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Toward a Pedagogy of Educational Technology
for Teacher Education Programs

Ian James Loverro

A dissertation submitted in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

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Program Authorized to Offer Degree:

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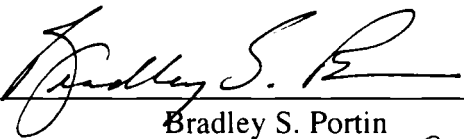


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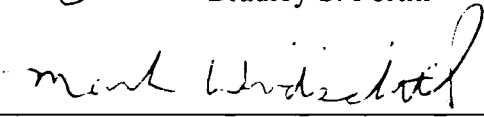
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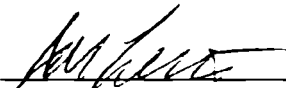
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Abstract

Toward a Pedagogy of Educational Technology
for Teacher Education Programs

Ian James Loverro

Chair of the Supervisory Committee:
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A pedagogy of educational technology is necessary before the field can join the current educational reform movement. This two-part descriptive study investigated the current needs of pre-service teachers and the current practices of early adopters of technology integration in methods of teaching courses. The goal was to develop a list of guidelines and recommendations for teacher education programs, and to lead the field of educational technology toward a widely accepted pedagogy. The first part of the study, dealing with course content, was a survey of 180 pre-service teachers concerning their technology skills with respect to the National Educational Technology Standards for Teachers prior to any formal instruction. Through a principal components analysis, the six standards were reduced to three components: 1) Classroom-Specific Teacher Skills, 2) Professional Development and Curriculum Planning, 3) Routine Applications and Basic Operations. These components were ranked in terms of the content most urgently needed by the pre-service teachers. The second part of the study used the constant comparative method to analyze a series of interviews with four instructors of secondary pre-service methods

courses that attempted to integrate technology with various subject areas. Their unique instructional delivery formats were used to identify strengths and weaknesses of their various approaches to technology integration. The emergent themes highlighted the need for instructor preparation, the need for a meaningful connection between lecture and technology laboratory sections, and the need for increased awareness of the National Educational Technology Standards for Teachers among faculty and support staff. When viewed together, the results produced six foundational recommendations for improving technology integration and instruction within teacher education programs that are considering technology integration as part of their developing curriculum.

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My teaching partner, Carole, provided moral support and camaraderie on a daily basis. My good friend, Tony, delighted in telling me that simply driving around with journals in the back of my car would not result in finishing my dissertation. My friend and roommate, Jeff, witnessed this process firsthand and provided the right combination of distraction and motivation.

I want to acknowledge my advisor, Dr. Steve Kerr, for his generous support and encouragement. He allowed me the freedom to work independently and to find my own path. Drs. Brad Portin and Mark Windschitl contributed to my experience as a doctoral student both in class and during the writing of this document. They were invaluable counselors and advisors.

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DEDICATION

To my wife, Wendy, my daughter, Dylann, my son, Stuart, and my parents.

Chapter I

What Do Pre-Service Teachers Need from Their "Ed Tech" Classes?

Within teacher education, most content subject areas, such as mathematics or language arts, reflect a particular, well-established pedagogical approach. A pedagogy is defined as "the art, science, or profession of teaching; *especially*: the study that deals with principles and methods in formal education" (Merriam-Webster Unabridged Dictionary, 2005). However, when considering the elements of any standard pedagogy, I would argue that three fundamental dimensions can be derived:

- 1) a content core of knowledge, facts and/or skills,
- 2) generally accepted instructional delivery methods, and
- 3) a shared vision regarding the organization, scope and sequence of the material to be taught within a given field.

All three components interact and the pedagogy evolves as a function of external traditions and trends, as well as exchange between the components. The process is a fluid and dynamic one. The three elemental dimensions of a pedagogy may each reflect aspects of human development, instructional philosophy, political climate, economical reality, and technological advances and feasibility. Figure 1.1 illustrates this view of the fundamental and interactive nature of these elements of a standard pedagogy.

Shared vision is the most overarching aspect of any pedagogy, and is often the first aspect of a pedagogy to develop. Although it may emerge first, a shared vision alone is not sufficient for the pedagogy to thoroughly develop. However, once it begins to evolve, the shared vision may guide the nature of both content and format, which in turn

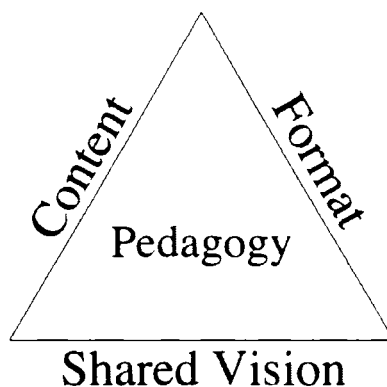


Figure 1.1. Pedagogy Triangle. Any pedagogy consists of three fundamental components: A shared vision, an agreed-upon content, and a standard instructional delivery format. All three components interact and the pedagogy evolves as a function of external traditions and trends, as well as exchange between the components.

influence the vision in a reciprocal fashion. According to the National Council for the Accreditation of Teacher Education (NCATE) (2002a), the shared vision develops as part of a larger conceptual framework that provides direction for the training of teachers that is knowledge-based, articulated, coherent, consistent and continuously evaluated. Despite its elusive and ephemeral nature, shared vision is about consensus of opinion and a commitment to an evolutionary path. It usually involves the opinions and perspectives of teaching professionals, including K-12 and post-secondary educators. In fact, for a vision to be shared, it must emerge from the experience of all professionals, not only from those in positions of authority (Schrum, 2000). However, a formal pedagogy remains unrealized until both curriculum content and instructional delivery format are conceptualized, developed and put into practice on a large scale.

Just as the shared vision within a field evolves over time, so too do core knowledge and instructional delivery methods. These three aspects of the pedagogy for a particular

subject (once established) reflect a larger conceptual framework that itself may be so widely accepted that it is taken for granted. For example, within mathematics, the use of manipulatives (the method) to teach basic operations in the base-ten system (the content) is widely practiced and often expected. Among reading professionals, a consensus over the whole language vs. phonics debate has not been reached, yet each camp has a well-defined identity, an accepted core knowledge set and an established set of values and directives regarding their preferred instructional approach. Similar conventions exist among science educators in their approach to inquiry learning. However, within educational technology, as it relates to teacher education, a true pedagogy has yet to be formalized. Although there currently is wide (if not universal) consensus on the need for technology in education, a single, widely accepted curriculum and instructional approach for preparing future teachers does not exist. Educational technology, as it is taught in colleges and departments of education, is in a transitional phase, and a formal pedagogy of educational technology has yet to emerge.

Over the last several decades, pre-service teacher training in educational technology has moved away from preparing some teachers to be media center specialists or computer lab teachers to a training model that is more in-line with technology integration across content disciplines. As this shift has occurred, signs of a new approach are beginning to take shape. Specifically, a growing number of teacher education programs (TEPs) are shifting away from skills-based, stand-alone technology classes and toward an integration model - one that focuses on different course content and utilizing a

different instructional format. This integration movement is so pronounced that whenever “technology” is mentioned, it seems the word “integration” immediately follows.

Unfortunately, a universally-accepted definition of the term “technology integration” is lacking. More importantly, a clear vision for how educational technology should best be developed regarding its integration with various core contents and curricula, particularly where pre-service teacher training is concerned, is only beginning to evolve.

Technology Integration Defined

Technology integration in teacher education may be manifest in a variety of ways. Typically, in a well-integrated K-12 classroom, the relevant technologies are blended with the content in ways that enhance and support student learning. However, in teacher education, technology integration should achieve goals beyond K-12 use. In addition to demonstrating how teachers might integrate particular technologies into their K-12 lessons, they must also be prepared to use technology in a variety of out-of-class situations such as lesson planning, assessment and professional development. The core idea of “ed tech” integration is to put the technology into a relevant context. In teacher education that context is different than it would be in the K-12 classroom. It has a broader scope because the students are prospective teachers, not K-12 children. At some institutions, the task of teaching technology to pre-service teachers might fall to a single “methods of teaching” instructor. In another, the relevant technologies might be divided among several required courses such as methods of teaching, assessment, curriculum planning, and/or mainstreaming. In yet others, a combination of a stand alone, general

educational technology course might be enhanced with integrated lab sections for other content specific courses. In theory, different TEPs could create any number of variations on the “integration” theme. Ultimately, the goal and the great challenge facing TEPS remains the same: to produce in-service teachers who utilize technology effectively, both in and out of the classroom.

In the rush to integrate technology into course content, many TEPs are making quick decisions regarding the content and delivery format of educational technology. Moreover, they are doing so without carefully examining their students’ existing skills, their own current practices, and without explicit communication with other TEPs about their experiences with technology integration. The result is a slow, awkward and often undirected course of development toward the common goal of a pedagogy of educational technology.

Emergence of educational technology content and delivery methods. The present investigation sought to facilitate the process of developing of an explicit pedagogy of educational technology in two critically important ways. First, I wanted to examine whether current, nationally-accepted standards for educational technology (a crucial part of a shared vision) are reflected in the existing technology skills of pre-service teachers. The goal was to gain a better understanding of what *the content* for an educational technology course should be. Such an investigation may provide explicit and immediate direction for curriculum development based on today’s national standards for teachers. I also hoped that I could develop and test a needs-focused, standards-based curriculum assessment for pre-service teachers.

Second, in addition to curriculum content questions, it is also important to address *instructional delivery method* since both issues are central to the development of a unified pedagogical approach for educational technology. Therefore, an in-depth analysis of attempts by TEP instructors to integrate technology across a variety of subject areas could prove informative and directive. My goal in communicating with TEP instructors that have attempted to integrate technology into their specific content methods courses was to determine whether such instructors could provide valuable insight into integration techniques that have been effective as well as those that have fallen short.

The result is a two-part study designed to address the two, most critical, first questions in the systematic development of an explicit pedagogy of educational technology:

- 1) *Content*: What do pre-service teachers need to be taught about educational technology? More specifically, what do our pre-service teachers already know about technology, and how does their knowledge align with national standards of educational technology for new teachers?
- 2) *Format*: What might effective technology integration look like in practice? What delivery methods appear to work well for experienced instructors of various content areas (such as science or math) who have attempted to integrate technology into their classes?

As an instructor of future teachers, I want the content of my classes to be useful to my students, not to simply repeat what they already know. Current public discussions of educational technology use suggest integration should be simple to accomplish (Starr,

2002), but the details regarding implementation and infrastructure are often lacking (Wepner, 2001). Furthermore, very little research is available regarding successful and unsuccessful attempts to integrate technology into content areas. I wanted to find out what some early technology integrators experienced in terms of what methods of integration worked for them, and what did not.

