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Using Technology as a Tool for Learning and Developing 21st Century Citizenship Skills: An Examination of the NETS and Technology Use by Preservice Teachers With Their K-12 Students

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Abstract

This study examined work samples and reflections of 223 elementary and secondary preservice teachers in a graduate teacher education program. The 5-year study addressed two questions: (a) To what extent did preservice teachers integrate technology into their instructional planning? (b) To what extent did K-12 students use technologies as a result of preservice teachers' instructional designs? In addition to addressing these questions, the data from 344 preservice teacher work samples and 151 preservice teacher reflections were examined through the lens of the *National Educational Technology Standards and Performance Indicators for Teachers* (ISTE, 2000) and *National Educational Technology Standards for Students: The Next Generation* (ISTE, 2007). Findings indicated 85% of preservice teachers integrated technology skills and knowledge in instructional practice with their K-12 students. Approximately 50% of the work samples and reflections documented K-12 students' use of technology in the areas of creativity and innovation, communication and collaboration, and research and information fluency. There is little evidence that K-12 students used technology to support critical thinking, problem solving, and decision-making.

Computer technology is almost ubiquitous and a major contributor to the "flat world" described by Thomas Friedman (2007). In a recent poll of registered voters conducted by Public Opinion Strategies and Peter D. Hart Research Associates, 71% of those polled ranked computer and technology skills as important (Partnership for 21st Century Skills, 2007a). However, only 25% believed that schools are doing a good job of teaching those skills. For over a decade, leaders and researchers in technology use have been criticizing teacher education programs for inadequately preparing preservice teachers to integrate technology into instruction with their students.

The purpose of this study was to analyze how K-12 preservice teachers used technology as a tool for student learning given technology standards for teachers and students from the International Society for Technology in Education (2000, 2007) and to consider how those experiences relate to 21st-century citizenship skills. This longitudinal 5-year study examined work samples and reflections of 223 elementary and secondary preservice teachers in a graduate teacher education program. The data provided preliminary answers to two questions: (a) To what extent did preservice teachers integrate technology into their instructional planning? (b) To what extent did K-12 students use technologies as a result of preservice teachers' instructional designs?

Theoretical Framework

Technology Preparation of Teachers

The National Council for Accreditation of Teacher Accreditation standards (1997) and the American Council on Education (1999) called for improving technology experiences of preservice teachers and encouraged university faculty to integrate technology into their teaching and scholarship. According to Moursund and Bielefeldt (1999), the principal investigators of a study conducted by the International Society for Technology in Education (ISTE), "71% of teacher education programs in the study required students to take at least three credit hours related to generic instruction technology skills" (p. 32). However, these courses did not provide a meaningful context for how technologies apply to and can improve teaching and learning. Nor did these courses prepare teachers to use technologies in various instructional settings.

Moreover, stand-alone instructional technology courses did not result in classroom integration of technologies with K-12 students. The ISTE study also revealed that teacher educators did not model the use of educational technology skills in their teaching. Furthermore, when educational technology was available in K-12 classrooms, preservice teachers did not use the technology in field experiences and most did not work under cooperating teachers and supervisors who could advise or support them in technology applications (Moursund & Bielefeldt, 1999).

Willis and Tucker (2001) criticized the isolation of teacher preparation programs from a society in which technology plays a vital everyday role.

> Teacher education programs do not prepare new teachers to be the change agents for the public school environment....Just teaching them how to use computers is not enough....Pre-service students need to experience alternative teaching and learning models and strategies as part of their own education. (p. 4)

Unfortunately, effective modeling of information technologies by teacher educators in universities is not common. According to Gilbert (1996), the majority of US undergraduate education faculty members continue to use traditional lecture/discussion/textbook methods. Bolick, Berson, Coutts, and Heinecke (2003) reported, "Regular use of technology is infrequent among most social studies faculty members (p. 304)." As a result, most teachers graduate from teacher preparation institutions with limited knowledge of the ways technology can be used in the classroom. In contrast, those teacher preparation programs embedding hands-on technology models in methods courses and student teaching requirements are more likely to produce teachers who use technology in their own practice (Vannatta, 2000). Thomas and Cooper

(2000) argued that college of education faculty should increase their use of technology, provide their students with opportunities to use technology, and model the use of technology in instruction.

More recently, Franklin (2007) cited 2005 data from the National Center for Educational Statistics (NCES), indicating that

...99% of public elementary schools and 96% of elementary instructional rooms have access to the Internet....However, only about one-third of elementary teachers in the United States felt well prepared or very well prepared to use computers and the Internet for classroom instruction, and less experienced teachers felt better prepared to use technology than their more experienced colleagues. (p. 268)

Franklin (2007) further reported that "elementary teachers use computers primarily for administrative and preparatory tasks and not for instructional activities with students" (p. 268). Echoing these findings, Bolick et al. (2003) surveyed social studies methods faculty regarding technology applications in social studies teacher education. Results from the baseline survey in 1999 indicated "almost all use of technology in social studies methods instruction is accounted for by word processors, email, and the Internet" (p. 306). Although teacher educators are using technology with their university students, they are not preparing preservice teachers to integrate technology into instruction with K-12 students. Nor are teacher educators preparing preservice teachers to facilitate the use of technology by their K-12 students (Bolick et al. 2003).

In their discussion of the state of technology, social studies, and teacher education, Friedman and Hicks (2006) articulated the need to "research and evaluate the impact of the use of technology and technology enhanced instruction within classrooms" (p. 250). They explained the need to recognize the digital divide and its impact on teaching and learning social studies and to examine the digital disconnect between teachers' and students' abilities and expectations with regard to using technology. Similarly, Whitworth and Berson (2003) found that Internet use and accessing information on the Web was the most common use of technology in the social studies. They expressed a concern that technology was being used as a more sophisticated and expensive way to meet the same learning outcomes that could also be achieved through more traditional methods.

Recent surveys suggest technology integration is limited. Hicks, Doolittle, and Lee (2004) reported on a national survey of high school social studies teachers conducted in 2002 that "just over 50% of teachers indicated they rarely (less than once a month) or never use digital historical resources" (p. 2). In a similar but broader reaching finding, the National Assessment of Educational Progress (NAEP) reported in the 2001 US history *Nation's Report Card* that "58% of high school history students in public and private school rarely or never use computers" (National Council on Education Statistics, 2002, p. 2).

