Pre-Service Teachers and Technology Integration: International Cases and Generational Attitudes toward Technology in Education

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Abstract
The current generation of young teachers entering the profession is often presumed to have an easy comfort with and seemingly innate understanding of technology. Prensky (2001) has gone so far as to name them “digital natives” and has claimed that members of the millennial generation “think and process information fundamentally differently from their predecessors” (p. 1). However, recent studies in several English-speaking western nations call the millennial generation’s innately skillful use of technology into question, and some studies of millennial teachers indicate that they are, in fact, no better at integrating technology into their teaching than their colleagues from other generations. Rogers’ (2003) diffusion of innovations theory provides an alternative to the digital native/digital immigrant approach for explaining teachers’ technology integration habits. Based on this approach, suggestions for teacher educators are recommended for training millennial teachers to integrate technology and pedagogy.

Keywords
digital immigrants, digital natives, educational technology, information and communication technology, millennials, novice teacher, pedagogy, pre-service teacher, TPACK, technology integration

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Handbook of Research on Global Issues in Next-Generation Teacher Education

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Chapter 5

Pre-Service Teachers and Technology Integration: International Cases and Generational Attitudes toward Technology in Education

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ABSTRACT

The current generation of young teachers entering the profession is often presumed to have an easy comfort with and seemingly innate understanding of technology. Prensky (2001) has gone so far as to name them “digital natives” and has claimed that members of the millennial generation “think and process information fundamentally differently from their predecessors” (p. 1). However, recent studies in several English-speaking western nations call the millennial generation’s innately skillful use of technology into question, and some studies of millennial teachers indicate that they are, in fact, no better at integrating technology into their teaching than their colleagues from other generations. Rogers’ (2003) diffusion of innovations theory provides an alternative to the digital native/digital immigrant approach for explaining teachers’ technology integration habits. Based on this approach, suggestions for teacher educators are recommended for training millennial teachers to integrate technology and pedagogy.

INTRODUCTION

In schools today, there are as many as four distinct generations at work, which each have their own unique characteristics to describe them (Oh & Reeves, 2014; Pegler, Kollewyn, & Crichton, 2010). The youngest generation of teachers—those just entering the profession—are often assumed to be technologically savvy, interested in collaboration, and possessing learning style preferences different from earlier generations (Oh & Reeves, 2014; Southall, 2013). Prensky (2001) named this generation “digital natives” because of their preferences and proclivities for using technology. However, other voices have noted concern with this assumption that today’s novice teachers are somehow “native” in their use of technology (Bennett & Maton, 2010; Kennedy et al, 2009;...
Pre-Service Teachers and Technology Integration  

Margaryan, Littlejohn, & Vojt, 2011). Bauerlein (2009) went so far as to name this generation “the Dumbest Generation,” which raises concern about their ability to teach at all!

At the forefront of this collision of perspectives is the question of the abilities of this young generation of teachers to integrate technology into their teaching practices. If they are truly “digital natives,” they should be able to integrate technology with ease and facility. Does the literature bear this out? If so, to what degree? And if not, what are the implications for teacher preparation programs charged with training this generation of teachers?

BACKGROUND

What is Technology Integration?

Over the past decades, technology and education have become intrinsically entwined. Pierson (2000) suggested that integrating technology in one’s teaching practice is “becoming an inseparable part of good teaching” (p. 1598). Teo (2011) indicated that technology integration has become basic job requirement for teachers in contemporary society. However, simply having technology present in the classroom is not enough. Spector (2012) noted, “technology integration is perhaps the most challenging and complex aspect of designing educational environments and systems of instruction” (p. 151).

Although there are now a wide variety of technological tools available for teachers to integrate into their teaching practices (Brown & Green, 2013; Gray, Thomas, & Lewis, 2010), it is important to determine exactly what is meant by “technology integration.” Certainly, different teachers will place different levels of emphasis on the tools, and may even have their own definitions for “technology integration” (James, 2009). Pierson (2000) proposes that the term “integration” may often be used too lightly, suggesting that some schools and districts seem to consider having a computer in every classroom “integration,” regardless of how (or even if) they are being used. However, true integration must involve more than simply having technology tools present. Roblyer (2003) defines “integrating educational technology” as “determining which electronic tools and which methods for implementing them are appropriate for given classroom situations and problems” (p. 8). Similarly, Mishra and Koehler (2006) describe technology integration as a combination of technology and pedagogy within a particular content area. In other words, technology in the classroom should not be an institution unto itself; it should be a natural and low-profile part of the teaching and learning environment. It is along these lines that Spector (2012) describes technology integration as the use of technology being regarded “an unobtrusive facilitator of learning, instruction, or performance” (p. 150). Thus, true integration of technology and teaching must be viewed as the skillful understanding of how and when technology can support teaching and learning, and how to select the right technological tools to incorporate given a teacher’s instructional goals.

