

## Technological Modeling: Faculty Use of Technologies in Preservice Teacher Education from 2004 to 2012

Joan E. Hughes, Sa Liu, & Mihyun Lim  
*The University of Texas at Austin*

### Abstract

This 7-year, cross-sectional study of a 1:1 laptop teacher preparatory program in the United States examined the nature and change in faculty technological modeling. Using survey methods, preservice teachers (n = 932) reported their faculty's use of technological activities in coursework. Through descriptive statistics, chi-square tests, and qualitative analysis, researchers found change in the number of faculty members incorporating presentation, word processing, email, learning management systems, and digital video activities in coursework. Emergent activities with low but increasing use included digital audio, social networking, text messaging, and blog activities. Less widely reported activities included social bookmarking, desktop publishing, webpage creation, and games. Overall results indicated all students did not report similar faculty technological modeling, which also meant that students had divergent technological experiences from which to base their future teaching. The discussion outlines an expansion of educational technology integration across teacher education methods/content courses to increase systematic and contemporary coverage of technological advancements in education through codeveloped curriculum and coteaching by educational technology and teacher education faculty.

Teacher education faculty members have an important role in the process of teaching future teachers about technology-supported teaching and learning. The learning experiences they design, with or without technology, serve as examples or models for preservice teachers. Teacher education is armed with standards guiding the integration of technology into preservice teacher education, including technology standards for teachers (International Society for Technology in Education, 2008), teacher education accreditation standards (National Council for Accreditation of Teacher Education, 2008), and content standards (Association of Mathematics Teacher Educators, 2006; National Council for the Social Studies, 2009; National Council of Teachers for Mathematics, 2000; National Governors Association Center for Best Practices and the Council of Chief State School Officers, 2010a, 2010b; National Research Council, 1996).

Yet, university faculty members' content expertise, independence in designing course content, and varied technological knowledge and skills for teaching and learning may lead to unsystematic inclusion of educational technology (edtech) preparation in teacher education. Schools and colleges of education (SCOEs) recognize the importance of the role education faculty members play in modeling technology as they adopt initiatives to assist their faculty in learning more about technology. For example, Kay (2006) identified 30% of SCOEs that aimed to increase technology preparedness of their teacher candidates, focused on improving their education faculty's computer knowledge and use. Similarly, Polly, Mims, Shepherd, and Inan (2010) found faculty technology development was a common feature of the U.S. Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) initiatives.

Conceptually, *modeling*—what and how instructors use technologies in the presence of preservice teachers—is an important facet in the preparation of new teachers. Course instruction is a significant influence on preservice teachers' abilities to understand the usefulness of integrating technology in the classroom (Doering, Hughes, & Huffman, 2003; Lambert, Gong, & Cuper, 2008; Lortie, 1975), and consistent modeling and use of technology by the faculty directly influences preservice teachers' perceptions of using technology for their teaching (Albee, 2003; Darling-Hammond, Meyerson, LaPointe, & Orr, 2009; Hsu, 2012; Mills, 2014). We refer to these faculty activities as faculty technological modeling. Faculty intentions for technological use may implicitly or explicitly include a goal of serving as a model of technology-supported teaching for students.

Given the strength of faculty modeling on shaping preservice teachers' ideas of technology integration possibilities and because preservice teachers often adopt these modeled practices into a technological repertoire for their future use in teaching (Doering et al., 2003; Cervetti, Damico, & Pearson, 2007; Figg & Jamani, 2011), this study investigated the nature of faculty technology modeling in preservice university coursework over 7 years. This research can reveal the changes in faculty technological practices over time, which may serve as one source to understand or theorize novice PK-12 teachers' technological practices.

### **Theoretical Framework**

This research is framed by theories of learning to teach (Cochran-Smith, Feiman-Nemser, & McIntyre, 2008; Darling-Hammond & Bransford, 2005), situated learning (Wenger, 1998), and new literacies (Leu, Kinzer, Coiro, Castek, & Henry, 2013). Working toward learning to think, know, feel, and act like a teacher, preservice teachers need to embrace activities of teaching and learning in a pedagogical framework and critically examine new ideas and practices (Feiman-Nemser, 2008). Borko and Putman (1996) suggested that preservice teachers engage in “an active, constructive process that is heavily influenced by an individual's existing knowledge and beliefs and is situated in particular contexts” (p. 674-675).

One of these contexts is university-based coursework. Preservice teachers, as novices, participate peripherally to learning how to teach by observing the expert, their instructor, which provides one model for teaching that influences their developing knowledge, skills, and attitudes of teaching (Rosaen & Florio-Ruane, 2008; Wenger, 1998). Thus, teacher educator choices in using or not using instructional technologies creates a set of digital technology experiences that embody the new literacies (Leu et al., 2013), influencing preservice teachers' decision-making in PK-12 classrooms as professionals (Cervetti et al., 2007). These digital technology experiences in a preservice teacher education program are mediated or designed by the teacher education faculty. This study examined the

extent to which preservice teachers' instructors used technologies to support teacher preparation.

### **Literature Review**

Learning to become a teacher should involve teacher educators "model[ing] technology instruction for their students" (Wilson, 2003, p. 35) and providing support for preservice teachers to link theory to the practice of technology integration. Without such preparation, preservice teachers are unlikely to integrate technology into their future teaching (Yilmazel-Sahin & Oxford, 2010). Darling-Hammond et al. (2009) found that preservice teachers were inclined to use technologies or recognize the value of technologies in the class when the faculty provided a pedagogical rationale underlying the modeled technology use. Thus, preservice teachers need opportunities to observe, understand, design, and practice integrating technology in subject area content and instructional objectives to experience and determine the value of technology for future teaching (Boulton & Hramiak, 2013; Richardson, 2010; Russell, Bebell, O'Dwyer, & O'Connor, 2003).

Jackson (2012) acknowledged that SCOE faculty who learn to integrate technologies into their courses may perceive their activity as high risk, especially in cultures where (a) research is emphasized and teaching is underemphasized; (b) security exists in status-quo pedagogy; and (c) administrative support is weak. Jackson (2012) claimed, "Failures to use technology in methods classes are undervaluing and misleading education candidates. The teacher candidates are entering student teaching and encountering students who are digital natives" (p. 522). Faculty members with strong technological literacy are more apt to integrate specialized technologies, such as videoconferencing, digital media, and gaming, into course assignments (Friedman, Bolick, Berson, & Porfeli, 2009; Georgina & Olson, 2008; Vaughan, Beers, & Burnaford, 2015). Yet, a persistent challenge for faculty is the time and opportunity to learn technology and to integrate it into coursework (Spotts, 1999; Vaughan et al., 2015).

### **Faculty Professional Development**

Building a faculty's technology literacy and abilities to integrate technologies within SCOE preservice teacher education courses is not a simple task. Collier, Foley, Moguel and Barnard (2013) recognized that "developing this expertise [to draw upon various technological literacies] will take time" (p. 263) among a teacher education faculty.

Professional development programs, through mentoring, workshops, or university-school collaborations, are a key component to building awareness and expertise (Polly et al., 2010; Yilmazel-Sahin & Oxford, 2010). Indeed, several research studies in the era of the PT3 grant program examined the impact of intensive technology professional development for faculty during the first 3 years of the initiatives. For example, Schrum, Skeeel, and Grant (2002) said that after intensive support of faculty development that included course releases (i.e., time), faculty participants ( $n = 26$ ) reported using technology for research, demonstrations, and personal use. They reported less expertise in using simulations, web publishing, online communications, and digital photography.

Howland and Wedman (2004) described a SCOE-supported faculty professional development learning cycle that encouraged decision-making regarding technology-supported learning and teaching. Nearly all content methods faculty members with 6-16 years teaching of experience in an undergraduate teacher education program ( $n = 21$ ) reported that their learning in the professional development "reinforced their

commitment to the value of technology in the classroom, increased their comfort level with its use, helped them reflect on new uses of technology and assisted them with determining which uses would enhance student learning” (p. 258). They reported evidence of significantly reduced lectures and increased use of problem-based learning in faculty teaching practices.

