Hall, L. (2006). Modeling technology integration for preservice teachers: A PT3 case study. *Contemporary Issues in Technology and Teacher Education, 6*(4), 436-455.

Modeling Technology Integration for Preservice Teachers: A PT3 Case Study

Leslie Hall
Washington State University

Abstract

This case study describes the outcomes of 4 years of professional development funded by a PT3 grant. Participants included general education university faculty members, teacher education faculty members, school administrators, and K-12 teachers. All professional development activities were based on the *National Educational Technology Standards for Teachers* (NETS-T). Findings show that all participants modeled Standards 1-5 of NETS-T. Discussion includes the absence of modeling of Standard 6 and levels of cognitive skills required by students to engage in technology integration activities. Based on this study, it is recommended that professional development in the area of technology integration for university faculty members and for K-12 teachers should stress uses of software and hardware for analysis, synthesis, and evaluation of information and concepts. Understanding the stages of adoption and their relationships to cognitive skills may help instructors reflect on personal practice and move through the stages more quickly. Special attention should be paid to NETS-T, Standard 6, to ensure understandings of ways in which specific pieces of software and specific pedagogical practices can empower and disempower groups of diverse learners.

The Preparing Tomorrow's Teachers to Use Technology (PT3) grants from the U.S. Department of Education provided the first large-scale funding for professional development in the area of educational technology across all levels of teacher preparation. Since 1999, the Department has awarded $335.7 million in competitive grants to 441 consortia for the purposes of faculty development, course restructuring, certification policy changes, online teacher preparation, video case studies, electronic portfolios, mentoring triads, and embedded assessments (U.S. Department of Education, n.d.).

In the early 1990s, many scholars (Bruder, Buchsbaum, Hill, & Orlando, 1992; Campoy, 1992; Collins, 1991; Newman, 1992) identified technology as vital to school reform. Yet, by 1999 computers had still made only minor impacts on instruction in K-12 classrooms. Many PT3 grants sought to address this through professional development across teacher preparation.

This article describes one PT3 grant that provided professional development activities in the area of technology integration for general education university faculty members, teacher education faculty members, and potential cooperating teachers in K-12 schools. First, relevant research is reviewed on professional development and technology integration in teacher preparation. Then the context of the study and the case study methodology used in this research are described. These are followed by a description of the professional development opportunities offered to the three constituencies of participants. The findings reveal the ways in which these educators changed their teaching as a result of engagement in technology integration professional development activities. The reported teaching activities are linked to the ways in which the *National Educational Technology Standards* (International Society for Technology in Education [ISTE], 2002) were modeled for preservice teachers. The discussion shows how the participants' approaches to technology-integrated instruction reflect stages of technology adoption (Dwyer, Ringstaff, & Sandholtz, 1991; Hord, Rutherford, Huling-Austin, & Hall, 1987). Finally, it is recommended that professional development in the area of technology integration for university faculty members and for K-12 teachers emphasize the empowerment of students.

Technology in Education

Many in education assumed that preservice teachers enrolled in initial licensure programs after the year 2000 would be quite familiar with technology, especially computers, and therefore more willing and able to integrate computers into K-12 instruction. Although these early 21st century preservice teachers are more comfortable with computers, they are not necessarily more willing to incorporate them into their repertoire of instructional strategies (Russell, Bebell, O'Dwyer, & O'Connor, 2003). Modeling the use of multiple technologies as teaching and learning tools in university courses has been suggested as a way to help preservice teachers understand the potential of technology in the learning process (Howland, & Wedman, 2004; Rosaen, Hobson, & Khan, 2003). However, this modeling cannot take place without professional development in the area of technology integration for postsecondary faculty.

In recent years, attempts to provide professional development for postsecondary faculty have taken many forms. Across various initiatives, partnering technology savvy undergraduates with university faculty has proven successful (Denton, Davis, Strader, Clark, & Jolly, 2003; Wedman, & Diggs, 2001), as have collaborative groups (Cradler, Freeman, Cradler, & McNabb, 2002; Graves & Kelly, 2002; Rosaen et al., 2003), partnering teacher educators with practitioners (Murphy, Richards, Lewis, & Carman, 2005), and support from an educational technology specialist (Feist, 2003; Slavit, Sawyer, & Curley, 2003). Popham and Rocque (2004) reported that faculty-as-students in a preservice technology course proved to be an effective form of professional development. Faculty also commented favorably on efforts that customized professional development for individual needs (Cradler et al., 2002) and just-in-time support for learning (Feist, 2003), as opposed to the stand-alone workshop model. Kahn and Pred (2001) noted the importance of faculty members' working with the hardware and software available to them in their colleges.

Although many postsecondary faculty members remarked on the effectiveness of the professional development provided in these studies, it was also noted that the traditional university reward system does not generally recognize innovation in classroom instruction (Wedman & Diggs, 2001). In most tenure and promotion decisions, changing instructional practices to model technology integration only benefits postsecondary faculty members if they publish their experiences.

In practicum and student teaching experiences, the modeling of technology integration passes to supervising teachers. The placement of student teachers with technology-using in-service teachers is critical due to the value preservice teachers place on the experience and practical knowledge of in-service teachers (Margerum-Leys, & Marx, 2004). Unfortunately, 410 student teachers reported via surveys that two thirds of their supervising teachers used only word processing (Carlson, & Gooden, 1999). Preservice teachers may enter student teaching with better computer skills and more technology integration ideas than the supervising teacher. McCoy (2000) found that student teachers felt hampered in their desire to integrate computers by the lack of support from supervising teachers.

