Journal of Technology and Teacher Education (2010) **18**(1), 5-33

Preservice Technology Integration Course Revision: A Conceptual Guide

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With technology rapidly changing, preservice teacher technology skills improving, and highly qualified teacher licensure requirements, more teacher education programs may need to reevaluate how they are currently teaching technology. Although no empirical evidence recognizes the most effective experience, previous studies have indicated the affordances and limitations of various experiences. In addition, these studies described why the experiences were the most appropriate for specific situations. This review of over 100 programs led to the construction of a conceptual guide for teacher education faculty considering various experiences. The guide assists in the selection of the most appropriate learning experiences in order to achieve the specific intended goals of the faculty member. The conceptual guide addresses three main elements of technology experiences: approaches (information delivery, hands-on activities, practice in the field, observation or modeling, authentic experiences, and reflection), technology content goals (e.g., NETS-T standards), and the broader context (e.g., stand-alone course, full implementation). The primary goal of this review was to gain a stronger understanding that may inform the design process of technology experiences within a teacher education program. Through this process, teacher education faculty can consider various experiences and select the most appropriate learning experiences to achieve their intended goals of preparing preservice teachers to use technology in their future classrooms.

INTRODUCTION AND PURPOSE

Many teacher education programs have recognized the difficulties associated with developing teachers' abilities to use technology in the classroom and have proposed original, innovative approaches to use technology. "Extensive time and money has been spent developing strategies and programs to help preservice teachers use technology effectively… collaboratively crafted to address the technology needs of preservice teachers" (Kay, 2006, p. 392). The U.S. Department of Education's "Preparing Tomorrow's Teachers to Use Technology" (PT3) program provided funds to support the development of teacher technology learning experiences. From its genesis in 1999 until 2003, the PT3 program dedicated over $750 million to projects focusing on new methods for preparing future teachers to effectively integrate technology into their teaching (Pellegrino, Goldman, Bertenthal, & Lawless, 2007).

Many of the technology experiences developed with the PT3 project funds may no longer meet the needs of preservice teachers. Emerging technologies such as Web 2.0 and mobile technologies have already greatly affected the way K-12 students interact with their world (Bull & Garofalo, 2006). These emerging technologies have the potential to greatly influence education and "empower our youth in ways that we simply can't even imagine yet" (Norris & Soloway, 2006, p. 2353). The recent National Education Technology Plan (U. S. DOE, 2004) highlighted the importance of using technology to be able to compete globally, as well as change our educational system. Teacher education programs need to consider how these new technologies may change their classrooms. With technology rapidly changing, preservice teacher technology skill sets improving, and the notion of the highly qualified teacher licensure requirement, more teacher education programs may need to reevaluate how they are currently teaching technology. These changes necessitate revision of the technology integration experiences currently preparing teachers to use technology. The necessity for change prompted this review, in an effort to determine the best practices for preparing preservice teachers to use technology in their future classrooms.

Numerous curriculum ideas and experiences have been proposed for preparing preservice teachers to use technology. While nearly all agree that stand-alone technology “skills” classes do not provide adequate or appropriate experiences to prepare prospective teachers to effectively use technology in their future classrooms, there is little empirical evidence that the large number of other methods and models are any more effective (Mims, Polly, Shepard, & Inan, 2006). These various experiences include courses that blend technology skills and technology integration (Algozzine, Antonak, Bateman, Flowers, Gretes, Hughes, et al., 1999), technology skills courses coupled with field experiences (Brush, Glazewski, Rutowski, Berg, Stromfors, Hernandez Van-Nest, et al., 2003), project-based courses that focus specifically on technology integration strategies (Park & Ertmer, 2008), or a tiered series of courses that are infused within the entire teacher education program (Brush & Appleman, 2003; Sanzone, Hunt, & Bevill, 2002). Much of the research examining these various approaches consists of individual case studies, with little to no evaluative data that could provide insight regarding which approach (if any) is most effective for preparing pre-service teachers with regards to technology (Kay, 2006). Another common problem with the research is that many of these preservice teachers have not been followed into the field to investigate which methods best prepared them for teaching (Brush et al., 2003). In fact, after a review of 68 studies discussing various strategies for incorporating technology into pre-service teacher education programs, Kay concluded that “…only a handful of studies have carefully and rigorously pursued the evaluation process. The jury is still out on which strategies work best…” (p. 395).

Although no empirical evidence recognizes the most effective experience (Kay, 2006), previous studies have indicated the affordances and limitations of the various experiences, as well as how appropriate the experiences were in addressing the specific situations. The primary goal of this review was to analyze existing studies and elicit a process of how to design technology experiences within a teacher education program. Through this process, teacher education faculty can consider various experiences and select the most appropriate learning experiences to achieve their intended goals of preparing preservice teachers to use technology in their future classrooms. For the purposes of this paper, appropriate learning experiences are defined as those experiences included in teacher education programs that best meet the needs of the specific program.

Search Method

This synthesis was developed from a review of peer-reviewed articles and conference proceedings that examined technology integration experiences in teacher education programs. To examine the various abilities educational technology faculty felt meaningful, publications from 2000 to 2007 that provided a clear description of a specific technology integration program were collected and examined. Since the intent of this study was to look across the spectrum to include all potential methods for teaching preservice technology integration, any form of publication, including conference proceedings were included. Publications that pertained to inservice teachers, literature reviews, and opinion papers were not included in the analysis; however, certain articles may have been used to support claims.