Teclehaimanot and Lamb (2005) found workshops that taught technology tools and provided ideas for integration into the classroom were the most effective professional development approach for SCOE faculty ( $n = 19$ ). Evidence of change in practice included six faculty participants intending to use technology for planning and record keeping and 12 providing examples of classroom technology integration that involved both the faculty and the students. Further, analysis of pre/post syllabi revealed that the most common technology uses were email and research on Internet/web for both faculty and students.

More recently, SCOE's have offered shorter term professional development for teacher educators, such as Vaughan et al.'s (2015) investigation of an iPad professional development program in which the faculty ( $n = 9$ ) participated in 5 hours of independent (e.g., website tutorials, YouTube videos) or department-led, 30-minute sessions for learning iPad applications. After 6 months, faculty members used the iPads in ways that supported their research practice or their own children's needs, but “uses did not necessarily reflect direct integration of iPads in face-to-face classroom teaching” (p. 28).

Another approach described by Archambault, Wetzel, Foulger, and Williams (2010) involved faculty participants ( $n = 20$ ) attending an 8-hour summer workshop that taught Web 2.0 technologies and led them to redesign a lesson/unit for use the following term, with a postlesson student survey. All faculty participants used Web 2.0 technologies with their students, and about 40% perceived a change in their instructor role toward being a “facilitator.” Most of them capitalized on instructor-student communication technology affordances to provide more feedback to support student learning.

Overall, multiyear, technology-related professional development of teacher educators has reduced alongside dwindling federal grant resources. SCOE's have scrambled internal resources for more modest workshops or discussions (e.g., French et al., 2012; Vaughan et al., 2015) or university grants for longer action research (e.g., Archambault et al., 2010).

### **Technological Modeling**

When teacher educators possess the experience and knowledge to incorporate technological activities into their courses, numerous case studies of lesson enactment or courses reveal salient technological practice opportunities for preservice teachers. For example, Mills (2014) examined the effect of faculty-mediated Twitter chats during a preservice teacher internship. At completion, preservice teachers were likely to continue following the Twitter account as “an informal professional development medium” to learn about classroom resources and strategies. This Twitter activity led preservice teachers to use Twitter as connected educators to continue their own professional learning (Nussbaum-Beach & Hall, 2012), and this professional use of Twitter could eventually inspire connected learning activities in the classroom with children (Hughes, Ko, Lim, & Liu, 2015; Krueger, 2013; Schulten, 2013).

Collier et al. (2013) described a writing project that used digital media tools such as blogging, texting, and social media as part of the writing process. Four education faculty members developed a closed social network that had common social networking elements

(pictures of members, status updates, etc.) as well as blogging and online writing modules. Several university courses were situated within this educational, writing-focused social network. After the courses, teacher candidates' skills in both traditional and digital writing literacies increased, and they developed nuanced considerations for social networking's role in literacy development.

For example, some were concerned about children's tendency to write informally, ignore traditional conventions (e.g., abbreviations, grammar, capitalization), and post without revision. Others noted tremendous value in social-media-based writing, such as the potential for personal writing, frequency, authentic audiences, and peer feedback. Ultimately, they found

the consensus of both the TCs [teacher candidates] and faculty members was that the project increased awareness of the possibility of using current digital media tools such as Facebook, Twitter, Google Groups, and wikis in teaching writing. It also provided exposure to key vocabulary TCs need to use with such platforms. (p. 278)

Salinas, Bellows, and Liaw (2011) described the inclusion of a digitized primary source archive, the Presidential Timeline, into instruction on critical historical thinking. The researchers investigated preservice teachers' methods for evaluating digital sources as resources for historical thinking in their future social studies teaching. The preservice social studies teachers initially determined usefulness of the web resource based on its vastness, uniqueness, utility, and organization of the curricular materials. Then, with guidance, they layered knowledge of pedagogy (social constructivism) and content knowledge (historical thinking) to examine the digital sources and curriculum in a deeper way.

Research also connects the technological modeling during preservice education for use by early career teachers. For example, Boulton and Hramiak (2013) described mandatory blog use within a year-long post-bachelor of arts preservice course for critical reflection of their developing professional practice and for classroom pedagogical use (e.g., for instructor-student interaction, support, and feedback). Preservice teachers ( $n = 33$ ) at program completion reported understanding blog pedagogy and possessing a range of example uses for future teaching. Following 17 participants in their first year of teaching revealed that 10 had used and four intended to use blogs. They found barriers to blog use included lack of time to teach students necessary technology skills, nonfunctioning or prohibited blog technology at school for security or infrastructural reasons, or lack of leader or collegial support for blogs. Overall, the main enabler of blog use was the blog experiences of teachers themselves during their preservice education, along with intrinsic motivation to use technology in the classroom.

In another study, Mayo, Kajs, and Tanguma (2005) found that first-year teachers ( $n = 96$ ) who had technological training in preservice teacher education were more positive and had higher teaching efficacy, and their students used technology more than first-year alternatively certified teachers who did not participate in technology training.

### **Longitudinal Examination of Technology Modeling**

Given the current and historical low levels of federal funding for research on technology and teacher education and the high resource needs for longitudinal studies, few studies have examined teacher education instructors' use of technology in courses in SCOEs over time. One 7-year longitudinal study (Bolick, Berson, Friedman, & Porfeli, 2007; Friedman

et al., 2009) examined national trends in SCOE social studies faculty member' technology use. This research revealed that most social studies faculty members in 1999 did not use technology, while the few who did used word processing to prepare lesson plans, email for communication, and the Internet for information. The percentage of faculty members using word processing, email, and Internet increased in 2001, and by 2006 ( $n = 88$ ; 30% response rate) social studies faculty members' technology use increased, with the most-used activities being email (92%), Internet (82%) and word-processed lesson plans (80%), lessons for digital presentation (66%), and learning management systems (66%); 92% of faculty participants reported feeling confident in general use of technology (Bolick et al., 2007). While these data are illustrative, educators need more longitudinal data on technology use in teacher education.

This research study reports on a 7-year, cross-sectional case study of one teacher education program, which provides a broader programmatic view of faculty technology modeling. The landscape of technological modeling is reflected in preservice teachers' reports of university faculty technology use during their preparatory experiences. This landscape provides a longitudinal, cross-sectional representation of the ebb and flow of technological modeling that contributes to preservice teachers' knowledge base as they enter the teaching profession.

Meyer and Xu (2007) suggested that faculty technology integration is best examined when contextual parameters are focused and specific. Thus, this research was set in a teacher education program within a research-intensive university that had established a federally funded ubiquitous laptop computing environment for all faculty and students but that in the timeframe of the study transitioned to university-funded technology supports for faculty. Thus, this research also reveals what happens over time and when the rich resources that come with grants are removed.

### **Methodology**

This research was a multiyear, cross-sectional study of preservice teachers' technological literacies and course experiences using descriptive survey methods in one U.S. teacher education program in a large, research-intensive university. The study data represent 7 years within the first 10 years of an implementation of a multidimensional, programmatic approach to the technological development of preservice teachers, the core of which involved 1:1 laptop deployment for the faculty and students.

When data collection for this study began, the laptop implementation had been in place for 2 years and data collection continued through Year 10, a timeframe that captured a sustained, long-term innovation that endured beyond the elimination of federal funding resources (Polly et al., 2010; Rogers, 2003). We are unaware of any research that has examined a technological innovation over such an extended period of time, despite a call for and need to examine programs that have endured across years (Polly et al., 2010).