In any educational reform, leadership is key. Israel and Kasper (2004) reviewed the importance of the administrator in recognizing barriers to change, supporting the transition, and continuing to demystify the processes of transformation. Central to the success of effective technology use for instruction are administrators' roles in supporting organizational structures and providing leadership as educators engage in professional development (Wizer & McPherson, 2005). This support is vital both from department chairs and deans in university settings and for department chairs, principals, and superintendents in school settings. Technology standards can guide these education leaders as they support instructional change.

National Educational Technology Standards

The *National Educational Technology Standards* (NETS) address many issues of technology in K-12 education through the identification of understandings, skills, and competencies needed by students, teachers, and administrators (ISTE, 2005). The *NETS for Students* (NETS-S; ISTE, 2000) describe what students should know about technology and what they should be able to do with it in learning settings. *NETS for Teachers* (NETS-T; ISTE, 2002), focus on skills and competencies considered necessary for preservice teacher education students as they enter the field. College faculty members and cooperating teachers are expected to provide multiple opportunities for preservice teachers to meet these standards. NETS-A, the technology standards for K-12 school administrators (Technology Standards for School Administrators Collaborative, 2001), define the technology knowledge and skills needed by building- and district-level administrators as they provide leadership for technology adoptions and educational reform.

Stages of Technology Adoption

Two widely cited studies (Dwyer et al., 1991; Hord et al., 1987) have indicated that teachers' adoption of technology into instructional practices follows predictable stages. Initial efforts to use technology generally reinforce traditional teaching practices. In the middle stages of learning to integrate technology, teachers begin to understand the affordances of their available hardware and software. These insights result in creating learning opportunities not possible without technology.

Although many teachers remain in the mid-stages of technology indefinitely, others adapt their approaches to instruction based on deep reflection of the teaching-learning process and ways in which various types of hardware and software can support new ways for students to engage with content and to display learning. Various types of software commonly fall into patterns of use based on teachers' levels of adoption. Productivity tools like word processing support traditional activities such as papers and reports; presentation software supports traditional lectures; and drill-and-practice programs replicate flashcards.

In mid-stages of adoption, teachers move toward more learner-centered instructional practices that include curriculum-based software and research tools. In the most advanced stages of technology adoption, teachers meld their knowledge of teaching and learning with their understandings of learning affordances offered by multiple pieces of software. Technology becomes a tool that can move students into higher levels of thinking—analysis, synthesis, and evaluation (Bloom, 1956).

Context of the Study

The technology standards for teachers, NETS-T (ISTE, 2002), guided the professional development activities of the PT3 grant reported here. The overarching goal of this $1.48 million, 4-year (3 funded and 1 unfunded) PT3 grant at a doctoral extensive university was the infusion of NETS-T across all phases of the elementary and secondary teacher preparation programs from general education courses to teacher preparation courses and into field experiences. The intent was to capitalize on the computer experiences of today's preservice teachers and to assist collaborators in modeling the use of computers and other digital technologies as tools for learning in K-12 classrooms.

The University and College of Education

Situated in a rural area, the University serves a population of approximately 18,000 students in a community of 7,000. The College of Education (COE) annually prepares 150-200 elementary teachers and 50-75 secondary teachers. The 2-year undergraduate elementary education program resides in the College of Education, while the undergraduate secondary education program courses are taught in the College and in the students' major disciplinary departments. Due to the small size of the community, practicum experiences for preservice teachers could overwhelm the local schools. To address this potential problem, undergraduate students participate in field experiences in the local schools during the first two semesters of the program. More concentrated field experiences, including student teaching, generally occur in schools in or near the preservice teachers' home communities. In proximity to the University, these communities may be as near as 20 miles and as far as 350 miles. Students maintain contact with the University during the final field experience and student teaching, but are not observed or supervised by teacher education faculty members.

The post-BA masters with licensure programs for elementary and secondary preservice teachers follow similar patterns as the undergraduate programs in the area of coursework. The elementary preservice teachers take all coursework in the College of Education while the secondary preservice teachers take coursework in the College and in their major disciplines. Unlike the undergraduates, the post-BA preservice teachers are placed locally for practicum and student teaching experiences. They are observed and supervised by teacher preparation faculty members.

Grant Personnel

During the first 2 years, 2000-2002, this PT3 grant relied on the expertise of the project director, an assistant professor of educational technology (who operationalized the grant but did not write it), a half-time graduate student, and a half-time undergraduate student. In the final 2 years, 2002-2004, the grant came under the leadership of a new project director who was also an assistant professor of educational technology. A new half-time graduate student assisted the new project director. In addition, one or two graduate students offered one-on-one, on-demand assistance for teacher education faculty members and, in the final semester of the grant, worked with the project director on survey development and data gathering. The grant evaluator worked with the second project director and half-time graduate student from May 2003 through June 2004.

Grant Partners

PT3 grant partners included three University colleges, a University center for integrating technology into students' learning experiences, and four school districts. Four project coordinators assisted the project director in coordinating and carrying out professional development activities in the area of technology integration for faculty members across the university. The project coordinators included a full professor from liberal arts, an associate professor from science, the director of the university center for integrating technology into students' learning experiences, and the half-time graduate student from education. The coordinators from liberal arts and science supported faculty members in their respective colleges. The half-time graduate student, who served as project coordinator in the College of Education, and the project director worked with all other grant participants that included College of Education teacher education faculty members, preservice teachers, in-service teachers, principals, and school district administrators. The project director also served as the coordinator of the required technology course for preservice teachers.

The four partner school districts included a small district on an Indian reservation 120 miles from the University, a small district just off another Indian reservation 150 miles from the University, a medium-sized district serving predominantly Hispanic students 190 miles from the University, and a large urban district 325 miles from the University. In the schools, district administrators and principals consulted with the project directors and the College of Education project coordinators to plan and carry out professional development activities for in-service teachers.

