Digital Natives As Preservice Teachers: What Technology Preparation Is Needed?

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Abstract

This study focused on "digital natives" as preservice teachers to examine their beliefs, attitudes, and technology experiences and expertise, identify the strengths and weaknesses in their technology knowledge and skills, and explore what technology preparation was needed to prepare them to integrate technology in their future classrooms. Results reveal that (a) the digital-native preservice teachers reported strong positive beliefs in technology, yet moderate confidence and reserved attitude in using technology; (b) the majority (80%) of them spent the most time on social-communication activities, and only about 10% of them spent the most time on learning-related activities; (c) they were very proficient with basic technologies but were not familiar with more advanced technologies; (d) the scope of their use of Web 2.0 technologies was limited to mainly social-networking Web sites, and they lacked the experiences and expertise in using Web 2.0 technologies with great potential for classroom application; and (e) they lacked experiences and expertise in using classroom technologies, especially assistive technologies. The results suggest that, growing up with technology, digital natives as preservice teachers are savvy with basic technologies and social-communication technologies. However, their technology proficiency is limited by both the narrow scope and the lack of depth of their technology activities. Systematic technology preparation is needed to help them learn more advanced technologies, classroom technologies, and assistive technologies, and more important, to help them make the connections between technology and teaching and to help them make the transition from digital-native students to digital-native teachers.

Introduction

Since Prensky (2001a) first used the term digital natives to describe the younger generation who has grown up with technology, that term, along with several other popular phrases such as the "Net generation" (Oblinger & Oblinger, 2005; Tapscott, 1998) and "Generation M(edia)/(ultitasker)" (Rideout, Foehr, & Roberts, 2005), has been widely used to differentiate the younger generation from their parents and teachers. Because they have grown up with digital technology—first computers, then the Internet and other ubiquitous information and communication devices such as game consoles, cell phones, PDAs, and iPods—digital natives are considered to be more comfortable with digital technology than previous generations. Educators have pointed out that digital natives use technology differently and learn differently from their parents and teachers (e.g., Beck & Wade, 2004; DeDe, 2005; Gee, 2003; McHale, 2005; Oblinger & Oblinger, 2005; Powell, 2007; Prensky, 2001b; 2006b).

Almost all studies and survey reports on digital natives focus on digital natives as students, especially K–12 students (e.g., Stearns, 2006; Wood, 2006; Zevenbergen & Logan, 2008). Rarely has research examined digital natives as teachers or preservice teachers. Teachers, as a large group of individuals at different technology proficiency levels and at different ages, have been defined as the other side of the divide—the digital immigrants who speak the technology language with attitudes and accents (e.g., Prensky, 2001a; 2001b; 2006a).

However, we must recognize that the first generation of digital natives, defined by Prensky as "K through college" students several years ago (Prensky, 2001a) or as young people born after 1980 (Bennett, Maton, & Kervin, 2008), includes not only K–12 students, but also young people who are in their late teens and 20s. They have entered the workforce (Rainie, 2006), and many have entered the field of education as teachers or preservice teachers (Dutt-Doner, Allen, & Corcoran, 2005). It is time to review the first generation of digital natives as they enter college and choose teacher education programs. As digital natives who are supposed to be enthusiastic users of technology and who are often "setting trends of technology use both in school and at home" (Rideout et al., 2005), are they equipped with the technology knowledge and skills for their future teaching tasks? Is technology integration preparation still necessary in teacher education programs?

This study examines the beliefs, attitudes, and technology experiences and expertise of a group of 2007 intake freshmen—digital natives, based on their age—enrolled in teacher education programs in a large northeastern university; identifies the strengths and weaknesses in their technology knowledge and skills; and explores whether or not technology preparation is still needed to prepare them to integrate technology in their future classrooms, and, if so, what preparation is needed.

Literature Review

Teacher technology preparation has consistently been emphasized in technology policies and reports in the last two decades as "the single most important step" toward integrating technology into education (Culp, Honey, & Mandinach, 2003; Groth, Dunlap, & Kidd, 2007; National Council for Accreditation of Teacher Education, 1997; The CEO Forum on Education and Technology, 1999; U.S. Department of Education, 1996; 2000). Specific projects and grants have been dedicated to improving teacher technology preparation. For example, the U.S. Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) program has spent $275 million and awarded 441 grants since 1999 (U.S. Department of Education, n.d.). Similarly, besides hardware, teacher technology professional development remains the most common top priority for educational technology spending in most states (Education Week, 2005).

Most technology preparation programs focus on two major aspects: technical skills and positive attitude (Zhao, Pugh, Sheldon, & Byers, 2002). The rationale for focusing on these two components is related to teachers being digital immigrants: First, teachers do not have the technology knowledge, skills, and experiences that are necessary for teaching with