Expectations for Citizenship Skills and Knowledge in a Digital Age

In a recent effort to describe how technologies might be integrated into social studies teaching and learning, Mason, et al. (2000) developed criteria for appropriately integrating technology into social studies teacher preparation programs. These criteria also provided guidance to preservice teachers for integrating technology into instruction with K-12 students. According to Mason et al. (2000), infusing technology into instruction should

1. Extend learning beyond what could be done without technology.
2. Introduce technology in context.
3. Include opportunities for students to study relationships among science, technology, and society.
4. Foster the development of the skills, knowledge, and participation as good citizens in a democratic society.
5. Contribute to the research and evaluation of social studies and technology.

The fourth criterion in these guidelines directly relates to the expectations for the skills and knowledge of citizens. *The Civic Mission of Schools* (Center for Information and Research on Civic Learning and Engagement [CIRCLE], 2003) described goals for civic education as preparing competent and responsible citizens who are informed and thoughtful. They further suggested that citizens should understand public and community issues, be able to obtain information, think critically, and be willing to enter into dialogue with others and understand diverse perspectives. *The Civic Mission of Schools* also suggested that citizens act politically by organizing to address social issues, solve problems in groups, speak in public, petition, protest, and vote. In support of the Mason et al. (2000) guidelines, the group argued,

Being an engaged and effective citizen today requires reading, writing, and mathematical skills; the ability to understand complex issues (which sometimes have scientific or economic dimensions); *knowledge of computers and the Internet* [italics added]; and the ability to talk with people from different backgrounds. (p. 13)

One of the most far reaching and influential projects to distinguish how teachers and students should utilize technology in support of the aims of education can be found in the ISTE National Technology Standards. ISTE developed these technology standards for teachers and students in such a way as to inform expectations for citizenship skills in a digital age. *The National Educational Technology Standards and Performance Indicators for Teachers* (NETS-T; ISTE, 2000) provided criteria for teachers' use of technology in instructional planning:

I. Teachers demonstrate a sound understanding of technology operations and concepts.
II. Teachers plan and design effective learning environments and experiences supported by technology.
III. Teachers implement curriculum plans that include methods and strategies for applying technology to maximize student learning.
IV. Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.
V. Teachers use technology to enhance their productivity and professional practice.
VI. Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply that understanding in practice.

Since this research study was completed, ISTE has published revised technology standards and performance indicators for teachers (ISTE, 2008). These 2008 standards were not included in this study.

In 2006, ISTE convened panels of educators and technology specialists to review the technology standards for students. Much of the discussion focused on moving beyond technology operations and concepts. *The National Educational Technology Standards for Students: The Next Generation* (NETS-S; ISTE, 2007) now emphasize technology as a tool for research, communication, collaboration, problem solving, and decision making, which are essential citizenship skills. The standards identify six core components:

1. Creativity and Innovation
   Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
2. Communication and Collaboration
   Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
3. Research and Information Fluency
   Students apply digital tools to gather, evaluate, and use information.
4. Critical Thinking, Problem-Solving and Decision-Making
   Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources.
5. Digital Citizenship
   Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
6. Technology Operations and Concepts
   Students demonstrate a sound understanding of technology concepts, systems and operations.

The Partnership for 21st Century Skills (2007b) has also developed student outcomes representing the skills, knowledge, and expertise students should master for success in 21st-century work and life. In addition to core academic subjects, the *Framework for 21st Century Learning* suggested interdisciplinary themes that are especially relevant for citizenship skills.

- *Global Awareness* focuses on using 21st-century skills to understand and address global issues and learn from and work collaboratively with individuals representing diverse cultures, religions, and lifestyles.
- *Financial, economic, business and entrepreneurial literacy* requires students to understand the role of the economy in society and make appropriate personal economic choices.
- *Civic literacy* emphasizes effective participation in civic life by staying informed and understanding governmental processes, exercising the rights and obligations of citizenship at local, state, national, and global levels and understanding the local and global implications of civic decisions.
- *Health literacy* includes understanding national and international public health and safety issues.

The *Framework for 21st Century Learning* also incorporated technology into Learning and Innovation Skills, which focus on creativity, critical thinking, communication, and collaboration. These skills are also important for citizenship. The Framework emphasizes information literacy, media literacy, and information, communications, and technology (ICT) literacy. Specifically, information literacy requires the ability to efficiently access and critically evaluate information and creatively use it to solve problems. Media literacy focuses on the construction and interpretation of media messages and how media influences beliefs and behaviors. ICT literacy focuses on using digital technology, communication tools, and networks to access, manage, integrate, evaluate, and create information.

Research on the technology preparation of classroom teachers contrasts starkly with technology leaders' expectations for K-12 students' digital citizenship skills and knowledge. Both the *National Educational Technology Standards for Students* (ISTE, 2007) and the *Framework for 21st Century Learning* illustrated the movement away

from teaching technology operations to focusing on students' active use of technology in creative problem solving. This research study focused on technology as a tool for learning and developing 21st-century citizenship skills by preservice teachers with their K-12 students. Specifically, this research study examined technology integration through the lens of the NETS-T (ISTE, 2000) and the NETS-S (ISTE, 2007),

Methodology

The research reported here is part of a larger study of the use of technologies to develop 21st-century citizenship skills. The goal of this research is to enumerate the technologies used by preservice teachers in instructional planning, as well as by these preservice teachers' K-12 students. The data presented here represent a slice of a larger set of data, and the goal of these initial findings is to create a foundation for future work and research.

Participants and Settings

The 223 preservice teachers in this longitudinal 5-year study were students in a four-quarter graduate teacher education program at a major university in the Pacific Northwest. The program used a cohort model, and the teachers in this study participated in three elementary (preK-6) and five secondary (7-12) cohorts between June 2002 and June 2007. Cohorts ranged in size from 22 to 31, with an average of 28. Data from 88 elementary and 135 secondary teachers were included in this study. Secondary cohorts included preservice teachers seeking endorsements in a variety of subjects, including language arts (49), social studies (29), foreign languages (19), music (11), art (8), health (4), business education (4), science (4), drama (3), and mathematics (2).