Methods

The research question informing this study was as follows:

> What effects did the activities of this PT3 grant have on the modeling of NETS-T by general education faculty members, teacher education faculty members, and K-12 cooperating teachers for preservice teachers enrolled in initial licensure programs?

Case Study Methodology

Case study methodology (Creswell, 2003; Stake, 2000) was used for this research. This methodology offered the opportunity to better understand the context and subsections (e.g., individuals, groups, events, and issues, relating to this PT3 grant). The process of learning to integrate and model NETS-T was bounded in time and activity by the duration of this grant, 2000-2004. Of particular interest in this case study was how the participants modeled NETS-T for preservice teachers given the professional development opportunities and support structures provided by the PT3 grant.

The case in this instance encompassed the grant situated within the university system of general education courses, teacher preparation courses, and schools that educate and prepare preservice teachers. Participants included the general education faculty members, teacher education faculty members, and K-12 school personnel who provided this particular university system's programs and support for preservice teachers.

The University and College of Education in this case study are similar to other institutions engaged in the preparation of preservice teachers. They are also unique in their geographical setting, faculty areas of expertise and experience, and grant personnel. This case study attempted to document the variety of ways university faculty members and K-12 teachers modeled NETS-T for preservice teachers. It is hoped that readers of this research gain an understanding of the phenomena of learning to model technology integration for preservice teachers. Thus, the confines of the University system, its intentionality in the preparation of preservice teachers, the unique qualities of the participants, and the heuristic intent of case study methods made case study the logical research methodology for this research (Patton, 1990; Shank, 2002; Stake, 2000).

Data Sources

Data sources for this case study included syllabi from University courses ($n = 26$), exit interviews with teacher education faculty ($n = 19$), exit interviews with project coordinators and their staff members ($n = 5$), and end-of-grant surveys from University faculty members ($n = 55$), principals ($n = 7$), and in-service teachers ($n = 35$).

The second project director (2002-2004) conducted all interviews with teacher education faculty members. Questions focused on the faculty members' opinions of the value of computers as tools for teaching and learning; their personal experiences and readings that influenced that opinion; their involvement in PT3 grant activities; changes in their thinking concerning technology integration in their teaching; ways they had actually changed their teacher preparation courses to integrate technology; ways they had changed other courses to integrate technology; their personal meaning when saying that time is a barrier to technology integration in teaching; and activities or support the college or department could offer that would help sustain the work of the PT3 grant.

The grant evaluator conducted all interviews with project coordinators and their staff members. Questions focused on the impact of the PT3 grant on the teaching practices of the general education faculty, plans for sustaining the modeling of technology integration in general education courses, and particular insights gained over the life of the grant.

The second project director created the online survey for all grant participants. Topics addressed in the open-ended questions included hardware and software purchases funded by the PT3 grant; ways in which students were using technology in learning; participation in grant-sponsored professional development activities; ways in which the knowledge and experiences from professional development activities were being used; ways in which the combination of hardware, software, and professional development affected the educators' professional, administrative, and instructional work; and their opinions of the importance of computers as tools for teaching and learning in K-12 settings.

Using both open and axial coding (Strauss & Corbin, 1990), a content analysis was performed across data sources to identify categories concerning the modeling of NETS-T . Coding of responses and constant comparison of emerging results led to identification of themes. This analysis of syllabi, exit interviews, and culminating surveys identified three areas impacting the modeling of NETS-T improved professional technology skills, improvement in or enhancement of technology integration, and enhancement of student learning.

Supporting the Modeling of NETS-T

The NETS-T served as the core curriculum for this PT3 grant. The six standards of NETS-T state that teachers should have knowledge and skills in the areas of technology operations and concepts; planning and designing learning environments and experiences; teaching, learning, and the curriculum; assessment and evaluation; productivity and professional practices; and social, ethical, legal, and human issues surrounding the use of technology in K-12 schools. With proficiency in NETS-T it is expected that teachers will then guide their students toward proficiency in NETS-S, which state that students should demonstrate understandings and expertise in basic technology operations and concepts; social ethical, and human issues; and technology productivity, communication, and research tools. From the beginning of the project, the NETS-T framed the work of all collaborators and continued to be the grounding focus throughout the grant, with standards embedded in every aspect of professional development provided by the project for university faculty members and in-service teachers.

Focusing on the NETS-T, project staff offered or facilitated multiple opportunities for general education faculty members, teacher education faculty members, and K-12 teachers to learn to infuse technology standards across the entire elementary and secondary teacher preparation programs and provided opportunities for preservice teachers to meet and demonstrate the technology standards.

University Faculty

Promoting substantive change within educational organizations involves multidimensional innovation. According to prior research on technology integration programs (e.g., Cradler et al., 2002), participants needed differentiated support in improving or enhancing the use of technology in their teaching. This need resulted in a range of professional development opportunities for university participants. Under the original project director, in 2000 and 2001, university faculty members applied for summer mini-grants. Successful proposals illustrated connections to the ISTE NETS-T and explained specific ways the technology support would enhance curriculum and instruction. Presentations by grant staff (2000-2002) provided interested faculty members with information on topics such as the basics of HTML, the Internet and World Wide Web, PowerPoint, and CD-ROM production. In May 2001 and May 2002, a week of workshops to develop technology skills and to engage in technology integration activities attracted many faculty members from all University partner colleges.