Conceptual Framework. Figure 2 illustrates a theoretical overview of the current investigation. My focus on curriculum content, instructional format, teacher preparation and instructional technology requires a synthesis of information from a variety of sources, namely educational technology, national educational standards, teacher education, and the K-12 educational climate. These independent perspectives represent both direct and indirect influences on the development of the shared vision for educational technology and the training of pre-service teachers. Certainly, the *content* of an educational technology course would necessarily be influenced by all of these perspectives, and often rather quickly. *Instructional format* for “ed tech” courses, on the other hand, is most directly influenced by traditional teaching methods used in higher education, TEPs, and K-12 instruction. Many educational technology courses continue to be taught in ways that are analogous to the traditional lecture/lab methods used in the sciences or foreign languages, or using the K-12 computer lab model. For example, in some institutions, the traditional lecture/lab format has been the model for technology integration in which a content-based lecture course is augmented with a brief weekly laboratory section, often taught by the principle instructor or by a graduate teaching assistant. In other cases, all students, regardless of content discipline or grade level are

Conceptual Framework for the Current Study

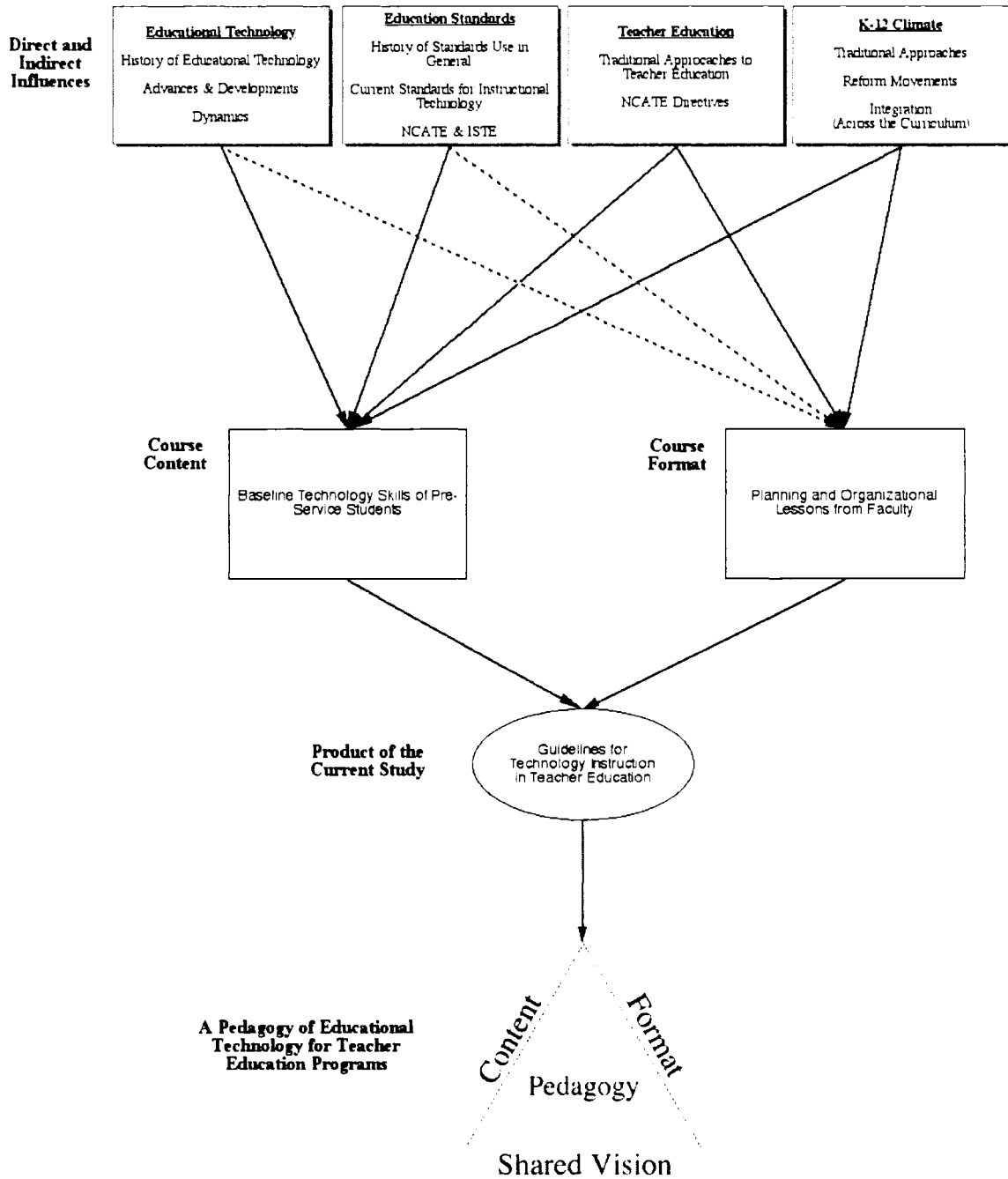


Figure 1.2. The Conceptual Framework illustrates how the current investigation would help to make progress toward a pedagogy of educational technology for teacher education programs. Solid lines represent direct influences, dashed lines represent indirect influences.

enrolled in a single, stand-alone technology course taught in a traditional computer lab with little or no integration with the students' disciplinary content. While the trend has been to move toward a more integrative approach, these two traditional instructional approaches seem to dominate (Hargrave & Hsu, 2000; Mehlinger & Powers, 2002).

Technological advances and national technology standards have less direct influence on the instructional delivery method adopted for educational technology courses. Whereas the *content* of an "ed tech" course might be directly and rapidly influenced by the emergence of a new technology (such as video-conferencing or digital cameras), *instructional format* is only indirectly influenced by such technological advances, except when the technology is discipline-specific (e.g. radio-tracking technology within biology, telescope technology in physics, acoustic technology in music, etc.). In such instances, the way in which an instructor teaches could change (for example, away from lecture and toward a more hands-on laboratory approach). Yet such revolutionary advances are rare and often very expensive, thus slowing the influence of technological advances on instructional format and making it less direct. Even for those technologies that have entered the higher education classroom rapidly, such as overhead projectors, VHS, digital projectors and smartboards, impact has been primarily on presentation format but it has not altered the general course format – they have further supported and entrenched a heavy emphasis on teacher-centered learning methods like lecture. Similarly, while national standards for technology education for teachers can directly help to identify course content, they do not dictate best practices for instructional delivery. It was my hope that the results from the current investigation would provide

valuable information and direction from which guidelines for technology instruction within teacher education could be derived. A data-based guide for policy makers in teacher education, as it relates to educational technology, would facilitate the development of a true pedagogy of "Ed Tech".

ISTE's National Educational Technology Standards for Teachers

The International Society for Technology in Education (ISTE) recommends a broad foundation in technology for all teachers (ISTE, 2000). NCATE, in turn, has adopted minimum technology requirements expected of all TEPs, based upon ISTE's recommendations (NCATE, 2002b). The National Educational Technology Standards for Students (NETS-S), Teachers (NETS-T), and Administrators (NETS-A) are each composed of six areas of technology competency (see Appendices A, B & C). However, the nature of these areas varies with each audience. The standards for K-12 students deal primarily with the different types of tools that students use such as communication, problem-solving and decision-making tools, while the standards for administrators address issues of school leadership and management. According to ISTE (2004), 48 of the 50 US states and the District of Columbia have considered at least one sets of the NETS standards for their "state technology plans, certification, licensure, curriculum plans, assessment plans or other official state documents" (see Appendix D). Of particular relevance to the present study, the standards for teachers (NETS-T) are logically tailored toward curriculum, planning, assessment, and professional development.

The NETS. A brief review of the NETS-T reveals six major categories of recommendations from ISTE regarding standards and performance indicators in which K-12 teachers should be versed.

1) *Technology Operations and Concepts:* This category requires teachers demonstrate an understanding of technology at the level expected from their students (NETS-S). It also requires that teachers demonstrate continual growth in their technology skills and understanding. While it is clear that ISTE expects teachers to be fluent with the technologies that they will use with their students, even this first category foreshadows the need for professional development within instructional technology for teachers.

2) *Planning and Designing Learning Environments:* This category outlines ISTE's expectations regarding lesson planning and implementation as supported by technology. It recommends that teachers utilize technology in their lessons in ways that are developmentally appropriate and that support the needs of a diverse study body. They recommend that teachers remain knowledgeable of current research regarding the instructional use of technology, including being able to identify, locate and evaluate appropriate technology resources. Teachers should be prepared to manage both technology resources and student leaning in a technology-enhanced environment. Here, too, there is a focus on non-instructional technology uses and knowledge.

3) *Teaching, Learning, and the Curriculum.* Here, ISTE urge teachers to employ the use of technology-enhanced lessons that meet both their content curriculum goals and the NETS-S. They recommend that such lessons be student-centered, that they help students

to develop higher-order cognitive skills, and that they be prepared to manage such learning environments effectively.

4) *Assessment and Evaluation.* Teachers should be prepared to apply technology in assessing student learning using multiple methods of evaluation. They should be trained to gather and analyze data on student learning using appropriate technological tools. They should be practiced in interpreting and communicating the results of such assessments in ways that improve instruction and maximize student learning.

5) *Productivity and Professional Practice.* It is here that ISTE explicitly recommends that teachers should engage in ongoing professional development as it relates to educational technology and to do so using technology. Appropriate goals under this category include self-evaluation and reflection on one's current teaching practices that rely on technology, applying technology to increase productivity and teaching efficacy, and to use technology to expand one's professional community beyond local resources.

6) *Social, Ethical, Legal, and Human Issues.* This last category sweeps broadly in terms of what teachers should know about technology as it relates to safe and healthy educational use. It requires that teachers not only understand legal and ethical issues like Internet copyright or acceptable use policies, but that they model and teach them to their students. It recommends that teachers apply the use of technologies that respect and empower learners of diverse backgrounds, characteristics and abilities and that they use technologies that affirm diversity. They should ensure equitable access to technology resources for all students.

This summary demonstrates that the ISTE standards for teachers (NETS-T) do not merely reflect fluency with computer applications or specific content-relevant technologies that they may teach to their own students. Rather new teachers should be knowledgeable of the NETS-S, and also be prepared to use technology in pedagogical matters that naturally lie outside the realm of classroom instruction.

It is important to note that the exact scope and sequence of meeting the NETS-T requirements are not prescribed by NCATE, nor have appropriate methods of competency assessment been defined. Hence, the transition away from a “basic computer skills literacy/media specialist” model (that was appropriate when computer technology was new to public schools), and toward a more modern, integrative approach to instructional technology in pre-service teacher education has largely developed without clear guidance from experts within the field of educational technology. (It is important to note that the field of education technology does not have teacher education as its central, primary goal. So there has been little impetus to educate TEPs from this direction either. Put simply, there has been a gross lack of communication between the relevant parties: TEPs, the field of education technology and ISTE/NCATE.) As a result, much of pre-service teacher instruction in technology has retained a heavy focus on teaching new teachers what their young students will need to know, instead of focusing on what the teachers need to know (Hargrave & Hsu, 2000). While this orientation continues to be an important aspect of pre-service teacher preparation, the establishment of broader technology goals for new teachers has been adopted by NCATE via the NETS-T.

Course Content: What to teach versus what not to teach?

The present investigation can be conceptualized in terms of the two important questions, one dealing with *curriculum content* for educational technology courses, and the second, designed to provide information about the *instructional format* of technology integration in the “ed tech” pre-service teacher classroom. A detailed overview of each question follows.

Without a thorough and comprehensive awareness and/or understanding of the standards, goals and guidelines set for pre-service teachers, instructors in higher education have been left to their own devices to define, design and implement a policy of “technology integration” into their pre-service teacher education curricula. The result is an overemphasis on basic computer skills and computer literacy (what the children need to learn), and a lack of teacher-related knowledge and skills. Put simply, there continues to be too much emphasis on computer applications and software products, and not enough on the important issues related to teacher education and professional development.