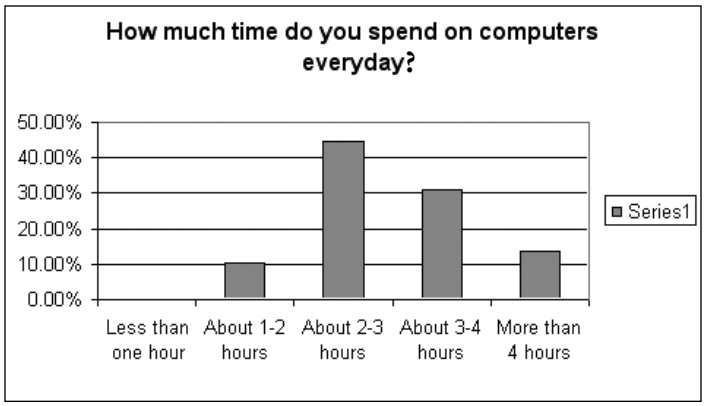

Figure 1: Time Spent on Computers Every Day

technology because they did not grow up with technology and were not taught with technology (National Council for Accreditation of Teacher Education, 1997; Office of Technology Assessment, 1995; Prensky, 2001a; Rosenthal, 1999). Second, teachers often hold negative attitudes and are skeptical about the use of technology for teaching (Bahr, Shaha, Fransworth, Lewis, & Benson, 2004). The image of teachers in relation to technology has not been very positive. In the early days, teachers were compared to Luddites in the industrial revolution who destroyed machines (Bryson & Castell, 1998; Conway & Zhao, 2003). Research in the first decade of technology integration into schools also emphasized teacher computer anxiety (e.g., Harris & Grandgenet, 1996; Marcoulides, 1989; McInerney, McInerney, & Sinclair 1994; Paivi, 1992). Later, teachers were more commonly described as gatekeepers because they decided what technologies may enter the classroom and whether and how they could be used (Cuban, 1986; Noble, 1996). In general, teachers are characterized as reluctant and unwilling to use new technologies (Eteokleous, 2008; MacMillan, Liu, & Timmons, 1997).

Prensky (2001a; 2001b) suggests that when the digital natives take over the teaching profession, using digital technologies to teach in classrooms will cease to be a problem. In fact, most of the existing literature, especially a number of national survey reports, has painted a very optimistic and promising image of the digital natives (e.g., NetDay, 2006; Prensky, 2006a; Rainie, 2006; Rideout et al., 2005; Tapscott, 1998). The digital natives are viewed as innovative users of available technology and eager adopters of new technology (Rideout et al., 2005); They are using more kinds of technology and increasingly more sophisticated technology, at an increasingly earlier age (Kaiser Family Foundation, 2003), and they are using technology more regularly (NetDay, 2006). It is estimated that the average time this generation spends on all types of media every week is equivalent to a full-time job (Rideout et al., 2005). The digital natives also use the Internet more frequently and at an increasingly younger age. The UCLA Internet Project Year Three report (UCLA Center for Communication Policy, 2003) shows that Internet usage is highest among those between 12 and 18 (97% online), followed by those aged 19–24 (87%). Today a typical 21-year-old has, on average, exchanged 250,000 emails, instant messages, and phone text messages; and has spent 5,000 hours playing digital games, 10,000 hours using a cell phone, and 3,500 hours online (Rainie, 2006b).

It is believed that their digital experiences have changed not only the ways today's young people communicate, socialize, and entertain, but also fundamentally altered how they approach learning (DeDe, 2005; Prensky, 2006b). They are technology savvy, confident in the positive value of technology, and reliant upon technology as an "essential and preferred component of every aspect of their lives" (U.S. Department of Education, 2004, p. 19). They are multitaskers, often working on two or more tasks using two or more technology devices simultaneously (Rideout et al, 2005; Shifrin, 2006, p. 450). To them there is no clear distinction between play and learning. They have been learning from playing and have been playing while learning. They are not passive consumers of information, but have taken on multiple roles in the digital world, becoming "producers, collaborators, researchers, and publishers" (Stead, 2006, p. 6). "Growing up digital" (Tapscott, 1998), they are natural participants in the digital world, and they are shaping and creating it.

In some schools, technology-savvy students provide technology support to their teachers, motivate their teachers to integrate technology into classrooms, and even become technology instructors to their teachers (e.g., Hruskocy, Cennamo, Ertmer, & Johnson, 2000; Tapscott, 1998; Waters, 2008). For example, the GenYES project focuses on teacher technology professional development facilitated by students. Students who participated in this project work with teachers to help teachers integrate technology into their lessons and to provide technology support to teachers (Generation YES, n.d.).

Given the fact that digital natives, as students, are already playing an active role in using technology in classrooms, it seems reasonable to expect them to be more ready to use technology for teaching as preservice teachers than previous generations of teachers—the digital immigrants.

However, some researchers point out that the digital natives may not be as technology savvy as expected. For example, Cameron (2005) reports that many first-year college students in an Australia university are surprisingly ill prepared to work with technology, even for programs with a vocational focus on using digital tools. Although they meet many of the expectations in many areas, they are "still not the complete Digital Natives we are waiting for" because of the low penetration of some digital devices, their resistance to online learning, and their unfamiliarity with some technology areas. Similarly, based on a survey of more than 4,373 freshmen and sophomores from 13 U.S. higher education institutions, Kvavik, Caruso, and Morgan (2004) find that students' technology use varies greatly. Among the digital natives they also find many reluctant or skeptical technology users. Although a majority (93.4%) of these students own personal computers, a significant proportion of them have lower technology skills than expected.

A few more recent studies suggest that there might not be such a distinct boundary between the digital natives and the digital immigrants in terms of technology use. For example, based on classroom observations and survey data from more than 2000 participants in Canada, Guo, Dobson, and Petrina (2008) report no significant digital divide between digital native and immigrant users. Another study that examined the expectations, use, and instructional impact of e-mail between faculty (digital immigrants) and students (digital natives) but did not find significant differences between these two groups (Weiss & Hanson-Baldauf, 2008).