### **Research Questions**

The focal research questions guiding this study were as follows:

- From preservice teachers' perspectives, what is the nature of faculty technological modeling within a technology-rich, teacher preparatory program?
- Do faculty technological modeling activities change over time?

We examined these questions by analyzing preservice teachers' perceptions of faculty use of a range of technological activities during their preparation program.

### **Research Context**

This research occurred within a large U.S. university teacher education program that began requiring Apple Macintosh laptops for all faculty members and preservice teachers in 2002. A requirement was not instituted in secondary math and science certification because cross-platform technological practices were already in use. The resulting ubiquitous computing environment created a technology-rich learning environment with ample tools, Internet access, and online learning systems. The redesigned program was designed to (a) integrate technology into all courses, (b) develop education faculty's technology abilities and use, (c) offer short workshops for faculty and students, and (d) maximize infrastructure support and access to technology. No educational technology course was required within the overall program.

In the first few years of the redesign and laptop requirement, the faculty participated in technology training to develop lesson plans, technology-enriched assignments, and assessment rubrics. After grant funds ended, these formal learning opportunities transitioned into informal learning, which were initiated by faculty requests and supported by dedicated instructional technology integration staff in the program's technology center. Instructors of the preservice courses were tenured and tenure-track faculty, part-time faculty, and graduate student assistant instructors. Yearly, there was both stability and change in these faculty, but each cohort was led by a faculty member.

Students beginning the certification program attended a half-day technology orientation about their computer, Mac OS, iWork software, and program resources. Faculty members could organize within-class workshops as needed to support specific content and project needs. The technology center also provided optional student and faculty workshops, a student-staffed help desk for student software and hardware support, dedicated staff support for faculty (e.g., hardware, software, and pedagogical), technology check-out (e.g., videocameras, microphones, and tripods), technology-enhanced meeting areas or classrooms, high-end computers for media production, and high-speed wireless Internet.

### **Participants**

Two separate research initiatives yielded the participants for this study. The first involved a program evaluation, in which graduates of the preservice programs participating in the 1:1 laptop initiative (all except secondary science and mathematics) were asked to complete an anonymous survey. Between 2004 and 2007, 772 of 1,194 preservice teachers who finished the certification program completed this survey, representing a range between 52-81% of each year's program graduates (see Table 1). The available evaluation data included preservice teachers' self-reported evaluation of their instructors' technology use. IRB approval was gained in 2008 to use this existing anonymous data set.

The second initiative was IRB-approved in 2008 and involved active consent procedures. Each semester, we asked instructors for time in their classes to recruit participants. All students in courses in which instructors allowed us entry were invited to participate in the research. A total of 688 students voluntarily consented in 2008-2012, and 206 participants completed the survey, representing between 7-25% of each year's program graduates (see Table 1). Most participants' certification areas were early childhood through sixth grade, with 10% in secondary English and in social studies and less than 5% in special education, fine arts, foreign languages, or kinesiology. Participants were

emailed an invitation to complete the online survey 2 weeks prior to their graduation. Three email reminders across 2 weeks were sent before the survey closed.

**Table 1**  
Participant Background, by Graduation Year

	<b>Number of Participants</b>	<b>% of Program Graduates</b>	<b>Age (Mean, SD)</b>	<b>Female (%)</b>
<b>Survey 1</b>				
2004-2005	207	52%	—	—
2005-2006	321	81%	—	—
2006-2007	244	61%	—	—
<b>Survey 2</b>				
2008-2009	90	25%	23.2, 4.03	91.4%
2009-2010	46	14%	24.6, 6.30	85.0%
2010-2011	46	13%	23.8, 3.87	92.7%
2011-2012	24	7%	23.4, 3.83	94.7%
<i>Note: “—” indicates survey did not include this information.</i>				

### Survey Instruments

**Survey 1 (2004-2007).** The instructional technology educational staff developed and administered an anonymous program evaluation survey in 2004-2007. In the survey, preservice teachers rated their instructors' technology use in university classes using a dichotomous (Y/N) scale of 20 technological activities identified by the evaluators as prominent in society and education at the time.

**Survey 2 (2008-2012).** Beginning in 2008, we began a research study that included a 20- to 30-minute end-of-program survey for preservice teachers in the same university program. The survey items used in this iteration of the study included students' perceptions of faculty use of 28 contemporary technology activities involving communication, web, productivity, and creativity. Fourteen of these items overlapped exactly with items from Survey 1. For some items in Survey 2, more specificity was added. For example, “Use email” in Survey 1 became two items, “Send email” and “Read email.” Students also answered five open-ended questions that sought examples of the faculty's use of technology in each of the technological themes. All technological activities items are reported in [Table 2](#). Items were adapted from the Educause Center for Applied Research (ECAR) 2008 survey (Salaway, Caruso, Nelson, & Ellison, 2008).

### Data Analysis

Survey items were analyzed using descriptive and inferential statistics using SPSS 21.0. Chi-square tests of association were conducted to examine if statistically significant differences existed across years for all survey items, which were categorical. These statistical tests were completed separately for the two survey administrations, as the items were not identical. Thus, chi-square tests compared trends across years 2004-2007 and then also across years 2008-2012. The assumption of independence of observations



was satisfied. Most data met the assumption of expected frequencies greater than 5, or less than 20% of expected frequencies below 5 for our larger contingency tables. For tests that did not meet this assumption and where the association was statistically significant, we reported the Likelihood test statistic,  $L\chi^2$ . For statistically significant comparisons, we analyzed the contingency tables and report the statistical expected counts and standardized residuals (z-score), which provide a sense the directionality underlying the significance difference.

The responses to five open-ended survey questions were analyzed qualitatively in NVivo 10.0 software. Two researchers collaboratively coded the open-ended survey items regarding specific examples of faculty's use of technologies using research-based codes (as in DeCuir-Gunby, Marshall, & McCulloch, 2011) employing open-coding techniques reflecting emergent categories as needed (as recommended in Glaser & Strauss, 1967). The coding process was iterative and ongoing through extended discussion until coders reached 100% agreement on coding.

## **Results**

Conceptually, the technological activities are grouped into seven activity categories. Productivity activities allow users to engage in business heritage applications or general conceptual activities. Communication activities allow users to correspond with other people via digital software or hardware. Learning management activities involve activities set within systems such as Blackboard. Web 2.0 activities allow users to participate with the web in interactive capacities that involved reading, contributing, and sharing. Creation activities facilitate the creation of video, audio, graphics/images, webpages, designed documents, portfolios, and multimedia. Content area technologies include those applications that are specific to a subject area, such as a graphing calculator (mathematics) or a virtual tour of colonial Williamsburg (social studies). Game activities allow users to play games on computers or the Web.

### **Productivity Activities**

Preservice teachers reported rising use of most productivity activities among their faculty in the early years of this study (2004-2007) along with some decreases from 2008-2012 (see Table 2). A high proportion of preservice teachers reported faculty members using digital presentation activities, word processing, and web browsing. Most technological activities differed significantly across years. For example, use of presentation technologies was increasing and statistically significant between 2004 and 2007,  $\chi^2(2, n = 773) = 7.699, p < .05$ , Cramer's  $V = .100$ ; but in the latter 4 years use of presentation technologies slightly decreased and was statistically significant,  $L\chi^2(3, n = 175) = 7.876, p < .05$ , Cramer's  $V = .210$ . The standardized residuals revealed only one cell ( $z = 2.2$ ) in 2004-2005 and only one cell ( $z = 2.2$ ) in 2011-2012 at significance, both where more preservice teachers than expected reported that faculty members did not use presentation technologies.