The question might then be raised: are all teachers equally able to integrate technology and pedagogy in this way? Or is it more likely that some teachers are better able to integrate technology into their teaching because of their personal proclivities for using technology? A further question may stem from these: are younger teachers better able to integrate technology, because of their preference for using technology in other areas of life?

Understanding Generational Attitudes and Behaviors

In order to answer these questions, it is necessary to first understand some generational attitudes and behaviors. A significant body of research has developed in recent years examining the differences between generations and how they approach working with technology (Harris, Grandgenett, & Hofer, 2012; Murray, 2011; Oblinger & Oblinger,
Pre-Service Teachers and Technology Integration

2005; Oh & Reeves, 2014; Pegler, et al., 2010; Prensky, 2001; Tapscott, 2009; Wang, Hsu, Campbell, Coster, & Longhurst, 2014). It can be challenging to name the different generations, and different authors have their own unique terminology. However, it is generally agreed “four primary generational cohorts may be observed across Western society since the early/mid 1900s, each sharing similar motivators, work styles, and attitudes, although the labels of these generations vary even within particular societies” (Murray, 2011, p. 55).

In their synthesis of much research on generational attitudes toward technology, Oh and Reeves (2014) include Lancaster and Stillman’s (2010) descriptions of these four generations:

- **Traditionalists**, including those born in 1900-1945,
- **Baby boomers**, including those born in 1946-1964,
- **Generation X**, including those born in 1965-1980, and

These are the names for the various generations that will be used throughout this chapter.

Several authors have noted that the members of the millennial generation have an easy facility in using technology in their day-to-day lives—or at least they are perceived that way (Bang & Luft, 2013; Dawson, 2008; Oblinger & Oblinger, 2005; Prensky, 2001; Tapscott, 2009). In fact, Oblinger and Oblinger (2005) choose to refer to the millennials as “The Net Generation,” because they are the first generation to have grown up with ready access to the Internet, and they argue that widespread usage of online resources is a defining feature of this generation. Beginning in 2001, Prensky argued that the millennial generation is comprised of “digital natives,” and that older generations are made up of “digital immigrants,” for whom the technology-infused life is akin to learning a new culture. In his seminal work, Prensky (2001) introduced the idea that because of the proliferation of digital media and technology tools around them, “today’s students think and process information fundamentally differently from their predecessors” (p. 1), and that this is the essence of what it means to be a “digital native.”

EXPLORING THE ISSUES

Digital Natives: Becoming Teachers

Having been named “digital natives,” there has been much interest in the ability of young teachers—millennials—entering the profession, and how well they are able to integrate technology into their teaching practices (Bate, 2010; Bennett & Maton, 2010; Bullen, Morgan, & Qayyum, 2011; Pegler, Kollwyn, & Crichton, 2010; Southall, 2013; Wang et al., 2014). Southall (2013) suggests,

There is a common assumption supported by educators and popular media that today’s preservice teachers are ‘digital natives.’ They have been raised with digital media and have spent a great deal of time using the Internet and engaging with different digital technologies. This group is said to be different as compared to previous generations because they supposedly think, behave, and learn differently as a result of continuous, pervasive exposure to modern technology. (p. 1428).

This echoes the ideas expressed by Prensky (2001) and Tapscott (2009); they see the next generation as living a fully digital life, and thinking—and acting—differently from previous generations.

How well does this conception of the digital native novice teacher work out in practice? In their exploration of technology integration among millennial science teachers entering the profession, Bang and Luft (2013) enthusiastically support the idea of digital natives having exemplary
technology integration skills, stating, “Using technology effectively in the classroom may be best accomplished by new science teachers, who tend to be digital natives and who are more likely to work toward adopting new technologies in their daily instruction” (p. 118). Along the same lines, Towell (2009) describes today’s students as quick to embrace new technologies, while the older generation may need repeated experiences with a particular technology before adopting it. Fluck and Dowden (2013) agree, asserting, “Pre-service teachers are especially well positioned to support the more advanced uses of ICT [information and communication technology]” (p. 2).

Not all authors have this rosy view of the millennials’ abilities to integrate technology and pedagogy. Bennett and Maton (2010) call the assertion of innate ability for technology integration into question, noting that although millennials may have a greater overall preference for using technology, “everyday technology-based activities may not prepare students well for academic practices” (p. 325). Further, research conducted by Littlejohn, Beetham, and McGill (2012) indicated that millennials’ supposed facility with digital technologies are overstated, and that naming this generation “digital natives” may actually be hiding a wide diversity of different ability levels and comfort levels in working with technology.

The Digital Native: Myth or Reality?