Furthermore, being able to use technology does not necessarily mean being able to use technology critically, wisely, or meaningfully. The digital generation often falls short in demonstrating the fundamental understanding of digital media (Heverly, 2008). Students' superficially competent use of technology often conceals the narrow scope of the activities, the ineffectiveness of online searches, and the lack of exploration, and this use is often curtailed by the lack of interest in information and poor skills in searching and evaluating information (Livingstone, 2008, p.103–106). Researchers also find that children have difficulty judging the legitimacy of information (Eastin, Yang, & Nathanson, 2006). Based on a thorough review of existing literature, Bennett, Maton & Kervin (2008) argue that the digital native versus digital immigrant divide and the call for fundamental change in education to accommodate the new generation's changed learning style lacks empirical evidence and is an "academic moral panic." Guo and colleagues (2008) further point out that this divide might be misleading and distracting education researchers from more careful consideration of the diversity of ICT users and the nuances of their ICT competencies.

Existing literature has presented a mixed and often conflicting image of the digital natives. Researchers call for a closer scrutiny of the so-called digital natives to gain a much deeper understanding of their technology practices, proficiencies, and the interaction of technology and their learning (Lohnes & Kinzer, 2007).

This study focuses on preservice teachers to examine the assumptions about their beliefs, attitudes, and technology experiences and expertise as digital natives. More importantly, this study aims to identify the strengths and weaknesses in preservice teachers' technology knowledge and skills, and explore what technology preparation is needed to prepare them to integrate technology in their future classrooms.

Methods

Participants were the 2007 intake freshmen in teacher education programs at a large northeastern university. The author collected data through a technology survey administered in October 2007. At the time of this survey, the participants had little classroom teaching experience.

The survey included the following sections:

General technology use information, such as ownership of technology devices, time spent on computers, and other technology activities. Questions in this section were multiple-choice questions.

Attitudes and beliefs toward technology. This section included a series of statements about technology. Participants were asked to rate their degree of agreement on a scale of 1–5 with 1 being "strongly disagree" and 5 being "strongly agree."

Proficiency in 51 specific common technologies and interest in learning these technologies. Students rated their proficiency on these technologies on a scale of 1–5 with 1 being "beginner" and 5 being "expert." Detailed description was given for each category. For example, being a "beginner" means having little to no skills, and being an "expert" means being able to teach others how to use and create/customize the application, or to teach others how to perform the task.

Experiences and opinions on using technology in education. This section included two open-ended questions. Participants were asked to state their understanding of, experiences with, and opinions about technology integration in K–12 classrooms.

The survey was piloted with three preservice teachers enrolled in the same school of education. The main goal of this pilot survey was to test the appropriateness of the survey items, identify any misunderstanding in the language, and seek comments on the scope of preservice teachers' technology activities. Based on feedback and comments from the pilot survey, a few minor revisions were made to the survey. The finalized survey was administered to 70 students, and valid responses were collected from 55 participants. Among the 55 participants, 9 were male and 46 were female.

The difficulty level of these 51 technologies in section 3 was rated by four people: two educational technology faculty members and two technology support staff members in the teacher education program. The difficulty level was rated on a scale of 1-3 with 1 meaning "basic," 2 being "intermediate," and 3 being "advanced." Each person rated the technologies independently. An average rating was obtained for each technology by taking the mean of the ratings. Based on the ratings, these 51 technologies were grouped in four categories:

Basic technologies (difficulty level 1–1.25). This category included 11 most commonly used technologies such as using e-mail, word processing, and surfing the Web.

Lower intermediate technologies (difficulty level 1.5–1.75). This category included 15 technologies such as desktop publishing and using presentation software.

Upper intermediate technologies (difficulty level 2–2.25). This category included 17 technologies such as using a Web-based course management system and using handheld computing devices.

Table 1: Beliefs, Confidence, and Interest in Technology

	Strongly Agree/ Agree	Neutral	Disagree/ Strongly Disagree
Computers are generally reliable.	92.9%	7.1%	0
Technologies can help me teach better.	82.8%	17.2%	0
Technologies can help my students learn better.	79.3%	20.7%	0
I do well with computer technologies.	48.2%	31.3%	22.5%
I can solve most of the problems when my computer doesn't work.	13.8%	51.7%	34.5%
I am interested in computers and related technologies.	55.6%	44.4%	
I am interested in learning new technologies.	58.6%	31.0%	10.4%
I am interested in learning technologies that will help me teach in the future.	100%		

Advanced technologies (difficulty level 2.5–3). This category included eight technologies such as editing audio files, video-conferencing, and designing Web pages.

The author analyzed the data using frequency analysis, descriptive analysis, and correlation analysis. Qualitative data obtained from the open-ended question were analyzed and categorized according to the research questions.

Results

This section describes this group of digital native preservice teachers' attitudes and beliefs about technology and their regular technology use, examines their technology proficiency, and discusses the strengths and weaknesses of their technology competencies.

Technology Access

Almost all (96.4%) of the preservice teachers surveyed reported that they started using computers before sixth grade, and nearly half of them (49%) started using computers in kindergarten or before the end of third grade. All participants reported that they owned at least one personal computer and one cell phone. Almost all participants (94.5%) owned one iPod or other mp3 player, and more than half (54.4%) owned four or more of the five technology devices surveyed (personal computer, cell phone, iPod or mp3 player, game console, and PDA). In terms of the access to technology, this group of preservice teachers fit in the image of digital natives.