**Table 2**  
Percentage of Preservice Teachers Reporting Instructor Use of Technology, by Student Graduation Year

Activities	Survey 1			Survey 2			
	2004-2005	2005-2006	2006-2007	2008-2009	2009-2010	2010-2011	2011-2012
<b>Productivity Activities</b>							
Presentation software	77.8*	86.4*	85.6*	94.3*	100*	97.7*	85*
Word processing	71.5*	79.9*	80.2*	98.6	97.6	93.2	90
Web browsing	70.0***	82.0***	85.2***	—	—	—	—
Use of Web search engine	55.1**	66.3**	71.5**	—	—	—	—
Concept maps	44.9*	37.2*	47.7*	67.2***	31.7***	29.5***	30***
Spreadsheet	30.0	31.3	31.8	68.8*	53.7*	45.5*	40*
Online Productivity Suite	—	—	—	10.4	4.9	22.7	20
Database	9.7	8.0	8.9	—	—	—	—
<b>Communication Activities</b>							
Use Email	67.1***	80.8***	81.6***	—	—	—	—
Send Email	—	—	—	98.7	93.0	100.0	100.0
Read Email	—	—	—	97.4	93.0	97.8	100.0
Send message to an email listserv	—	—	—	47.2	32.6	32.6	21.7
Text-based instant messaging (e.g. iChat, aim, Gmail chat)	20.8	21.1	28.3	24.5	9.3	10.9	17.4
Text message on a phone	—	—	—	16.7**	4.7**	21.7**	39.1**
Participate in Online Audio/Video interactions	—	—	—	16.3	9.3	23.9	8.7
<b>Learning Management Software Supported Activities</b>							
Participate in Learning Management System	59.4	60.7	69.1	94	95.1	90.5	100.0
Read online discussion boards/forum	—	—	—	82.5	69.8	71.7	60.9
Post online discussion boards/forum	—	—	—	82.3	67.4	76.1	60.9
Use of online forums	52.2	52.6	54.7	—	—	—	—
<b>Web 2.0 Activities</b>							
Read blog	—	—	—	34.6**	44.2**	67.4**	34.8**
Write/Comment On blog	—	—	—	37.7**	44.2**	71.7**	34.8**
Participate in SNS website	—	—	—	21.6	21.6	27.8	28.6
Read Wiki	—	—	—	31.4	16.3	26.1	8.7
Write/Edit Wiki(s)	—	—	—	14.6	16.3	26.1	4.3
Build and tag bookmarks socially	—	—	—	10.8*	21.6*	5.6*	0*
<b>Creation/Adaption/Publishing Activities</b>							
Use of <sup>a</sup> / Create or modify <sup>b</sup> digital video	49.8*	49.5*	61.4*	97.9*	90*	76.9*	100*

Use of <sup>a</sup> / Create or modify <sup>b</sup> digital pictures or art	44.4*	42.4*	54.7*	65.0	50.0	30.8	57.1
Create or modify webpages	35.3*	25.4*	23.3*	44.4	20.0	23.1	14.3
Use graphics applications	26.6	19.2	22.6	—	—	—	—
Use of <sup>a</sup> / Create or modify <sup>b</sup> digital audio	21.3	21.1	19.9	16.1	10.0	23.1	28.6
Use multimedia development tools	15.5	13.9	17.4	—	—	—	—
Desktop publishing	6.8*	3.4*	13.9*	17.6*	2.4*	2.3*	5.0*
<b>Content Area Activities</b>							
Subject-Specific / Content Area Software	8.7*	5.9*	12.7*	58.8**	56.1**	25.6**	52.6**
<b>Game Activities</b>							
Play computer games	7.7	5.3	9.3	—	—	—	—
Participate in Online Multiuser computer games	—	—	—	5.3	0	2.8	0
Participate in Online virtual world	—	—	—	5.3	0	0	4.8
<p><i>Note.</i> “—” indicates survey did not include a question about this technological activity. *<math>p &lt; .05</math>, **<math>p &lt; .01</math>, ***<math>p &lt; .001</math>.</p> <p><sup>a</sup> Language used in 2004-2007 survey</p> <p><sup>b</sup> Language used in 2008-2012 survey.</p>							

Preservice teachers described their instructors using PowerPoint to present information, as an outline to sum up their main points during lectures, and to encourage use by preservice teachers. Example statements including the following:

“Instructors usually used PowerPoint as an outline to sum up their main points during lectures.”

“PowerPoint presentations were used to lead and generate classroom discussion.”

“They used PowerPoint to present information and encouraged us to use it in class assignments.”

Word processing also increased in 2004-2007 and was statistically significant,  $\chi^2(2, n = 773) = 6.397, p < .05$ , Cramer’s  $V = .091$ . Again, standardized residuals indicated only in 2004-2005 that more preservice teachers than expected reported instructors not using word processing ( $z = 1.9$ ). In the latter years, 90% or more of preservice teachers reported instructors using word processing. Examples of the ways preservice teachers described faculty using word processing included the following: “Most of our assignments and rubrics were attachments in a word document,” and

One of the most handy uses of word processing was when teachers would receive and return work via attachments in e-mail. The teacher would use the comment function in MSWord to give me feedback. This enabled a quick turn-around, and it was paperless.

A similar pattern in the early data revealed that web browsing differed across the years,  $\chi^2(2, n = 773) = 17.604, p < .001$ , Cramer's  $V = .151$ ; and web search engines,  $\chi^2(2, n = 772) = 13.646, p < .001$ , Cramer's  $V = .133$ . Further, standardized residuals showed more preservice teachers than expected reporting faculty members *not* using web browsing ( $z = 3.1$ ) or web search engines ( $z = 2.4$ ) in 2004-2005.

Except in 2008-2009, less than half of the preservice teachers reported concept maps being used by the faculty, which differed significantly across 2004-2007,  $\chi^2(2, n = 724) = 6.893, p < .05$ , Cramer's  $V = .098$ ; and across 2008-2012,  $\chi^2(3, n = 169) = 21.753, p < .001$ , Cramer's  $V = .359$ . The academic year 2008-2009 seemed to be the height of use, with standardized residuals also revealing significance, with more preservice teachers than expected reporting that instructors used concept maps ( $z = 2.7$ ) and fewer than expected reporting their instructors not using concept maps ( $z = -2.4$ ). One student explained, "There are also sites like Wordle and [bubbl.us](http://bubbl.us) that allow students to create word clouds and concept maps over the concepts we have been working on in class." However, use decreased through 2012, and one student in 2010-2011 noted, "Concept maps were rarely used except for one of my classes [in which] my teacher and the College of Education collaborated to give each of us Inspiration software."

Preservice teachers reported that faculty use of spreadsheets was low, with no statistically significant differences in use in the early years, highest use in 2008-2009, and decreasing use in the latter years through 2012,  $\chi^2(3, n = 169) = 8.353, p < .05$ , Cramer's  $V = .222$ . Only one preservice teacher mentioned the use of spreadsheets or Excel in the open-ended comments and noted, "Spreadsheets were done to look at students' grades."

Overall, the largest percentage of preservice teachers indicated that their instructors used presentation, word processing, and the web. Few preservice teachers in the latter years perceived faculty to be using online productivity suites such as Google Docs. These findings seem to show that in 2004-2005, only the third year after laptops became required in this preservice program, faculty members were still developing their instructional uses of presentation, word processing, and web uses, based on statistically significant residuals that reflected more preservice teachers than expected reporting that their instructors did *not* use these technologies.

This result may be expected during the earliest years of a new innovation (Rogers, 2003). The trends in data from 2008-2012 may indicate that preservice teachers noticed slightly less use of these business heritage productivity technologies among their instructors, or these activities were moving to cloud-based technologies.

### Communication Activities

Overall, a majority of preservice teachers reported their instructors used email to communicate with them, and the percentage increased across the years from 2004-2012 (see [Table 2](#)). Email use increased in the early years (2004-2007) and was statistically significant,  $\chi^2(2, n = 774) = 16.980, p < .001$ , Cramer's  $V = .148$ . The standardized residuals revealed only one cell ( $z = 3.1$ ) in 2004-2005 at significance, indicating that more preservice teachers than expected reported faculty not using email.