The databases included in this search were Academic Search Premier, ERIC, Education FullText, PsycARTICLES, Google Scholar, and Professional Development Collection to find articles discussing various programs. In the databases, several combinations of keywords such as: ‘‘technology,’’ ‘‘computer,’’ ‘‘PT3,’’ ‘‘preservice,’’ “teacher,’’ “educational technology,” “integration,” and ‘‘course” were used. This initial search yielded information regarding approximately 60 programs. In addition to the first search, a ‘‘snowball’’ method was used to locate additional studies from within the selected publications’ reference sections. Additional search-terms gathered from these articles were used to conduct a second search in the databases and search engines mentioned previously to generate information on more programs. In the end, over 100 programs reported clear descriptions of appropriate technology integration learning experiences included in preservice preparation.

For each of the 100 programs, keywords were recorded to identify the main activities. For example, one program (Gado, Ferguson, & Van ‘t Hooft, 2006) discussed handheld computers in the context of a science methods course. Provided below is a brief excerpt from the description:

> First, the instructor performed a science activity integrating technology to explain the set-up and use of handheld computers in a scientific investigation. Second, students engaged in hands on discovery activities, focusing on activities such as taking and sharing still pictures of a science investigation set-up, and using probeware for data collection, display, and analysis... (p. 506)

The initial approach keywords for this program included "demonstration by instructor," "integrated into a methods course," "skill building," "probeware," "handheld," "scientific investigation," "technology integration into science content," and "discovery learning." After reviewing several articles, it seemed that the activities could be separated into three main constructs: the specific methods used to conduct the activities (approaches), the substance or curriculum covered in the activities (technology content goals), and how the activities were situated in the overall teacher education curriculum (broader context). For example, the keywords referring to *approaches* from the aforementioned example were "demonstration by instructor," "skill building," and "discovery learning." These were all in reference to how the material was taught. The keywords associated with the *technology content goals* were "probeware," "handheld," "scientific investigation," and "technology integration into science content." These were all specific content ideas that the instructor wanted students to learn through the activities. Finally, the keyword associated with the *broader context* was "integrated into a methods course," indicating where the activity was situated within the overall teacher education curriculum. While all three of these constructs were included in the review, the primary emphasis was on the approaches. The focus on approaches was selected as most of the literature discussed the different types of approaches. In addition, many times teacher education faculty have little control over the broader context and the specific technology content goals may change.

As the purpose of this review was to identify what types of approaches were included in teacher education programs, a constant comparative approach was used (Glazer & Strauss, 1967). A constant comparative approach allowed the categories to emerge directly from the data. In addition, the categories could be constantly compared to new approaches and adjusted as necessary. After reviewing several articles, emerging *approaches* categories were noted by the researchers (e.g., lectures, readings, technology skill-building activities, modeling, observations, field experiences, unique activities to simulate field experiences). As each article was reviewed, the keywords identifying the program were compared to the emerging categories. If the keywords did not fit into an existing category, a new category was created or the category most closely aligned with the approach was adjusted. Through an evolutionary process of constantly comparing the new keywords with existing categories, this resulted in six main categories: information delivery, hands-on computer skill building activities, modeling/observation, authentic experiences, practice in the field, and reflections. Each article abstract was reviewed and categorized according to the main approaches used in teacher preparation for technology integration. Table 1 summarizes these approaches and each is discussed in more detail below.

Table 1
Summary of Approaches and Defining Characteristics

Approach	Defining Characteristics	Common Example(s)
Information delivery of technology integration content	How preservice teachers receive technology integration information	Lectures, textbooks, websites
Hands-on technology skill building activities	How preservice teachers develop technology skills	Tutorials, workbooks, step-by-step procedures
Practice with technology integration in the field	How preservice teachers test their teaching skills in a K-12 environment	Field experiences
Technology integration observation or modeling sessions	How preservice teachers see good examples of technology integration	Classroom observations of K-12 teachers or teacher education faculty
Authentic technology integration experiences	How preservice teachers are provided with a wide range of problems and given time to solve the problem	Problem-based learning situations
Technology integration reflections	How preservice teachers self-reflect on technology integration decisions or beliefs	Electronic portfolio, journals

SYNTHESIS OF RESEARCH

Types of Approaches

Through the constant comparative process (Glazer & Strauss, 1967), six approaches teacher education programs typically used to develop preservice teacher technology abilities were identified: (1) information delivery of technology integration content, (2) hands-on technology skill building activities, (3) practice with technology integration in the field, (4) technology integration observation or modeling sessions, (5) authentic technology integration experiences, and (6) technology integration reflections. Others have found similar strategies in previous reviews (Kay, 2006; Mims et al., 2006).

However, this synthesis sought out detailed descriptions of the courses used to prepare preservice teachers to use technology without any focus on the results of research studies (Kay) or limiting selection of studies to certain initiatives (Mims et al.). For each of these approaches, this paper presents defining characteristics, discuss benefits and limitations, and provide examples. Note that many programs incorporated more than one approach within teacher preparation education. Other limitations include not mentioning all approaches used in the reviewed article (e.g., information delivery was most likely used in all programs), and specific programs may have changed their approach since the press date of the publication.