With an eye on sustainability, in fall 2002 the second project director steered the direction of project activities away from general hardware and software skills and toward professional development around technology integration. This new direction included a more focused emphasis on adaptation of instructional planning and curriculum development at the University. Refocused grant activities took several forms. Under the new project director, from fall 2002 through spring 2004, the grant continued to offer a limited number of workshops to faculty participants in partner colleges, provided copies of the text adopted for the preservice technology courses to the teacher preparation faculty and selected faculty members in partner colleges, provided copies of all software used in the technology courses to the teacher preparation faculty, engaged an educational technology specialist for 2 days of workshops and discussions, and sponsored a series of group discussions to think through critical issues surrounding technology integration in schools. In March 2004, two national experts on educational technology were invited to the University for small group discussions with faculty members and students and for a panel discussion on the roles of technology in society.

During this same period, 2002-2004, the PT3 grant employed graduate students for on-demand, one-on-one support for the teacher preparation faculty in the College of Education. In summer 2003, 13 College of Education faculty members received funding for individual curriculum development with support from graduate assistants, for a total of 82 faculty workdays. The added components during the final 2 years of the grant were designed to deepen faculty members' understandings of how and why technology integration could impact curriculum development and student learning. The intent was to lead faculty members into institutionalizing the use of technology into overall content and pedagogy.

Partner-School Teachers

Field experiences provide preservice teachers with unique learning conditions. University faculty members can model technology integration in adult learning situations, but cooperating teachers serve as frontline models of K-12 teaching *in situ*. It was, therefore, important for the University's preservice teachers to observe technology integration in K-12 classrooms. From 2000-2002, teachers in the partner schools received support for integrating technology into their curricula through funding for requested hardware and software. Professional development for these teachers was planned and carried out by their respective districts. Activities included presentations from outside speakers and trainers, release time, stipends, support for conference attendance, and staff presentations. The project director conducted workshops at some district sites to assist teachers in using hardware and software effectively for instruction. In-service teachers also applied for summer mini-grants. As with University faculty members, successful proposals illustrated connections to the ISTE NETS-T. Beginning in fall 2002, the second project director guided the school partners away from general hardware and software acquisition and skills development. All grant expenditures were required to support professional development for technology integration to further the goal of in-service teachers' modeling of technologies as learning tools for preservice teachers begun earlier in University courses.

Findings

Culminating surveys and interviews revealed specific examples of changes in pedagogy and thinking through improved professional technology skills, improvement in or enhancement of technology integration, and enhancement of student learning. In the area of professional technology skills, university faculty members and K-12 teachers identified practices encompassing NETS-T, Standard I, understanding technology operations and concepts; Standard II, planning and designing learning environments and experiences; Standard III, teaching, learning, and the curriculum; and Standard V, productivity and professional practice (ISTE, 2002). Under the theme of improvement in or enhancement of technology integration, faculty members and teachers noted practices exemplary of NETS-T, Standards II, III, and IV, assessment and evaluation. Practices reported in the enhancement of student learning fell under NETS-T, Standards II, III and IV.

Professional Technology Skills

To model NETS-T, Standard I, technology operations and concepts; and Standard V, productivity and professional practices, faculty members and teachers needed hardware and software skills. Data revealed that far more university faculty members, 31%, mentioned learning and using PowerPoint in their courses than any other software. Some went beyond the basics with PowerPoint and embedded video clips in course presentations. Seven created course and personal Web sites, while others investigated Web course tools such as Blackboard. One science faculty member explored freeware for upper division astrophysics courses. A faculty member in music stated, "Learning about software has enabled me to utilize these tools in my teaching and professional work. Also, I have become one of the Music School's primary resources regarding the use of music notation software for students and faculty."

Some faculty participants used the opportunities provided by the PT3 grant to improve their skills in basics such as Word and e-mail. A faculty member from liberal arts said, "The main thing I was able to gain … was the language so I could ask for help" In the College of Education, faculty members mentioned improved skills in using Inspiration software and incorporating a SmartBoard into instruction. One faculty member in teacher education made this statement concerning professional technology skills, "The professional development I received both taught and inspired me to use PowerPoint, the Internet, and Web pages as instructional tools. I noticed that students had much more inherent respect for these technological tools than for overheads, lecture, etc." Tables 1 and 2 summarize the professional development opportunities provided for general education faculty and for teacher education faculty.

In the partner schools, principals noted that teachers used SmartBoards for instruction, grading software, and mail merge in Word for communicating with parents. Table 3 summarizes the professional development and support provided for K-12 teachers. The unique demands of K-12 teaching were reflected in the professional skills developed by classroom teachers, who frequently mentioned efficiency and organization as benefits of PT3 professional development. Thirteen teachers reported using software for tracking students' skills, individualizing instruction, and calculating grades. Nearly all 13 also remarked on the ease of generating progress reports to share with students and/or parents. One teacher stated, "The professional development in the use of certain programs has made classroom organization more simple, and the ease of lesson planning on the computer has made me a better-planned teacher."

Many teachers learned to use software to create graphic organizers and templates for students. Five teachers noted that class Web pages made it easier to communicate with parents. The Internet served as a tool to share information on listservs, collaborate with other educators, communicate with parents, and locate resources and information. Teachers also became more familiar with the software used for student instruction, such as Math Facts in a Flash, Accelerated Reader, Accelerated Math, Star Reader, Star Math, and NovaNet.