In 2008-2012, almost all preservice teachers indicated that instructors sent and read email. However, sending messages to an email listserv decreased from 47% to 21% from 2008-2012. Preservice teachers indicated that instructors used email to communicate assigned readings and provide additional information, such as the class schedule or assignments. Student comments included the following examples:

“Emails were typically used as reminder of class information.”

“Email[s] were sent to communicate important information as well as turn in homework.”

Text-based instant messaging (IM) on the computer increased in the early years with about one quarter of preservice teachers reporting that their instructors used instant messaging, but the use decreased to 17.4% in 2012. Text messaging on phones increased across 2008-2012 and was statistically significant,  $\chi^2(3, n = 160) = 12.573, p < .01$ , Cramer's  $V = .280$ . The standardized residuals revealed only one cell at significance, ( $z = 2.4$ ) in 2011-2012, which indicates that more preservice teachers than expected reported faculty were not using text message on a phone. A student explained that faculty were “sending text[s] about class or answering questions about coursework through text message.” Another preservice teacher noted, “I text messaged some professors over course work and personal issues.” Unlike the increased use of text messages, 20% or fewer preservice teachers reported that instructors used online video/audio communication.

### **Learning Management Software Supported Activities**

In 2004-2007, about half of the preservice teachers reported that instructors used learning management systems (LMS) software or online discussion boards (see [Table 2](#)). A growing percentage of preservice teachers, up to 100%, reported faculty use of LMS in 2008-2012. A decreasing proportion of preservice teachers reported that instructors used online discussions from 2008-2012, with about 60% reporting that instructors read or posted in online forums by 2012, indicating that use of online discussions may have decreased or that instructors did not participate in online discussions.

For those preservice teachers who reported faculty use of LMSs, they described that the Blackboard LMS was commonly used for discussions, uploaded announcements, and emails through the Blackboard email messaging system. One student described a typical faculty-designed activity, “In one of my classes the assignment was to read an article, write a short essay on a question that was discussed during the class, and post it on the discussion board. Then read and comment on two different essays from our peers by the end of the week.” Faculty members also used the LMS for sharing comments, posting announcements, and sending emails. One student noted of her instructors, “Most of my teachers used Blackboard to communicate with students. Mostly teachers posted announcements, examples of work, assignments, etc.” Another student added, “Many instructors used Blackboard for grades and some assignments.”

### **Web 2.0 Technology Activities**

Across the Web 2.0 activities, preservice teachers identified blogging as most often used by their instructors in coursework. Overall, there were more Web 2.0 activities with decreasing use trends to about 8% (i.e., reading wikis, editing wikis, social bookmarking) than activities with an increasing trend to about 30% (i.e., use of social networking site; see [Table 2](#)).

In terms of reading blogs, a statistically significant change occurred across the latter 4 years,  $\chi^2(3, n = 164) = 12.388, p < .01$ , Cramer's  $V = .275$ . According to the standardized residuals, one cell in 2010-2011 ( $z = 2.1$ ) was significant, indicating more preservice teachers than expected reported faculty were reading blogs in this year. In terms of “write/comment on blog,” there was a statistically significant difference across 2008-

2012,  $\chi^2(3, n = 165) = 14.458, p < .01$ , Cramer's  $V = .296$ . Both cells in 2010-2011 ( $z = -2.2$  and  $2.3$ ) were significant, indicating fewer preservice teachers than expected reported their instructors were not writing/commenting on blogs, and more preservice teachers than expected reported faculty were writing/commenting on blogs.

Preservice teachers reported faculty-created class blogs, which were used as a space for sharing thoughts and opinions, similar in nature to the discussions hosted in the LMS. Students wrote their reflections on course readings and read and commented on their peers' contributions. Example student comments included the following: "The teacher would comment on our blogs, and then we would read other blogs and comment on those. It helped to learn from others' experiences and get a grasp on things outside of our individual student teaching experience." Another student described the blog activities as, "Thinking aloud about experiences, with room for comments by peers and instructors." Students wrote their reflections on course readings and read and commented on their peers' contributions, and faculty members also participated by interacting with the students.

Although a low percentage of preservice teachers reported their instructor used social networking sites (SNS), social networking was emergent and increased to 28.6% in 2012. A student explained, "One teacher had us complete activities and post findings via Twitter. We made accounts specifically for the class."

The percentage of preservice teachers reporting instructors reading or writing wikis was not consistent, ranging from 4% to 31%. Students described that instructors required assignments that involved creating content-based wiki pages, such as "my instructor divided us into groups and had us create our own wiki for a disability we were learning about." In a language arts class, a student explained that her instructor "made an example of a wiki page and then had us do a group project on creating a wiki page. [Faculty] and our peers commented on our wiki page, and we made a presentation about the page." In another writing course, the faculty used a wiki "as a way to facilitate discussion between students outside of class and in class—we would comment and read one another's comments outside of class and discuss our interactions in class."

A statistically significant decrease occurred in activities involving "build and tag bookmarks socially" from 2008 to 2012,  $L\chi^2(3, n = 131) = 9.629, p < .05$ , Cramer's  $V = .249$ . By 2012, no preservice teachers reported that an instructor used this activity.

### **Creation/Adaptation/Publishing Activities**

Overall, the frequency of reported faculty creation activities significantly changed across 2004-2012 (see [Table 2](#)). Using digital video significantly increased between 2004-2007,  $\chi^2(2, n = 766) = 9.164, p < .01$ , Cramer's  $V = .109$ ; and significant differences appeared in creating or modifying digital video during 2008-2012,  $L\chi^2(3, n = 111) = 9.893, p < .05$ , Cramer's  $V = .297$ . Standardized residuals revealed one cell ( $z=2.4$ ) in 2010-2011 at significance, where more preservice teachers than expected reported faculty were not using digital video activities.

One student explained, "Instructors showed us how to make movies to display what we have learned in a different form of media." Preservice teachers described their faculty assigned class video presentations on what they had learned and various class topics. Videotaping and editing their teaching lessons with K-12 students supported chances to observe and reflect on their teaching. One student said, "We had to create a movie depicting a service learning activity we participated in. We also had to create movies

showing one-on-one tutoring with students and examples of student learning that may influence how we shape their instruction." Another student wrote, "We also had to videotape ourselves teaching a lesson and edit it on iMovie for our professor to watch."

Using digital photos showed statistically significant differences that increased from 2004-2007,  $\chi^2(2, n = 766) = 8.814, p < .05$ , Cramer's  $V = .107$ ; no statistical differences were found in creation or modification of pictures or art across 2008-2012. Preservice teachers described instructors asking them to take pictures of their K-12 student's work.

There was a statistically significant difference in creating or modifying web pages in 2004-2007,  $\chi^2(2, n = 766) = 9.082, p < .05$ , Cramer's  $V = .109$ . Across 2008-2012, the percentage of preservice teachers reporting faculty-created or modified web pages gradually decreased to 14%. Preservice teacher statements included the following:

"We had to create a webpage on iWeb as if we were teachers with our own classrooms."

"We used Glogster to make a website for students we tutored."

About 20% of preservice teachers reported that instructors used graphic applications like Adobe Photoshop from 2004-2007. Similarly, only about 20% of preservice teachers reported that instructors created or modified digital audio. One student described the use of audiobooks for comprehension activities and songs for "transitions and for learning and recalling information." Desktop publishing use significantly increased from 2004-2007,  $\chi^2(2, n = 766) = 6.742, p < .05$ , Cramer's  $V = .094$ . However, this use also significantly decreased from 2008 to 2012,  $L\chi^2(3, n = 156) = 10.191, p < .05$ , Cramer's  $V = .262$ , with not more than 17% of preservice teachers reporting faculty use.