What is lacking is a shared vision: a vision that is driven by the ISTE recommendations and NCATE requirements, and that could be broadly adopted by TEPs regarding what aspects of technology and technology-related issues must be taught to pre-service teachers. This is not to say that such standards or methods do not exist anywhere. Since teacher education is primarily governed by state agencies, most states have begun to address the need for educational technology training for prospective teachers (Lemke, 1999). However, there is a great deal of variability across these state-

based standards, and a nationally shared vision that includes curriculum content and delivery format has yet to emerge. A divide exists between the national agencies which set the standards and goals regarding the “what and how” of modern technology as it relates to teacher training, and the very people, at the state and local level, who are charged with the responsibility to provide pre-service teachers with those skills, knowledge and techniques. This is particularly true for those colleges and universities that rushed to “integrate technology” into content courses, and who placed the task of technology education in the hands of faculty who were experts in fields other than “ed tech”. Reading, math and science education faculty were expected to integrate technology into their core content without explicit training in the curriculum expectations set by ISTE and NCATE. As such, TEPs are faced with three major problems that need resolution:

- 1) Content-area specialists generally are unaware of issues related to educational technology in general.
- 2) Content-area specialists often do not have access to, nor are trained in the use of educational technologies that are specific to their fields (e.g. physics-education teachers may not be trained to use the latest telescope technologies).
- 3) Content-area specialists have not been taught how to effectively integrate and teach using available technologies in ways that meet the NETS-T goals.

Despite attempts to provide direction to educational technology faculty through the use of published lesson exemplars (ISTE, 2002), ISTE and NCATE have yet to present

their expectations and requirements in a manner that effectively facilitates appropriate curriculum development by non-expert faculty. Despite the shortcomings of the NETS-T as they are currently written, if interpreted and utilized effectively by resident educational technology experts, TEPs might overcome the “basic skills” or “computer literacy” curriculum that characterizes so many programs. Frequently, it is assumed that technology education course content should focus primarily on building pre-service teachers’ computer skills and that students, who are already experienced in using computers, do not need to take the classes. The general belief appears to be that a future teacher who is versed in using technology for everyday personal tasks will somehow be skilled in the use of technology to support their future students’ learning. And yet, the same logic does not apply in other disciplines. Pre-service teacher education students who are literate in mathematics or English are still required to enroll in courses in the methodology of teaching mathematics, reading, and writing taught by highly trained experts. For some reason, the situation is perceived differently for technology skills. Let us take a look at a set of illustrative examples of this phenomenon.

James, the Whiz Kid. James is a young pre-service teacher enrolling in a required educational technology course. He is fairly savvy when it comes to using a computer. Not only does he word-process his assignments, he uses the Internet on a regular basis for e-mail and for gathering information. He even maintains his own weblog (blog) and owns an iPod filled with MP3 files that he has “collected.” In general, he is very comfortable using computers in his daily life and has a good attitude about how they will fit in with his future teaching. When it comes to technology, he is clearly one of the more advanced

students in his pre-service cohort, and probably more advanced than most of his college professors. So why should he have to enroll in the educational technology course? What could he possibly learn from this class? He could probably teach it, couldn't he? Can't he simply "test-out" of it? (Wiencke, 2002). A careful review of the ISTE standards suggest that the answer should be "no" (ISTE, 2000). Yet, it is not unusual for such students to "test-out" of their instructional technology courses based on everyday non-instructional technology skills alone.

This scenario is fairly typical. James would probably fall into the category of computer "whiz kid". According to Vail (2005), James would best be described as a "technology native": someone who was born into a world of high tech computers, someone who finds the Internet, email and cell phones ordinary, and the someone for whom technology is central to everyday life. Although the whiz kids of the past were generally programmers, today's tech savvy students are best perceived as "power users," meaning that they are highly skilled in a variety of computer applications and software, troubleshooting skills, and perhaps in creating multimedia projects. James' skills, however, should not allow him to avoid the required educational technology course, nor should his computer and technology skills go unchallenged. The technology course ought to address more than just computer use skills (Wiencke, 2002). Rather it should focus on methods of integrating different forms of technology into the K-12 classroom to support, enhance and enrich student learning and teacher professional development. James still needs to learn about education-specific software, how to plan for and manage children using computers, as well as the ethical dilemmas surrounding computers, copyright, and

Internet connections in the K-12 classroom. Just as being fluent in the English language does not make an individual sufficiently prepared to teach a high school language arts class, simply being a computer whiz kid does not translate into being a teacher that effectively integrates technology into the classroom. There are skills related to computers that even James does not yet have, specifically those related to instructional use (Mehlinger & Powers, 2002).

Sonia, The Other Whiz Kid. Sonia is also someone who came to her education-training program with outstanding computer and technology abilities. Like James, she was well versed in word processing, spreadsheet use, email, gaming and Internet use. She also completed an educational technology course designed to prepare her to use those and other new skills in her new profession as a 4th grade teacher. In addition to her lay skills, Sonia also uses technology to do some very specific 'teacher-related' tasks such as maintaining contact with other 4th grade teachers via a listserv where she can exchange ideas and develop new curricula. She also interpreted her school district's acceptable use policy for technology use in public schools, and translated it into child-friendly language for the kids in both the upper and lower grades. Sonia has been asked to be the primary reviewer and purchaser of educational software, and has held several on-site in-service workshops for her co-workers regarding new educational software programs and computer-based teaching techniques, like WebQuests. Finally, when a blind student enrolled at her school, Sonia was asked by her administration to investigate assistive technology solutions to help the student participate fully in class activities. In short, while Sonia's previous experience with technology initially made her a "whiz kid" in her "ed

tech” class, she still had much to learn about technology as it relates to education. As a result of her professional training, she is now a better teacher and a valuable resource for her new school.

The Non-Whiz Kids. Unfortunately, not all of James' and Sonia's pre-service classmates are as confident or experienced when it comes to using computers. Most of them only use computers to word-process assignments and check e-mail. Even then, their skills using the word processor or e-mail client may be so limited, for example, that they don't know how to use headers and footers properly or how to create an e-mail attachment. For many, computer use is still an awkward and uncomfortable experience. Despite the common assumption that the majority of young teacher education students today are computer literate, non-traditional, returning adult students compose an increasing proportion of the student population and they may not have the technological skills of their younger classmates. While reasonably computer savvy students will gradually become the norm over the next several decades, we can expect non-traditional students to continue to comprise a significant proportion of our pre-service teacher corps (Mehlinger & Powers, 2002). Additionally, many teacher-education students continue to report that their dislike for computers was an important part of their decision to become teachers. They often do not view computer skills as a necessary part of the teaching profession (Myhre, 1997).

So, how can we tailor course content in an educational technology class to meet the needs of such a diverse pre-service teacher population? In the present investigation, my first question related to putting into practice a method of identifying which of the

technical/computer skills required by the NETS-T most pre-service teachers have already mastered, and which skills are most urgently needed. By clustering and ranking skills based on information provided by the students, curriculum decisions can be based on the actual needs of pre-service students, thus making more effective and efficient use of course time.

Ideally, a technology course for pre-service teachers should serve both James and his pre-service peers in terms of the content of educational technology. The first part of the current investigation consisted of a large-scale assessment of student technology strengths and weaknesses as they relate to the NETS-T across a broad sample of TEP students. The general goal of this first part of the investigation was three-fold:

- 1) to condense the NETS-T into a smaller number of functional categories,
- 2) to determine students' comfort with and mastery of particular technology-related knowledge and skills,
- 3) to show how the information gained from a given cohort of TEP students could be used to guide curriculum development.

The purpose of these three goals was to determine whether a standards-based educational technology curriculum could be developed for TEP students using the NETS-T. The second part of the current investigation targeted the question of best practices regarding instructional delivery format for educational technology.

Instructional Delivery Format: What works and what doesn't?

As an instructor of a traditional, stand-alone technology class in a large TEP, I was interested in the recent movement away from stand-alone technology classes toward integrating technology into existing “methods” courses. The notion of technology integration found favor within K-12 education as a result of a growing dissatisfaction with the campus “computer lab” which first became popular in the 1970’s. Today, fewer computer labs are being built in the public schools, in favor of distributing computers to each classroom (Tiene & Ingram, 2001). This infusion of computers into the classroom is typically justified as a way of ensuring that the computers are immediately available to students and teachers throughout the day rather than tucked away for exclusive use, or by requiring advance reservations to a centralized laboratory. This is similar to the practice of disseminating encyclopedias and dictionaries throughout a school rather than restricting their use to a central library. More importantly, there appears to be a trend for university-level colleges and departments of education to follow suit. The push is now for what appears to be a “technology across the curriculum” approach to educational technology training in higher education. This shift raises important questions regarding the appropriateness of parallel teaching methods across pre-service teacher education and K-12 education. Put simply, do pre-service teachers reap the same benefits of having their technology training integrated into other course contents (such as science, math and reading) as do K-12 children? Or is the current trend in pre-service teacher preparation leading us to produce new teachers with substandard technology training, particularly with respect to the NETS-T? Just as important as the curriculum content, the

development of an effective method to deliver educational technology instruction to pre-service teachers is critical to the development of a pedagogy of education technology. Yet, can a stand-alone educational technology class provide pre-service teachers with sufficient, real life, integrative experiences that will generalize to their own teaching later? It appears that the voice of TEPs nationwide has echoed with a resounding “No!”, hence the race to integrate technology across the curriculum. Stand-alone educational technology classes (technology courses that are not directly linked to other content courses) have failed to meet the technology goals in ways that translate easily into practice for new teachers (Cuban, 2001; Knapp & Glenn, 1996; Myhre, 1997).

Surely, modeling technology integration is a good idea that few instructional technology experts would question (Knapp & Glenn, 1996). However, current TEP faculty may not really be prepared to effectively integrate technology into their existing courses in a manner that meets the objectives set by NCATE. Are most TEP instructors who are experts in math, science, reading and social studies really well versed in the best ways to integrate educational technology within their existing content-based curricula? Presently there are no clear answers to these questions. In fact, there is very limited information in the available research literature about what is actually happening in TEPs regarding the integration of technology in terms of instructional delivery methods.

According to Larry Cuban (1998), many instructors use technology in their personal and professional lives, but they rarely utilize it in their teaching unless required to do so. This is often more due to their beliefs about the role of technology in education than to their training or access to equipment (Cuban, 1998). I wanted to know whether

TEP faculty who integrate technology into their content courses use similar or different technologies in and out of classrooms. What attitudes do these TEP instructors hold about technology in the classroom? What sort of technical and administrative support do they require or use? What are their goals for the integration of technology in their courses? And how effective have their attempts at technology integration been?

According to the CEO Forum (1999), the rate or degree of technology use in K-12 classrooms can be increased through the use of technology skills-specific staff development and in-service training for college-level TEP faculty. Cuban (1998, 2001) disagrees, suggesting that the barriers to effective computer use in the public schools are not linked to computer literacy by the teacher or by their college faculty, but rather to a lack of a pedagogical view that includes technology. Similarly, Becker (2000) found that mastering relevant computer skills, combined with having a constructivist educational philosophy, was highly correlated with technology integration in the K-12 classroom. This would suggest that pre-service teacher training would benefit from an integrative, hands-on approach to technology designed to ensure both basic and teacher-relevant skills at the university level. This perspective is supported further by Beyerbach, Walsh, and Vannatta (2001). They suggest that integrating technology within a TEP does enhance pre-service teacher perceptions of technology infusion. It stands to reason that pre-service teachers that have positive experiences, in college classes that integrate technology, will have more positive attitudes toward integrating technology in their own classes. But it is not clear whether increased use translates directly into effective use.

Millions of dollars have been awarded in the form of PT³ (Preparing Tomorrow's Teachers to use Technology) grants by the U.S. Department of Education, and as a result, colleges of education nationwide are re-designing their approaches to instructional technology education (Mullen, 2001). The increased interest in issues related to technology integration by NCATE and ISTE has further created strong incentives for deans and program directors to ask their faculty to increase the role of technology in their courses (NCATE, 1997). The current trend to restructure and integrate technology into content-specific TEP courses raises many questions that must be examined before jumping headlong into a round of uninformed or minimally informed decisions about teacher preparation. But before we can determine the efficacy of the current practices regarding instructional technology education in TEPs, we must understand exactly what those practices are.