Wang et al. (2014) report that there is a common assumption that digital natives may be characterized by a desire to multitask, a preference for visual media over reading texts, and being less motivated by environments that lack technology. There are some indications that millennials—when considered together as a group—do have proclivities for using technology in all areas of life (Oblinger & Oblinger, 2005; Pangrazio, 2011; Tapscott, 2009). However, other authors have noted that the literature on the development of “digital natives” is lacking in empirical research to support the claims that millennials think differently as a result of their exposure to technology (Kennedy et al., 2009; Oh & Reeves, 2014; Southall, 2013), and some researchers have called into question the whole concept of whether or not the digital native/digital immigrant dichotomy has any merit (Bennett, & Maton, 2010; Bullen et al., 2011; Littlejohn et al., 2012; Margaryan, Littlejohn, & Vojt, 2011; Wang et al., 2014). Questions remain whether high personal technology usage in fact correlates to high abilities among millennial teachers to integrate technology into their teaching practices (Oh & Reeves, 2014; Pierson & Cozart, 2005).

Comparing Millennials across English-Speaking, Western Nations

Studies of the millennial generation’s use of technology (particularly within higher education settings, but also among recent graduates) have been conducted across English-speaking Western nations in recent years, including Australia, Canada, the United Kingdom, and the United States. As these nations are culturally similar, it may be productive to compare the findings of these studies to discern the degree to which the “digital native” label holds true.

Australia

In recent years, the Australian government has emphasized developing ICT resources for primary and secondary schools (Albion, 2011; Fluck & Dowden, 2013). In parallel, this push for technology integration has also meant technology has become more prevalent in Australian higher education, and “students entering university are assumed to be ‘media literate’ and technologically competent, simply needing educators to harness those skills” (Albion, 2011, p. 74). This is the assumption, but is it borne out in practice? Many studies indicate that Australian millennials are no more “native” in their use of technology...
Pre-Service Teachers and Technology Integration

than members of other generations (Bate, 2010; Bennett & Maton, 2010; Cameron, 2005; Fluck & Dowden, 2013; Kennedy et al., 2009). In their study of millennials’ actual technology use, Corrin, Lockyer, and Bennett (2011) found that while many participants were heavy users of technology, their technology use was actually limited to a small number of tools. And although their study culminated in a case study comprising a single individual (which limits the generalizability of the findings) they did note, “this level of detail [provided through a thorough examination of a single case] reminds us to question the generational assumptions so commonly used to justify technological changes in higher education” (Corrin, Lockyer, & Bennett, 2011, p. 2949).

Canada

In their examination of how first-year students at a Canadian university use technology, Gabriel et al. (2012) found that there is a great difference in the technologies students employed for personal and academic uses. While millennial students expressed clear preference for using technology for learning, the actual set of tools used by the participants was limited to Internet research, email, word processing, and accessing electronic databases: “the students tended to use digital technologies to collect, select, and work with information” (Gabriel et al., 2012, p. 11). Other researchers have found very little difference between how members of the Canadian millennial generation and other generations use technology (Bullen et al., 2011; Pegler et al., 2010). Bullen et al. (2011) found that students, regardless of their generation, tend to make use of a rather limited set of technologies based on three key issues: familiarity with the tools, financial cost of the technology, and immediacy of access. They found that millennial and non-millennial students were just as comfortable using computers, the Internet, and other information and communication technologies for a variety of purposes (Bullen et al., 2011, pp. 13-14). Pegler et al. (2010) found similar results; they report that younger generations may seem to have “an edge” in working with particular technologies. However, they emphasize, “This advantage comes from experience with technology rather than innate ability. In their study, Oblinger and Oblinger suggested the evolving skills and attitudes that millennials display are also displayed by older generations when those generations have increased exposure to technology” (Pegler et al., 2010, p. 454). While the Canadian millennials may have strong preference for using technology, they do not seem to be any more “native” in their use of technologies than older generations.

The United Kingdom

There are some indications that millennials in the UK are avid users of technology (Ashraf, 2009; Hammond, 2011; Selwyn, 2008). However, many studies have cast doubt on the idea that they are somehow “native” when it comes to their use of technology (Hall, Nix, & Baker, 2013; Helsper & Eynon, 2010; Jones, Ramanau, Cross, & Heating, 2010; Littlejohn et al., 2012; Margaryan et al., 2011). Jones et al. (2010) found a wide diversity among first year university students in the way they used technology, both for personal and academic pursuits. Littlejohn et al. (2012) report, “Some aspects of learners’ everyday practices with technology are in fact at odds with the practices valued in traditional academic teaching and assessment” and “there is considerable research evidence that learners’ ICT skills are less advanced than educators tend to think” (p. 551). Regarding the research on digital natives in the UK, Buckingham expresses, “The optimistic view of young people as a ‘digital generation’ – as somehow automatically liberated and empowered through their experience of these new technologies – is little more than a form of wishful thinking” (2007, p. 75). This sentiment is borne out in the data collected by Helsper and Eynon (2010) in their investigation of supposed digital natives’ and supposed digital immigrants’
use of the Internet and other technologies; there are clearly a range of factors affecting technology use, including generation, gender, experience working with technology, self-efficacy for using technology, and education.