Time Spent on Computers

Preservice teachers who participated in this study were asked how much time they spent on computers every day. As shown in Figure 1, all participants worked with computers on a daily basis. Approximately 10% of them spent less than 2 hours a day on computers, and about 14% of them spent more than 4 hours a day on computers. Overall, most participants spent 2–4 hours on computers every day. As expected from the digital natives, they spent a considerable amount of time using technology every day.

Strong Positive Beliefs, Moderate Confidence, Moderate Interest

Participants were asked to rate their degree of agreement on a series of statements about beliefs, confidence, and interest in technology. Table 1 shows the percentage of participants who reported that they "strongly agree/agree," were "neutral", and "strongly disagree/disagree" with each

Table 2: Internet Activities that Participants Spent the Most Time on Every Day

Internet Activity	% of participants
Social networking (e.g., Facebook, Myspace, etc.)	41.4%
Online chatting	27.6%
Searching information for my study (e.g., preview, review, homework)	10.3%
Sending and receiving emails	10.3%
Searching information for other practical purposes (e.g., weather, health, etc.)	3.45%
Reading news to know what's going on in this country	3.45%
Surfing online for fun (reading novels, stories, entertainment)	3.45%

Note: Activities with zero percentage were omitted to save space.

Table 3: Correlations Between Technology Proficiency, Interest in Learning, and Technology Difficulty Level

		Interest	Difficulty
Proficiency	Pearson Correlation	-.716*	-.650*
	Sig. (2-tailed)	.000	.000
	N	51	51
Interest	Pearson Correlation		.378**
	Sig. (2-tailed)		.006
	N		51

**** Correlation is significant at the 0.01 level (2-tailed).***

statement. Five scales were combined into three scales to make presenting the results possible.

Strong beliefs. As shown in Table 1, in general, participants reported strong positive beliefs about technology. They trusted the reliability of computers (92.9%). They believed that technologies can help them teach better (82.8%) and help their students learn better (79.3%). None of the participants reported negative beliefs about technology.

The strong beliefs were also reflected in their responses to the open-ended questions. As expected from digital natives, they considered technology as "an essential part of our daily lives" and "a necessity in society," and therefore agree that "it seems crazy to live without technology." They believed that technology "is a way to help all types of learners learn."

One participant stated:

> It is amazing how much our computers and other technology can do for us, it has become hard to imagine life without a computer and Internet, or cell phone. With technology being such a huge part of our lives, it is imperative to use it in the classroom.

Moderate confidence. However, their confidence in using technology was not as strong as what would be expected from the digital natives. As shown in Table 1, about half (48.2%) of participants felt that they did well with computer technologies. One third of them reported they were "neutral" about this statement, and 22.5% of them did not think that they did well with computer technologies. Their confidence was even lower with their ability to solve computer problems. Only 13.8% felt confident that they could solve most of the problems with their computers.

Overall there was much variation in terms of confidence in using computers. As some researchers suggested, there was often greater variation within the same generation than between generations (DeDe, 2005). We cannot assume that this generation of preservice teachers is a homogeneous group with the same technology experiences. Growing up in a digital age does not necessarily mean that every child had equal access to the digital technologies. One preservice teacher reported that technology "is something I never experienced as a young child growing up, and nowadays in our fast-paced and ever-changing world of technology I often feel lost and confused because I really struggle with computers and other devices."

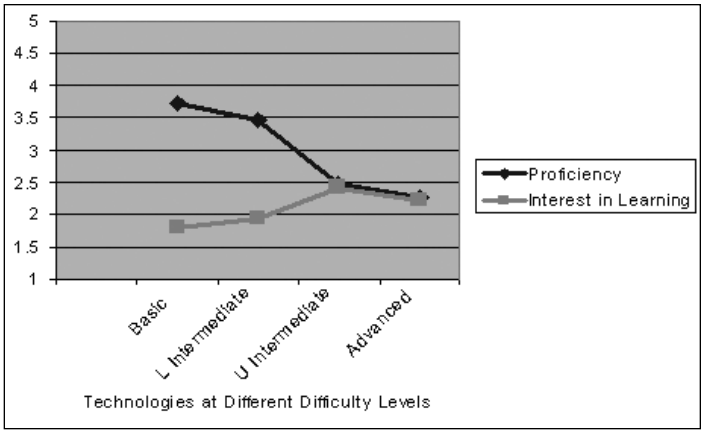

Figure 2: Student Technology Proficiency and Interest in Learning

Moderate interest. Participants also reported only moderate interest in technology. Although more than half (54.5%) of them agreed or strongly agreed with the statement "I am interested in computers and related technologies," nearly half (45.5%) of them were neutral to this statement. To them, technology was more a fact of life than something to like or dislike.

A similar pattern was found in participants' attitudes toward learning new technologies. More than half (58.6%) of participants were interested or strongly interested in learning new technologies, nearly one third (31%) were neutral to this statement, and 10.4% reported they were not interested in learning new technologies.

However, when it came to learning technologies that would help them teach in the future, all (100%) participants reported interest or strong interest.