Table 2

Approach Summary: Information Delivery

Definition	The approach of information delivery refers to how the instructor of the course delivers important information on technology integration to the preservice teachers. Preservice teachers are typically passive receivers of information. (Pellegrino et al., 2007)
Examples	Readings, lectures, demonstrations, computer demonstrations, videos, PowerPoint presentations, textbooks, articles, websites, or web-based delivery methods (e.g., streaming video tutorials or podcasts)

Information delivery. The first approach identified in the review was *information delivery* (see Table 2). Many information delivery formats were heavily embedded in other approaches. However, one creative format for providing information delivery approaches is having preservice teachers use online resources to obtain information. For example, one student teacher at Willamette University found listservs as a valuable learning tool, receiving advice on technology ideas and integration from inservice teachers (Weisner & Salkeld, 2004). New Mexico State University has developed podcasts to deliver content about meeting the ISTE (International NETS-T) standards. Other formats, such as WebQuests (Allan & Street, 2007), have also been expressed as a strong format for delivering information to preservice teachers on technology integration.

Many programs deliver technology integration information through didactic instruction where the instructor presents information on a specific subject during whole-class recitation, potentially using questioning techniques to elicit student interaction (e.g., Zheng & Young, 2006). This format is particularly helpful in delivering important and consistent technology integration information necessary to prepare preservice teachers to use technology, especially when teacher education programs are limited in the number of credit hours (Zheng & Young). However, this format may limit teacher ability to transfer the information learned to practice (Zheng & Young). As a primary approach, this was the least commonly referenced. Although not always explicitly mentioned, most programs incorporated this with other approaches.

Table 3
Approach Summary: Hands-on Skill Building

Definition	Hands-on skill building refers to the activities that help preservice teachers develop necessary computer skills. These computer skills are typically built within a laboratory setting that requires students to follow step-by-step procedures to learn a specific technology skill set.
Examples	Workshops (Durnin, 2003), computer laboratory courses (Bucci, 2003), and online tutorials (Basham, Palla, & Pianfetti, 2005).

Hands-on skill building. The second approach identified in the review was *hands-on skill building* (see Table 3). Many programs use this approach to learn specific technology skills through step-by-step instructions. At Texas Women's University, preservice teachers self-monitored their own technology integration proficiency and development over the course of three semester-long field experiences (Snider, 2003). With each new semester, preservice teachers were required to perform certain technology integration activities at progressive levels: Intern 1, Intern 2, and Resident. To gain the technology skills necessary to achieve these levels, preservice teachers were required to attend professional development activities, open labs, document their learning progress and plans, as well as use the online web portal for technology resources. The program provided a support system with "just-in-time" assistance center, which also monitored preservice teacher progress with technology skills and integration over the course of the three semesters (Snider).

Another project at Villanova University used graduate inservice teachers enrolled in a technology integration course to deliver hands-on technology integration workshops for undergraduate preservice teachers. The inservice teachers received instruction on basic computer skills such as word processing, database, spread sheet, slide show and presentation software, and the use of the Internet in the classroom. The inservice teachers were then expected to develop three workshops and deliver these to the preservice teachers in computer labs (Durnin, 2003).

Another common format for providing hands-on activities was the computer laboratory course. The Ohio State University at Mansfield had preservice teachers enroll in a two-hour lab session to learn technology skills during the same semester as their methods course (Bucci, 2003). Preservice teachers were encouraged to work with the technology instructor to experiment with technology and brainstorm technology integration ideas for lessons. Preservice teachers used pedagogical strategies learned in their methods course, applied technology learned from the integration course, and designed a lesson for their field experiences. In addition, the lab was open throughout the day, serving as a supplemental consulting for technology integration and support.

Table 4

Approach Summary: Practice in the field

Definition	Practice in the field refers to opportunities which allow preservice teachers to practice using their teaching skills. Preservice teachers are able to test strategies, visually see consequences of practice, gain feedback, and adapt their practice to better integrate technology into K-12 classrooms (Dawson & Norris, 2001; Simpson, 2006)
Examples	Technology-rich field experiences (Strudler & Grove, 2003), field-experiences paired with methods courses (Pope, Hare, & Howard, 2002), internships/ apprenticeships during student teaching (Grove, Strudler, & Odell, 2004), learning communities (Sherry & Chiero, 2004), working with teachers to incorporate technology into their classrooms (Dawson & Norris, 2001), and working one-on-one with K-12 students (Dismukes, Yarbrough, Zenanko, & Zenanko, 2004)

Practice in the field. The third approach identified from the review was *practice in the field* (see Table 4). In teacher education, *practice in the field* typically occurs within the confines of field experiences. Field experiences that incorporate technology positively affects preservice teacher attitudes toward technology integration (e.g., Bahr, Shaha, Farnsworth, Lewis, & Benson, 2004). Preservice teachers are able to apply technology integration abilities and skills and see the classroom change (Bahr et al.; Li, Guy, Baker, & Holen, 2006). This opportunity for practice with technology is especially important because there are many additional barriers teachers encounter when they attempt to use technology in the classroom (Hew & Brush, 2007).

One limitation to incorporating practice in the field includes the difficulty of finding enough suitable placements (Allen, 2003). Furthermore, technology integration is often seen as an auxiliary area within teacher education programs, and therefore, may not have room to incorporate technology field experiences within the curriculum. However, there are several different programs that designed novel formats to provide opportunities for practicing technology integration in the field (See Table 4).

Perhaps the most common format was requiring an educational technology course as a co-requisite of a methods course. Teacher education programs commonly couple field experiences with methods courses to provide opportunities for practice in the field. Therefore, preservice teachers learn about technology integration and have opportunities to apply learned practices within their methods field experiences (Brush & Appelman, 2003). Arizona State University provided technical and pedagogical support during preservice field experiences. One graduate assistant was provided to each K-12 field placement school. Their role was to assist preservice teachers in the field with technology and pedagogical issues. The preservice teachers were asked to observe, develop, and integrate technology into real K-12 classrooms, while being provided with a full community of support from mentor teachers, graduate assistants, and university faculty (Brush et al., 2003). Teacher education programs have also incorporated technology integration experiences during preservice student teaching (e.g., Strudler & Grove, 2003; Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003). At the University of Nevada Las Vegas, preservice student teachers had the option of self-selecting technology-rich classrooms for their field experience placements (e.g., Strudler et al.).