The United States

In recent years, many U.S. researchers have raised questions about whether the conception of millennials as “digital natives” in fact works out in practice (Martin, 2011; Oh & Reeves, 2014; Southall, 2013; Tufts, 2010; Wang et al., 2014) Oh and Reeves (2014) report that millennial students currently in higher education “do not naturally adopt and adapt technologies in academic settings” (p. 824). Tufts (2010) found that the supposed generational gap between the supposed-digital-native millennials and older generations is fictitious: the groups may have different preferences for the technologies they choose, but neither group had greater facility when it came to working with technology. Martin (2011) found similar results in her study comparing novice teachers from different generations, observing “there are more similarities than differences between Digital Natives and Digital Immigrants in regards to background experience and classroom technology use” (p. 97). Along the same lines, Wang et al. (2014) report a synthesis of research that indicates “no significant difference in ICT competencies between the digital natives and the digital immigrants” (p. 641) And even among the supposed digital natives, Hargittai and Hinnart (2008) found stark differences between the way different members of the millennial generation used technology.

The Story so Far: What are the Trends?

Pangrazio (2011) describes the terms “digital native” and “digital immigrant” as “emblematic, not only of how the debate regarding digital technology has progressed, but of the way research has been conducted” (p. 1734), implying that researchers assume that there will be a difference between the ways these generations approach using technology. However, researchers across the West have developed a compelling body of evidence arguing against millennials’ “native” use of digital technologies, with other generations being “immigrants.” Jones & Czerniewicz (2010) assert that applying the label of “digital natives” to the millennial generation persists “despite a growing body of evidence that questions the foundations of the idea” (p. 317). And it is notable that even Prensky himself—the originator of the terminology of “digital natives” and “digital immigrants”—has backpedaled from this position somewhat; in a 2011 piece, he explains that he simply meant to create a metaphor, and even states:

*Being a Digital Native is not, at its core, about capabilities, or even knowledge, regarding all things digital. No matter who you are, all those things have to be learned in some way. The distinction is, I think, much more about culture. It is about younger people’s comfort with digital technology, their believe in it’s ease, its usefulness, and its being generally benign, and about their seeing technology as a fun “partner” that they can master, without much effort, if they are shown or choose to.* (Prensky, 2011, p. 17.)

While it may be true that younger people are perceived to have a greater level of comfort with digital technology, Jones (2011) asserts, “The generational argument [about the differences between how individuals use technology] does not have any real academic support” (p. 39). Jones goes on to explain that millennials actually have a wide diversity of ways that they choose to use technologies, and that while members of this generation do generally seem to have a preference using technology, they are a much more complex group than the “digital natives” narrative would have us believe.
Thus, the unifying trend observed across these English-speaking, Western nations is this: millennials do seem to have a real preference for using technology in their day-to-day lives, but the individuals within this generation are perhaps not as innately skillful as they might seem at first glance (Corrin, Lockyer, & Bennett, 2011; Gabriel et al., 2012; Margaryan et al., 2011; Prensky, 2011; Wang et al., 2014). Further, lumping members of the millennial generation together into one broad category of “digital natives” actually loses the nuance of the many different ways they actually use technology (Bennett & Maton, 2010; Bullen et al., 2011; Hall et al., 2012; Hargittai & Hinnart, 2008; Jones, 2011; Oh & Reeves, 2014). Regarding the supposed digital immigrants, Palfrey and Gasser (2011) bluntly state, “Many people born before 1980, too, are skilled at using new digital technologies, often more skilled in fact than their younger counterparts” (p. 190). Cameron (2005) summed up the situation, stating, “Regardless of age we are all – in the western world at least – surrounded by digital technology. So today’s generation gap appears to be less about ideological or demographic differences, and more about demonstrated comfort and ability with the tools of everyday living” (p. 2).

Moving Beyond Natives and Immigrants: Teacher Beliefs and Technology Integration

Let us now shift our attention back toward schools, and consider how teachers choose to integrate—or choose not to integrate—technologies into their teaching practices. What drives their technology adoption practices?

In her exploration of how novice teachers who—by age—would fit into either the “digital natives” or “digital immigrants” generations, Martin (2011) found that teachers’ experiences with technology were a far greater influence on their technology integration habits than their age. She also found that teachers use of technology in their teaching practices did not correlate to their supposed “native” or “immigrant” status—in fact, it varied widely, with some so-called “natives” using almost no technology in their teaching practices, and some so-called “immigrants” making heavy use of technology for all sorts of teaching tasks, from planning, to delivering content, to assessment (Martin, 2011). Age—and the corresponding generational membership—is not the defining feature for teachers’ technology integration habits. Indeed, Bullen et al. admonish their readers to “avoid the temptation to base our decision [about preferences for using technology] on generation stereotypes and instead seek a deeper understandings of how students are using technology and what role it plays in learning and teaching” (2011, p. 17).