Technology Instruction

These preservice teachers completed a required two-term instruction and technology course, taught by the primary researcher in this study. Preservice teachers learned to use a variety of technologies as they participated in the Intel Teach to the Future curriculum (Candau et al., 2001) and other technology-based workshops. Findings from the research literature about the importance of weaving technology into instructional methods informed the instruction in these courses. As the instructor/researcher, I modeled all of the technologies, including presentation, graphic organizer, desktop publishing and spreadsheet software, Web tools (webquests, webpages, weblogs), digital still and video cameras, and computer/video projection devices.

Preservice teachers in both elementary and secondary cohorts were expected to learn to use all of the technologies; however, instructional application of these technologies differed depending on the grade level of the K-12 students. For example, elementary preservice teachers tended to use digital cameras to document their students' projects, while secondary preservice teachers asked their students to use the cameras to document findings, such as urban architectural styles and transportation patterns.

As the instructor for the courses involved in this study, I embedded a constructivist approach, similar to a model described by Resnick (as cited in Willis & Tucker, 2001) in course activities. The model suggests that learning is an active process, and learning is more effective when students are engaged in constructing personally meaningful products. In his research on teacher education in social studies, Molebash (2004) found support for using this model, arguing that a "consistent theme among methods course technology integration success stories is a constructivist approach" (p. 415).

Preservice teachers in this study were required to develop technology-enriched lessons within a curriculum unit that incorporated a variety of technologies appropriate to the grade level(s) and subject(s) they subsequently taught in student teaching. In addition to learning how to use specific information technologies, preservice teachers used the backwards curriculum design process (Wiggins & McTighe, 1998) and explored ways to use technology as a tool for problem solving (Jonassen, Howland, Moore, & Marra 2002).

The first instructional technology course was taught prior to or simultaneously with the "initial field experience" course, in which preservice teachers completed 90 hours of observation and taught mini-lessons under the supervision of a cooperating teacher. The second instructional technology course was taught during a half-time student teaching experience for participants, in which the preservice teachers were expected to teach 20 hours per week under the supervision of a cooperating teacher while attending university courses. Preservice teachers were encouraged but not required to implement technology enriched lessons in both their half-time student teaching (Student Teaching I) and subsequent full-time student teaching (Student Teaching II) field experiences.

During both field experiences, preservice teachers completed a work sample that included the classroom context, unit rationale, detailed lesson plans, sample instructional materials, and pre and post K-12 student assessment data. Student Teaching I work samples represented a unit of study lasting 2 to 3 weeks, while Student Teaching II work samples represented a 4- to 5-week unit of study. The work samples did not include every lesson taught during the student teaching experience—only the lesson plans for a specific unit of study to meet licensure program requirements.

Data Collection

The data included (a) 344 work samples collected at the end of half-time Student Teaching I and full-time Student Teaching II from 223 preservice teachers and (b) 151 final reflections from preservice teachers at the end of the licensure program. During the first 2 years of the study, 2002-2004, obtaining all of the work samples from Student Teaching II was difficult, since the preservice teachers were using their work samples in an action research course that immediately followed full-time student teaching. Reflections were not collected from the preservice teachers in the 2003-04 cohorts.

Table 1 lists the study participants and data sources. Between 2003 and 2006, 86 Student Teaching I work samples and 54 Student Teaching II work samples were collected for a total of 140 work samples from 88 elementary preservice teachers. Between 2002 and 2007, 111 Student Teaching I work samples and 93 Student Teaching II work samples were collected for a total of 204 work samples from 135 secondary preservice teachers. The secondary work samples for which subject area was recorded during data collection included units in language arts (69), social studies (42), foreign languages (25), music (10), art (7), science (7), drama (6), business education (5), mathematics (3), and health (3).

At the conclusion of Student Teaching II, preservice teachers in two elementary cohorts (49) and four secondary cohorts (102) responded to the following open-ended prompt: "To what extent were you able to use technology as a tool for learning in your university coursework and/or in half-time Student Teaching I and full-time Student Teaching II?" These reflections were collected from 151 preservice teachers in the study.

Table 1
Study Participants and Data Sources

Level	Academic Year	Participants	Work Sample I	Work Sample II	Reflection
	2003-2004	32	31	4	0
Elementary	2004-2005	28	28	24	26
	2005-2006	28	27	26	23
	2002-2003	22	11	11	22
	2003-2004	29	20	5	0
Secondary	2004-2005	28	24	21	26
	2005-2006	25	25	25	25
	2006-2007	31	31	31	29
Totals		223	197	147	151

Initial Data Analysis

Data analysis involved an examination of the work samples (140 elementary and 204 secondary) for specific examples of preservice teachers' use of technology for instruction with their K-12 students and also for examples of technology use by K-12 students themselves. Each type of technology was recorded once for an individual preservice teacher, whether the technology was used one or more times by the preservice teacher or by K-12 students. For example, a work sample indicating that the preservice teacher developed a PowerPoint presentation was coded as one type of technology use, even if the preservice teacher developed several such multimedia presentations. Similarly, if K-12 students used word processing software, it was coded as one type of technology, even if the students used that technology for multiple assignments within a work sample. Consequently, this research reports the percentage of preservice teachers or K-12 students who used any given technology at least once.

At the end of full-time Student Teaching II, preservice teachers in two elementary and four secondary cohorts were asked to respond to this open-ended question: "To what extent were you able to use technology as a tool for learning in your university coursework and/or in half-time Student Teaching I and full-time Student Teaching II?" The reflections of 151 respondents were labeled by the types of instructional technology hardware and software mentioned. In addition, the reflections were read according to whether or not the technology was used for instructional purposes by the preservice teachers or by their K-12 students. Preservice teacher reflections were examined for examples of technology use throughout their student teaching field experience, not just during the instruction of the work sample.

Follow-Up Data Analysis

Following the initial data analysis, work samples and reflection data were reexamined using the lens of the NETS-T (ISTE, 2000) and NETS-S (ISTE, 2007). Four of the NETS-T standards were particularly useful criteria for work sample analysis: Standard II-learning experiences are supported by technology; Standard III-technology maximizes student learning; Standard IV-technology facilitates assessment and evaluation; and Standard VI-technology enhances productivity and professional practice.