Reserved Attitude

Although the digital-native preservice teachers reported strong positive beliefs about the potential of technology to help them teach and to help their students learn, they had some reservations about using technology in classrooms. First, the digital-native preservice teachers believed that new technology was an indispensable part of their lives, but they also valued the importance of traditional technologies and traditional ways of learning and believed that technology should not replace everything. For example, several participants commented on the importance of the library and stated that they believed that "people need to be familiar with searching the Web, but also searching the library," and that "people still need to have basic skills and be able to communicate face to face without relying on a computer."

Second, the digital native preservice teachers were concerned with computer dependency and believed that technology should be used in moderation. One participant worried that students "could possibly rely too heavily on technology, that everyday tasks may seem unimaginable without the technology that they have become adapted to." Another participant believed that "technology should be used as a helpful tool but not something that people depend on."

Table 4: Proficiency in Web 2.0 Technologies

	Proficiency		
Web 2.0 Technologies	Mean (1-5)	% of Participants who are experts	% of Participants with little to no experience
Maintaining social-networking site	4.31	58.2%	3.6%
Blogging	2.41	3.6%	32.7%
Developing wiki	2.25	7.3%	40.0%
Publishing pictures	2.51	7.3%	27.3%
Publishing audio files	2.24	1.8%	36.4%
Publishing video files	2.50	5.5%	29.1%
Video conferencing	2.67	14.5%	29.1%
Developing Web pages	2.05	1.8%	41.8%

Third, the digital-native preservice teachers were aware of the complicated issues around integrating technology into classrooms. Participants commented that integrating technology into classrooms had "both its plusses and minuses" and was "a double-edged sword" because technology could help students learn better but also could be "extremely distracting to students and can become a cause for children not to want to learn." They recognized that technology itself could be a problem; one participant commented, "Technology can also fail at crucial times, and a back-up plan is necessary."

In addition, the digital-native preservice teachers believed that students' age should be considered when using technology in classrooms. To them, integrating technology in classrooms was essential but should occur "carefully, and only in certain situations" and should be limited in lower grades because, as one participant commented, "There are other basic skills that are acquired in elementary school that should be more focused on, rather than technology." Similarly, another participant wrote, "For younger students, I think technology use should be more limited because they are learning to express themselves in a variety of ways, so if the emphasis is on technology, they may never get the chance to fully develop their creativity or explore everything to figure out what exactly it is that they enjoy."

Internet Activities: Most Time Spent on Social-Communication Activities

Participants were asked what Internet activities they spent the most time on every day. As shown in Table 2, social-communication activities were the most popular online activities. Nearly 80% of the participants spent the most time online every day on social-communication activities; 41.4% of participants spent the most time online on social-networking Web sites such as Facebook and MySpace, 27.6% spent the most time online chatting with friends, and 10.3% spent the most time on e-mails. Another 10.3% spent the most time searching for information for their studies.

Self-Reported Technology Literacy: Strong in Simple Technologies, Weak in Advanced Technologies

Figure 2 illustrates two lines and their relationship. The line on the top is the digital native preservice teachers' self-reported proficiency with 51 different technologies, divided into four categories based on the difficulty level (as explained in the Methods section). As shown in Figure 2, participants reported the highest proficiency in the easiest technologies such as using e-mail, word processing, and surfing the Internet. As the difficulty level of the technology increased, the proficiency decreased. This result suggested that participants were savvy with basic technologies but were not proficient with more advanced technologies.

Table 5: Proficiency in Classroom Technologies

	Proficiency		
Classroom Technologies	Mean (1–5)	Experts (%)	Beginners (%)
Using hand-held and other scientific digital probes	2.37	1.8%	18.2%
Using interactive whiteboard	2.19	9.1%	45.5%
Using idea processors	2.04	3.6%	49.1%
Using software specific to content in areas you plan to teach	2.39	1.8%	29.1%
Using augmentative systems to help persons with disabilities communicate	1.77	3.6%	50.9%
Using assistive technology to help persons with disabilities learn	1.75	3.6%	52.7%

The second line illustrated participants' interest in learning technologies at different difficulty levels. A general trend was that they were more interested in learning more advanced technologies. However, it was also evident that the overall interest was low (under 2.5 out of 5).

A correlation analysis was conducted to identify the relationship between participants' technology proficiency, their interest in learning different technologies, and technology difficulty level. As shown in Table 3, participants' proficiency in a specific technology was significantly negatively correlated to the difficulty level of this technology, and participants' interest in learning a technology was significantly positively correlated to the difficulty level of this technology.

These results suggested that although this group of the digital native preservice teachers was very proficient with easy-to-use basic technologies, they lacked the experiences and expertise to work with more advanced technologies.

Limited Scope of the Use of Web 2.0 Technologies

With the widespread use of social-networking Web sites, data-sharing Web sites, blogs, podcasting and wikis, Web 2.0 technologies have become popular among young people and are making the Internet "more important than ever, with exciting new applications and sites popping up with surprising regularity" (O'Reily, 2005). It is believed that young people today are using these emerging technologies to build communities, create media, and share their works (Stead, 2006).

All the digital native preservice teachers who participated in this study maintained one or more social-networking profiles, and many of them spent the most time on social-networking Web sites. However, as shown in Table 4, their use of the Web 2.0 technologies seemed to be limited to social-networking Web sites only. Many of them lacked the experiences or expertise in using some of the Web 2.0 technologies with great potential for classroom application, such as wikis, blogs, and podcasts. About one third (32.7%) of the participants had little to no experience with blogging, 40% had little to no experiences with wikis, and the percentage of participants with little to no experience with publishing audio files and videos was 36.4% and 29.1%, respectively.