I decided to investigate and determine how instructional technology education actually occurs in practice in a large university TEP that has moved forward with an integration model. I suspected that while it may appear to be an easy, logical step to mimic K-12 technology integration within a TEP, instructors and faculty members might not be prepared for this challenge, particularly where instructional delivery is concerned. I also wondered whether there existed similarities - some sort of order or systematic plan - across the TEP instructors for integrating technology across their methods courses. This part of the current investigation was designed to gather information from experienced TEP instructors who have implemented technology integration across a variety of content areas to determine:

- 1) how instructors define technology integration for pre-service teachers, and for TEPs in general.
- 2) what methods of technology integration they have employed.
- 3) what kind of support (both real and virtual) do these instructors use and/or feel they require.
- 4) how successful they feel their delivery methods have been.

The main objective was to talk to those on the front lines of educational technology integration to determine how they view the role of “ed tech” in teacher education, to determine what methods they used to achieve this integration, and to determine how effective the instructors thought these methods were. When viewed together, I hoped the information from both parts of the current investigation would provide insight into the "What to teach" and the "How to best teach it" questions that I view as critical to the development of a formal pedagogy of educational technology in pre-service teacher preparation.

Summary

Although a movement toward integrating educational technology throughout TEPs is already underway, sufficient and meaningful progress toward a formal pedagogy of technology within teacher education does not yet exist. Along with a shared vision, an “ed tech” curriculum based on national standards, and effective, instructional-delivery methods are the foundation upon which successful reform in TEPs must be built. I have outlined two critically important questions designed to provide information and insight in terms of both course content and instructional delivery methods for technology

instruction in TEPs. The first part of the investigation categorizes the technology skills already possessed by pre-service students prior to receiving any formal training, and will be interpreted relative to the NETS-T. The second part examines a group of TEP faculty, considered practitioners of technology integration, in which they share some stories of successes and failures.

Overview

In an attempt to provide you, the reader, with a basic roadmap for this dissertation, here is an overview of the remaining chapters. In Chapter II, I discuss the history of educational technology in schools, particularly the recent standards movement and the trend toward “technology across the curriculum”. In addition, I address some of the special challenges facing reformers as they attempt to encourage technology integration. Chapter III details the methodologies employed to address the two important aspects of curriculum content and instructional format in question. The curriculum question was addressed by a survey-based, quantitative study that examined the relationship between student familiarity with technology and national standards for educational technology training based on the NETS-T. Answers to the instructional format questions were obtained through an interview-based qualitative study that focused on TEP instructors who had sought to integrate technology education into their subject-area methods classes. Chapter IV presents the results of each study. First, I present the results of the survey in which student technology skills were assessed prior to any formal training in an attempt to measure, categorize, and rank the students’ educational

technology content needs. Second, I present the results of the personal interviews with the teacher education faculty currently integrating technology in content-specific methods courses. In Chapter V, I compare the technology skill survey results with the NETS-T. The result is a list of recommendations regarding the appropriate curriculum content of pre-service technology courses. Furthermore, a case is made regarding the use of principal components analyses as a method of program assessment and for making curriculum development recommendations. Additionally, Chapter V presents a cross-case analysis of the interviews in which I compared perceived successes (and failures) and the degree of integration reported for each teacher educator's class. I then present additional analyses of themes and findings across cases and discuss the lessons learned from the early adopters. Some recommendations for effective technology integration are discussed. Finally, broad implications of the studies and suggestions for further research are offered in the final chapter, Chapter VI. In conclusion, given the current national consensus regarding the importance of technology training for pre-service teachers, the current study was designed to address the under-developed aspects of a pedagogy of educational technology: namely curriculum content and instructional format. Without a systematic understanding of both pre-service teacher technology needs, and the efficacy of recent attempts to integrate technology into other sub-disciplines, a true pedagogy of educational technology cannot begin to evolve.

Chapter II

Teacher Education and Technology: History, Challenges and Current Directions

The field of teacher education has recently focused educational renewal and reform. In many ways, teacher education would characterize itself as undergoing a continual process of evolution and growth, seeking to find better ways to prepare teachers to facilitate the learning process for their students. The search for best practices and ideal learning environments is the engine that drives the educational reform movement as it attracts and engages the energies of numerous researchers and instructors within the professoriate. Its idealistic and lofty goals notwithstanding, progress has been slow and disjointed. Yet in the midst of decades of independent and sometimes confusing research findings, specific research directions have surfaced that have sparked a synthesis and melding of knowledge that lends form and character to the face of modern teacher education reform. In the words of Linda Darling-Hammond and John Bransford (2005), the teaching profession has "begun to identify and develop the knowledge base that will frame its core curriculum". A preliminary consensus has begun to emerge regarding fundamental pedagogical knowledge and experiences that are shaping the way teachers are being trained. Darling-Hammond and Bransford (2005) recently put forth a thorough overview of the modern teacher education reform movement entitled: *Preparing Teachers for a Changing World*. A brief review of several key topics presented in their treatise (e.g. how children learn; curricular vision; developmental perspectives) will provide a brief but broad background for the current work.

How children learn. Conceptual learning theory research has finally led to the crystallization of a view of teaching that emphasizes an approach that is observant, reflective, flexible, dynamic, and responsive to frequent assessment. New teachers are trained to continually re-evaluate their assumptions about student learning, to identify many forms of evidence of learning, and to put into practice those methods and features that best produce the kinds of learning they desire from their current crop of pupils. Research within the field has focused on the mechanics of how children learn, the nature of expertise and knowledge organization, and the constructive nature of knowing. It includes issues related to learner-centered education, meta-cognition and other basic cognitive processes like attention, fluency, memory, comprehension, and brain development. It incorporates social- and community-centered learning and the notion of distributed expertise. It characterizes ideal teachers as being adaptive experts, teachers who regularly update or change their own core competencies and expand the breath and depth of their own expertise as teachers. In short, they are life-long learners who construct effective learning environments based on their own knowledge of pedagogical principles and methods, on an empirical understanding of the needs of their students, and often (for better or for worse) on national standards or norms for achievement (Bransford, Derry, Berliner, Hammerness & Beckett, 2005).

Curricular Vision. Another major area of research within the teacher education movement involves the development of a curricular vision among new teachers. Put simply, teachers need to learn that education goes beyond mere knowledge and facts - that a deeper curriculum exists. This broader concept of curriculum includes the

traditional, *formal curriculum* that typically comes to mind (e.g. topics, concepts, themes and facts), an *enacted curriculum* that emerges from activities and interactions between students and teachers (e.g. groups projects, collaborative learning systems and interactive lessons), and finally a *hidden curriculum* that promotes underlying social, interpersonal and educational targeted outcomes (e.g. cooperation, group identity, and social responsibility) that teachers, schools and society hold for children individually and socially. It is a comprehensive and thorough understanding of curriculum at these various levels that must be communicated to the pre-service teacher so that the teacher can make curriculum decisions consciously, thoughtfully and with purpose. Modern and progressive TEPs are making serious efforts to impart this curriculum awareness, knowledge and skill as part of their own larger pre-service training agenda (Darling-Hammond, et al., 2005).

Developmental Perspectives. Developmental psychology has long informed teacher education, but the degree to which new teachers are expected to adopt a developmental perspective has increased exponentially. Modern pre-service teachers are drilled in the workings of social, physical, emotional, cognitive and linguistic development as well as in the role that gender, culture and status may play in the progression along this multi-dimensional roadway to learning. No longer steeped in conceptions of learning and development that are based on stage theories of psychological development, modern teachers are expected to recognize and respond to the individualized ways in which children of diverse backgrounds travel along their unique developmental pathways. A K-12 teacher who is developmentally aware should

recognize that while a child excels in one aspect of development, s/he may simultaneously lag behind in another. Such a teacher is expected to organize a developmentally supportive environment to engage such students in meaningful and productive work in both cases. Modern TEPs emphasize that good teaching focuses on student needs, and supports their progress along various developmental pathways. Student learning is both productive and affirming. Individual differences are viewed as the status quo, and modern pre-service teachers are learning to recognize and respond proactively to even rather extreme cases of developmental fragmentation. TEPs have begun to emphasize the significant interaction between development and learning, the centrality of culture and gender in development, and are seeking strategies for assisting prospective teachers to acquire developmental sensitivity and awareness (Horowitz et al., 2005).

Other areas of research that have attained similar degrees of consensus include the importance of multiculturalism, mainstreaming and the need to prepare teachers to deal with a diverse learner population, alternative routes to teacher certification, classroom management, and assessment. All these sub-disciplines within teacher education are beginning to develop sufficient consensus that they are becoming cogs in the wheel of modern pre-service teacher training. Even issues related to the conceptualization of TEP design and organization in general have received growing attention in terms of research and reform efforts. Once considered overly theoretical and fragmented, modern TEPs seek to provide a more integrated, intra-disciplinary connection and coherence. As a result, true pedagogies for preparing teachers are emerging (Hammerness, Darling-

Hammond, Grossman, Rust & Shulman, 2005). This degree of consensus within teacher education is relatively new, and is due, at least in part, to a formalization of the three aspects of pedagogy – shared vision, curriculum content and instructional format – within TEPs and within each sub-disciplinary field.

No longer based on vague conceptions of educational values and goals, important changes are beginning to emerge in TEPs nationwide. The most dramatic changes include

- 1) initiatives that are institution-based (rather than individualized by instructor),
- 2) deliberately cultivated relationships between K-12 schools and university TEPs,
- 3) a greater focus on requiring foundational knowledge and a skill base that better reflects the needs of new in-service teachers,
- 4) an emphasis on university-wide systems, rather than directing efforts at school districts as the first line of defense.

The resulting adjustment and realignment has led to a burgeoning reform movement within teacher education. Educational technology is becoming increasingly poised to join and enhance this radical and progressive educational reform movement. Teacher education programs, instructional technology educators and departments of educational technology need to recognize this opportunity and to begin asking (and answering) some preliminary critical questions. While TEPs nationwide are moving forward in many other aspects of teacher education, pre-service teacher training in instructional technology is

falling behind and failing to reliably produce in-service teachers who use technology effectively in their instructional lives.

One Sub-discipline Left Behind. Technology education for pre-service teachers today can be simultaneously characterized as one of the most expensive and, perhaps, least effective areas of pre-service teacher training in TEPs across the US. The cost of establishing, upgrading and maintaining a state-of-the-art technology laboratory in a department or college of education, at even a small college or university, can easily represent the largest budgetary expenditure in a given biennium, outside faculty salaries. American colleges and universities have allocated significant resources to making technology readily available to post secondary students. Equipment and software purchasing is at an all time high in post-secondary education for such things as computer labs in every academic building and wireless computing networks reaching nearly every nook and cranny of the campus. Pre-service teachers have never had such widespread access to computing technology on campuses and in their homes and yet, a significant number of them continue to report discomfort with computers (Mehlinger & Powers, 2002). Many do not have a clear understanding of the role of instructional technology in K-12 education (Moursund & Bielefeldt, 1999; Mullen, 2001; Myhre, 1997). Moreover, teachers must believe in their own ability to use technology before they will actually do so (Zhao & Cziko, 2001). It is widely known that many new K-12 teachers fail to fully utilize the technology available to them in their K-12 classrooms after graduation despite their training (Cuban, 2001). Put simply, TEPs (like many K-12 institutions) are over-invested in technology equipment and software, but an equally strong commitment to

instructional technology education for pre-service (or in-service) teachers has not been made. In short, although the call for effective teacher training in the area of educational computer technology has begun to be heard (Glennan & Melmed, 1996), colleges and departments of education, nationwide, have failed to nurture the development of a systematic, companion pedagogy of instructional technology to accompany their state of the art facilities.