Because the *National Educational Technology Standards* do not list the technologies that may be used to meet each standard, the process of identifying technologies according to the ISTE standards is a judgment call. This process involved reexamining the copies of the technology lessons and notes from initial analysis of the work samples to determine the intended purpose of each technology use in each work sample. The resulting categories represent the best fit of the technologies in these work samples to the ISTE standards.

A similar process was used to categorize the K-12 students' use of technology documented in the preservice teachers' work samples and reflections. I reread the copies of the technology lessons and notes from initial analysis of the work samples to determine the intended purpose of each technology use by K-12 students in each work sample. Again, in my judgment four of the NETS-S (ISTE, 2007) provided particularly useful criteria for the work sample analysis: Standard 1-Creativity and Innovation; Standard 2-Communication and Collaboration; Standard 3-Research and Information Fluency; and Standard 4-Critical Thinking, Problem Solving, and Decision-Making. K-12 students' uses of technology were assigned to one of these four NETS-S.

Findings

Use of Technology in Instruction Documented in Work Samples and Reflections

To what extent did preservice teachers integrate technology into their instructional planning, and to what extent did K-12 students use technologies as a result of preservice teachers' instructional designs? These were the two questions driving this research. Analysis of 344 work samples, reported in Table 2, indicated the 25 technology tools preservice teachers integrated into instructional planning or K-12 students used during the preservice teachers' instruction.

In 268 of the work samples (78%) preservice teachers documented technology integration in their instruction or use of technology by their K-12 students (see Table 3). Analysis of the work samples revealed a slightly higher percentage of technology integration by secondary teachers (81%) than elementary teachers (73%).

Similar results were documented in preservice teachers' end-of-program reflections. One hundred twenty-nine preservice teachers (85%) described technology use with their K-12 students (Table 4). In contrast to the work sample analysis, a slightly higher percentage of elementary preservice teachers (92%) referenced use of technology with their students than did secondary preservice teachers (82%). Both the work samples and preservice teachers' reflections indicated integration of technology skills and knowledge into instructional practice.

Alignment of Preservice Teachers' Use of Technology With NETS-T

Given the findings about the extent of preservice teachers' technology use, how did these uses relate to or conform with NETS-T (ISTE, 2000)? To accomplish this analysis, I reexamined the data from the initial work sample analysis and assigned technology uses in each work sample to the relevant NETS-T, depending on the purpose of the technology use. For example, preservice teachers generally used an LCD projector, DVD/streaming video, or a CD-ROM to support delivery of the lesson (NETS-T II), while they used graphic organizers, webquests, and simulations to maximize student learning during instruction (NETS-T III). Preservice teachers tended to use digital still and video cameras to document student learning and spreadsheets to communicate student

assessment data (NETS-T IV), while they used presentation (PowerPoint) and desktop publishing to enhance their productivity and professional practice (NETS-T V). Internet search tools were used both to maximize student learning (NETS-T III) and enhance teacher practice (NETS-T V).

Table 2
Use of Technology in Instruction by Preservice Teachers and by Their K-12 Students Documented in Work Samples (2002-2007)

Technology	Elementary Work Samples: Teacher Use	Elementary Work Samples: Student Use	Secondary Work Samples: Teacher Use	Secondary Work Samples: Student Use
Word Processing Software	51%	11%	58%	12%
Internet Search Tools	44%	18%	44%	27%
LCD Projector	17%	<1%	39%	0
Presentation Software	14%	2%	40%	6%
DVD/Streaming Video	12%	0	17%	<1%
Tape/CD player	7%	0	13%	1.5%
Graphic Organizer	6 %	2%	13%	0
Digital Cameras	14%	0	4%	2.5%
Webquest	11%	3%	3%	3%
Desk Top Publishing	3.5 %	0	8%	1.5%
Web Log	0	0	6%	5%
Video Cameras	2 %	0	4 %	<1%
Graphics Clip/Art	3.5 %	0	3%	1.5%
Webpage/Class website	0	<1%	4%	<1%
Create CD's	0	0	3%	2%
Spreadsheet	2 %	0	2%	2.5%
CD-ROM	3%	<1%	1%	0
Smart Board	<1	0	2%	<1%
Subject specific software	1 %	<1%	1.5%	2%
Email	0	0	1.5%	1.5%
I-Movie	0	0	1%	2.5%
MMP3/Podcast	0	0	1%	<1%
Simulations	<1 %	0	0	<1%
Photo Shop	0	0	<1%	<1%
Computer Games	<1 %	<1%	0	<1%

Table 3
Evidence of Technology Use in Instruction Documented in Work Samples (N = 344)

Level	Academic Year	Work Sample I With Technology/ Total Work Sample I	Work Sample II With Technology/ Total Work Sample II	% Work Samples I, II Using Technology
	2003-2004	20/31	2/4	63%
Elementary	2004-2005	19/28	19/24	73%
	2005-2006	17/27	25/26	70%
Subtotal Elementary		56/86	46/54	73%
	2002-2003	10/11	10/11	91%
	2003-2004	13/20	4/5	68%
Secondary	2004-2005	13/24	19/21	71%
	2005-2006	19/25	21/25	80%
	2006-2007	30/31	27/31	92%
Subtotal Secondary		85/111	81/93	81%
Totals		141/197	127/147	78%

Table 4
Evidence of Technology Use in Instruction Documented in Preservice teachers' Reflection (N = 151)

Level	Academic Year	Reflections Identifying Technology Use/ Total	% of Reflections Identifying Technology Use
Elementary	2004-2005	22/26	85%
	2005-2006	23/23	100%
Subtotal Elementary		45/49	92%
	2002-2003	18/22	82%
Secondary	2004-2005	23/26	88%
	2005-2006	20/25	80%
	2006-2007	23/29	79%
Subtotal Secondary		84/102	82%
Totals		129/151	85%

Table 5 indicates the percentage of work samples in which preservice teachers completed a number of technological tasks. A variety of other technologies were also evident, but in smaller percentages of the work samples. Whitworth and Berson's (2003) finding that Internet use and accessing the Web was the most commonly used technology in social studies was supported by this study. Word processing and accessing the Web were the most frequently used technologies in the 42 social studies work samples, as well as the other subject area work samples in this study

In addition to analyzing the data for its fit with NETS-T categories, the data were also considered in several comparative contexts. One area of comparison was between preservice teachers' instructional grades levels. Although a similar percentage of elementary and secondary preservice teachers used Internet search tools (44%), there were striking differences between elementary and secondary preservice teachers' general uses of technology. Secondary preservice teachers were three times more likely to use presentation software and twice as likely to use LCD projectors in the classroom than were elementary preservice teachers. Secondary preservice teachers' work samples indicated that they were almost one and a half times more likely to use DVD/streaming video and twice as likely to use desktop publishing and graphic organizer software as elementary preservice teachers. Four technologies used by secondary preservice teachers (creating CDs, webpages, emails, and blogs) were not used at all by elementary preservice teachers.