Table 1
2000-2002 Professional Development for University Faculty Members

Activity	General Education Faculty	Undergraduate and Post BA Teacher Education Faculty
Summer minigrants	X	X
Presentations on technology topics	X	X
Workshops during academic year	X	X
One-week intensive workshops	X	X

Table 2
2002-2004 Professional Development for University Faculty Members

Activity	General Education Faculty	Undergraduate and Post-BA Teacher Education Faculty
Copies of textbook used in preservice technology course	Selected faculty members	X
Group discussions on critical issues concerning technology integration in K-12 schools	X	X
Educational specialist—workshops and discussions	X	X
Small group discussions with national experts	X	X
University-wide panel discussion by national experts	X	X
Copies of National Educational Technology Standards for Teachers		X
Copies of software used in preservice technology course		X
On-demand, one-on-one support during academic year		X
Summer funding for curriculum and skill development		X

Table 3
Professional Development and Support for K-12 Teachers

2000-2002
Funding from Project Director for requested hardware and/or software
Minigrants funded by Project Director
Workshops conducted by Project Director
District-planned activities’ varied by district but included presentations from outside speakers and trainers, release time, stipends, support for conference attendance, and staff presentations
2002-2004
Workshops conducted by Project Director
District-planned activities’ varied by district but included presentations from outside speakers and trainers, release time, stipends, support for conference attendance, and staff presentations

Statements by two teachers illustrate the impact of PT3 activities on professional technology skills:

- I've used *Lessons by Design*, shared information through listservs, collaborated with other educators online, communicated with family members of students, and learned SO much that enhanced my students' learning opportunities. I've taught classes for other educators, paraprofessionals, and parents of students. Weekly classroom newsletters work well for my students and parents in communicating upcoming events, lesson assignments, and classroom activities.

- Most lesson plans are done on the computer, which makes organization very efficient. My classroom web page allows parents and students to check announcements and homework.

These uses of technology recounted by K-12 teachers indicate they were gaining knowledge and skills related to NETS-T Standard I, technology operations and concepts; Standard II, planning and designing learning environments and experiences; Standard IV, assessment and evaluation; and Standard V, productivity and professional practice.

Improved Technology Integration

The increased modeling of technology integration in instruction by university faculty members and K-12 teachers was a major goal of this PT3 grant. The NETS-T standards where preservice teachers would actually see this modeling of technology integration include Standards II, planning and designing learning environments and experiences; III, teaching, learning and the curriculum; and IV, assessment and evaluation. For the purposes of this study, technology integration was defined as activities requiring students to use technology actively in the completion of projects and assignments. The use of PowerPoint to illustrate and enhance lectures was not included in these technology integration data because students were not using the technology. PowerPoint used in lectures does not change the traditional classroom dynamic of active teacher/passive student.

Many university faculty members noted that they integrated technology by asking students to locate and evaluate information and resources found on the Web. In the College of Education preservice teachers created lesson plans utilizing software commonly found in schools, such as KidPix and Inspiration. They used interactive journaling in Web course tools and digital photography and video to document presentations and other classroom activities. One teacher education professor stated,

> I had the secondary certification preservice students post images from their teaching onto Blackboard. They then used these images of their actual teaching (in the classroom with their high school students) as the basis of threaded discussions, which they themselves initiated. I had the preservice teachers organize these discussions according to an action research cycle, giving them new perspectives on their teaching.

Another example of technology integration came from a liberal arts professor:

> I completely revised my [history] course, comprised mostly of pre-service secondary education teachers, to engage students more deeply in using primary source materials available on the Web. I developed an extensive set of [Web course tool] activities and discussion board questions to develop and build on skills and content knowledge.

Project collaboration among the three University colleges and the Center for technology integration resulted in one important new emphasis in the work of the Center. The student assistants from the Center who provide training and/or technical assistance to faculty members began to aid faculty members intentionally in understanding how to incorporate new technology skills into their curriculum and instruction. These student assistants built scaffolding questions into the training processes to help faculty members see the connections between their own learning and their teaching. Center staff reported that, while this kind of support had been part of the their mission before the project, awareness of PT3 project goals and objectives brought new attention to this component of technical assistance.

From the K-12 settings, teachers and principals reported many ways technology integration provided opportunities for students to use hardware and software for classroom learning experiences. In science classes some teachers integrated spreadsheets and probes for student data gathering. Students then used word processing and PowerPoint for reporting these data. Other science students used computer simulations to conduct experiments in chemistry. High school French students read both *LaMonde* and U.S. news sources online to compare and contrast reporting on world events. K-12 students learned to evaluate online resources for accuracy and to access online reference materials in the school library. They also engaged in WebQuests.

SmartBoards were integrated into both English and science courses to provide students opportunities for interactive learning. One teacher said, “The SmartBoards are a great way to integrate technology into lessons. They allow students to physically interact in the lessons in a fun and innovative way.” Students used concept mapping and graphing software for completing assignments. In addition, they used paint and draw software to create visual models of the plant life cycle and to illustrate scenes from award-winning books. Software specifically mentioned by teachers included KidPix, Word, Dreamweaver, Final Cut Pro, Publisher, and PowerPoint. One teacher reported a very creative use of digital photography:

> With great enthusiasm, my students have created dialog and planned PowerPoint presentations about such things as pronouns or adjectives. We took digital pictures of them posing in different scenes for pronoun use, inserted dialog bubbles, and have used the project to teach other students about using pronouns correctly. Their retention of mundane things is much greater.

In general education courses, teacher education courses, and student teaching experiences, preservice teachers experienced, saw, and planned technology integration to support learning as outlined in NETS-T, Standards II, III, and IV (ISTE, 2005c).

Enhanced Student Learning Experiences

For the purposes of this study, data included in this category showed evidence of providing experiences or examples to support student learning using technology. Here, using PowerPoint in lectures was included if Web links or video examples were embedded in the presentation. Data falling under this theme indicated the University faculty members and the K-12 teachers were modeling skills and knowledge contained in NETS-T Standard II, planning and designing learning environments and experiences; Standard III, teaching, learning, and curriculum; Standard IV, assessment and evaluation; and Standard V, productivity and professional practices.