Teachers’ beliefs about the value of technology for teaching and learning affect their likelihood of integrating technology into teaching (Bate, 2010; Ertmer, 2005; Hammond, 2011; Hughes, 2005). To develop technology integration skills, teachers must view themselves as learners and be willing to practice (Hughes, 2005), and it is important to note that this “learner stance” can be assumed by members of any generation (Ertmer, 2005). Dweck (2012) reinforces this perspective in her description of a “growth mindset.”

Cameron (2005) suggests, “The gap that digital technology creates between students and teachers may not be so much generational as it is experiential” (p. 4). In their study of Canadian teachers’ technology integration habits, Pegler et al. (2010) found that although teachers in younger generations (Generation X and millennials) may have greater facility with information and communication technology (ICT) applications compared to their older colleagues, they are, in fact, no better at integrating these tools into their teaching. Rather than assuming that differences in generation membership best explain teachers’ varying approaches to technology integration, they
propose Rogers’ (2003) diffusion of innovations model might be a more likely explanation (Pegler et al., 2010).

Rogers (2003) indicates a wide variety of reasons some individuals are more likely to adopt an innovation—such as a particular educational technology—than others, including: more years of formal education, higher level of literacy, higher social status, greater empathy, less dogmatic belief system, greater ability to deal with abstractions, greater rationality, better able to cope with uncertainty and risk, higher aspirations, greater social participation, greater exposure to mass media, greater knowledge of innovations, and higher degree of opinion leadership (Rogers, 2003).

Notably absent from Rogers’ (2003) list of potential factors influencing adoption of an innovation: the age of the adopter. Rogers (2003) specifically highlights this fact:

Earlier adopters are no different from later adopters in age. There is inconsistent evidence about the relationship of age and innovativeness. About half of the many diffusion studies on this subject show no relationship, a few found that earlier adopters are younger, and some indicate they are older. (p. 288.)

This provides a strong indication that diffusion of innovations theory might be a more likely explanation of the differences between teachers’ approaches to technology integration than generational differences. Teachers of all generations are more likely to adopt an innovation—perhaps changing their beliefs about the value of a particular technology for teaching—when they have time to interact with colleagues, observe how they are using the tool, and re-conceptualize how a technology could be integrated into their teaching (Ertmer, 2005; Kereluik, Mishra, & Koehler, 2010).

Teachers, regardless of their generational membership, must keep up with developments in technologies for teaching and learning (Pegler et al., 2010). The approach a teacher selects—whether to use a particular technology or not—is often based on their personal level of comfort in working with the technology; whether a teacher is an expert or novice in the use of a particular technology makes a tremendous difference in whether it is integrated into classroom practice! (Ertmer, 2005; Judson, 2006). Ertmer (2005) emphasizes that teachers rely on their previous beliefs and experiences when making decisions about how and when to integrate technology. And all educators would do well to bear in mind that “people tend to teach the way they were taught” (Adamy & Heinecke, 2005, p. 233).

RECOMMENDATIONS

How Can We Best Prepare Millennial Teachers for Technology Integration?

Because of their membership in the millennial generation, novice teachers entering the profession today are often assumed to be “digital natives” (Bang & Luft, 2013; Fluck & Dowden, 2013; Murray, 2011). However, as we have seen, there is a large body of evidence that this assumption does not imply that they are better at integrating technology than their more experienced peers. While they may have greater perceived comfort in working with technology in their day-to-day affairs, millennials entering the profession are, in fact, no better at integrating technology into their teaching than their more experienced peers (Albion, 2011; Bate, 2010; Pegler et al., 2010; Wang et al, 2014), and in some cases, may actually be worse at technology integration (Martin, 2011). However, even if the assumption that millennials are “native” integrators of technology and pedagogy is flawed, a burden is placed on teacher educators to prepare millennial pre-service teachers for the expectation that they will be able to integrate technology into their teaching (Pegler et al., 2010).
Teacher educators must not take their influence on the next generation of teachers lightly. As Pierson and Cozart (2005) put it, “Novice teachers should be prepared to enter their profession with a varied and strong repertoire of technology uses” (p. 3337). In order to ensure millennial teachers entering their professional career will be able to integrate technology from the beginning of their teaching practice, the relationship between technology-use and teaching ability must be made strongly in pre-service teacher preparation (Pierson, 2000). However, this training likely will need to be differentiated based on the unique needs of individuals, because—as we have seen—the individual members of the millennial generation may have technology skills and experiences that vary dramatically. Bonk (2009) described this phenomenon as “upskilling digital natives” (p. 390) and suggested that while some teachers will need basic training on how to use web resources for teaching, others might need familiarization with specific tools, because “they may think that they know how to use all the latest technologies, but those intended for learning may be different or unfamiliar to them” (Bonk, 2009, p. 390).