In contrast, elementary preservice teachers used digital cameras to document student performance three and a half times more frequently than did secondary teachers, and they used webquests with their students four times more often than did secondary teachers. These data contradict Franklin's finding (2007) that elementary teachers do not use technology for instructional activities with students. Although less frequently than their secondary school colleagues, elementary preservice teachers in this study used word processing, Internet search tools, graphic organizers, and webquests to maximize student learning.

Similar differences in the types of technologies used in instruction were found in the data from preservice teachers' reflections. Each of the 151 reflections was analyzed for the types of technology that preservice teachers reported using with their K-12 students. Each reflection was labeled for the NETS-T (ISTE, 2000) and instructional practices it documented. Preservice teachers reported integrating 18 different technologies into instruction. These data are summarized in Table 6. Comparing reported technology use to the NETS-T suggested that preservice teachers used technology to support their lessons (II), maximize student learning (III), facilitate assessment (IV), and enhance productivity and professional practice (V). For example, reflections documented technology-supported lessons (Standard II) in which preservice teachers used an LCD projector to show multimedia presentations, streaming video, websites, documentaries, and news clips. Virtually every preservice teacher used Internet search tools to find resources and lesson plan ideas, created Excel spreadsheets to analyze student learning gains, and created word documents, PowerPoint presentations, and concept maps/graphic organizers. A smaller number of preservice teachers created class webpages and blogs, recorded student work with digital cameras, and communicated by email with students and parents.

Table 5
NETS-T Documented in Work Samples

Types of Technology	Number of Elementary Work Samples[a] Documenting Technology Use	Number of Secondary Work Samples[b] Documenting Technology Use	Totals[c]
II. Technology Supports Lessons			
LCD Projector	24/17%	79/39%	103/30%
DVD/Streaming Video	17/12%	35/17%	52/15%
Tape/CD player	10/7%	27/13%	37/11%
Graphics Clip/Art	5/3.5%	6/3%	11/3%
CD-ROM	4/3%	2/1%	6/2%
Smart Board	1/<1%	4/2%	5/1.5%
I-Movie	0	2/1%	2/<1%
Photo Shop	0	1/<1%	1/<1%
III. Technology Maximizes Student Learning			
Word Processing	71/51%	119/58%	190/55%
Internet Search Tools	62/44%	90/44%	152/44%
Graphic Organizers	8/6%	27/13%	35/10%
Webquests	16/11%	6/3%	22/6%
Webpage/Class websites	0	8/4%	8/2%
Subject specific software	2/1%	3/1.5%	5/1.5%
MMP3/Podcasts	0	2/1%	2/<1%
Simulations	1/<1%	0	1/<1%
Computer Games	1/<1%	0	1/<1%
IV. Technology Assists Assessment			
Digital Cameras	20/14%	8/4%	28/8%
Video Cameras	3/2%	9/4%	12/3.5%
CD's of student work	0	7/3%	7/2%
Spreadsheet	3/2%	4/2%	7/2%
V. Technology Enhances Productivity & Professional Practice			
Internet Search Tools	62/44%	90/44%	152/44%
Power Point	20/14%	81/40%	101/29%
Desk Top Publishing	5/3.5%	16/8%	21/6%
Web Log	0	13/6%	13/7%
Email	0	3/1.5%	3/<1%

[a] Total elementary work samples analyzed = 140.
[b] Total work samples secondary analyzed = 204.
[c] Total work samples analyzed = 344.

Table 6
NETS-T Documented in Reflections

Types of Technology	Teachers' Instructional Practice With K-12 Students
II. Technology Supports Lessons	
TV/VCR	Show films, documentaries
Slide projector	Demonstrate artists' work and primary source documents
Streaming Video	Show documentaries
LCD Projector	Show power points, streaming video, websites, documentaries, news clips
Graphics software	Create documents, multimedia presentations
III. Technology Maximizes Student Learning	
Internet Browser	Locate teaching strategies for diverse learners
WebPages	Create class website including syllabus and resources for students
Word Processing	Create instructional materials for students of diverse ability and language levels
Subject specific software	Accounting, math drill, math problem solving, reading,
Graphic organizer software	Create unit concept maps and graphic organizers for students
Cassette recorders, CD players, iPods	Provide examples for students in music/foreign language classes
IV. Technology Assists Assessment	
Digital Cameras	Record and discuss students' work and analyze for improvement
Digital video cameras/I-Movie	Create examples for student projects; video student performance and analyze for improvement in music and language classes
Word Processing	Create scoring rubrics for assessing student projects
Excel software	Analyze pre/post student assessment data
Cassette recorders, CD players	Tape student performances for student/peer evaluation
V. Technology Enhances Productivity and Professional Practice	
Internet Browser	Find lesson ideas; locate primary sources, music, photos, documents, international newspaper databases especially in social studies
Presentation Software	Create subject matter presentations, "Jeopardy" review games, webquests, Use animations, sounds, text, pictures, graphics, and interactive features to engage students
Weblog	Create teacher or class weblog
Email	Share student work and progress with parents; connect with absent students
Desktop Publishing	Create unit brochures for students/parents; create class newsletters, Zine, music concert program

Finally, preservice teachers in this study tended to integrate technologies modeled in their teacher education program. This finding confirmed previous research that preservice teachers tend to use the technologies they were taught (Mason et al., 2000; Wright & Wilson, 2005).