Over the last quarter century, university TEPs have emphasized the purchase of hardware, the installation of computer labs, and the wiring of these labs to the Internet. Instructional technology training for pre-service teachers has traditionally taken a backseat to technology purchases. The original purchasing mania of the early 1980s was driven largely by a perceived need for computer literacy among high school graduates and by a community pride related to the number of computer labs on campus rather than the educational benefits conferred by their use (Kerr, 1996). The same may be said for the current race to wire every classroom to the Internet. The desire to get schools "online" is so strong that the Clinton administration established Net Day, a short-lived annual event where community volunteers and politicians installed high-speed Internet access in local schools with considerable media fanfare (Stoll, 1999).

Unfortunately, simply purchasing and installing the latest technology in a TEP is not sufficient to get prospective teachers ready to effectively employ technology in their classrooms. In 1985, Apple Computer, Inc. sponsored the Apple Classrooms of Tomorrow and found that immediate access to computer technology does not necessarily produce changes in teachers' practices. Instead, Dwyer, Ringstaff, and Sandholtz (1990)

suggested that teachers' beliefs about the usefulness of technology and its role in the classroom must first change as they pass through five stages of technology use (entry, adoption, adaptation, appropriation, invention). Only then will they begin to gain the skills and confidence needed for effective instructional use of technology. Training and practice are critical to helping teachers pass through these stages. Without a well-defined pedagogy of educational technology for pre-service teachers, the final steps toward effective integration of computer technology in K-12 education will continue to elude us.

A Brief History of Educational Technology Curriculum

As within any field, a pedagogy of educational technology requires both an accepted curriculum or content, and an effective method of instructional delivery. In terms of course content, existing pre-service technology classes have shifted their emphases in ways that reflect the current technologies available. Traditionally, TEPs offered instructional technology classes that focused mainly on media presentation and production. Sample course manuals from the late 50s and early 60s (Brown & Lewis, 1964, Indiana University Audio-Visual Center, 1958) addressed such topics as: the creation of instructional materials, the selection and use of ready-made materials, and the operation of audio-visual equipment. The range of media production covered in these manuals was enormous with the individual chapters providing instruction in drawing letters, using stencils, designing classroom displays, chalkboard techniques, flannel and magnetic boards, picture mounting, mimeograph production, handmade and machine-made slides and transparencies, mounting objects in plastic, making dioramas, puppets

and puppet theaters, building aquaria, writing scripts for recording, taking and developing still photographs, making short films, and the operation of record players, reel to reel tape recorders, overhead, slide, opaque, film and filmstrip projectors.

With the increased availability of small computers, these TEP classes slowly shifted away from other forms of media and toward computer-based data entry, programming. For a short time, a strong emphasis was on computer programming, either with teachers learning to program instructional software for their students or with students developing logic and problem solving skills through writing their own programs (Papert, 1980). But this trend faded fairly quickly, partly because the supposed value of these skills was shown to be limited. By the late 80s and early 90s, the typical pre-service technology class included introductions to operating systems, word processing, spreadsheets, Hypercard, and methods for evaluating early “edutainment” software such as “Sim City” and “Carmen SanDiego”. With the advent of and subsequent rapid spread of the Internet, CD-ROM software was replaced with instruction on navigating the Internet and eventually, with skills for creating webpages and PowerPoint presentations. Today, one would be hard-pressed to find an educational technology course where traditional media production is still taught (Hargrave & Hsu, 2000).

In essence, traditional media production has been replaced with digital multi-media production. True, we are no longer teaching teachers how to use a camera and develop pictures in a darkroom. Instead we are teaching them to take and print digital photographs. We used to teach teachers how to type on mimeographs, now we teach them how to use Microsoft Word and print to the laser printer. The primary difference is that

the computer has become the center of pre-service technology education, and while additional technological capabilities are available, frequently the final product differs in only minor ways. Despite the heightened availability of computers in instructional technology classes that resulted from the purchasing frenzy that has consumed post-secondary education for the last several decades (Cuban, 1998, 2001), there has not been a matching growth in the pedagogical skills of many new teachers.

One possible reason for this lack of growth in technology use and application within teacher education may be due to a lack of an accepted curriculum or core content for these courses. In many cases, the curriculum content has remained unchanged since instructional technology teachers adopted word processing, spreadsheet use and webpage composition. Yet there are many programs and applications that offer outstanding technology uses appropriate to a wide variety of K-12 classes. For example, each of the following technologies has potential as a K-12 classroom tool that might enhance one's teaching and student learning. Some are clearly content specific, while others could be used in a variety of creative ways by a well-trained teacher: satellite tracking technologies like GPS, virtual dissections, GIS technologies, digital photography, graphic arts applications, music composition or editing applications, video conferencing, PDAs, Blogs and Wikis, podcasting, artificial intelligence, real-time weather programs, robotics, etc... While it is critical to remember that the NETS are about *how technology is used* in education, not about specific programs or software applications (none of the above are endorsed by ISTE or NCATE), it is easy to imagine the educational possibilities that such technologies offer given a teacher with rich educational technology training.

The NETS are educationally theme-based, not applications-based. More importantly, the NETS-T urges a focus on technology information, skills, issues and knowledge that targets teachers, not children (ISTE, 2000, 2002). Pre-service teacher training, according to the NETS-T, requires explicit instruction in technology areas that may only indirectly effect K-12 student learning. For example, NCATE requires training that informs teachers how to use technology to continue to grow as professionals. They require instruction that enhances a teacher's ability to perform student assessment using technology. They require teachers to be prepared to create effective learning environments using technology (ISTE, 2000, 2002). In all of these cases, the NETS-T are best viewed as themes that will outlast any specific technology application or software program – themes that will weather changes in technological applications and software, and that will continue to enhance our educational goal of providing the best educators for America's children. Furthermore, any standards-based curriculum (e.g. one based on the NETS-T or one generated by the TEP itself) would allow a given TEP to assess its educational technology goals directly, and would also provide a mechanism for long-term program assessment in terms of technology use by in-service teachers after their graduates have been placed in classrooms.

In terms of overall program assessment, one such university-oriented assessment is the STAR Chart, aka School Technology and Readiness (CEO Forum on Education and Technology, 2001). While not a *curriculum assessment* tool, the STAR Chart is an assessment tool that determines the level of technology taught at the university as well as the institutional climate as it relates to pre-service teacher training in instructional

technology. While the STAR chart is informed by the NETS, it is not intended to be a curriculum guide. Rather it is an institutional companion to the NETS that provides a self-assessment tool for TEPs and other university organizations that wish to fully understand where their TEP program stands on technology integration and readiness, and how to move forward. Such an assessment tool is valuable but incomplete. What is needed, beyond the assessment at the level of the school/TEP organization, is a generally accepted, standards based curriculum for educational technology such as those provided by the NETS. Working together, a strong standards-based curriculum combined with informative institutional assessment can begin to pave the road to a shared vision.

Unfortunately, a generally accepted content curriculum for instructional technology courses for pre-service teachers has yet to emerge, despite the acceptance of the NETS by NCATE. And, although complex, a large part of the difficulty stems from the curriculum's relationship to the instructional delivery format. Teaching method and content curriculum are inextricably linked. How we deliver instructional technology education may, in large part, dictate what can and will be taught. In many ways, a large number of TEPs are entrenched in a teaching style or format that fails to accommodate the themes put forth in the NETS.

Instructional Delivery Format

Although the content of educational technology classes has changed over the last 25 years, the instructional delivery format for the most part has not. There have been experiments with film, radio, television and computers as tools for delivering instruction

to teachers (Cuban, 1986; Saettler, 2004), but these practices often faded with either the introduction of a new technology or as a result of teachers' preference to retreat to the standard face-to-face method of instruction, rather than as a result a lack of available tools. The promise of high-tech, large-scale, low-cost instruction simply has not been realized. To say that developments in educational technology itself have changed how we teach teachers about technology would be overly optimistic, and naive. Not only is the method of instruction often traditional, so too is the placement of technology content in teacher preparation. In many TEPs, there continues to be a single technology class, typically separated from the rest of the teacher education curriculum and program (Moursund & Bielefeldt, 1999), even so far as to be offered outside the TEP itself in the business school or in computer science departments. Even when a stand-alone class is taught by an instructor who is trained specifically in educational technology for teachers, this format has both advantages and disadvantages (Mehlinger & Powers, 2002). The most common alternative to the stand-alone class is to integrate instructional technology content into the “methods of teaching” courses such as math, science and reading, or into “grade specific” courses such as elementary and secondary curriculum courses. A closer look at both the stand-alone and integrated approaches will highlight their potential strengths and weaknesses.

Stand-alone Technology Courses. On the positive side, the single instructional technology course can provide an overview of a wide variety of technologies, other than just the traditional word processing, web browsing and presentation applications. As previously mentioned, real world technologies, in general, continue to expand and evolve

rapidly. Recently developed technologies or techniques can have direct instructional value in K-12 education, particularly in the sciences, the arts and the humanities. Unfortunately, stand-alone, instructional technology courses are often taught by instructors with limited “ed tech” training or genuine interest. However, when led by a trained educational technologist with a teacher education focus, pre-service teachers have a tremendous resource for accessing these fun, interesting and recent innovations in technology. Furthermore, a well-organized educational technology course can provide initial exposure to particular technologies favored by colleagues teaching subsequent content-specific courses. Science education faculty could rely on their students’ initial training with the GPS or virtual frog dissections, and then expand on that knowledge in their own classes later.

Stand-alone courses can also ensure that the curriculum content tracks evolving technology standards. Educational technology experts are more likely to remain abreast of developments within the field, and of changes in the NETS-A, NETS-T, and NETS-S. Their professional growth, scholarship and service may well serve as a feedback loop for their courses. In short, having an educational technology expert on the TEP faculty can help a college or department of education develop a highly specialized approach to instructional technology curriculum. As such, a stand-alone course is usually viewed as the easiest method of introducing technology into a teacher education program without disrupting the content or faculty of other courses.

On the other hand, there are some distinct disadvantages of the stand-alone course. The most obvious is the lack of a discipline-specific approach to technology

education. While not all educational technology instructors in a stand-alone class are unaware of or unskilled in discipline specific technologies, the typical pre-service teacher audience in these type of classes is so diverse (so many subject areas and grade levels) that instruction along discipline specific lines can become cumbersome, unwieldy and sometimes impossible.

In a comprehensive course in educational technology, all teaching content areas are represented among the students. Interest areas vary widely and instructors may struggle to connect the technology instruction with such a wide array of subject interests. Furthermore, prospective teachers of younger and older children are represented, and this too can lead to an overly general curriculum that makes poor contact with the age-specific needs and curricular differences represented by the pre-service teachers.

Another disadvantage involves pre-service teacher computer literacy. Students, in both stand alone and integrated courses, enter the class with a wide variety of technical skills and the instructor has to respond to this diversity. In an integrated course with a content-specific focus, students can be grouped according to skill without concern for subject area interests. There is simply greater overlap of student subject areas in these content driven courses. In the stand-alone class, on the other hand, students with similar technical skills may have little in common in terms of content or curriculum interests. In such cases, a typical solution is to reduce the content to the basic skills of computer use – instructors feel forced to teach to the lowest skill level of the students. The "how to" of computer use can overshadow the more pedagogical issues relevant to new teachers, simply because a significant number of the students need remediation of basic skills.