At the University, multiple uses of digital technologies enhanced student-learning experiences. The Web provided university faculty members and students access to scholarly materials, museums, and other cultural collections. A student response system allowed one professor to assess student answers immediately during lecture and to adapt his instruction according to student understanding of key concepts. Teacher education faculty members used online group discussions to maintain contact with students placed in field experiences far from campus. Many of these same faculty members also used video examples of classroom teaching as illustrations and as discussion points.

A faculty member from liberal arts reported,

> I built a series of interrelated, ever more complex units based upon close analysis of the Web as a reliable and unreliable knowledge source. Greater familiarity with the software also allowed me to think more about the teaching and less about the technical components.

The teacher education faculty member who had his students use images in Blackboard™ for action research continued the use of images when these preservice teachers engaged in student teaching.

> The preservice teacher action-research website became part of [my course], which is the course that accompanies the preservice internship (for the secondary student teachers). This site directly let me use a case study approach—based on the students' action research—to their teacher preparation.

In the area of enhanced student learning experiences, teachers in the K-12 partner schools noted many changes in their thinking and instructional practices. Several teachers mentioned a conscious effort to include technology in classroom instruction and the increased use of graphic organizers for better understanding. One teacher mentioned a new awareness of ways to assess student learning. Another stated, “I have been more thoughtful about encouraging critical thinking skills in the classroom. Additionally, I have given credit to students for their critical thinking on my rubrics.” A different teacher noted, "[The professional development] has given me a chance to research ideas for lesson plans, and to have students learn more than what I can tell them and what the textbook has without leaving the classroom." A primary grade teacher said, "The children are fascinated when, after they read a story about ants … and see ants building a home in a sidewalk crack. They can see greatly enlarged ant pictures from Encarta or access Websites about ants that show close-up pictures of ants."

Professional development activities funded by the PT3 grant allowed university faculty members and K-12 teachers to model skills and understandings of the NETS-T improving their professional technology skills, experimenting with integrating technology into instruction, and expanding learning experiences for students. However, not all uses of technology recounted by university faculty members and partner-school teachers gave students agency and control in the learning process. Based on research examining teachers' uses of technology in teaching (cf. Baker, Gearhart, & Herman, 1993; Dwyer et al., 1991; Hord et al., 1987; Sheingold, & Hadley, 1990), these findings are not unusual.

Discussion and Recommendations

Participants in this study followed patterns of technology adoption reported by early research on teachers' technology integration practices (cf. Dwyer et al., 1991; Hord et al., 1987). Most began in the adoption stage with integration activities that supported traditional instruction and progressed to the adaptation stage by moving technology into existing classroom activities. A few entered the appropriation stage by developing new approaches to teaching that took advantage of available technologies.

Figure 1 depicts a continuum of instructional technology practices identified by the two groups of university faculty participants, general education and teacher education faculty members. The continuum begins with elemental communication practices, continues through instructor-centered practices, and moves into student-centered work, where students were allowed to construct their own meaning of learning while demonstrating required competencies for entry level teaching. The continuum presented in Figure 1 progresses from less powerful uses of technology on the left to more powerful uses of technology on the right. Student inquiry and student demonstration of knowledge and skills were considered the most powerful uses of technology because the learners made decisions concerning data collection, content, and display of information. In these uses of technology, the learners reflected on and prioritized information, thus requiring them to engage more deeply with content and key concepts. The continuum roughly follows Bloom's Taxonomy for cognitive skills (Bloom, 1956).

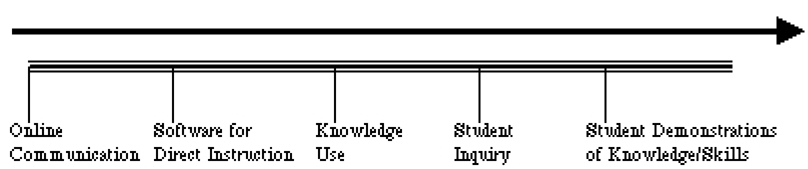

Figure 1. *Continuum of instructional technology practices implemented by university faculty participants: progresses from less powerful uses of technology on the left to more powerful uses of technology on the right.*

Table 4 presents more detailed descriptions of instructional technology practices as described in University syllabi and related in self-reports from faculty participants. Online communication and software for direct instruction, considered to be less powerful instructional technology practices, were often teacher centered with students responding to instructor determined questions and topics or passively receiving information. Practices identified as *Knowledge Use* in Table 4 required students to use previously learned content knowledge in concrete situations but generally asked them to respond in prescriptive ways that had best answers. For example, students were asked to go online, find a software evaluation form, and use that form to evaluate a piece of educational software. Web site evaluation assignments were much the same. The final two categories of instructional technology practices, *Student Inquiry* and *Student Demonstrations of Knowledge/Skills*, required students to choose topics, locate and evaluate information, and determine the display of information or new knowledge.