Challenges to Integrating Technology in Instructional Practice

Many of the preservice teachers' reflections acknowledged the technology operations and concepts they learned during their teacher education program (NETS-T Standard I). Two reflections were typical of most preservice teachers' changed outlook:

Though reluctant and hesitant to use new technology when I started this program, I have learned to love and appreciate its many uses and the opportunities it provides me as an educator. Becoming more familiar with it and capable of using it was one of the most significant changes in my professional development.

Using and mastering technology helped me become a better teacher. I learned and was able to communicate with other teachers and research new instructional strategies via email and internet. The new tools that I have learned this year helped me become much more organized, much more efficient with my time, and much more capable of creating a wider variety of activities and lessons for my students.

Another preservice teacher illustrated the challenge of using technology appropriately in every situation.

I am a beginning teacher. Because of my coursework ... and my student teaching placement, I have a huge toolbox chockfull with ways to create an engaging, student-centered, accessible learning environment for the diverse students with whom I will work in the coming years. I even know how to use most of the tools in my toolbox—which doesn't mean that sometimes I [don't] pick up the hammer when I should really go for the Sawzall.

Preservice teachers were also cognizant of the social, ethical, and human issues related to technology integration (NETS-T Standard VI). Preservice teachers were sensitive to the digital divide and did not feel they could assign completion of technology projects for homework when technology was lacking in the classroom and at home. At some elementary schools the students lacked prerequisite skills to use the technologies, and the preservice teachers did not feel there was adequate time for them to teach both technology skills and the academic content.

While the preservice teachers in this study taught in a variety of settings (urban, suburban, and rural), as well as a variety of grade levels and subjects, they faced a consistent challenge in using technology as a tool for learning: lack of access to adequate technology in the K-12 schools. With rare exceptions, computer labs, classroom computers, printers, Internet connectivity, projection and recording devices, and appropriate software were insufficient to meet student demand. Lack of technical support staff and adequate time to figure out how to use the equipment, set it up, and test it was another hurdle. Even when the technology existed in the school, it was not well maintained and was frequently unavailable. In some schools the computer labs were booked for over a month to administer state tests.

Often preservice teachers brought their own or the university's technology (computers, digital cameras, video cameras, recorders, or LCD projectors) to the schools. Lack of

adequate technology was specifically mentioned in 50% of the preservice teachers' reflections. However, the vast majority of preservice teachers still used technology for instruction despite the lack of adequate resources.

Technology Use by K-12 Students, Documented in Work Samples and Reflections

This research also examined the use of technology by K-12 students. A total of 344 work samples (140 elementary and 204 secondary) were examined specifically for evidence that K-12 students used the technology for their own learning. The results are summarized in Table 7. A total of 170 work samples (49%) showed evidence of K-12 students' use of technology for their own learning. Specifically, 56% of secondary work samples and 40% of elementary work samples showed evidence of K-12 students' use of technology.

Table 7
*Technology Use by K-12 Students Documented in Work Samples (*N = *344)*

Level	Academic Year	Student Technology Use in Work Sample I/ Total	Student Technology Use in Work Sample II/ Total	Work Samples I & II with Student Technology Use
	2003-2004	12/31	2/4	40%
Elementary	2004-2005	10/28	12/24	42%
	2005-2006	10/27	10/26	38%
Subtotal Elementary		32/86	24/54	40%
	2002-2003	6/11	6/11	55%
	2003-2004	6/20	3/5	36%
Secondary	2004-2005	10/24	15/21	55%
	2005-2006	14/25	14/25	56%
	2006-2007	21/31	19/31	65%
Subtotal Secondary		57/111	57/93	56%
Totals		89/197	81/147	49%

Similar results were found in the preservice teachers' program reflections. Table 8 indicates that 82 preservice teachers (54%) described their K-12 students' use of technology. A slightly higher percentage of secondary preservice teachers (58%) acknowledged their students' use of technology than did elementary preservice teachers (47%).

Alignment of K-12 Students' Use of Technology With NETS-S

Based on a reexamination of the data from the initial work sample analysis, I assigned the K-12 students' use of technology to one of the NETS-S (ISTE, 2007), depending on the purpose of the technology use. K-12 students used presentation and graphic organization software to promote creative thinking and created movies and CDs as innovative products (NETS-S Standard 1). Students used word processing and blogs to communicate and

collaborate (NETS-S Standard 2). They used Internet search tools for research and information fluency (NETS-S Standard 3) and spreadsheet software to support critical thinking and problem solving (NETS-S Standard 4). Each of the 344 work samples was labeled for the NETS-S and student learning practices it documented.

Table 8
*Technology Use by K-12 Students Documented in Preservice Teachers' Reflections (*N = *151)*

Level	Academic Year	Reflections Identifying Students' Technology Use/Total	% Reflections Identifying Students' Technology Use
Elementary	2004-2005	11/26	42%
	2005-2006	12/23	52%
Subtotal Elementary		23/49	47%
	2002-2003	12/22	55%
Secondary	2004-2005	18/26	69%
	2005-2006	11/25	44%
	2006-2007	18/29	62%
Subtotal Secondary		59/102	58%
Totals		82/151	54%

The NETS-S were also used to examine whether the K-12 students' use of technology reflected digital citizenship skills. NETS-S focus on six core technology competencies that support effective citizenship skills and may be exhibited through the appropriate use of technology tools. For example, creativity and innovation may be demonstrated through presentation, graphics, and graphic organizer software. Communication and collaboration may be enhanced through email, word processing, presentation and desktop publishing software, and digital cameras. Research and information fluency can be accomplished by appropriately using Internet search tools. Critical thinking, problem solving, and decision-making can be supported through simulations.

All 344 work samples were examined, revealing 23 specific types of technology used by K-12 students. These results are summarized in Table 9. A small number of work samples (15) documented students' use of presentation software to support creative thinking (NETS-S Standard 1). Students used word processing (40 work samples) and blogs (11 work samples) to support communication and collaboration (NETS-S Standard 2). The most frequent student use of technology (81 work samples) was Internet search tools to support research (NETS-S Standard 3). Few work samples showed use of technology to support critical thinking and problem solving (NETS-S Standard 4).

Each of the 151 preservice teacher reflections was also labeled for the NETS-S and student learning practices it documented. For example, reflections documented K-12 students who demonstrated creative thinking and who developed innovative products by using digital video cameras and I-Movie software to create video poetry.