Although the ability to integrate technology with an entire class is desirable, it is not always probable. Some programs have substituted opportunities teaching a whole K-12 class practice with teaching individual K-12 students. This interaction with one individual student provides preservice teachers with the practicing opportunity to interact and see the consequences of their technological integration practices. Preservice teachers can practice strategies, technologies, and integration techniques in a less threatening. This is also a practical solution for faculty as it minimizes the need for coordinating large quantities of field placements, making this a more feasible option for implementation purposes. While not ideal, this offers the practical solution of providing the preservice teacher with an opportunity to practice teaching with technology (Dismukes et al., 2004). For example, one program required their preservice teachers to tutor local K-12 students at the university's Teaching/Learning Center. During the tutoring sessions, preservice teachers were encouraged to integrate technology to help students learn (Dismukes et al.). Another program paired preservice teachers enrolled in a technology course with local eighth grade students to design and implement individualized, technology-enhanced instruction (Kariuki & Duran, 2004). This opportunity provided preservice teachers with the opportunity to practice and receive immediate feedback from K-12 students on their technology integration strategies (Kariuki & Duran).

Table 5

Approach Summary: Observations and models

Definition	Observations and models show preservice teachers good teaching with technology examples. In turn, preservice teachers can take these observed actions, and mimic them in their own classrooms or add them to their teaching repertoire (Bennett, 1991).
Examples	Teacher education faculty modeling (Mims et al., 2006) and short video vignettes of good technology use in the classroom (Krueger et al.).

Observations and models. The fourth approach found for preparing preservice teachers to use technology was *observations and models* (see Table 5). Studies have indicated that most preservice student teachers acquire their practices from observing their mentor teacher (Bennett, 1991). Observations and models allow preservice teachers to view different ways to use technology as a teacher. When preservice teachers see different teaching approaches, they can make more informed decisions about the teaching strategies and methods to implement in their own classrooms, (Ertmer, Conklin, Lewandowski, Osika, Selo, & Wignall, 2003). Ertmer and colleagues (2003) found that "in order to translate skills into practice, teachers need specific ideas about how to use these skills to achieve meaningful learning outcomes under normal classroom conditions" (p. 96). Furthermore, observations and models of technology integration can help preservice teachers construct pedagogical knowledge and analyze teaching strategies, methods, and ideas associated with quality technology integration (Krueger, Boboc, Smaldino, Cornish, & Callahan, 2004).

Many have expressed the importance of having teacher education faculty model technology integration situated within methods courses (Mims et al., 2006; Pope et al., 2002). The PT3 project at Purdue University addressed sponsored mini-grants for teacher education faculty that integrated technology into their courses (Lehman & Richardson, 2004). The PT3 project director provided the following reasoning for this approach: "There's an old saying in education, that 'teachers teach as they were taught,'… if our student teachers only see faculty members lecturing, they're likely to just lecture. But if they see their faculty members using technology in effective ways, they're going to use technology in effective ways as well" (U. S. Department of Education, 2005, ¶1). However, one of the major limitations of achieving this approach has been the lack of skills and/or interests in technology integration by teacher education faculty (Brzycki & Dudt, 2005; Mims et al.).

The difficulty associated with requiring observations of K-12 teachers using technology is the lack of technology used by teachers in the field. Therefore, field observations are not commonly used in technology integration education due to the lack of placements (Ertmer, Gopalakrishnan, & Ross, 2001). To address these limitations, teacher education programs have incorporated vignettes (or short videos) of teachers using technology to address the goals of a typical observation (Krueger et al., 2004);

Vignettes commonly show exemplary examples of certain methods or strategies for including technology into the classroom. Having preservice teachers observe these teachers through videos is a "viable means for increasing capacity (ideas and self-efficacy) for technology integration" (Ertmer et al., 2003, p. 111). This observation format provides additional benefits since preservice teachers are able to "stop, think, write, talk about it, replay the activity over, and chunk activities together in different ways for different analytic purposes" (Krueger et al., 2004, p. 208). Vignettes can address a variety of specific situational strategies that can be analyzed and evaluated by individuals or groups. Because many diverse vignettes exist that provide good examples for using technology in the classroom, this format can provide examples of multiple views, methods, and strategies that preservice teachers can later emulate and add to their teaching toolkit (Ferdig, Roehler, Boling, Knezek, Pearson, &Yadav, 2004).

Perhaps the most well-known teacher technology vignette repository is the Integrating New Technologies into the Methods of Education database (InTime) from the University of Northern Iowa (Author A & Cullen, 2006). This searchable database contains 540 videos of quality technology integration examples, categorized by wide range of content areas and situations. Each vignette is equipped with raw footage and edited video of the lesson, written and video narratives/ reflections from the teacher, scrolling transcripts, background information, lesson insights from the teacher, probing questions for viewers, and an online discussion forum. All of these features were incorporated to enable teacher educators, or even preservice teachers, to easily view, analyze, and evaluate exemplary technology integration models (Krueger et al., 2004).