Table 4
Description of University Faculty Members' Instructional Technology Practices

Continuum of Practices	Faculty Members' Instructional Technology Practices
Online Communication	E-mail, interactive communication software, instructor websites, Web course tools
Software for Direct Instruction	Power Point, demonstration software, multimedia, Web course tools
Knowledge Use	Instructor directed Web searches and Web site evaluation, word processing (communication of requirements, feedback, rubrics) online literature/research reviews, software evaluation, new skills learned through training updates, use of multimedia, demonstration/simulation software, student feedback/input into course design, assessment tool development
Student Inquiry	Student directed Web searches and Web site evaluation, scientific processes, data collection/display, action research procedures, use of multimedia, interactive student journals or other communication, student input into course design
Student Demonstrations of Knowledge/Skills	Word processing (lesson plans, reflections, etc.), student websites, spreadsheet creation, multimedia authoring, publishing programs (newsletters, brochures), presentation software (Power Point)

The instructional practices of the K-12 teachers who participated in the PT3 grant also fell on a continuum. Figure 2 shows these practices beginning with student skill development, moving into teacher directed instruction, and like the instructional practices of university faculty members, advancing to student-centered work. The software for skill practice mentioned by 9 of the 35 teachers requires the least creative thinking or problem solving from students. Content is predetermined and only one answer can be correct.

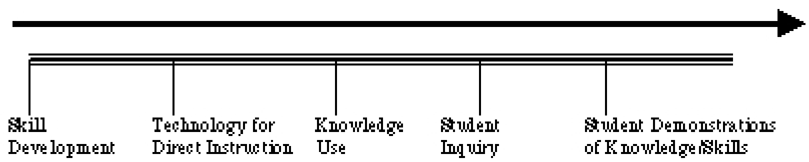

Figure 2. *Continuum of instructional technology practices implemented by K-12 teacher participants: progresses from student skill development, to teacher directed instruction, and then to student-centered instruction.*

Table 5 contains a description of the instructional practices of the K-12 teachers in more detail. In the area of *Technology for Direct Instruction*, students engaged with content through projected materials. Two examples, document cameras and SmartBoards, may encourage more active participation. The *Knowledge Use* activities and assignments described by teachers involved students in classifying, illustrating, arranging, comparing, and examining. Again, *Student Inquiry* and *Student Demonstration of Knowledge/Skills* activities put the students in control. In these activities, students determined the content and the displays of information that required them to integrate, modify, plan, design, assess, compose, and convince.

Table 5
Description of K-12 Teachers' Instructional Technology Practices

Continuum of Practices	K-12 Teachers' Instructional Technology Practices
Skill Development	Skill software for reading and math
Technology for Direct Instruction	Document camera and SmartBoard for editing student work, SmartBoards for solving math problems, PowerPoint for instruction
Knowledge Use	Teacher directed Web searches, drawing tools, word processing for reports, WebQuests, spreadsheet use
Student Inquiry	Student directed Web searches for research, data collection using probes, and displays of data
Student Demonstrations of Knowledge/Skills	PowerPoint presentations of research findings, video production, Web site production, tutoring teachers on software skills, publishing programs

Although the university faculty members and K-12 teachers successfully modeled NETS-T Standards I, II, III, IV, and V many activities for learners focused on lower cognitive skills. With the unfunded extension year, this PT3 grant worked with participating faculty members and teachers for 4 years. Technology integration for lower skills can be justified; however, it is troubling to discover the number of faculty members and teachers who moved little beyond these levels if they progressed at all. Notably, a professor in liberal arts was heralded as an excellent example of a technology-integrating instructor because he put all lectures into PowerPoint software.

Equally troubling was the absence of any reference to NETS-T, Standard VI, social, ethical, legal, and human issues surrounding the use of technology. In full, Standard VI states

> Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply those principles in practice. Teachers:
>
> A. model and teach legal and ethical practice related to technology use.
>
> B. apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.
>
> C. identify and use technology resources that affirm diversity
>
> D. promote safe and healthy use of technology resources.
>
> E. facilitate equitable access to technology resources for all students.

No teacher, university faculty member, or school administrator directly addressed new understandings or practices in the areas covered in Standard VI. The one comment that may have related to these issues came from a K-12 teacher who stated, "I create more personalized, appropriate lessons." Arguably, Standard VI, Performance Indicators B, C, and E, are the most easily neglected and the least easily demonstrated parts of the NETS-T. Preservice teachers' thorough understanding of Standard VI requires explicit instruction in the meanings of Performance Indicators A and D and thoughtful, careful modeling of Performance Indicators B, C, and E that aim to empower all learners.

University faculty members and K-12 teachers did model NETS-T, Standards I through V for the preservice teachers in these university programs; however, many questions remain. Would the participants have moved through the stages of adoption more quickly if they had been made aware of them? Would reflection on personal practice related directly to stages of adoption have helped faculty members and teachers move beyond activities focusing on lower cognitive skills? What information or instruction do faculty members and teachers need to deeply "understand the social, ethical, legal, and human issues surrounding the use of technology and apply those principles in practice" (ISTE, 2002)?

Based on this study, it is recommended that professional development in the area of technology integration for university faculty members and for K-12 teachers emphasize the empowerment of students. Work with these groups on NETS-T Standards I through V should stress uses of software and hardware for analysis, synthesis, and evaluation of information and concepts. Understanding the stages of adoption and their relationships to cognitive skills may help these instructors reflect on personal practice and move through the stages more quickly. Special attention should be paid to NETS-T Standard VI to ensure understandings of ways in which specific pieces of software and specific pedagogical practices can empower and disempower groups of diverse learners. Consideration of these areas could enhance the modeling of the NETS-T for preservice teachers and bring the promise of technology integration in education closer to that envisioned in the NETS-T.

Acknowledgments

Special thanks to Rosalita D. Mitchell, Ph.D., University of New Mexico, and Gail Furman, Ph.D., Washington State University, for their assistance in the preparation of this manuscript.

References

Baker, E. L., Gearhart, M., & Herman, J. L. (1993). *The Apple Classrooms of Tomorrow: The UCLA evaluation studies.* Los Angeles: National Center for Research on Evaluation, Standards, and Student Testing. (ERIC Document Reproduction Service No. ED 378 219)

Bloom, B. S. (Ed.) (1956).*Taxonomy of educational objectives; the classification of educational goals, by a committee of college and university examiners* (1st ed.). New York: Longman.