While there may be many technology natives in the class, the technology immigrants cannot keep up and create a bottleneck in terms of curriculum focus.

It is also important to note that stand-alone “ed tech” courses are traditionally taught in computer labs where students are able to practice using new skills and technologies. This presents challenges in building, staffing and maintaining suitable labs as well as scheduling them. When a class is using a lab, it is no longer available for drop-in use by others. Thus, more than one lab may be necessary to encourage a) the regular use of technology among TEP students and b) effective technology instruction among TEP faculty.

An additional downside to the stand-alone instructional technology course is the tendency for TEPs to relegate the course to non-expert instructors. The employment of adjunct faculty, graduate students and faculty trained in areas other than instructional technology to teach these courses places them at a disadvantage in terms of orienting toward the course as having a content of its own, independent from other educational disciplines and then of conceiving the course content and approaches to be employed. This adds an additional burden on non-expert faculty to stay abreast of the changing technologies and technology standards (Willis, 2001). Of course, some TEP faculty have a natural affinity for the field and may well be up to the challenges. However, in many cases, the reduction of instructional technology content to little more than computer applications is the direct result of having non-experts serve as instructors.

Finally, the addition of a stand-alone class can increase the total number of credits required of students to graduate, potentially increasing the length of the preparation

program. From an administrative perspective, this can have profound ramifications in terms of support from departmental chairs, college deans and higher-level administrators. The result can be an uphill battle for those TEPs wishing to institute a stand-alone class and to recruit the financial and administrative support needed for its effective implementation. For these reasons (as well as others, mentioned below), the alternative - educational technology integration - may be viewed as the only choice.

Technology across the curriculum

Ultimately, we cannot forget the context within which these students will one day be employed. Regardless of grade level or subject area, teachers are increasingly expected to be able to integrate technology into their classrooms. The technology integration movement is encouraging K-12 educators to consider computer use within the classroom in ways that echo the "Reading Across the Curriculum" movement of the 1970s . That original movement prompted K-12 teachers to include elements of literary fluency (reading, writing, sentence structure, spelling and grammar) into all other major curriculum areas.

Today's teachers are simply expected to be minimally proficient in using computers, and not merely to use them but to use them in their instruction. This includes preparing and delivering lessons as well as assessing student skills and designing appropriate, technology-rich activities for children. This creates a challenge for TEPs whose goal it is to develop strong instructional technology knowledge and skills in their pre-service teachers in a manner that will translate into good K-12 technology use and

integration. If instructional technology is presented in a single stand-alone class, independent of all other TEP courses, a significant aspect of that “translatability” may be lost. Without good modeling of technology integration into content areas during their training, pre-service teachers are less likely to build a strong understanding of how technology can actually be integrated in their future teaching and professional practice. (Beyerbach, Walsh, & Vannatta, 2001; Knapp & Glenn, 1996; Myhre, 1997; Sandholtz, 2001; Stetson & Bagwell, 1999).

According to Knapp and Glenn (1996), "The key is for program instructors to model appropriate use in restructured classrooms and curricula, and for prospective teachers to have practice using technologies as learning tools and as teaching tools." Even James, the whiz kid, needs to practice integrating the technological skills he already has with what he is learning about teaching and learning. However, technology integration in TEPs has its potentially negative side as well. And the question is whether shifting to an integrated format for the instructional delivery of educational technology curriculum will eliminate the risks associated with the stand-alone course format, and whether its promise of enhancing and facilitating technology integration in K-12 instruction will hold true. Although a true "Technology Across the Curriculum" movement has not been formalized, it is clearly on the horizon given the increasing frequency and emphasis placed on technology integration over skills training (Hargrave & Hsu, 2000; McAnear, 2002). In short, will the potential benefits of educational technology integration in TEPs be realized? Or will its own potential risks, outweigh the promised benefits?

National Educational Technology Standards for Teachers

In 1995, NCATE adopted the NETS-T created by ISTE. These standards (see Appendix B) address the following issues and require reasonable proficiency by K-12 teachers in each of the following areas:

- 1) technology operations and concepts,
- 2) planning and designing learning environments and experiences,
- 3) teaching, learning and the curriculum,
- 4) assessment and evaluation,
- 5) productivity and professional practice, and
- 6) social, ethical, legal and human issues (ISTE, 2000, 2002).

In order to fully realize these standards, traditional educational technology classes (stand-alone or integrated) have to change in both content and form. In fact, the adoption of these standards results in ramifications for an entire TEP. The fact is that it is nearly impossible to thoroughly address all of these standards in a single course. Fluency with specific curricula and specializations, sufficient familiarity with all of the various content areas is simply not reasonable to expect from a single technology instructor. Similarly, the current trend of modeling technology use in different subject areas requires educational-methods faculty to expertly manage and model emergent technologies in their classes. Just as technology spreads across the K-12 curriculum, achieving the goals set by the NETS-T will depend directly on a TEP's ability to foster the spread of technology integration across the entire teacher education curriculum. Thus far the

success of such integration attempts in TEPs has been limited. According to NCATE (1997):

Bluntly, a majority of teacher preparation programs are falling far short of what needs to be done. Not using technology much in their own research and teaching, teacher education faculty have insufficient understanding of the demands on classroom teachers to incorporate technology into their teaching. Many do not fully appreciate the impact technology is having on the way work is accomplished. They undervalue the significance of technology and treat it merely as another topic about which teachers should be informed. As a result, colleges and universities are making the same mistake that was made by P-12 schools; they treat "technology" as a special addition to the teacher education curriculum- requiring specially prepared faculty and specially equipped classrooms- but not a topic that need to be incorporated across the entire teacher education program. Consequently, teachers-in-training are provided instruction in "computer literacy" and are shown examples of computer software, but they are rarely required to apply technology in their courses and are denied role models of faculty employing technology in their own work.

Mehlinger and Powers (2002) state that most teacher education programs operate at only the lowest of three levels with regard to technology: literacy, integration, and transformation. Just as the NCATE study revealed, the vast majority of these programs appear to be content offering the most basic of computer literacy classes rather than addressing the more complex and important issues of computer integration. Unfortunately, this is a shortsighted response to NCATE's adoption of the NETS-T standards.

In a well-publicized study commissioned by the Milken Exchange and conducted by ISTE (Moursund & Bielefeldt, 1999), it was revealed that the number of hours of technology instruction integrated across the teacher education program had only a moderate correlation with the pre-service teachers' use of technology, while the number of hours in a stand-alone course had none. The implication of the findings is that both

approaches seem to fall short of the standards set by the NETS-T. And yet, witnessing technology integration appears to be at least part of the solution to this puzzle.

The challenge of breaking the cycle

What is known about the apprenticeship of observation is that teachers teach as they were taught (Lortie, 1975). If the pre-service teachers' professorial models of exemplary math, science, language arts, and social studies instruction do not include technology use, they are unlikely to make this a part of their own teaching. "The system self-replicates: a new generation of teachers inherits the last generation's classroom practices," (Willis & Sujo de Montes, 2002). And this appears to be true, for better or worse.

According to Kerr (1996), most educators view technology in a supplementary role of how schooling ought to be organized. This is true of both K-12 and teacher education faculty. Some pre-service teachers and TEP faculty see technology as necessary to the job market – as a mere selling point for employment. Others are so averse to the use of computers that they feel that they would have avoided the teaching field if they had known the requirements for computer literacy. Myhre (1997) examined pre-service teachers' perceptions of technology and found that they entered their teacher education programs viewing technology as a tool supporting teacher-centered classrooms. As the pre-service teachers explored more student-centered strategies, they actually found less room for technology in their images of their future practice. According to a U.S. Department of Education study (Office of Technology Assessment, 1995), only 3% of

teacher education graduates felt "very well prepared" to use technology in the classroom. Only 20% reported that they feel "well prepared" to integrate computers into classroom instruction. Furthermore, 9% reported feeling "completely unprepared" (United States Department of Education, 1998). It is disconcerting that fewer than 3 out of every 10 pre-service teachers leave their TEP confident in their ability to integrate technology into their classrooms. And yet, when we look at the technology integration behavior (or lack of it) of TEP faculty, these figures become increasingly understandable. It seems almost ironic that K-12 teachers are fully expected to integrate technology in their classroom, while their TEP professors, who are intended to serve as role models and mentors often are not. According to Stetson and Bagwell (1999):

Instructors in teacher education programs are presented a double challenge: how to integrate technology into the K-12 classroom as well as their own. A large majority of teacher education faculty have not spent extensive time in a K-12 classroom for several years, and in the information age . . . that means a lifetime. It is the responsibility of teacher education faculty to, not only, explore, create, and evaluate effective teaching strategies with technology for K-12 classrooms but to also integrate it into university curricula as a way to increase pre-service teacher effectiveness. We must begin to practice what we preach."

A Shared Vision

A systematic plan or vision for technology integration within education must be established and agreed upon (Willis, 2001). Although ISTE (2000, 2002) has developed their own vision in the NETS-T, the prospect of providing adequate in-service technology training to TEP faculty is daunting. Not only is top-down technology introduction often unsuccessful (Kerr, 1991), it is exceedingly slow. College professors tend to require more than brief in-service training experiences. If we are to realize any sort of meaningful

"trickle down" to pre-service students' practice, there needs to be a well-planned, gradual and sustained program of technology training for teacher education faculty, within their colleges of education. In a sort of chicken-and-the-egg situation, faculty need help in overcoming their own fears and reluctance to use technology so that they may do the same for their pre-service students.

Breaking the extant pattern of teaching is difficult (Mehlinger & Powers, 2002). Where do we start? As Stetson and Bagwell (1999) claim, "therein might lie one of the biggest challenges facing teacher education programs, *how to integrate* the use of technology with those teaching techniques, management strategies, learning environments, materials, and curricula that meet with success among a culturally pluralistic population and a growing number of at-risk K-12 students?"

What is needed is a vision of what is possible, and how the teacher education program will conduct its business differently. "Rather than dreaming about a future and building towards it, most [schools, colleges, and departments of education] are adding technology bit by bit while holding on to the existing way of doing business" (Mehlinger & Powers, 2002).

One of the most important conditions is shared vision - stake-holders, educators, and leaders must adopt and consistently communicate a vision for technology use. This vision should include a primary purpose and outcome for technology integration in the classroom and reflect student-centered learning, another ISTE condition. An established vision will then be the foundation and guiding principle of the technology infusion into teacher education (Vannatta & O'Bannon, 2002).

A formal pedagogy of technology education depends on the development of such a shared vision. Without a shared vision, curriculum content and instructional

format have no context or systematic direction. Only with the established vision of how content and format fit together within an accepted set of goals and expectations, will educational technology find the same direction and momentum as the rest of modern teacher education. Today, many TEPs will remain at a crossroads until they can recognize the nature of their dilemma. With one or two pieces of the pedagogical puzzle in place, a formal pedagogy will continue to elude teacher education as it relates to educational technology.

Elements of a pedagogy of educational technology

Just as the “reading across the curriculum” movement established general procedures for infusing literacy across the K-12 curriculum, there is a need for a formalized content and format of technology integration instruction for teacher education students. In establishing such a pedagogy, the assumption should not be made that teacher's views of technology need to be fixed (Kerr, 1991). Instead, the plan should provide content that is engaging, accessible, and relevant to a wide range of teacher educators and pre-service teachers. Starting with the ISTE standards for teachers and students, a core curriculum of necessary skills (operational, instructional and professional) should be established.