Table 6
Approach Summary: Authentic Experiences

Definition	Authentic experiences provide preservice teachers with the opportunity to encounter a wide range of messy and ambiguous problems that they are likely to encounter with technology in their future classrooms (Rosaen & Bird, 2005). During these experiences, preservice teachers identify specific problems, analyze various strategies to use within the situation, establish recovery mechanisms, and revise their practice for when they encounter a similar problem in the future (Weisner & Salkeld, 2004).
Examples	Cases (Beck et al., 2002), project-based learning (Howard, 2002), simulations (Sanzone, Hunt, & Bevill, 2002), open-ended learning environments (Hill, 1999)

Authentic experiences. The fifth approach utilized to prepare preservice teachers to use technology is *authentic experiences* (see Table 6). One aspect lacking from a majority of technology integration programs is the realism and variety of problems associated with technology integration in K-12 schools (Weisner & Salkeld, 2004). Authentic experiences allow preservice teachers to experience problem solving technology integration problems, as well as practicing their solutions without the logistical issues associated with actual practice in the field (Rosaen & Bird, 2005). They can examine issues and apply decision-making skills to a situation before it happens to them. Although not every situation can be addressed or anticipated, this approach prepares preservice teachers to enter the classroom better prepared to use technology (U. S. Department of Education, 2005). After authentic experiences regarding technology, preservice teachers show improvement in their ability to: (a) identify instructional problems, (b) consider multiple perspectives, (c) create solutions on large, varied pieces of evidence, (d) consider consequences of their solutions, (e) identify potential issues, and (f) synthesize final solutions and conclusions (Beck, King, &Marshall, 2002).

However, several studies indicate that novices tend to focus on the surface problems (e.g., Hsu, 2004). Preservice teachers typically lack the expert knowledge needed to solve the problem and overlook the main dilemma (Brush, 1998). In addition, these types of environments often require a large amount of preparation, especially when utilizing rich multimedia environments (Cannings & Talley, 2002).

The PT3 project at the University of Northern Colorado created a case-based simulation based on typical experiences of first-year teachers and common technology integration problems. Each week, preservice teachers encountered new authentic problems with reality-based artifacts, such as videos of other teachers, sample lesson plans, and official memos. Preservice teachers were charged with exploring and identifying the problem, gathering resources, and proposing a solution (Sanzone et al., 2002). In a similar format, one program used case assignments from the Educational Theory into Practice Software (ETIPS) project to place preservice teachers in the role of a teacher facing a technology integration decision or problem. The preservice teachers used the information from the case to search simulated school websites for information related to technology integration. Using this information, they proposed a solution in the form of an essay and reflected on their decision and problem-solving process through an online guide (Dexter, Gibson, Riedel, & Scharber, 2005).

Table 7

Approach Summary: Reflection

Definition	Reflection encourages preservice teachers to think about their current beliefs and pedagogy. As teachers develop self-reflective abilities, they are able to challenge themselves and turn into life-long learners, critically considering their teaching practices (Lasley & Matczynski, 1995). Reflection facilitates teacher exploration of "routine and complex dimensions of classroom practice" (Lasley & Matczynski, p. 307).
Examples	Electronic portfolios (Strudler & Wetzel, 2005), narratives (Ferdig, 2004), journals

Reflection. The final approach found in teacher education programs was *reflections* (see Table 7). A key characteristic of quality teachers is constant reflection on their teaching including the learning experiences and strategies they are implementing, the reasons behind those choices, and methods of possible improvement (Lasley & Matczynski). As teachers reflect, they consider their teaching practices in a way that may challenge their current beliefs and necessitate change (Ertmer, 2005); this is especially true with technology.

Many teacher education programs have used electronic portfolios as a form of technology integration reflection (e.g., Britten, Mullen, & Stuve, 2003). The electronic portfolio necessitates preservice teachers to document their learning process and define themselves as a teacher. Some programs are using portfolios as exit requirements, insisting preservice teachers meet the required standards before granting them a degree (Strudler & Wetzel, 2005). In one specific example (Doty & Hillman, 2001), the portfolio was used throughout the teacher education program. Each faculty member was required to include activities in their course that related to the electronic portfolio. Faculty members provided preservice teachers with ideas, examples, sample templates, and connections to the International Society for Technology in Education (ISTE) standards for preservice teachers to use within their portfolios (Doty & Hillman).

As another form of reflection, narratives allow individuals to reflect on the experiences of each individual and how they understand the context and situation of different events (Ferdig, 2004). When preservice teachers write and tell their own stories related to teaching, this process helps them understand their teaching practice and pedagogy. Narratives provide opportunities to evolve and change as the individual changes; it can help build self-perceptions of teaching as preservice teachers develop as educators (Strehle, Whatley, Kurz, & Hausfather, 2002). At the University of Florida, a faculty member and preservice student teacher worked together to create an understanding of technology integration in the curriculum (Ferdig). They collaborated through discussions and journals to create a narrative account of technology integration within the classroom. By talking through problems, performing "just-in-time" training when needed, and brainstorming alternatives together, the preservice student teacher was able to directly apply the knowledge to her student teaching situation.

Summary of approaches. Teacher education programs typically include several of these approaches within their technology experiences (See Table 8). While many have recommended specific approaches based on their own studies, none have been proven as the most effective: "Numerous teacher education programs have made extensive efforts to implement effective and meaningful use of technology, however the strategies used to attain these goals are complex, diverse, often conflicting, and rarely evaluated well" (Kay, 2006, p. 384). This could be due to the fact that teacher education programs have different needs and contexts.

