent use; and yet for using e-mail for professional purposes, both teachers who were newer to their school and teachers who had been at their school for a long period of time reported infrequent use. These patterns suggest a complex relationship between technology uses and the length of time that teachers report having been at their current school. However, it is apparent that teachers who are new to a school generally use technology with students less often than teachers who have been at the school for three to ten years.

Comparing the relationships between teachers' technology uses and years teaching throughout their career and years teaching in their current school, it appears that the transition to a new school affects some uses of technology. In most cases, this effect is negative and leads teachers to use technology for some purposes less frequently than their colleagues who have been in the school for longer periods of time. We suspect this negative effect results, in part, from teachers who are new to a school requiring time to adjust to a new curriculum, instructional materials, school culture, and technology-based tools. It is only after teachers have developed comfort with the curriculum and have become aware of the technology-based tools that are available within the school that they are able to make use of these tools in the classroom.

For some uses of technology, there is also an association between the years teaching throughout career variable and the years teaching in current school variable. In such cases, it was generally teachers who had been teaching for longer periods of time but who were new to a school who reported lower levels of use. As an example, although teachers with more than 15 years experience teaching throughout their career reported the lowest levels of e-mail use for

professional purposes, those teachers with 15 or more years experience who had moved to a new school within the past two years reported noticeably lower levels of use than their peers who had been at their current school for three years or more. Similarly, teachers with 11-15 years experience who had moved to a new school in the previous year reported much less frequent e-mail use than their colleagues who had been at their current school for three years or more. This pattern was less pronounced, however, for teachers with 10 or fewer years experience throughout their career. This pattern may be due to these more experienced teachers feeling less comfortable using e-mail coupled with needing time become acquainted with colleagues in a new school setting. Only after they have developed working relationships with colleagues do these more experienced teachers who are relatively new to a school make more regular use of e-mail.

Focusing on teachers directing students to use technology during class time, teachers who were new to their school generally reported lower levels of use during their first one or two years regardless of how many years they have taught throughout their career. Yet, for use of technology to prepare lessons, a different pattern emerged in which teachers with 6-10 years experience but who were brand new to their school reported higher frequency of use compared to their peer group who had been at their current school for more than a year.

Implications

The findings from the analyses have several implications for support and research on educational technology. First, as Bebell and colleagues (2004) have demonstrated, these findings reveal the importance of examining specific, discrete uses of technology rather than considering technology use as a generic construct. As described above, the relationships between teachers' technology use, teacher tenure, and the number of years teaching at their current school, and the interaction between these variables differs depending upon the specific use examined. Without developing separate measures for each specific use and then conducting separate analyses for each discrete use, many of these patterns would not be revealed. These findings are consistent with previous research that decomposes "technology use" into a multidimensional construct (Becker, 1999; Bebell et al., 2004).

Second, contrary to some observers' expectations, these analyses reveal that new teachers who have grown up in a computer-rich environment do not use technology for professional purposes noticeably more often than their more experienced peers. While teachers who have been in the profession for more than 15 years reported lower levels of use for many technology uses, there were relatively small differences between teachers who had been teaching for five years or less versus those who had been teaching for 10-15 years. Given that many teachers with 10-15 years experience attended high school in the late 1980s when computers had not yet become widely available, while many teachers

with less than five years experience attended high schools that had begun to acquire large numbers of computers, the relatively small differences in the use patterns for these two groups suggests that past experience with technology may not influence use for teaching as much as is popularly believed. This finding suggests that both pre-service teacher preparation programs and programs that schools establish for new teachers should increase their efforts to introduce new teachers to instructional uses of technology. While new teachers appear to be comfortable using technology outside of the classroom for communication and preparation, additional efforts are needed to help expand their knowledge of uses during instruction.

Third, these analyses reveal that the transition to a new school appears to have a temporary negative effect on several uses of technology by teachers, despite their years of teaching experience. Although we can only speculate as to why these effects occur, it seems reasonable that the frequency with which teachers direct students to use technology during class time might decrease due to an unfamiliarity with the software and other technology resources available in the new school and due to their need to become familiar with the curriculum and materials used by the new school. Similarly, it seems reasonable that professional e-mail use may decrease because teachers who are new to a school do not know many of their colleagues. Uses of technology that occur outside of the classroom or do not involve familiarity with colleagues, however, were affected less by the transition. This pattern suggests that schools that value technology use may consider providing additional support to teachers new to their schools so as to familiarize them with the technology resources available for use during instruction and how these resources may be linked to the curriculum.

Although the focus of these analyses was on teachers' uses of technology, the findings also apply to principals and district administrators. As part of the USEIT study, principals and district leaders in each of the participating sites were interviewed. Through these interviews, it became clear that the vast majority of school leaders did not have a good sense of the many ways in which teachers were using technology and how to evaluate these uses of technology. As an example, when asked what criteria they would apply when evaluating teachers' use of technology for instructional purposes, less than 8% of principals interviewed were able to respond with specific criteria. Clearly, teacher and school-leadership training programs, whether they are pre-service or in-service, would benefit from a more nuanced approach to preparing educators to use technology in and out of the classroom for professional purposes.

Limitations

As with any research study using survey data, it is important to consider the characteristics of the sample and reflect on the interpretation of the analyses. The current analyses examined teachers' self-reported technology use patterns.

Although the participating USEIT schools were selected to reflect a representative sample of teachers, the sample was comprised of only Massachusetts teachers. In addition, the sample was largely selected from suburban and rural schools, with little to no representation from large urban schools. Finally, not all teachers in each school responded to the survey. However, given that the survey was typically completed by all teachers attending a faculty meeting and that we do not believe there is a correlation between technology use and faculty meeting attendance, we believe the data is representative of the participating schools. Similarly, while the sample of schools was limited to those in Massachusetts, we believe the patterns found in this study are relevant to schools outside of Massachusetts.

The current article closely examined the technology use patterns for those teachers who had taught for many years but had only taught at their current school for a limited time. In our sample, teachers with these characteristics were rare as relatively few veteran teachers reported teaching in a "new" school setting. In other words, there were few teachers in the current analyses that had taught for a long time but were relatively new to their current school. As such, the number of teachers examined in this situation was relatively small and some caution should be exercised before generalizing too broadly from this limited sample.

Final Remarks

Without question, the large influx of new teachers projected to occur over the next ten years offers a unique opportunity to shape our nation's educational system. This notion is especially promising for the transformation of our classrooms into the 21st century technology-enriched learning centers envisioned by educational theorists, policy makers, and school leaders (Lemke & Coughlin, 1998; Papert, 1992, 1996). Indeed, the current generation of teachers entering the field is more comfortable and confident with technology than any generation before. This confidence, however, is not enough to reform education. Teachers entering the profession need to develop the positive beliefs about technology that have been found to be associated with technology adoption (O'Dwyer, Russell, & Bebell, 2006) and develop skills to use technology in a wide variety of ways. Through interviews with principals, it is apparent that teachers and school leaders would benefit from exposure to new models of teaching which capitalize on specific instructional uses of technology. The extent to which these uses can be linked to positive effects on students and their learning will likely bolster positive beliefs about the impacts of technology use. While it may not be possible to pair every pre-service teacher with an experienced and sophisticated technology-using teacher, efforts to bring the practices employed by these teachers into the vision of teaching pre-service teachers has the potential to enhance beliefs about and increase instructional uses of technology.

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