### **Content Area Software Activities**

From 2004-2007, few preservice teachers reported that instructors used subject specific software or technology,  $\chi^2(2, n = 766) = 7.970, p < .05$ , Cramer's  $V = .102$  (see [Table 2](#)). About half of the preservice teachers reported that instructors used subject specific technologies between 2008-2012,  $\chi^2(3, n = 154) = 12.291, p < .01$ , Cramer's  $V = .283$ .

According to standardized residuals two cells in 2010-2011 ( $z = 2.0$  and  $-2.1$ ) were significant, indicating that more preservice teachers than expected reported that their instructors did not use content area software, while also fewer preservice teachers than expected reported that their instructors used content area software. Student comments included the following:

"We have used graphing calculators in a math course. In my social studies course we used historical websites to find information."

"They [faculty] used websites with DBQs [document-based questions]."

"During my history class, we used software that was through a textbook company. It was for all elementary students and helped with the formulation of lesson plans with [state standards] required."

## **Game Activities**

Across the 4 years of Survey 2, consistently less than 10% of preservice teachers reported that their instructor used any kind of computer games in the classroom, and no significant difference was found over the same time span (see [Table 2](#)).

## **Discussion**

In 2010, 25% of teachers nationally reported that their undergraduate teacher preparation program prepared them to use educational technology effectively in the classroom to a “major/moderate” extent (Gray, Thomas, & Lewis, 2010). Increasing the percentage of teachers who are prepared to integrate technology underlies institutional program innovations, such as the 1:1 laptop program established in this case study. In this study, we sought to understand the preservice teachers’ perceptions of their university faculty’s technological practices, which we conceptualized as a form of technological modeling. The context of this study can be considered a technologically robust setting, as all the preservice teachers and faculty possessed the same laptop technology and had high access to technical and pedagogical supports within the institution we examined.

The most prominent faculty technological modeling that preservice teachers reported included presentation, word processing, email, learning management systems, and digital video activities in coursework. These activities, with the exception of digital video, match the common uses among higher education faculty across other disciplines when last surveyed (Georgina & Olson, 2008; Oliver, 2007) and, with the exception of learning management systems, match K-12 teachers’ most frequent technological activities in the classroom in 2010, of whom 96% sometimes/often used word processing, 63% used presentation software, 94% used the Internet, and 59% used email with parents (Gray et al., 2010).

This match may be reassuring, as it appears that the teacher preparation program is modeling the prominent technological activities occurring in K-12 school settings. On the other hand, this result may be interpreted as problematic in that even in this technology-rich context, the most-modeled technological activities mirrored the same dominant activities reported across the last 20 years (Kay, 2007; Moursund & Bielefeldt, 1999; Willis & Mehlinger, 1996).

Despite rapid technological development and innovation in society, the most ubiquitous faculty technological activities in this study were also the most prominent in teacher education in 1996. Teacher preparation programs can be leaders in advancing new pedagogy, including technologically supported pedagogy, so we might have expected an expansion of technological activities.

Indeed, the results reveal some emergent activities with low but increasing use over time, which included digital audio, social networking, text messaging, and blog activities. These activities tend to reflect Internet-powered, multimodal, and possibly collaborative activities resonant in new literacy practices described as being vital for teachers to understand and experience in order to enact them in K-12 classrooms (Cervetti et al., 2007; Leu et al., 2013). Yet, the descriptive and inferential statistics did not reveal consistent, significant growth in technological activities across time that might be expected in a 1:1 laptop program aiming to better prepare teachers to integrate technologies.



A low percentage of preservice teachers indicated faculty use in many of the technological activities, indicating that these preservice teachers may not all have similar technological experiences through the program, leading to a technological experience base that differs among graduates. The seeming lack of coordinated technological experiences could relate to institutional technological resources, support, and vision; faculty independence in developing syllabi and designing learning activities; and faculty technology awareness, knowledge, and adoption.

Over time, educators and researchers have implemented and critiqued many approaches to technological preparation in teacher education, with a general move away from classes focused on technology tools to courses with integrated approaches to technology across preparatory experiences. The institution in this research mirrored this shift when it eliminated a required educational technology course due to reduced total credit hours for teacher preparation set by the state legislature. In the same timeframe it enacted the 1:1 laptop innovation to integrate technology, through the adoption of laptops and support, into content and methods courses.

Success (i.e., uses of educational technology in support of curriculum, instruction, and learning in content/methods courses) in programmatic technology integration requires high interest, commitment, and participation from teacher education faculty members whose main areas of expertise likely do not involve educational technologies (Archambault et al., 2010; Jackson, 2012; Polly et al., 2010; Vaughan et al., 2015). By the tenth year of this institutionalized 1:1 laptop innovation, preservice teachers depicted emerging but sparse faculty use of Internet-based, multimodal activities but nearly ubiquitous faculty use of general technology activities (e.g., presentation, word processing, and email activities). The institution's gradual shift from formal learning opportunities for faculty in the early years to just-in-time, personalized, individual-requested edtech learning and support in the latter years may have supported innovators or early adopters (Rogers, 2003) but might have undermined broader innovation among teacher education faculty members, because many or most may be unaware of new technological innovations or what support or learning to request.

Guided professional development for teacher educators that reveals current technological advancements and facilitates curriculum planning, such as described by Archambault et al. (2010), may be required for teacher educators to stay abreast of innovations and possibilities for technology integration in courses. In addition, at this institution strong expectations for edtech use dwindled over time, possibly because grant-funded interventions and personnel were removed. One remaining expectation was an annual review question for faculty members asking if and how technology was integrated into courses. For adoption and diffusion of innovations, an optimal balance of support and pressure must be maintained (Rogers, 2003). In this case, pressure to adopt edtech lessened at the same time support was maintained; those faculty members implementing emerging technologies were likely innovators and early adopters.

### **Recommendations for Teacher Education**

Innovative curricular activities can be accomplished through the often-used word processing, presentations, and email, but a technological experience base primarily involving these technology activities alone does not optimally prepare teachers for contemporary classrooms, schools, and districts. Technological innovations such as blended learning, online learning, bring-your-own-device/bring-your-own-technology, social technologies, mobile learning, maker spaces, personalized learning, adaptive learning, learning analytics, coding, game-based learning, and open educational resources are entering the K-12 education space, and many are already being adopted by

districts or through grant-funded projects. Examining digital equity and teachers' technology leadership in these PK-12 educational technology efforts should also be prioritized within teacher education.

While many edtech faculty and researchers (ourselves included) have encouraged the programmatic integration of edtech throughout teacher education courses as a theoretically optimal alternative to a 1, 2, or 3-credit edtech course, this case study (see also Hughes, 2013; Hughes, Gonzales, Wen, & Yoon, 2012; Hughes et al., 2015) revealed significant challenges in the integration approach, specifically in relation to the expertise and autonomy of the instructor to integrate technology, which can result in a lack of consistency of technological experience for all preservice teachers. An expansion of the integration approach aimed to increase systematic and contemporary coverage of technological advancements in education may be useful.

The key improvements in this context would be (a) maintaining high expectations for edtech integration within the teacher preparation program, which is facilitated through strong technology leadership within the institution, and (b) involving educational technology faculty or experts to codevelop and coteach curriculum with teacher education faculty.

In high-stakes, time-intensive, and research-focused university contexts, teacher education faculty will respond to priorities set by SCOE leaders. If teacher preparation for leading and learning with technology is a priority, drawing commitment and interest across most teacher education faculty will be easier. Further, the model, which positioned responsibility for integrating technology into teacher preparation on faculty whose core expertise was not edtech, needs to shift to a collaborative responsibility across scholars of educational technology and disciplinary education scholars (e.g., social studies, science, literacy, mathematics, and physical education).