Table 8
A Summary of the Six Approaches

Approaches	Intended Outcomes	Example Formats
Information Delivery	Be familiar with specific technology integration content	Textbooks, articles, websites, lectures, podcasts, listservs, YouTube, WebQuests
Hands-on Skill Building Activities	Build technology skills	Tutorials, workshops, step-by-step instructions, computer-lab courses, screencasts
Practice in the Field	Apply technology integration knowledge with students	Field experiences, microteaching, tutoring K-12 students
Observations and Modeling	Recognize quality technology integration	Faculty modeling, peer modeling, video vignettes
Authentic Experiences	Discern consequences of instructional technology integration decisions	Cases, project-based learning, simulations, open-ended learning environments
Reflections	Contemplate abilities and how to address gaps	Electronic portfolios, narratives

IMPLICATIONS FOR DESIGN OF TECHNOLOGY EXPERIENCES

While many teacher education faculty often use recognized "best practices" to inform the design of their technology integration experiences, it seems that considering their individual needs would be more important to achieving the desired outcome. As all approaches have benefits and limitations, the approaches should be selected based the critical outcomes of each program. By examining the technology content goals and broader context, the approaches selected can more specifically achieve the intended results.

Teacher education faculty should consider which approaches best meet the intended goals of the teacher education program. What skills do their graduates need in order to be prepared to use technology in their future classrooms? Therefore, before considering which approaches to include in the technology experiences, teacher education programs need to establish a list of the specific technology content goals they believe are necessary for preservice teachers to achieve in order to be succeed in using technology in the classroom.

Technology Content Goals

Depending on the teacher education program, specific technology content goals may vary. Teacher education programs may have different ideas about which specific technology content will best prepare their graduates to use technology in their future classrooms. Many seem to believe that focusing on computer-based content is the content that will most likely prepare preservice teachers to use technology in their future classrooms (Betrus, 2000; Author A et al., 2005). In a recent study by the National Center for Education Statistics (NCES) (Kleiner, Thomas, & Lewis, 2007), 1,439 degree-granting four-year institutions with teacher education programs for initial licensure were surveyed to determine the types of technology experiences these institutions provided to students in their programs. This report indicated a strong preference for addressing computer-based content goals such as using Internet resources and communication tools for instruction (100%), developing curriculum plans using technology to address content standards (99%), and using content specific software tools for instruction (97%). In another study, which surveyed 344 AACTE teacher education programs, those programs indicated a strong tendency to address content goals of trends/ethics/issues (74%), technology integration (72%), and instructional design (60%) (Betrus). Based on the results of this study, Betrus and Molenda (2002) suggested that there were two main types of courses: one that "maintained a balanced concern for all sorts of media, including computer based media" and a second that focused primarily on "teach[ing] computer technologies, ignoring the earlier technologies, and is more closely associated with the content interests of the membership of International Society for Technology in Education (ISTE)" (p. 20).

Purdue University's program seems to incorporate the focus of both types of courses. The required educational technology course includes a large lecture focused on instructional design decisions, as well as a computer-based laboratory that focuses on word processing, spreadsheets, databases, presentation software, Internet resources, and webpage development. However, even with technology content goals from both areas, preservice teachers have indicated that they still feel apprehensive about integrating technology into future classrooms. Preservice teachers indicate this apprehension was due, in part, to their lack of knowledge on actual implementation strategies such as classroom management and subject-specific uses of technology (Author A et al., 2005).

Due to the large variance in technology found in schools and how various subject areas use technology, teacher education programs can feel pressured to prepare their teachers for all of these environments and subject areas (Sanders & Craig, 1999). For example, some graduates may find jobs in schools with limited access to technology resources. If this is the case, many of the technology skills focused on during their teacher education program may lack relevance for their current jobs (Hughes, 2005). Some programs have compensated for this by incorporating a broader range of technology content goals. However, this often results in an overly full workload and crammed semester schedule; students in educational technology courses often complain about the workload (Author A et al., 2005). Therefore, when designing the technology experience curriculum, it becomes necessary to specify the technology content goals the faculty believe will best prepare preservice teachers to use technology in their future classrooms and intentionally select the approaches that will best address these goals.

Broader Context

In addition to specific technology content goals, teacher education faculty also need to consider how the technology experiences are situated within the *broader context* of the teacher education program. The *context* of technology experiences can range on a continuum from one stand-alone technology course to fully-integrated throughout the program. In the recent NCES study, results of the survey indicated that nearly all teacher education programs incorporate technology use for teachers, with 85 percent offering a stand-alone educational technology course (Kleiner et al., 2007).

Often times, the teacher education faculty have little control over the context. Therefore, certain approaches may need to change in order to fit the constraints of the broader context. Within the broader context of the teacher education program, it is important to consider the constraining factors that may influence the selection of the best approach for technology experiences. Such factors could include the technology and teaching skills of the preservice teachers and faculty, the resources available to the preservice teachers and faculty, and the placement of the technology integration experiences within the broader context of the curriculum.

Design Process Guide for Teacher Technology Experiences Revisions

The primary goal of this review was to gain a stronger understanding that may inform the design process of technology experiences within a teacher education program. Through this process, teacher education faculty can consider various experiences and select the most appropriate learning experiences to achieve their intended goals of preparing preservice teachers to use technology in their future classrooms. Appropriate learning experiences are defined as best meeting the needs of the specific program. Depending on the teacher education faculty and needs of the specific program, the most appropriate learning experience will vary. After considering the three main elements (broader context, technology content goals, and approaches), there is still the question of how to design the most appropriate technology experiences to intentionally meet the specific technology content goals faculty feel are necessary to prepare preservice teachers to use technology in their classrooms within the constraints of a broader teacher education program context. Therefore, based on this synthesis, a guide was developed to help facilitate this process (see Figure 1).