Limited Proficiency in Teaching-Related Technologies

In addition, the digital native preservice teachers lacked experiences and expertise in using classroom technologies such as interactive whiteboards, idea processors, content-related technology, and assistive technologies. As shown in Table 5, among these technologies, participants showed the least experiences with assistive technologies and the highest interest in learning these technologies (3.5 out of 5, compared to an average interest level at 2.12 out of 5).

Born around 1989, this generation of digital-native preservice teachers witnessed a dramatic increase in the access to computers and the Internet in schools throughout their K–12 years. In 1994, when participants of this study were in kindergarten, only 3% of public school classrooms had access to the Internet. By 2005, when they were in high school, every 3.8 students had access to one instructional computer and nearly 100% of instructional rooms had access to the Internet (National Center for Education Statistics [NCES], 2006, p. 4). However, as researchers have repeatedly pointed out, increased access to technology does not mean increased use of technology in classrooms (e.g., Brzycki & Dudt, 2005; Cuban, 1999; Lei, Conway, & Zhao, 2008; Zhao & Frank, 2003). Although this generation of digital-native preservice teachers has been using technology on their own and outside of school (Education Week, 2007; Levin & Arafeh, 2002) during their K–12 schooling, their teachers have not been using much technology to teach (Education Week, 2005; 2007). It is therefore not surprising that they do not have much experience with subject-specific technologies and learning-centered technologies. As a participant noted, she did not know "all the possibilities that exist to incorporate technology in the classroom."

Conclusions and Implications

This study examined the technology-related aspects of the digital natives as preservice teachers. Specifically, we surveyed the digital natives about their beliefs, attitudes, confidence, and interest in technology and evaluated their strengths and weakness in technology by examining their proficiency along 51 commonly used technologies at four difficulty levels. This section recaps the findings and discusses the implications for practice and research.

Strong Positive Beliefs yet Reserved Attitudes Toward Integrating Technology in Classrooms

The digital-native preservice teachers in this study reported strong and positive beliefs about technology. They viewed technology as an indispensable component of their daily lives, and they strongly believed in the potential of technology to help teaching and learning. Yet their attitudes toward integrating technology in classrooms, especially in their future classrooms, were somewhat reserved. Their reserved attitudes, on the one hand, showed that they had a mature understanding of the complexity of technology integration in schools, but on the other hand, revealed that they might not be active users of technology in their own teaching.

Proficient Use of Technology Within a Limited Scope

The participants were very proficient with the use of technology for social-communication activities. The majority of them spent the most time on social-networking Web sites and other social-communication activities. The scope of their use of Web 2.0 technologies was also limited to mainly social-networking Web sites. They lacked the experiences and expertise in using Web 2.0 technologies with great potential for classroom application, such as blogging and wikis.

Proficient with Basic Technologies yet Lacking Experience with Advanced Technologies

As digital natives, the participants spent a considerable amount of time on computers every day. They were very proficient with basic technologies, especially those for social-communication purposes. They reported lower proficiency with more difficult technologies and the lowest proficiency with the most advanced technologies.

Lacking Experience and Expertise in Classroom Technologies

Most participants did not have experiences with subject-specific technologies, and they knew even less about technologies that could help students with special needs. Although they had access to technology in their K–12 schooling, they were not commonly taught with technology. They did not have much opportunity to learn from their teachers how technology could be used to facilitate subject learning. They recognized the importance of subject-related technologies and showed strong interest in learning technologies that could help them teach subject matter.

In summary, these findings suggest that, although digital natives as preservice teachers use technology extensively, their use of technology has been mainly focused on and related to their social-communication activities and their learning activities as students. As preservice teachers, they lack the knowledge, skills, and experiences to integrate technology into classrooms to help them teach and to help their students learn, even though they fully recognize the importance of doing so.

Considering the fact that the preservice teachers who participated in this study were in the first year of their teacher education programs, with little classroom teaching experience, it was not surprising to find that they did not have the knowledge and skills to integrate technology into teaching. However, findings from this study warn of potential pitfalls of assuming that digital natives as preservice teachers will naturally integrate technology into classroom teaching. Although this generation of preservice teachers has grown up in a digital age and they have been using more technology for their learning as students than previous generations, they have not been exposed to different ideas about teaching with technology due to the slow adoption of technology in classrooms in the last two decades. They might be considered digital-native students, but they are not yet digital-native preservice teachers.

It is the responsibility of teacher education programs to help them make the transition from digital-native students to digital-native teachers who can use technology in meaningful ways in classrooms. Findings from this study suggest that technology preparation programs in teacher education should pay more attention to the following aspects:

Expose preservice teachers to a variety of technologies that can be used to support different teaching and learning activities. As students, their experiences with technology have been mainly focused on a small scope of activities such as social networking and Internet surfing. Teacher technology preparation programs need to help them gain knowledge and experiences with a wider range of technologies and more advanced technologies that can support their future role as teachers, and help them understand that technology can be used as a media not only for expression and communication, but also for inquiry and construction (Bruce & Levin, 1997). Enriched experiences with a variety of technologies can also help them build stronger confidence in using technology.