Table 9
National Education Technology Standards for Students Documented in Work Samples

Types of Technology	Number of Elementary Work Samples[a] Documenting Student Technology Use		Number of Secondary Work Samples[b] Documenting Student Technology Use		Totals[c]	
1. Creative Thinking & Innovative Products & Processes						
Power Point	3	2%	12	6%	15	4%
Digital Cameras	0	0	5	2.5%	5	1.5%
I-Movie	0	0	5	2.5%	5	1.5%
Graphic Organizer	3	2%	0	0	3	<1%
Cassette Tape/CD Player	0	0	3	1.5%	3	<1%
Graphics/Clip Art	0	0	3	1.5%	3	<1%
Class Webpage	1	<1%	1	<1%	2	<1%
Photo Shop	0	0	1	<1%	1	<1%
Video Cameras	0	0	1	<1%	1	<1%
2. Communication & Collaboration						
Word Processing	16	11%	24	12%	40	12%
Weblog	0	0	11	5%	11	3%
Create CD's	0	0	4	2%	4	1%
Email	0	0	3	1.5%	3	<1%
Desktop Publishing	0	0	3	1.5%	3	<1%
MMP3/Podcast	0	0	1	<1%	1	<1%
LCD Projector	1	<1%	0	0	1	<1%
Smart Board	0	0	1	<1%	1	<1%
3. Research & Information Fluency						
Internet Search	25	18%	56	27%	81	24%
Web quests	4	3%	7	3%	11	3%
DVD/Streaming Video	0	0	1	<1%	1	<1%
CD-Rom	1	<1%	0	0	1	<1%
4. Critical Thinking, Problem Solving & Decision-Making						
Spreadsheet	0	0	5	2.5%	5	1.5%
Computer Games	1	<1%	1	<1%	2	<1%
Simulations	0	0	1	<1%	1	<1%

[a] Total elementary work samples analyzed = 140.
[b] Total work secondary samples analyzed = 204.
[c] Total work samples analyzed = 344.

K-12 students used five different tools to demonstrate creative thinking, construct knowledge, and develop innovative products (NETS-S Standard 1). They used digital video cameras with I-Movie software to create news broadcasts, campaign videos, original short story dramatizations, video poetry and commercials. Students created numerous

multimedia presentations to share their research and developed webpages to publicize school events and publish graphic novels and poetry anthologies. They created digital photographs of their paintings and CDs of their projects and used graphic software to design posters and book jackets. They also downloaded songs onto their iPods to accompany oral presentations on historic protest movements.

Students used 11 of the technology tools to communicate and work collaboratively to support their own and other students' learning (NETS-S Standard 2). They created multimedia presentations and webpages. They recorded projects and demonstrations with digital still and video cameras. They created printmaking projects as part of a digital cultural exchange with students at their sister school in Uganda. Students used desktop publishing software to create brochures and pamphlets, such as Spanish and Southwest Asian cookbooks, poetry zines, and history magazines. They created concept maps and graphic organizers of their research to support their writing.

Students in a French class created a movie with PowerPoint, including voice recording and digital photographs, to demonstrate their grammar and vocabulary knowledge. Other students wrote persuasive essays, research papers, poetry anthologies, and lab reports with word processing software. They eagerly shared their learning with others by posting to the class blog, by using an LCD projector for class presentations of group work, and by emailing their teachers, public officials, and students in other countries.

Students used several digital tools to gather and evaluate information (NETS-S Standard 3). They conducted research with Internet browsers, used webquests and streaming video in their research, participated in online virtual fieldtrips and simulations, and evaluated primary source documents and artists' work displayed by slide projectors. Students also used technology tools to plan and conduct research, manage projects, solve problems, and make decisions (NETS-S Standard 4). They compared and analyzed film and text versions of novels and plays using TV/VCR and DVD players. Students also created spreadsheets and graphs to propose a state budget, analyze data from science labs, and propose a startup student business. Webquests, simulations, virtual field trips, and mathematics and foreign language sites were also utilized to support their problem solving skills.

Challenges Presented by K-12 Students' Technology Skills

The NETS-S on understanding societal issues related to technology and the practice of legal, ethical behavior was not addressed by the reflections. However, preservice teachers did receive instruction on teaching ethical and safe technology practices. Analyzing K-12 students' understanding of technology operations and concepts (NETS-Standard 6) revealed the challenges presented by the diversity of students' technology skills. Some K-12 students loved the use of technology in the classroom and knew more about the applications than the preservice teacher, while others lacked the technology skills to successfully complete Internet research, and others were distracted from classroom instruction by their personal technology. One high school preservice teacher commented,

The greatest challenge I have had with students and technology is knowing how to effectively research a topic. Students in many cases do not approach Internet research appropriately and they do not know how to assess whether the source is adequate or credible....Finally students do not know how to interpret extensive information.

Another high school preservice teacher commented,

> All year I have been battling iPods, CD players, game players, and especially mobile phones. They are all classroom distractions that keep each kid in their own little world when they should be working with the rest of the class. It even affects the students' own larger school community. Between classes they all put on their earphones and walk past each other in the hall, rarely communicating with each other.

Another comment from a preservice teacher in the study was even more negative about the uses of technology.

> Many of my students felt far more comfortable using different forms of technology as toys instead of as learning tools. Given the opportunity to use word processors and printers to complete assignments, students would frequently waste time checking their email, updating their "My Space" pages, and downloading music onto their mp3 players.

These comments contrast with more positive reflections. An elementary preservice teacher wrote,

> For the students I teach I believe the use of technology enhances most units. Students at my school enjoy creating presentations on computers. Some of the seemingly most difficult to teach students focus well and work when using programs such as Microsoft Word, publisher, and PowerPoint.

A preservice teacher at a secondary alternative program wrote,

> At its best [technology] helps students form personal connections with the subject matter and puts them in control of their learning experience. If we really are working toward implementing effective student centered instruction, we must be willing and able to utilize materials and techniques that help students in this exact manner. Yes, it's more work to set up and maintain a class website and it requires a broader range of skills and research, but the results are noticeable.