(Re)Conceptualizing the Technology Component in Teacher Preparation

Based on their analysis of over one hundred different teacher preparation programs at a wide variety of institutions of higher education, Ottenbreit-Leftwich, Glazewski, and Newby (2010) outline a four step process for conceptualizing (or re-conceptualizing) the technology component for a teacher preparation program:

1. Consider how technology expectations fit into the broader context of a teacher education program.
2. Establish specific technology content goals for all pre-service teachers within the program.
3. Select approaches to best meet these specific technology goals.
4. Design learning activities that will incorporate these approaches to deliberately meet the technology goals.

Teacher educators would be well advised to reflect on this process as they consider how they will work to prepare their students to integrate technology into their future teaching. The goal of the proceeding sections is to explore a practical model for developing pre-service teachers’ abilities to connect technology with pedagogy.

Shifting from Stand-Alone Technology Courses to an Integrated Approach

Historically, teacher preparation programs have included a stand-alone course aimed at developing pre-service teachers’ skill and knowledge at using technology (Ottenbreit-Leftwich, Glazewski, & Newby, 2010; Pope, Hare, & Howard, 2005; Wang & Chen, 2007). While such courses are still widespread in teacher education, Grossman, Hammerness, and McDonald (2009) have called for dissolving the artificial line teacher educators have drawn between “foundations” and “methods” and instead consider integrating these two domains. In the realm of educational technology, this would mean reconsidering the value of separating instructional technology courses from pedagogical methods courses, and instead look for ways to integrate technology skills into other courses. As early as 2005, Pope, Hare, and Howard raised the question of whether learning technology skills in isolation from instructional methods actually benefits pre-service teachers, and would in fact result in true technology integration in the classroom. They instead advocated that teacher educators deliberately integrate technology into methods courses.

Wang and Chen (2007) strongly supported the integration approach, while noting that the
stand-alone technology course might still provide value to the students if the knowledge and skills developed in such a course are then integrated throughout the entire teacher preparation program. They argued that pre-service teachers still need to learn the basic skills of how to use various instructional technologies, and that a stand-alone course might be a good way to do so, but only if this course is full of examples explaining how technology can be used as a means of instruction in the context of various content areas (Wang & Chen, 2007). Simply learning how to use various technological tools will not actually result in technology integration; the use of technology must be contextualized.

This viewpoint is similar to that expressed by Koehler, Mishra, and Yahya (2007) who have called for a move away from stand-alone technology courses, explaining that technology use in teaching must always be viewed in relation to the content to be taught as well as the pedagogies being employed. They argued that decontextualized approaches are in fact unlikely to promote technology integration since there is such a wide disconnect being modeled for the students.

Establishing Standards for Technology Use

Part of the challenge for preparing pre-service teachers with regard to technology is the wide variety of comfort with and efficacy related to personal use of technology present among individuals (Mishne, 2012). Students will have differing needs for developing knowledge about and comfort with technological tools for teaching and learning; as we have seen, even the supposed “digital natives” exhibit a wide range of knowledge about and preferences for using different technologies (Bennett & Maton, 2010; Bullen et al., 2011; Corrin et al., 2011; Hall et al., 2012; Jones, 2011; Oh & Reeves, 2014). A technology integration model must take into account this range of ability and be able to flex to the needs of the individuals. Fortunately, some research has already been done in assessing pre-service teachers’ knowledge and skill in using educational technologies, and useful tools for this assessment are available (Schmidt et al., 2010). Students with different levels of skill in using instructional technologies will need different levels of support, but having clear descriptors of the expected skills and attitudes will aid in developing the technological abilities of all pre-service teachers (Ottenbreit-Leftwich, Glazewski, & Newby, 2010).

Faculty in teacher education programs will thus need to decide on the skills and attitudes pre-service teachers most need, and then deliberately provide opportunities to develop these. The International Society for Technology in Education (ISTE) has developed standards to guide teachers as they incorporate educational technologies into their teaching practices (ISTE, 2008). Several authors argued that the ISTE standards are an excellent depiction of the technology abilities today’s teachers need (Mumford, 2011; Ottenbreit-Leftwich, Glazewski, & Newby, 2010; Rodriguez & Chung, 2012). Because the ISTE standards are international standards, they are written in such a way as to be applicable to many different school settings, rather than being tied to just one nation or location. The ISTE standards for teachers include performance indicators that clearly outline the skills effective teachers need to be able to exhibit, which makes these ideal for understanding what pre-service teachers must know, understand, and be able to do with regard to instructional technology. Embedding these into pedagogical methods courses and throughout a teacher education program will help to develop not just technological skills, but also develop a greater sense of efficacy for the ability to teach with technology (Abbitt, 2011; Mumford, 2011). Alongside these standards, a growing body of research indicates that strong connections between technology and pedagogy are necessary for