Reluctance to integrate technology

Of course, such an undertaking is likely to be met with opposition. There is, however, an interesting precedent for it. Generally, university faculty have three broad

areas of responsibility: teaching, research, and service. Nearly every faculty member uses technology in their research and service goals, not because of some administrative decree, but because it makes the job easier and more efficient. Most are not technophobes. Word processing, data analysis, and web-based library searches are everyday activities for most faculty. PowerPoint presentations are popular at professional conferences and e-mail is central to professional communication. While it is possible to be a productive researcher without technology, there are clear social consequences. To be seen as "traditional" or "old-fashioned" in teaching is acceptable but potentially embarrassing when applied to research. Also, the cost of re-inventing (renewing, updating or renovating) existing courses can be difficult to justify. While tools for research are relatively easy to learn and perceived as valuable, many of these tools have not entered the university classroom. Why not?

Again, the answer lies in the apprenticeship of observation and a heavy reliance on the traditional lecture model. Cuban (2001) summarized several studies comparing faculty use of technology for professional activities, including course preparation with actual use of technology in front of students and assignments that required students to use computers. The data suggests that while the vast majority of faculty are comfortable using word processors, web browsers and e-mail in their offices, they rarely model these skills when teaching. Nor do they use discipline-specific software. In a survey at the University of Washington (Lowell, & McGhee, 2001), 92% of faculty rated their computer-skill level as intermediate or higher, yet 48% said they did not have the necessary skills for using technology to do their work. One interpretation offered was that

such faculty may actually have the skills but may simply be unclear as to how to use them effectively (University of Washington, Computing and Communications, 2002). Perhaps there is some truth to this statement. Just as James, the whiz kid is skilled in using his computer, and just as most faculty tend to use technology outside of the classroom, there seems to be a knowledge gap when it comes to actually using computers in the classroom. There is a lack of intuition regarding how one could best bring those technological skills to bear on a particular lesson in a way that does not appear purely superficial. A pedagogy of educational technology needs to be designed to fill this gap. Computer literacy skills are not the problem, a lack of knowledge of instructional uses is. Therefore, TEPs are charged with developing three important aspects of this pedagogy of instructional technology education:

- 1) Pre-service teachers need basic instruction in technology-related skills knowledge and professional development,
- 2) TEP faculty need to integrate technology by modeling appropriate and meaningful use of technology in their own instruction of content areas outside “ed tech”,
- 3) TEPs need to establish a culture of technology integration to mirror the one urged in K-12 instruction, and to do so not only at the level of pre-service teacher training, but at the graduate level as well. This way, newly hired faculty will bring with them these cultural values and skills.

Summary

Over the last two decades, the emphasis on school-based educational technology spending, policy and practice has been to purchase hardware, establish labs and connect schools to the Internet. This purchasing focus has been shown to be short-sighted in terms of inspiring teachers to use computer technology in their instruction. Training and practice are critical. Traditionally, the technology training once given to pre-service teachers focused on media production. As micro-computers were introduced, the curriculum of technology courses shifted to computer programming, then to application use. Today, the Internet plays a central role in the typical pre-service technology class. Media production has been replaced with digital media production. Although the content of pre-service technology classes have changed, their format generally has not. The stand-alone technology class is still very common, however, it is being replaced in some teacher education programs in an attempt to model technology across the curriculum. This movement has its advantages and disadvantages, in terms of faculty staffing, facilities, and alignment with other courses in the teacher preparation program. ISTE has made a significant contribution by presenting the NETS-T as a standardized set of technology goals for pre-service education programs.

The standards, however, are not enough to ensure that all colleges of education are able to provide the necessary instruction in technology integration required by NCATE. Other forces help to shape teaching practices in higher education and TEPs. Long, well-established patterns and styles of instructional practices exist and are resistant to change. Teacher education faculty are being asked to bear the burden of breaking the

cycle by teaching in ways that they were never taught themselves. Not only do colleges of education need to determine what they will teach about technology, but how. Such sweeping changes are often met with resistance from both students and faculty. And yet, a shared vision for such a grand reform is clearly needed

Before an ideal curriculum and instructional format can be identified and developed, it is crucial to understand what pre-service teachers need and what they already know, relative to a set of accepted standards. Furthermore, a methodology for identifying existing student skills and knowledge before instruction begins is necessary to determining the curriculum/emphases for any given course. Finally, it is important to learn what we can from teacher education professors who have begun the process of integration of technology into other method and content courses. What approaches or formats have worked successfully? Which appear to have failed or created additional hurdles?

Overview

In the next chapter, I describe the methodology I employed in a two-part study in an attempt to establish preliminary information regarding each of these goals. The first part is a principal components analysis of pre-service teachers' technology skills, in an effort to categorize student needs in terms of the NETS-T, thus informing the content of pre-service technology programs. It further serves as a potential model for using brief survey techniques to identify student needs relative to the NETS-T. The second part is a qualitative examination of current teacher educators who are integrating technology in

their methods courses in an effort to learn from their experiences and inform the format of other TEPs transitioning toward their own form of technology integration. Both parts of the study were designed to contribute toward establishing preliminary guidelines and recommendations regarding technology instruction in teacher education programs.

Chapter III

Study Methodologies

Two broad questions were addressed in the current study. The first question dealt with the issue of identifying the extant technology skills, and more specifically confidence in those skills, of pre-service teachers. The approach was to quantify those skills and attitudes using a survey designed for prospective teachers. The second question dealt with instructional delivery methods currently in use in a single TEP. A more qualitative approach was used to allow for a rich descriptive narrative of current practices, including faculty behavior, attitudes, infrastructural support and use. Given the distinct methods used to address the two questions, separate methodological descriptions are presented.

Course Content: What to teach versus what not to teach?

Methods

Participants

Participants included a population of 237 pre-service teachers enrolled in stand-alone educational technology classes, as part of their elementary or secondary teacher training program at a comprehensive four-year university. Both men and women participated. The majority of the participants were undergraduate upper-classmen, however some graduate-level students were included as they too were completing the requirement for teaching credentials, and enrolled in the classes.

Survey Construction

The survey was previously designed, with my assistance, and used as a tool to gauge the level of technology experience of students in the teacher education program. ISTE's NETS-T were chosen as the basis for developing the survey. Each of the six standards was carefully considered and used to phrase questions relating to the pre-service teacher's level of confidence using Fowler Jr.'s (1993) guidelines for survey question construction. Some items were divided into several questions, others were grouped together when appropriate. The original goal was to frame the survey questions as understandable, performance indicators rather than as broad pedagogical issues. For example, the first NETS-T standard deals broadly with current technology operations and concepts. So questions were devised to determine student confidence around a) computer competency in general, b) word processing, and c) text and graphics generation.. A copy of the survey can be found in Appendix E. Table 3.1 shows the relationship between the specific survey questions and the correlated NETS-T standards (Appendix B).

The original purpose of the survey was to determine how students felt about using computers for a variety of tasks associated with being a teacher. All six of the major sections of NETS-T were similarly represented across 18 of the 20 questions. Two additional questions that did not correspond to NETS-T but that were of interest to the original course instructors were added. The final product was an anonymous 20-question survey, using a 6-point Likert scale. Items ranged from basic to more advanced skills, ranging from lesson planning and direct instructional skills to larger transformational skills such as computer integration, professional communication, lifelong learning, and

Table 3.1. Relationship between Survey Questions and the NETS-T.

Survey Question	Summary of Question	NETS-T Standard	Standard Goal
Q1	General Computer Competency	I	Operations & Concepts
Q2	Word Processing	I	Operations & Concepts
Q3	Text & Graphics	I	Operations & Concepts
Q4	Grade Management	I & IV	Operations & Concepts, & Assessment
Q5	E-mail with Other Teachers	I & V	Operations & Concepts, & Professional Practice
Q6	Internet to Plan Lessons	II	Designing Learning Environments
Q7	Student Internet Use	III	Teaching & Curriculum
Q8	Website Construction	I	Operations & Concepts
Q9	Internet Filtering	VI	Ethical & Legal Issues
Q10	Instructional Material Design	II	Designing Learning Environments
Q12	Software and Program Selection	III	Teaching & Curriculum
Q13	Technology Integration	II & III	Designing Learning Environments, & Teaching & Curriculum
Q14	Technology Selection	II	Designing Learning Environments
Q15	Professional Growth & Productivity	V	Productivity & Professional Practice
Q16	Collaboration	V	Productivity & Professional Practice
Q17	Lifelong Learning	V	Productivity & Professional Practice
Q18	Ethic and Legal Uses of Technology	VI	Ethical & Legal Issues
Q19	Assess using Adaptive Technology	II, III, IV & VI	Designing Learning Environments, & Teaching & Curriculum, & Assessment, & Social, Ethical, Legal and Human Issues

ethical use of technology. An informed consent statement was included with the survey, informing students that their participation was voluntary and anonymous.

Data Collection

Surveys were administered by course instructors to their pre-service students on the first day of instruction in their stand-alone educational technology courses. Participation was voluntary and anonymous. Once completed, the surveys were collected for analysis. Of the 237 students surveyed, 205 students completed and returned the surveys (86% response rate). Twenty-five surveys were either incomplete or improperly marked, and were subsequently discarded. From the remaining 180 surveys, means and standard deviations were calculated for each class and reported to the respective instructors. For the current study, I was provided the complete anonymous data set without any indication of course instructor or class session. Only complete and correctly marked survey data were included in the data set.

Survey Adequacy. According to Kline (1994), “in factor analysis, the larger the sample the better”. A sample size of 100 subjects is preferable, but the ratio of subjects to variables should be at least 2:1. The sample size for the current survey was 180 subjects, and the number of variables was 18: producing a ratio of 10:1.

Data Analyses

The two questions that were not related to NETS-T were discarded. Means and standard deviations for the remaining eighteen questions were calculated. Further

analyses were conducted using SPSS. Survey reliability were determined using a Cronbach's alpha test for internal consistency. The Cronbach's alpha test measures how well a set of variables measures a single uni-dimensional construct. Technically speaking, Cronbach's alpha is not considered to be a true statistical test, rather it is a coefficient of reliability. Cronbach's alpha is a function of the number of test items AND the average inter-correlation among the items. The alpha value is a direct function of average inter-item correlation; low correlations produce low alphas, high correlations produce high alphas. This is intuitively sound – highly correlated items suggest that the items are measuring the same construct. This makes sense for this survey since all the items were related to technology use as it relates to education - if the resulting inter-item correlations are high, then there is evidence that the items are measuring the same underlying general construct. Once a high level of consistency (i.e. “good reliability”) is established for the survey, a factor analysis can be used to identify sub-components or domains within this larger construct. On the other hand, if you have multi-dimensional data, Cronbach's alpha will generally be low for all items. In this case, a factor analysis can be used to see which items load highest on which dimensions, and a Cronbach's alpha can be taken for each subset of items separately. The initial alpha test simply determines whether the data set reflects a uni-dimensional or multidimensional structure. The one limitation to Cronbach's alpha arises with very large surveys with many test items. If the number of items increases, the Cronbach's alpha value will increase as well. Because there were only 18 items on the survey, artificial inflation of alpha was not expected. Furthermore, a Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and a Bartlett's Test of

Sphericity were then used to determine the appropriateness of the data for the principal component analysis.

An exploratory principal components analysis was then conducted. This multiple regression analysis is generally used to transform a larger number of correlated variables into a smaller set of uncorrelated principal components or domains. (Boersma & Weenink, 2006) The first resulting component accounts for the largest proportion of the variability in the data, and every successive component accounts for as much of the remaining variability as possible. Once the super-variables are identified, they are reviewed and a comprehensive definition and label that capture the nature of each component is assigned. In order to reduce the eighteen survey items to a smaller set of highly correlated composite components, the principal components analysis was performed using the principal component extraction method with varimax rotation and Kaiser normalization (Kline, 1994). Finally, means and standard deviations for each obtained component were calculated as well.