Another secondary alternative program teacher agreed,

> Technology supported student learning by giving them [students] access to first hand accounts in a variety of formats. If students can access current information and real-life stories, they have a better chance of understanding the impact that historical events have on people's lives.

Discussion

This research responded to the need to evaluate the impact of technology-enhanced instruction within classrooms (Friedman & Hicks, 2006). The purpose of this study was to analyze how preservice K-12 teachers use technology as a tool for student learning and development of 21st-century citizenship skills. According to Bolick et al. (2003), while teacher educators are using technology with their university students, they are not preparing preservice teachers to integrate technology into instruction with K-12 students. As the instructor/researcher I was aware of the NETS-T and emphasized multiple uses of technology with the preservice teachers in this study. Specifically, I taught preservice teachers to use technology in four areas: (a) planning and designing effective lessons, (b)

maximizing student learning, (c) facilitating assessment, and (d) enhancing productivity and professional practice.

Findings from this study indicated that 85% of the preservice teachers in the study integrated technology tool use into instructional practice with their K-12 students. This study supported the findings of Whitworth and Berson (2003) that using the Internet to access information was the most common use of technology. However, preservice teachers in this study also used a variety of other technologies, including presentation and graphic organizer software, LCD projectors, streaming video, and webquests, for instructional purposes. K-12 students also used presentation software, webquests, and weblogs for their own learning. In contrast to Franklin's (2004) finding that elementary teachers did not use technology for instructional purposes, 73% of elementary preservice teachers in this study used technology for instruction with their K-12 students.

Possible explanations for the greater integration of technology by the preservice teachers in this study compared to earlier research include the following: (a) I emphasized integration of technology as a tool for learning and encouraged preservice teachers to use technology with their students; (b) the required course integrated technology tools into instructional design and was taught prior to and concurrently with Student Teaching I; and (c) the technology skills of entering graduate students have increased over the 5-year study. The first two explanations are supported by the research literature (Thomas & Cooper, 2000; Vannatta, 2000; Willis & Tucker, 2001), and likely a combination of all three factors impacted the results of this study.

Some critics may suggest that the integration of technology as demonstrated in this study is technocentric. To better understand how the findings of this study fit within the larger purposes for social studies, I considered how the Civic Mission of Schools (CIRCLE, 2003) and the Framework for 21st Century Learning (Partnership for 21st Century Skills, 2007b) and the ISTE NETS-S (ISTE, 2007) related to my findings. The organizations that developed these policy statements advocate for digital citizenship, which involves students actively using technology in creative problem solving and decision-making.

Approximately 50% of the work samples and reflections documented K-12 students' use of technology for digital citizenship in specific areas emphasized by the Civic Mission of Schools and the Framework for 21st Century Learning, including creativity and innovation, communication and collaboration, and research and information fluency. There was little evidence that students used technology in other areas emphasized by these organizations, including critical thinking, problem solving, and decision-making. The richest examples of K-12 students demonstrating digital citizenship skills were seen in the work samples and reflections of elementary and secondary preservice teachers who taught social studies units.

To facilitate this consideration of how findings from this study meet the goals of civic education as elucidated by the Civic Mission of Schools, the Framework for 21st Century Learning, and ISTE NETS-S (2007), I organized the work of these organizations around five aspects of digital citizenship. With each of the following five aspects of digital citizenship, examples are included of ways participants in this study used technology to support the development of digital citizenship competencies in these areas:

1. *Responsible citizens are informed; they are able to access, research, manage, evaluate, and use information.* Elementary students conducted research at teacher-approved websites to access information on leaders of the American Revolution, slavery and the Civil War, and the Oregon Trail. A middle school teacher created an informative brochure and posted resources on her weblog so

that her students could learn about the conflict in Darfur. Students conducted research in groups and "discovered a plethora of information on different websites." High school students analyzed a weblog and posted their own entries. High school students in an alternative program for at-risk youth participated in a digital simulation on reconstruction and Jim Crow laws.

2. *Informed citizens understand complex public issues and diverse perspectives.* Elementary students researched current examples of citizen action and analyzed Native American views of sustainability through oral stories. Secondary students downloaded and analyzed rap music for a unique perspective on racism. They compared CNN and international news broadcasts for multiple perspectives on the Iraq War. Students accessed a website to analyze their personal ecological footprint and learn ways to reduce their consumption of resources. They examined online photos and documents, revealing perspectives on the women's rights and civil rights movements not available in their textbook. Students traced the origin and processing locations of the components of manufactured items to better understand the globalization of trade.
3. *Competent citizens think critically and creatively, evaluate and make informed decisions.* Secondary students created a CD of songs representing the American Dream. Students created a startup business with a budget and marketing plan and developed commercials. They researched how food shapes the societies of northwest Africa and southwest Asia and created recipes. Students created and filmed news broadcasts and campaign videos for school officers. After studying the Vietnam War during the Johnson administration students researched and presented four foreign policy options for Vietnam in a simulated debate.
4. *Effective citizens communicate with diverse audiences.* Elementary students emailed their sister class in China and wrote letters to school officials about solutions to the problem of waste management A secondary social studies class studied concepts of representative democracy and looked at effective tactics of protest movements. The teacher posted a link for students to email their Congressional representatives. When students began to receive personal responses from their representatives, they could see they had, in fact, played a role in the democratic process. Some secondary students posted to the class blog, to have a public audience. Students at an alternative school for homeless teens became investigative reporters, conducted interviews, and published a newspaper to dispel myths and stereotypes of homeless youth. High school students in a world history class chose a published article about a contemporary issue related to Southeast Asia. After researching the issue from multiple perspectives, the students wrote a position paper and sent it to the author of the original article they read.
5. *Committed citizens work collaboratively to solve problems.* Elementary students participated in a Story Line project about community and created a brochure to promote their community. Students in a senior economics class studied the state budget, examined various proposals to balance the budget, created their own preferred budget, and presented it to a panel of community leaders and state legislators.

Follow-up research with the preservice teachers in this study who are now teaching, including interviews and classroom observations, would help to determine whether and how these educators are continuing to integrate technology into their instruction and if their K-12 students are also using technology. This follow-up study could also examine the extent to which teachers and their K-12 students are meeting current expectations for digital citizenship skills, including the use of social networking sites, wikis, and weblogs for creative problem solving and decision-making.

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