**Connecting Technology to Pedagogy and Content Knowledge: The TPACK Framework**

Today’s schools have adopted a wide variety of technologies, with the hope that their addition to classrooms will have a positive impact on student learning (Brown & Green, 2013; King, 2012; Project Tomorrow, 2013a; Project Tomorrow, 2013b). King (2012) suggested, “Instructional technologies are more present than ever” (p. 1201), but also noted, “all [educators] struggle to interpret the appropriateness and utility of new technology in the classroom” (p. 1204). Without a framework to guide their implementation, there is little indication that simply having technological tools present in the classroom will impact students learning.

The TPACK framework depicts three overlapping domains of teacher knowledge: Content Knowledge, Pedagogical Knowledge, and Technological Knowledge. Viewed as a Venn diagram as illustrated in Figure 1, the way these knowledge domains overlap result in seven distinct areas for consideration.

Abbitt (2011) provided helpful short descriptors of each domain of the TPACK framework:

1. **Pedagogy (PK)** - Knowledge of the nature of teaching and learning, including teaching methods, classroom management, instructional planning, assessment of student learning, etc.
2. **Content (CK)** - Knowledge of the subject matter to be taught (e.g., earth science, mathematics, language arts, etc.).

3. **Technology (TK)** - Continually changing and evolving knowledge base that includes knowledge of technology for information processing, communications, and problem solving and focuses on the productive applications of technology in both work and daily life.

4. **Pedagogical Content (PCK)** - Knowledge of the pedagogies, teaching practices, and planning processes that are applicable and appropriate to teaching a given subject matter.

5. **Technological Content (TCK)** - Knowledge of the relationship between subject matter and technology including knowledge of technology that has influenced and is used in exploring a given content discipline.

6. **Technological Pedagogical (TPK)** - Knowledge of the influence of technology on teaching and learning as well as the affordances and constraints of technology with regard to pedagogical designs and strategies.


The TPACK framework thus provides a structure for examining the role of technology and how it might support and enhancing students’ learning.

**Applying the TPACK Framework as a Model for Technology Integration**

The TPACK framework may best be viewed as a contextualizing approach for helping pre-service teachers develop their ability to integrate technology. Learning technology skills in isolation from pedagogy and content are unlikely to result in technology integration; that is, learning how to use technology is not the same thing as learning how to teach with technology (Mishra & Koehler, 2006). Technology does not replace pedagogy. Pre-service teachers must understand how instruction is implemented in order to understand the implications of teaching with technology (Spector, 2012).

There is widespread support of technology-infused teacher education programs based on the TPACK framework (Abbitt, 2011; Easter, 2012; Harris et al., 2010; Koh & Divaharan, 2011; Mouza & Karchmer-Klein, 2013; Pamuk, 2012). Of particular interest is Koh & Divaharan’s (2011) model, which emphasizes the role of faculty modeling of technology integration as well as case study for developing pre-service teachers’ abilities to connect technology and pedagogy.

**The Importance of Modeling Technology Integration by Instructors**

Many faculty members throughout higher education continue to rely on traditional, lecture-based teaching methods and make only modest attempts to incorporate technology into their own teaching practices (Brown & Green, 2013). To fully support development of pre-service teachers’ ability to connect technology and pedagogy, it is incumbent upon instructors to model technology integration. Koh and Divaharan (2011) mentioned modeling as a key element for pre-service teachers acceptance of a given instructional technology; without the opportunity to see it in use, students are far less likely to be able to envision how a given tool might be integrated into classroom practice. The modeling of appropriate technology instruction by instructors seems to be a key element to support pre-service teachers’ ability to integrate technology into their own teaching practices.

Baran, Chuang, and Thompson explicitly linked instructors’ modeling the TPACK framework to pre-service teachers’ developing thinking about technology integration, bluntly stating, “Teachers
tend to teach in the way they were taught” (Baran, Chuang, & Thompson, 2011, p. 374). They imply that if the only technology use pre-service teachers see modeled is PowerPoint-based lecture, their imagination for other possibilities for technology integration will be limited.

Several authors have argued that instructors must deliberately explain their own technology integration, making it explicit for the students so they will understand the instructional decisions being made, and how technology supports the teaching and learning (Koehler, Mishra, & Yahya, 2007; Koh & Divaharan, 2011; Pope, Hare, & Howard, 2005; Wang & Chen, 2007). This is a key element in Koh and Divaharan’s (2011) TPACK-based model for supporting pre-service teachers’ understanding of technology integration: instructors’ modeling must be rationalized and verbalized for the students. The intent is that by examining instances of their instructors’ use of technology and how the lessons unfold, the pre-service teachers will develop understanding of how technology and pedagogy are interrelated within the context of particular content to be taught.