Step 1. As a first step, teacher education faculty need to consider how technology experiences fit within the broader context of the teacher education program. Depending on the program, there may be certain limitations we need to consider when design technology experiences. Questions to consider may include current teacher education program curriculum requirements to establish a format (Where does technology fit within the teacher education curriculum?), available resources (What types of equipment and support are available?), and the current skills of those involved (e.g., What level of technology and teaching skills do preservice teachers have when they receive their technology experience?).

For example, one program may require a three-credit hour technology course as a prerequisite for entering the teacher education program (format). Since the course serves as a prerequisite, preservice teachers have no prior teaching experience (skills). In addition, a large number of preservice teachers enroll in the technology course at one time (format). With this substantial group of preservice teachers, a large lecture course with small accompanying labs addresses the needs based on limitations of the context. The large lecture portion of the course places students in a large lecture hall while the accompanying lab sessions take place in small computer labs (resources). In addition, supplemental computer labs, a variety of technology available for student-checkout, and local schools with varying levels of technology access may also impact the design of technology experiences (resources).

The broader context of any program will impact the preservice technology experience design. It is important to document and consider all the variables carefully. The deliverable outcome from this step should be a list of the format requirements (current placement and constraints of the technology experiences within the teacher education program), a list of available resources, and a list of the skills set for both preservice teachers and faculty within the teacher education program.

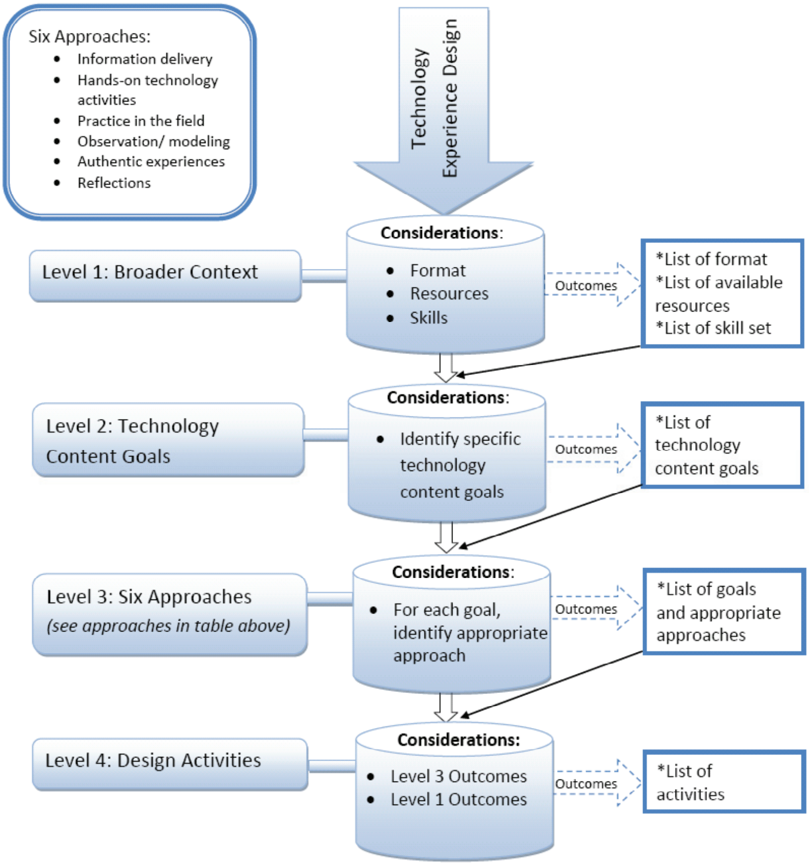

Figure 1. A conceptual guide for preservice technology experience design.

Step 2. The second step requires establishing specific technology content goals. This step is a critical component to determine what knowledge the designer believes preservice teachers need when they leave the program in order to be successful in using technology in their classrooms. For example, if the preservice teachers lack teaching experience, instructional design and high levels of integration may extend too far beyond the limitations associated with a three-credit hour course. Therefore, computer-based applications, aligning with the ISTE NETS-T standards, may be a good selection of focus (Betrus & Molenda, 2002). Some of the specific technology content goals could include the following: use web 2.0 tools to collaborate and share, identify high quality educational resources online, explore methods for learning new technologies, management of students within a computer lab, and evaluate educational applications of technology. The deliverable outcome of this step is a comprehensive list of the specific technology content goals. It is important to ensure that the technology content goals are as specific as possible as this will make the next step of selecting appropriate approaches easier.

Step 3. Using the specific technology content goals, teacher education faculty can begin the third step of selecting appropriate approaches to meet the specific goals. For each specific technology content goal, consider all the six approaches since each approach seems to target slightly different outcomes (see Table 8). The designer could use statements related to each approach to distinguish whether the approach is a good match for achieving the intended technology content goal. For example, when considering information delivery, the designer may think about the following statement: "There are specific viewpoints/strategies that preservice teachers need to have with regards to this skill in order to be successful in using technology in their future classroom." Or perhaps for hands-on skill building activities, they may consider the following statements: "There are specific elements of this technology that preservice teachers need to learn" or "It would be beneficial to learn this skill through a step-by-step procedure."