Emphasize subject-specific technology. As digital natives, most preservice teachers have sufficient expertise with generic technologies but are not familiar with subject-specific technologies. Teacher technology preparation programs need to emphasize the use of subject-specific technologies to help preservice teachers integrate technologies that can help them teach subject content.

Include assistive technology as an important component of teacher technology preparation programs. Most preservice teachers have no experiences with assistive technology. Since the passage of IDEA of 1999 and the No Child Left Behind Act, more students with special needs have been spending their schools days in regular classrooms. "The overall trend indicates a progressive increase of least restrictive environment placements for students with disabilities" (U.S. Department of Education, 2002). Teachers in regular classrooms need to be prepared to use and recommend assistive technologies to help students with special needs learn (Nelson, 2006).

Help preservice teachers understand the enabling conditions for technology use. Preservice teachers understand the complexity of technology use in schools and know that there are barriers to technology integration. This understanding may deter them from trying to use technology in their classrooms. To prepare them to face the challenges and remove the

barriers to technology use, it is important to help them understand the enabling conditions of technology integration, and know how to locate resources and where to find help when needed.

Help preservice teachers make meaningful connections between technology and teaching. Technology skills alone cannot guarantee the effective use of technology in the classroom (Ertmer et al., 2003). Meaningful technology integration is more of a pedagogical endeavor than a technological one (Dutt-Doner et al., 2005). Preservice teachers, digital natives or not, need to develop a systematic understanding of the technology, subject matter, pedagogy, and how theses aspects work together (Mishra & Kolher, 2006; Zhao, 2003). As pointed out by Mishra and Kolher (2006), for meaningful technology integration to happen, a teacher needs to develop a sound understanding of pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and all three taken together as technological pedagogical content knowledge (TPCK). To help preservice teachers integrate technology into teaching in meaningful ways, technology cannot be taught as a separate and independent domain. Instead, teacher education programs need to help preservice teachers understand how technology intersects with content and with pedagogy and make connections between technology, content, and pedagogy.

In addition, it is critical to note the variation within the digital-native generation. With the current media coverage on the technology use of young people, it is easy to paint a monolithic portrait of the young generation as technology savvy and technology enthusiastic. However, having been born in the digital age does not necessarily mean that they are natural digital natives. Within the generation, there are people who indeed grow up with technologies, are proficient in using technologies, and feel confident with technologies, but there are also people who did not start using technology at an early age, do not know much about technology, and are less confident in using technology. We cannot take a simplistic view of this generation and ignore the within-group variation and individuality. The large variation with the digital-native generation also calls for actions to narrow the persistent "digital divide" that has created inequity in the access to opportunities for all young people to benefit from modern technologies.

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Appendix

Technology Use Survey

(Note: This survey was administered online using Questionpro.com online survey tools.)

Section 1: Please check your responses to the following questions, or fill in the blanks where appropriate.

1. Your gender:
   - Female
   - Male
2. When did you start using a computer?
   - Before kindergarten
   - In kindergarten-grade 3
   - In grade 4-5
   - In grade 6-8
   - In grade 9–12
   - After grade 12

3. How much time do you spend on computers everyday?
   - Not at all
   - Less than one hour
   - About 1-2 hours
   - About 2-3 hours
   - About 3-4 hours
   - More than 4 hours

4. Do you own the following devices?

	Yes	No
Personal Computer		
Cell Phone		
Game Console		
iPod (or other mp3 players)		
PDA (Personal Digital Assistant)		

6. What do you use computers for (choose all that apply)?
   - For learning-related activities
   - For entertainment (playing games, watching videos, etc.)
   - For social/communication activities (chat, e-mail, IM, etc.)
   - For practical purposes (find info. you need)
   - For self-expression (blogging, commenting, etc.)
   - For constructive activities (creating Web pages, uploading video/audio/music, files, etc.)
   - Shopping
   - Other (please specify) _____

7. What do you use the Internet for (choose all that apply)?
   - Searching information for my study (e.g., preview, review, homework)

- Searching information for other practical purposes (e.g., weather, health, etc.)
- Reading news to know what's going on in this country
- Reading news to know what's going on in the world
- Sending and receiving e-mails
- Playing games
- Online chatting (chat rooms, Instant Messenger, ICQ, etc.)
- Surfing online for fun (reading novels, stories, entertainment)
- Downloading music, pictures, movies, etc.
- Blogging
- Publishing my digital media files online (e.g., on Youtube, podcasting, etc.)
- Social networking (e.g., Facebook, Myspace, etc.)
- Viewing and posting messages (e.g., on forums, discussion boards, etc.)
- Getting information about other places, countries, cultures, and peoples in the world
- Shopping (e.g., Amazon, Ebay, other online stores, etc.)
- Other (please specify)
-

8. Overall, on which task do you spend most time while using the Internet every day (only choose one)?

- Searching information for my study (e.g., preview, review, homework)
- Searching information for other practical purposes (e.g., weather, health, etc.)
- Reading news to know what's going on in this country
- Reading news to know what's going on in the world
- Sending and receiving e-mails
- Playing games
- Online chatting (chat rooms, Instant Messenger, OICQ, etc.)
- Surfing online for fun (reading novels, stories, entertainment)
- Downloading music, pictures, movies, etc.
- Blogging
- View or publishing digital media files online (e.g., on Youtube, Podcasting, etc.)
- Social networking (e.g., Facebook, Myspace, etc.)
- Viewing and posting messages (e.g., on forums, discussion boards, etc.)
- Getting information about other places, countries, cultures, and peoples in the world
- Shopping (e.g., Amazon, Ebay, other online stores, etc.)
- Other (please specify) _____