**Case Study and Conversation as a Means of Exploring Technology Integration**

Case study is a key element to Koh and Divaharan’s (2011) model, but this is by no means the only example expressing the value of case study for promoting technology integration among pre-service teachers. Many authors have advocated the case study approach for examining technology integration (Ertmer, et al., 2012; Mouza & Karchmer-Klein, 2013; Koehler, Mishra, & Yahya, 2007; Wang & Chen, 2006). Additionally, results of an investigation of case study effectiveness by Razzouk and Johnson (2013) indicated that pre-service teachers examining case studies are more engaged in their learning, and in fact learn more when compared to more didactic methods of instruction. Because case studies require students to apply their knowledge and skills to solve authentic, contextualized problems, collaboratively examining case studies can be an effective way to assist pre-service teachers’ developing abilities for technology integration (Kinuthia, Brantley-Dias, & Junor Clarke, 2010).

In support of this viewpoint, Mouza and Karchmer-Klein (2013) contended that cases are instrumental for aiding pre-service teachers’ development of the skills and practices required for teaching, and that this may be especially true in the domain of technology, as technologies are continuously evolving. They make heavy use of Mishra & Koehler’s (2006) TPACK framework as an organizing principle for the cases they assigned their students, which are intended to demonstrate to students how complex teaching with technology often is in practice. A clearer understanding of how the domains of the TPACK framework interact might best be explored through the conversations about authentic cases of technology integration (Mouza & Karchmer-Klein, 2013).

Pre-service teachers should also be encouraged to share their own first-hand experiences related to teaching and learning (Dunlap & Lowenthal, 2013). Dunlap and Lowenthal suggested that collaboratively discussing educational experiences could be a rich formative experience for helping students understand how people think and learn. Conversations of this sort might help students clarify their thinking about technology integration, and even identify gaps between their beliefs and practices related to technology integration (Ertmer, et al., 2012). Koehler, Mishra, and Yahya (2007) suggested that small group discussions between teacher education faculty and pre-service teachers might be the key for developing strong technology integration skills.

**CONCLUSION**

Even the most technologically savvy, “digital native” pre-service teachers will need support to learn
how to infuse their pedagogy with technology. To adequately prepare them for the rigorous realities of teaching with technology, teacher educators will need to reconsider the role of the stand-alone technology course, and shift towards more of an integration approach. The development of pre-service teachers’ technological knowledge is best conducted within the context of their learning of pedagogy and content knowledge.

As teacher educators move away from stand-alone technology courses towards the integration approach, clear descriptions for what knowledge and skills pre-service teachers must develop are needed, such as the ISTE (2008) standards. Once such standards are decided, faculty in teacher preparation programs will then need to clearly articulate an approach for integrating technology into the program. Such is the rationale for the Mishra & Koehler (2006) TPACK framework, which currently serves as a preeminent model for exploring technology integration in education. Teacher educators can thoughtfully embody the TPACK framework in their own teaching practices, demonstrating technology integration by modeling it in their own teaching. Finally, conversations about cases involving technology and pedagogy in contextualized teaching situations can expose gaps in students’ thinking and help them better understand how they will integrate technology in their own teaching practices. Infusing technology throughout a teacher education program is the best way to support pre-service teachers as they develop a clear connection between technology and pedagogy. When millennials explore the relationship between technology and pedagogy within the context of a particular content area to develop their skill at integrating these domains, they will live up to the name “digital native” when it comes to technology integration in their own teaching practices.

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Pre-Service Teachers and Technology Integration


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Pre-Service Teachers and Technology Integration


ADDITIONAL READING


Pre-Service Teachers and Technology Integration


KEY TERMS AND DEFINITIONS

Digital Immigrants: Individuals born prior to 1980; generally presumed to be able to learn to use digital technologies but with less facility, intuition, and preference than members of younger generations.

Digital Natives: Individuals born after 1980; generally presumed to have a high level of facility in working with digital technologies, and an intuitive understanding and preference for working with such technologies.

Educational Technology: A technology that may have been created for other uses that has been adapted for use in an educational setting.

Information and Communication Technology (ICT): A technological tool that allow users to more easily access and process information, or a tool that facilitates communication between users.


Novice Teacher: A certified/credentialed/licensed professional educator in his/her first years in the profession.

Pedagogy: The “art and science” of teaching.

Pre-Service Teacher: An individual in a teacher-preparation program who has not yet been certified/credentialed/licensed as a professional educator.

Technological: Pedagogical, and Content Knowledge (TPACK): A widely accepted framework for technology integration first proposed by Mishra and Koehler in 2006.

Technology Integration: The ability to skillfully combine pedagogy and technology to foster meaningful learning.