The following technology content goal will be used as an example to illustrate this process. Inservice teachers struggle with the management of students within a computer lab (Pierson, 1999). Therefore, this could be identified as a need for preservice teachers in order to use technology in their future classrooms. To successfully achieve this goal, it seems necessary for preservice teachers to recognize what quality management of computer labs look like, as well as the management decisions that result in positive or negative experiences. Consequently, observations or modeling would be an appropriate selection to provide examples of integration, while practice in the field or authentic experiences would provide an opportunity to see how different management decisions affect computer lab experiences. An outcome deliverable for this third step should produce a list of the specific technology content goals and the approaches that best meet those goals (see Table

3). Note that some of the technology content goals previously specified were made more specific to better target the desired learning goals. Furthermore, each technology content goal may require more than one approach for successful achievement.

Table 9
Examples of Step Three Outcome Deliverable

Specific Technology Content Goal	Appropriate Approaches
Management of students in computer lab Use Web 2.0 tools to collaborate and share Identify high quality educational resources online (how to perform targeted searches for valid resources) Explore methods for learning new technologies Evaluate educational applications of technology (is this a good use of technology, selection of appropriate technology for specific lessons)	Observations and modeling Practice in the field Authentic experiences Information delivery Hands-on skill-building Hands-on skill building Authentic experiences Hands-on skill-building Reflection Observation and modeling Authentic experiences

Step 4. Finally, in step four, the three elements (broader context, technology content goals, and approaches) converge to guide the design of activities that will intentionally address the specific technology content goals. This step begins with a review of the appropriate approaches from the step three deliverable (see Table 9). By reviewing these goals and appropriate approaches, some activities might be able to address multiple goals. For example, web 2.0 tools and explore methods for learning new technologies could be combined into one activity. By first showing preservice teachers how to use the web 2.0 tools (information delivery), they can collaborate with each other to discuss and reflect on methods for learning new technologies with their fellow classmates (reflection). In another example, identify high quality educational resources online, web 2.0 tools, and evaluate educational applications of technology can be combined into one activity. Preservice teachers can first review a tutorial on how to perform targeted searches for valid instructional resources, thereby being able to identify high quality educational resources (hands-on skill building). Preservice teachers will then participate in a case-based scenario that requires them search for educational resources online for a particular lesson plan and distinguish which educational resources work better than others (authentic experiences).

Multiple approaches can be included in one activity or assignment to meet technology content goals. Consider the following hypothetical assignment as a way to target the technology content goal of classroom management strategies in a computer lab. A preservice teacher observes a video of an exemplary teacher in a computer lab (observation/modeling), and uses some similar strategies within a microteaching session with classmates in a computer lab (practice in the field). Once the microteaching session is complete, the preservice teacher completes a journal entry (reflection) discussing what skills they still need to develop and identify strategies for achieving those skills. The preservice teacher can then use that list of skills to work with an educational technology consultant in the lab (hands-on activities) to develop specific technology artifacts. The approaches in this assignment would enable prepare preservice teachers to use technology by seeing good examples, having an opportunity to try out strategies, critically assess their technology integration abilities, and build new technology skills.

Also within step four, the broader context factors (established in step one) need to be considered. Depending on the format, resources, and skills within the broader context of the teacher education program, the approaches selected may need to change. For example, if preservice teachers receive their technology integration experiences before they enter the teacher education program, practice with technology in field opportunities may be limited. Therefore, microteaching activities or having preservice teachers instruct a K-12 student using video conferencing technology could provide opportunities to practice technology integration skills. The early placement could also create a large time gap between taking the course and becoming an inservice teacher. Many of the technology skills learned during the course could be forgotten or out-dated. Therefore, by including a specific technology content goal of exploring methods for learning new technologies, preservice teachers may be better prepared to learn new technologies once they beginning teaching.

CONCLUSIONS AND FUTURE RESEARCH

As discussed throughout this paper, there are six main approaches that teacher education programs have tried implementing to prepare their preservice teachers to use technology in their classrooms. These approaches can be combined and emphasis can be placed on the goals that teacher education programs feel are the most important for their preservice teachers' technology development. Since no approach has been proven as the most effective, technology integration within teacher education programs should incorporate multiple approaches (Kay, 2006). The formats and levels of emphasis placed on these different approaches can vary depending on program restraints and opportunities for technology integration within the teacher education program.

Future research should focus on evaluating the most effective ways to prepare preservice teachers to use technology. Recently, researchers have called for renewed efforts in exploring both what knowledge should be taught in pre-service teacher education programs with regard to technology, and how to best prepare teachers to effectively use that knowledge to support student learning (e.g., Lawless & Pellegrino, 2007; Pellegrino et al., 2007). To this point, research that has examined these issues has tended to rely heavily on self-reported survey data, (e.g., Kleiner et al., 2007), and tended to examine how technology was incorporated into teacher education programs at only a superficial "course" level (Pellegrino et al.). Finally, there are few detailed cross-institutional studies available that can provide more generalizable implications regarding how to best prepare prospective teachers to effectively use technology (e.g., Strudler et al., 1999, Pellegrino et al.). As Pellegrino et al. (p. 55) state: "A review of existing evaluation reports on the state of technology implementation in teacher education programs shows a lack of attention to cross-institutional and/or longitudinal studies. We found no systematic, conceptually driven effort to study the effectiveness of technology integration across multiple [institutes of higher education]."

Teacher education programs are currently implementing a variety of technology experiences. Furthermore, it is apparent that one technology experience does not work for all programs. Teacher education programs need to consider the specific competencies teacher education graduates need to be successful in order to use technology in the classroom. Teacher education faculty should consider the broader context and technology content goals before selecting approaches and designing activities. As technology develops and more is learned about how to best use new technologies in teaching and learning situations, technology content goals will need to continuously change. Therefore, it is important to consistently reevaluate technology content goals and select appropriate approaches to best prepare teachers to use technology in their classrooms.

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