9. To you, what's the most exciting thing about the Internet?

- Getting information I need for my study
- Getting information I need for other practical purposes
- Reading news
- Playing games
- Making new friends
- Communicating with my friends
- Chatting with strangers
- Knowing things about the world
- Shopping
- Downloading files I needs
- Express my ideas freely
- Other (please specify) _____

Section 2: Please indicate, on a scale of 1 to 5, your responses to each of these statements. (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree)

- Computers are generally reliable.
- The more technology you use, the more respect you will get from your peers.
- I feel comfortable using technology.
- I do well with computer technologies.
- Computers and related technologies will isolate students from one another.
- I am interested in computers and related technologies.
- I am interested in learning new technologies.
- I am interested in learning technologies that will help my teaching in the future.
- I believe that technologies can help me teach better.
- I believe that technologies can help my students learn better.
- I can solve most of the problems when my computer doesn't work.
- I am confident in using technology in my learning.
- I am confident in using technology to teach.

Section 3: How would you rate your proficiency of the following skills? Please check your response on a scale of 1 to 5. Thanks.

1 = No experience

2 = Beginner (little skill)

3 = Moderate (can use some already-prepared applications, or can perform the task with help)

4 = Substantial (can use and create/customize many applications on my own, or can perform the task on my own)

5 = Expert (could teach others how to use and create/customize many applications, or can teach others how to perform the task)

- Navigating the Web
- Finding information from Web searches
- Evaluating information from Web searches
- Searching electronic library databases for books, articles, and other resources
- Using e-mail
- Using Web-based course management software (e.g., SyrCLE, BlackBoard)
- Using instant messenger software
- Developing a wiki
- Blogging
- Maintaining a personal social-networking site (e.g., Facebook, Myspace, etc.)

- Downloading pictures/movie/music
- Setting up a video conference
- Word processing
- Using electronic spreadsheets (e.g., MS Excel)
- Using electronic databases (e.g., MS Access)
- Desktop publishing (e.g., writing newsletters)
- Using presentation software (e.g., PowerPoint)
- Scanning documents
- Editing documents
- Using digital cameras
- Using audio devices to record sounds
- Using digital video cameras
- Editing pictures
- Editing audio files
- Editing video files
- Publishing pictures (e.g., on Flickr.com)
- Publishing audio files
- Publishing video files (e.g., on Youtube.com)
- Using music edit applications
- Developing Web pages
- Using graphic design applications
- Creating animation
- Programming
- Playing computer games
- Using hand-held and other mathematical calculators
- Using hand-held and other scientific digital probes
- Using personal digital assistants (PDAs)
- Using a SMART board
- Using idea processors (e.g., Inspiration, concept mapping)
- Using drill and practice programs/tutorials
- Using other software specific to content in areas you plan to teach
- Using augmentative systems to help persons with disabilities communicate
- Using assistive technology to help persons with disabilities learn
- Setting up computers (e.g., connecting power cable, data cable, etc.)
- Installing software
- Managing, storing, and backing up files on servers, CDs, zip disks, etc.
- Using Macintosh operating systems
- Using PC-based operating systems
- Troubleshooting hardware problems
- Troubleshooting software problems
- Exploring new technology

Section 4: Please respond to the following two questions about your experiences and opinions on technology use in classrooms.

1. Based on your own experience, what are the good things about integrating technology into classrooms? What are the problems?
2. How technology should be used in PK–12 classrooms?

President's Message continued from p. 79

On another important subject, the 21st Century Assessment Project launched with SIGTE support a couple of years ago. The past two SIGTE Forums were devoted to discussing the need for better assessment in PK–12 education. A preview of this year's NECC program suggests that ISTE is increasing its discussion about this, and there may be a larger effort underway. In the 21st Century Schools strand, several sessions look at viable ways to authentically assess higher order learning outcomes, including a session by Kyle Peck, who has led the 21st Century Assessment Project.

For a final "where y'at," SIGTE is increasingly turning its focus to advocacy efforts with the guidance of Hilary Goldmann, ISTE's director of government affairs. Christine Greenhow has generously volunteered to serve as the advocacy chair for SIGTE. Chris has been active in SIGTE, writes a research column for ISTE's *Learning and Leading with Technology*, and has experience working as a congressional staffer prior to earning her doctorate and moving into higher education. As discussed in the last issue of *JCTE*, we are focusing our efforts this year on advocating for funding for the Preparing Teachers for Digital Age Learning (PTDAL) legislation that was passed last year. Look for more about these efforts on the SIGTE membership listserv and in the SIGTE wiki in the months leading up to this year's NECC in Washington, D.C.

Resources

Borthwick, A. & Pierson, M. (2008). *Transforming Teacher Practice: Professional Development Strategies in Educational Technology*. Eugene, Oregon: ISTE.

Google Earth for Educators: http://www.google.com/educators/p_earth.html

Google Lit Trips: http://www.googlelittrips.org

McGuire, M. E. (2007). What happened to social studies? The disappearing curriculum. *Phi Delta Kappan, 88*(8), 620–624.

SIGTE wiki: News and events for and by SIGTE members: http://sigte.iste.wikispaces.net