The objective of the codeveloped curriculum would be to introduce preservice teachers systematically (a) to significant and contemporary edtech developments; (b) at strategic moments in the preparatory experience that best match the preservice teachers' development, knowledge, and experience; (c) in ways that capitalize on and extend subject area coursework central to the methods/content courses; and (d) in ways that facilitate application or experimentation in field-based settings.

While a variation of programmatic formats would be appropriate, weekly or bimonthly technological experiences for preservice teachers led by edtech faculty and topical extensions throughout formal coursework cotaught by teacher education and edtech faculty is one method to be considered. Experiences would be designed to apprentice preservice teachers (and teacher education faculty) in the edtech space and culminate in capstone experiences that position preservice teachers as critical technology decision-makers and leaders (Selwyn, 2011). This proposed codeveloped curriculum and coteaching would significantly expand faculty technological modeling.

Significant barriers exist that could undermine this expansion to the integrated approach to edtech in teacher education. Teacher education programs may face other cross-curricular priorities that limit a SCOE's commitment to technological preparation if the priorities are perceived as conflicting or competing for time. Institutional policies and procedures relating to course-load credit, annual review, and tenure may limit participation in innovative collaborations that involve coteaching and significant curriculum development by faculty, especially in research intensive contexts (Jackson, 2012).

### Limitations and Trustworthiness

Generalizability is limited in this study, as it is a case study of one teacher education program at a U.S. university. The preservice teacher participants owned laptops for use during the preparation program, and the faculty members also each had university-provided laptops. These characteristics may not be representative of other teacher education programs. This study focused on students' perspectives of what faculty members do, which is important because what students experience and remember informs their future teaching. However, observations in classrooms and data from faculty would have enhanced the research.

In 2004-2007, participation was higher and the data represented a higher proportion of all program graduates, as compared with the participation between 2008-2012. The findings from 2008-2012 cannot be considered representative of the program's preservice teachers or faculty technological activities.

The study findings may be perceived as trustworthy due to the prolonged engagement with the program through the study's 7-year timeframe (Creswell, 1998) and its ability to complement other data and findings about preservice teachers' knowledge, skills, and practices examined in the larger research project (Hughes, 2013; Hughes et al., 2012; Hughes et al., 2015). Finally, this research does not show a causal relationship between faculty technological practices and the 1:1 laptop innovation; observed practices could be attributed to other variables, such as changing societal use of technology.

### Scholarly Significance

This research is significant to teacher education and learning technologies fields because it enables a longitudinal view of faculty technological modeling within teacher education; few such studies exist (e.g., Bolick et al., 2007; Friedman et al., 2009). Polly et al. (2010) specifically called upon the field to conduct studies that span beyond the typical grant-funded 3-year length; this study examined a technological innovation that was institutionalized over 10 years. These results, along with others from the project (Hughes, 2013; Hughes et al., 2012; Hughes et al., 2015) provide a case study of the 1:1 laptop innovation within teacher education that can be used as guidance for similar future innovations in teacher education. Last, the study forefronts preservice teachers' perspectives on their teacher education preparation. Listening to preservice teachers assists understanding of their digital technology experiences, which research indicates likely shapes their future teaching practices.

### References

Albee, J. (2003). A study of preservice teachers' technology skill preparedness and examples of how it can be increased. *Journal of Technology and Teacher Education*, 11(1), 53-71.

Association of Mathematics Teacher Educators. (2006). *AMTE technology position statement: Preparing teachers to use technology to enhance the learning of mathematics*. Retrieved from <http://amte.net/group/resources/01-06/position-preparing-teachers-use-technology-enhance-learning-mathematics>

Archambault, L., Wetzel, K., Foulger, T. S., & Williams, M. K. (2010). Professional development 2.0: Transforming teacher education pedagogy with 21st century tools. *Journal of Digital Learning in Teacher Education, 27(1)*, 4-11.

Bolick, C. M., Berson, M. J., Friedman, A. M., & Porfeli, E. J. (2007). Diffusion of technology integration in the preservice social studies experience: Results from a national survey. *Theory and Research in Social Education, 35(2)*, 174-195.

Borko, H., & Putman, R. T. (1996). Learning to teach. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology*. New York, NY: Macmillan.

Boulton, H., & Hramiak, A. (2013). Cascading the use of Web 2.0 technology in secondary schools in the United Kingdom: Identifying the barriers beyond pre-service training. *Technology Pedagogy and Education, 23(2)*, 151-165.

Cervetti, G., Damico, J., & Pearson, P. D. (2007). Multiple literacies, new literacies, and teacher education. *Theory Into Practice, 45(4)*, 378-386.

Cochran-Smith, M., Feiman-Nemser, S., & McIntyre, D. J. (Eds.). (2008). *Handbook of research on teacher education: Enduring questions in changing contexts*. New York, NY: Routledge and Association of Teacher Educators.

Collier, S., Foley, B., Moguel, D., & Barnard, I. (2013). Write for your life: Developing digital literacies and writing pedagogy in teacher education. *Contemporary Issues in Technology and Teacher Education, 13(3)*, 262-284. Retrieved from <http://www.citejournal.org/vol13/iss3/currentpractice/article1.cfm>

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

Darling-Hammond, L., & Bransford, J. (Eds.). (2005). *Preparing teachers for a changing world: Report of the Committee on Teacher Education of the National Academy of Education*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L., Meyerson, D., LaPointe, M., & Orr, M. T. (2009). *Preparing principals for a changing world: Lessons from effective school leadership programs*. San Francisco, CA: Jossey-Bass.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods, 23(2)*, 136-155.

Doering, A., Hughes, J., & Huffman, D. (2003). Preservice teachers: Are we thinking with technology? *Journal of Research on Technology in Education, 35(3)*, 342-361.

Feiman-Nemser, S. (2008). Teacher learning: How do teachers learn to teach? In M. Cochran-Smith, S. Feiman-Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education: Enduring questions in changing contexts* (pp. 697-705). New York, NY: Routledge and Association of Teacher Educators.

Figg, C., & Jamani, K. J. (2011). Exploring teacher knowledge and actions supporting technology-enhanced teaching in elementary schools: Two approaches by pre-service teachers. *Australasian Journal of Educational Technology, 27(7)*, 1227-1246.

French, K., Read, M., Price-Dennis, D., Yoon, H., Rodriguez, H., Hughes, J.E., & Pazey, B. (2012) Exploring tablet computing in teacher education: The UT COE iPad working group. In P. Resta (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2012* (pp. 2799-2801). Chesapeake, VA: Association for the Advancement of Computing in Education.

Friedman, A., Bolick, C., Berson, M., & Porfeli, E. (2009). National educational technology standards and technology beliefs and practices of social studies faculty: Results from a seven-year longitudinal study. *Contemporary Issues in Technology & Teacher Education, 9(4)*, 476-487. Retrieved from <http://www.citejournal.org/vol9/iss4/currentpractice/article1.cfm>

Georgina, D. A., & Olson, M. R. (2008). Integration of technology in higher education: A review of faculty self-perceptions. *Internet and Higher Education, 11(1)*, 1-8.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. Chicago, IL: Aldine.

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in U.S. public schools: 2009 (NCES 2010-040)*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Howland, J., & Wedman, J. (2004). A process model for faculty development: Individualizing technology learning. *Journal of Technology and Teacher Education, 12(2)*, 239-262.

Hsu, P.-S. (2012). Examining the impact of educational technology courses on pre-service teachers' development of technological pedagogical content knowledge. *Teaching Education, 23(2)*, 195-213. doi:10.1080/10476210.2011.622041

Hughes, J. E. (2013). Descriptive indicators of future teachers' technology integration in the PK-12 classroom: Trends from a laptop-infused teacher education program. *Journal of Educational Computing Research, 48(4)*, 493-518.