Bruder, I., Buchsbaum, H., Hill, M., & Orlando, L. (1992). School reform: Why we need technology to get there. *Electronic Learning*, *11*(8), 22-28.

Campoy, R. (1992). The role of technology in the school reform movement. *Educational Technology*, *32*(8), 17-22.

Carlson, R. D., & Gooden, J.S. (1999). *Mentoring preservice teachers for technology skills acquisition*. Paper presented at SITE 99: Society for Information Technology & Teacher Education International Conference, San Antonio, TX (ERIC Document Reproduction Service No. ED432280)

Collins, A. (1991). The role of computer technology in restructuring schools. *Phi Delta Kappan*, *73*(1), 28-36.

Cradler, J., Freeman, M., Cradler, R., & McNabb, M. (2002). Research implications for preparing teachers to use technology. *Learning and Leading with Technology*, *30*(1), 50-54.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Denton, J., Davis, T., Strader, A., Clark, F., & Jolly, D. (2003, February). *Technology professional development of teacher education faculty by net generation mentors*. Paper presented at the meeting of the Southwest Educational Research Association, San Antonio, TX. (ERIC Document Reproduction Service No. ED477711)

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership*, *48*(8), 45-52.

Feist, L. (2003). Removing barriers to professional development. *T.H.E. Journal*, *30*(11), 30, 32, 34, 36.

Graves, S. B., & Kelly, M. A. (2002, June). *Faculty technology professional development: A pedagogical and curricular reform model.* Paper presented at the meeting of the National Educational Computing Conference, San Antonio, TX. (ERIC Document Reproduction Service No. ED475931)

Hord, S., Rutherford, W., Huling-Austin, L., & Hall, G. (1987). *Taking charge of change.* Alexandria, VA: Association for Supervision and Curriculum Development.

Howland, J., & Wedman, J. (2004). A process model for faculty development: Individualizing technology learning. *Journal of Technology and Teacher Education*, *12*(2), 239-263.

International Society for Technology in Education. (2000). *National educational technology standards for students: Connecting curriculum and technology*. Eugene, OR: International Society for Technology in Education. Also available from http://cnets.iste.org/students/s_stands.html

International Society for Technology in Education. (2002). *National educational technology standards for teachers: Preparing teachers to use technology*. Eugene, OR : International Society for Technology in Education. Also available from http://cnets.iste.org/teachers/t_book.html

International Society for Technology in Education. (2005). National educational technology standards. Retrieved February 1, 2006, from http://cnets.iste.org/.

Israel, M. S., & Kasper, B. B. (2004). Reframing leadership to create change. *The Educational Forum*, *69*(1), 16-26.

Kahn, J., & Pred, R. (2001). Evaluation of a faculty development model for technology use in higher education for late adopters. *Computers in the Schools*, *18*(4), 127–150.

Margerum-Leys, J., & Marx, R. W. (2004). The nature and sharing of teacher knowledge of technology in a student teacher/mentor teacher pair. *Journal of Teacher Education*, *55*(5), 421-437.

McCoy, L. P. (2000). *Computer skills and instructional activities of student teachers and cooperating teachers.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED444985)

Murphy, K. L., Richards, J., Lewis, C., & Carman, E. (2005). Strengthening educational technology in K-8 urban schools and in preservice teacher education: A practitioner-faculty collaborative process. *Journal of Technology and Teacher Education*, *13*(1), 125-39.

Newman, D. (1992). Technology as support for school structure and school restructuring. *Phi Delta Kappan*, *74*(4), 308-315.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, CA: Sage.

Popham, J. A., & Rocque, R. (2004). Faculty-as-students: Teacher education faculty meaningfully engaged in a preservice technology course. *Computers in the Schools*, *21*(1/2), 115-26.

Rosaen, C. L., Hobson, S., & Khan, G. (2003). Making connections: Collaborative approaches to preparing today's and tomorrow's teachers to use technology. *Journal of Technology and Teacher Education*, *11*(2), 281-306.

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

Shank, G. D. (2002). *Qualitative research: A personal skills approach*. Columbus, OH: Merrill/Prentice Hall.

Sheingold, K., & Hadley, M. (1990). *Accomplished teachers: Integrating computers into classroom practice*. Washington, DC: Office of Educational Research and Improvement. (ERIC Document Reproduction Service No. ED 322 900)

Slavit, D., Sawyer, R., & Curley, J. (2003). Filling your PLATE: A professional development model for teaching with technology. *Tech Trends*, *47*(4), 35-38.

Stake, R. E. (2000). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 435-454). Thousand Oaks, CA: Sage.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage.

Technology Standards for School Administrators Collaborative. (2001). *Technology standards for school administrators*. Retrieved October 2, 2006, from http://cnets.iste.org/tssa/pdf/tssa.pdf

United States Department of Education. (n.d.). Preparing tomorrow's teachers to use technology program. Retrieved September 21, 2003, from http://www.ed.gov/programs/teachtech/index.html

Wedman, J., & Diggs, L. (2001). Identifying barriers to technology-enhanced learning environments in teacher education. *Computers in Human Behavior*, *17*(4), 421-430.

Wizer, D. R., & McPherson, S. J. (2005). The administrator's role: Strategies for fostering staff development. *Learning and Leading with Technology*, *39*(5), 14-17.

Author Note:

Financial support for this research was provided by the U.S. Department of Education, Preparing Tomorrow's Teachers to Use Technology grants.

Leslie Hall
Washington State University
ldhall@wsu.edu