Hughes, J.E., Gonzales, G., Wen, Y., & Yoon, H. (2012). The iron grip of productivity software within teacher preparation. In D. Polly, C. Mims, & K. Persichitte (Eds.). *Creating technology-rich teacher education programs: Key issues* (pp. 170-191). Hershey, PA: IGI Global.

Hughes, J. E., Ko, Y., Lim, M., & Liu, S. (2015). Preservice teachers' social networking use, concerns, and educational possibilities: Trends from 2008-2012. *Journal of Technology and Teacher Education, 23(2)*, 185-212.

International Society for Technology in Education. (2008). *ISTE standards for teachers*. Eugene, OR: Author.

Jackson, T. (2012). Ways to mentor methods' faculty integration of technologies in their courses. In D. Polly, C. Mims, & K. A. Persichitte (Eds.), *Developing technology-rich*

*teacher education programs: Key issues* (pp. 519-534). Hershey, PA: Information Science Reference.

Kay, R. H. (2006). Evaluating strategies used to incorporate technology into preservice education: A review of the literature. *Journal of Research on Technology in Education, 38*(4), 383-408.

Kay, R. (2007). The impact of preservice teachers' emotions on computer use: A formative analysis. *Journal of Educational Computing Research, 36*(4), 455-479.

Krueger, K. (2013). 'Connected educators' spur connected learning. *eSchool News, 16*(9), 45.

Lambert, J., Gong, Y., & Cuper, P. (2008). Technology, transfer and teaching: The impact of a single technology course on preservice teachers' computer attitudes and ability. *Journal of Technology and Teacher Education, 16*(4), 385-410.

Leu, D. J., Kinzer, C. K., Coiro, J., Castek, J., & Henry, L. A. (2013). New literacies: A dual-level theory of the changing nature of literacy, instruction, and assessment. In D. E. Alvermann, N. J. Unrau, & R. B. Ruddell (Eds.), *Theoretical models and processes of reading* (pp. 1150-1181). Newark, DE: International Reading Association.

Lortie, D. (1975). *Schoolteacher*. Chicago, IL: University of Chicago Press.

Mayo, N. B., Kajs, L. T., & Tanguma, J. (2005). Longitudinal study of technology training to prepare future teachers. *Educational Research Quarterly, 29*(1), 3-15.

Meyer, K. A., & Xu, Y. J. (2007). A Bayesian analysis of the institutional and individual factors influencing faculty technology use. *Internet and Higher Education, 10*(3), 184-195.

Mills, M. (2014). Effect of faculty member's use of Twitter as informal professional development during a preservice teacher internship. *Contemporary Issues in Technology and Teacher Education, 14*(4), 451-467. Retrieved from <http://www.citejournal.org/vol14/iss4/currentpractice/article1.cfm>

Moursund, D., & Bielefeldt, T. (1999). *Will new teachers be prepared to teach in a digital age? A national survey on information technology in teacher education*. Retrieved from ERIC database. (ED428072)

National Council for Accreditation of Teacher Education. (2008). *Professional standards for the accreditation of teacher preparation institutions*. Washington, DC: Author.

National Council for the Social Studies. (2009). *Media literacy: A position statement of National Council for the Social Studies*. Retrieved from <http://www.socialstudies.org/positions/medialiteracy>

National Council of Teachers for Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Governors Association Center for Best Practices and the Council of Chief State School Officers. (2010a). Common core state standards for English language arts and

literacy in history/social studies, science, and technical subjects. Retrieved from <http://www.corestandards.org/>

National Governors Association Center for Best Practices and the Council of Chief State School Officers. (2010b). Common core state standards for mathematics. Retrieved from <http://www.corestandards.org/>

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Nussbaum-Beach, S., & Hall, L. R. (2012). *The connected educator: Learning and leading in a digital age*. Bloomington, IN: Solution Tree Press.

Oliver, K. (2007). Design and development of a faculty technology practices directory. *Educause Quarterly*, 30(4), 38-47.

Polly, D., Mims, C., Shepherd, C. E., & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (PT3) grants. *Teaching and Teacher Education*, 26(4), 863-870.

Richardson, W. (2010). *Blogs, wikis, podcasts and other powerful web tools for classrooms* (3rd ed.). London, UK: Sage.

Rogers, E. M. (2003). *Diffusion of innovations*. New York, NY: The Free Press.

Rosaen, C. & Florio-Ruane, S. (2008). The metaphors by which we teach: Experience, metaphor, and culture in teacher education. In M. Cochran-Smith, S. Feiman-Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education: Enduring questions in changing contexts* (pp. 706-731). New York, NY: Routledge and Association of Teacher Educators.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use. *Journal of Teacher Education*, 54(4), 297-310.

Salaway, G., Caruso, J. B., Nelson, M. R., & Ellison, N. B. (2008). *The ECAR study of undergraduate students and information technology*. Retrieved from the Educause website: <http://net.educause.edu/ir/library/pdf/ers0808/rs/ers0808w.pdf>

Salinas, C., Bellows, M. E., & Liaw, H. L. (2011). Preservice social studies teachers' historical thinking and digitized primary sources: What they use and why. *Contemporary Issues in Technology and Teacher Education*, 11(2), 184-204. Retrieved from <http://www.citejournal.org/vol11/iss2/socialstudies/article1.cfm>

Schrum, L., Skeeel, R., & Grant, M. (2002). One college of education's effort to infuse technology: A systemic approach to revisioning teaching and learning. *Journal of Research on Technology in Education*, 35(2), 256-271.

Schulten, K. (2013, October 1). What 'connected education' looks like: 28 examples from teachers all over. *The New York Times*. Retrieved from <http://nyti.ms/1d8NNk6>

Selwyn, N. (2011). *Schools and schooling in the digital age: A critical analysis*. Hoboken, NJ: Routledge.

Spotts, T. (1999). Discriminating factors in faculty use of instructional technology in higher education. *Educational Technology & Society, 2(4)*, 92–99.

Teclehaimanot, B., & Lamb, A. (2005). Technology-rich faculty development for teacher educators: The evolution of a program. *Contemporary Issues in Technology & Teacher Education, 5(3/4)*, 330-344. Retrieved from <http://www.citejournal.org/vol5/iss3/currentpractice/article2.cfm>

Vaughan, M., Beers, C., & Burnaford, G. (2015). The impact of iPads on teacher educator practice: A collaborative professional development initiative. *Journal of Technology in Teaching and Learning, 11(1)*, 21-34.

Wegner, E. (1998). *Communities of practice: Learning, meaning and identity*. New York, NY: Cambridge University Press.

Willis, J., & Mehlinger, H. D. (1996). Information technology and teacher education. In J. Sikula, T. J. Buttery, & E. Guyton (Eds.), *Handbook of research on teacher education* (2nd ed., pp. 978-1029). New York, NY: Simon & Schuster Macmillan.

Wilson, E. K. (2003). Preservice secondary social studies teachers and technology integration: What do they think and do in their field experiences? *Journal of Computing in Teacher Education, 20(1)*, 29-39.

Yilmazel-Sahin, Y., & Oxford, R. L. (2010). A comparative analysis of teacher education faculty development models for technology integration. *Journal of Technology and Teacher Education, 18(4)*, 693-720.

#### **Author Notes**

Joan E. Hughes  
The University of Texas at Austin  
Email: [joanh@austin.utexas.edu](mailto:joanh@austin.utexas.edu)

Sa Liu  
The University of Texas at Austin  
Email: [lius@utexas.edu](mailto:lius@utexas.edu)

Mihyun Lim  
The University of Texas at Austin  
Email: [mhlim@utexas.edu](mailto:mhlim@utexas.edu)

*Contemporary Issues in Technology and Teacher Education* is an online journal. All text, tables, and figures in the print version of this article are exact representations of the original. However, the original article may also include video and audio files, which can be accessed online at <http://www.citejournal.org>