Instructional Delivery Format: What works and what doesn't?

Methods

Participants

Five university instructors of secondary “methods of teaching” courses at a major public university were invited to participate. Each instructor was an expert in their particular field: language arts, mathematics, science, social studies, and world languages. These particular five instructors were selected because their classes represented an instance where a single cohort of secondary TEP students was divided according to their

chosen teaching disciplines, and where technology education for teachers was integrated into the curriculum. One instructor declined to participate in the study so the participants consisted of the remaining four instructors.

In all four cases, the TEP students registered for a three-credit “methods” class and an accompanying two-credit technology laboratory taught by the same instructor as the teacher of record. According to this particular TEP, these required methods classes were designed to explicitly integrate technology. So in addition to containing both content-specific instruction and technology-specific instruction, these courses also provided an opportunity to include discipline-specific technology content. The classes met three times a week (once in the computer lab for the technology session and twice in a standard classroom) for an entire 10-week quarter. All but one of the professors were assisted graduate student teaching assistants (GTAs) who were enrolled in doctoral programs in education at the same university. The specific course content, the instructional methods used to deliver instruction and the GTAs’ instructional roles were determined independently by each instructor. Class sizes ranged from six to eighteen secondary-education TEP students. Taken together, the students of the five invited instructors represented the entire cohort of secondary pre-service teachers for that year; ultimately, only the social studies students’ instructor was not included in the study. Although I did not have access to information regarding the number of students in the class of the one instructor who declined to participate, it was clear that the data set generated by the study was obtained from the instructors of over 70% of the teaching cohort for that year.

This particular TEP and the instructors of the specific cohort were selected for four main reasons:

- 1) The university was a public institution and, within the United States, the majority of teachers are trained in public institutions.
- 2) The program integrated technology across all of the major secondary instructional disciplines.
- 3) The size of the secondary program was manageable for a study of this scale and the original five instructors represented the entire faculty of discipline-specific methods classes.
- 4) The program was in transition; only the instructors of the secondary education cohort were required to integrate technology.

The elementary TEP program was not included because it had yet to shift away from the more traditional stand-alone technology lab class to an integration model.

Setting and Procedure

To gain an understanding of the instructors' planning decisions and attitudes about technology integration, I used a combination of interviews and instructional materials analyses. Prior to the first interview, each instructor was asked to collect any class materials relevant to technology (syllabi, hand-outs, activity descriptions, etc.) and provide copies to me. The hour-long interviews were one-on-one, semi-structured and held in the instructors' offices. The questions asked can be found in Appendix F. The scripted interview questions were designed to lead to fuller responses and to allow for the

opportunity to ask additional, unscripted probing questions, according to recommendations by Patton (1990). There were four global themes addressed by scripted questions:

- 1) Identify and explore each instructors' approach to integrating technology into the class content,
- 2) Discuss their personal and professional/non-instructional use of technology,
- 3) Determine the role of each GTA,
- 4) Identify any perceived supports or barriers in attempting to integrate technology.

During the interviews, I both manually recorded the participants' responses on my interview form and audio-taped the conversation for transcription. Probing and clarifying questions based upon the participants' responses were also posed (Patton, 1990).

Data Analysis

Following each interview, I transcribed the audiotapes and examined the instructional materials. Unfortunately due to mechanical failure, one of the interviews was not recorded and I had to rely solely on my notes taken during the interview. Notes from this interview were immediately reviewed and transcribed manually. Missing details were added from memory at this point only.

During the coding stage of the analyses, coding schemes for the interviews and instructional materials were developed and refined employing the constant comparative

method. The constant comparative method provides the groundwork for what is otherwise known as grounded theory (for a more detailed review, see Strauss & Corbin, 1998). This approach reflects the use of inductive reasoning combined with cross case analysis as a method to “analyze different perspectives on central themes” (Patton, 1990). It is typically used with narrative- or interview-based data sets. The method can be described as following three distinct stages:

- Comparison of responses, observations of incidents applicable to each category,
- Integration and synthesis of initial categories and their properties,
- Identification of new larger, meaningful and universal categories or themes.

As meaningful responses to interview questions are recorded and classified, they are also compared across interviewees and across content categories. Thus, the discovery of specific relationships, and the development and generation of potential hypotheses, begins with the preliminary analysis of the obtained observations. This process undergoes continuous refinement throughout the data analyses. It results in a reciprocal feedback loop that redefines the category codings. As responses are compared, new dimensions emerge and new relationships are discovered. The result is a process that renders discriminably distinct responses into broadly equivalent categories or themes. It enables us to reduce the complexity of the responses and provides order and, on occasion, may give cohesive direction for future action. It is this process of repeated categorization and inductive reasoning that serves as the primary analytical method. It is the respondents' data that drive the themes rather than a preconceived theoretical framework. Its focus is less statistical; it is more directly tied to the meaningfulness of the categories that emerge.

These categories, while tied to an appropriate analytic context, should also be rooted in relevant empirical material: "The analyst moves back and forth between the logical construction and the actual data in a search for meaningful patterns" (Patton, p. 411). It is essential that the categories be meaningful both in terms of the responses to the interview questions as they were posed, and in terms of the larger ideas they express.

Data analysis for this data set followed the guidelines set out by Strauss & Corbin, (1998) involved open coding of individual responses and statements from the four instructors, as well as my impressions or notes (particularly those related to the interview that was not recorded on tape) regarding specific questions or responses onto individual 5 x 7 cards. These cards were then sorted into initial categorical concepts along lines of the initial interview questions. As I began comparing responses within and across categories (and within and across cases), single responses were divided into sub-themes (or sub-quotes), to create smaller, more detailed categorical groupings (aka axial coding) and as a result, additional 5 x 7 cards. For example, instructional formatting questions were divided into separate categories: one for lecture, one for lab. Then the lab category was further divided into self-taught and GTA taught categories. This sub-categorization based on instructional format and instructor type also found its way into other categories such as lesson planning and self-perceived limitations, In some cases, statement and quote cards were sometimes duplicated or divided if the information appeared relevant to more than one theme or category. As I began reviewing these subcategories, a meaningful set of larger universal themes emerged.

Chapter IV

Study Results

Consistent with the presentation of the two methodologies in Chapter III, the results of the two investigations are presented separately. A synthesis of the following data and the implications and ramifications of the data from both investigations are presented in the subsequent chapters.

Course Content: What to teach versus what not to teach?

One hundred eighty of the returned surveys were included in the final analysis. Incomplete or incorrectly marked surveys were eliminated prior to the data analysis. Two items, questions numbered 11 and 20, were disregarded as they were not directly related to the NETS-T, but were of interest to the course instructors who had developed the original survey. Question 11 asked participants how confident they felt using computers that were connected to a network. Question 20 asked participants to rate their ability to serve as the primary contact person for all new teachers with respect to using computers on their campus. While these test items relate to educational technology, they do not clearly align with any of the NETS-T.

Table 4.1 shows means and standard deviations for each of the remaining survey items. Means range from a low of 2.26 (Item #10: comfort in preparing complex, self-guided instructional materials on a computer for students) to a high of 5.53 (Item #5: comfort in using e-mail to contact other teachers for advice and professional development) on the 6-point Likert scale. Standard deviations were consistent, ranging

from 1.04 (Item #2: comfort in preparing written assignments for students using a word processor) to 1.55 (Item #8: comfort developing a class website). Even on a 6-point Likert scale, standard deviations between 1.0 and 1.5 suggest a reasonably stable group of respondents with similar levels of confidence on each of the items whether it is high, medium, or low.

Table 4.1. Descriptive statistics for the 18-item survey of technology confidence for all respondents ($n=180$) as produced by SPSS.

	Mean	Std. Deviation
<i>Q1</i>	3.93	1.10
<i>Q2</i>	5.31	1.04
<i>Q3</i>	4.24	1.46
<i>Q4</i>	4.64	1.31
<i>Q5</i>	5.53	1.06
<i>Q6</i>	4.76	1.24
<i>Q7</i>	4.76	1.12
<i>Q8</i>	2.82	1.55
<i>Q9</i>	2.49	1.42
<i>Q10</i>	2.26	1.32
<i>Q12</i>	3.88	1.31
<i>Q13</i>	3.25	1.43
<i>Q14</i>	3.87	1.31
<i>Q15</i>	4.39	1.32
<i>Q16</i>	4.13	1.33
<i>Q17</i>	4.66	1.23
<i>Q18</i>	4.18	1.51
<i>Q19</i>	3.44	1.42

Because the survey items all revolved around educational technology use, a high degree of internal consistency for all 18 items was predicted. The initial Cronbach's alpha test was conducted to determine survey reliability that was found to be high (alpha = .9384), suggesting good consistency.

In order to evaluate the appropriateness of the data for the principal component analysis, a KMO Measure of Sampling Adequacy and a Bartlett's Test of Sphericity were conducted. Table 4.2 shows the results. Both tests suggest the data were significant and appropriate for principal components analysis.

Table 4.2. Results from the KMO and Bartlett's Test.

<i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i>		.917
<i>Bartlett's Test of Sphericity</i>	Approx. Chi-Square	2158.320
	df	153
	Sig.	.000

The principal component analysis (varimax rotation with Kaiser normalization) was conducted and the results indicated three super-variables that accounted for 65.6% of the overall variance. The rotation converged in a total of 6 iterations. Table 4.3 shows the variables loading on each of three principal components. A cutoff for component loadings of .50 was used. Every test item loaded on at least one component, while two test items, questions numbered 13 and 19, loaded on two of the three components

Identifying the Components

The goal of this exploratory analysis was to identify those technology integration skills that tended to be the most highly correlated in terms of pre-teacher confidence, and to identify important "super-variables" for future study. By reducing the number of

variables, I hoped to be able to compare the relative needs of pre-service students in terms of educational technology course content. It was my intention to use these

Table 4.3. Results of the Principal Components analysis: Rotated Component Matrix

	Component		
	1	2	3
Q1			.528
Q2			.784
Q3			.638
Q4			.705
Q5			.788
Q6			.580
Q7			.543
Q8	.727		
Q9	.773		
Q10	.833		
Q12	.643		
Q13	.646	.538	
Q14		.510	
Q15		.794	
Q16		.774	
Q17		.797	
Q18		.636	
Q19	.612	.566	

components to begin the process of characterizing pre-service teacher needs in meaningful ways as they relate to the NETS-T, as an important step toward a shared vision of a pedagogy of educational technology for teacher education programs. Keeping in mind that components do not suggest causation, but are simply aggregates of highly correlated variables, the analysis revealed the following components:

- 1) Classroom-Specific Teacher Skills;
- 2) Professional Development and Curriculum Planning;

3) Routine Applications and Basic Operations

It is important to note that neither the number of components nor their nature was conceived prior to the analysis. This was an entirely exploratory investigation. Table 4.4 details the variance explained by each component.

Table 4.4. Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.945	49.693	49.693	4.244	23.579	23.579
2	1.780	9.891	59.585	3.892	21.623	45.202
3	1.078	5.989	65.573	3.667	20.371	65.573
4	.947	5.259	70.833			
5	.740	4.111	74.944			
6	.640	3.554	78.498			
7	.596	3.310	81.808			
8	.489	2.717	84.525			
9	.444	2.464	86.989			
10	.399	2.217	89.207			
11	.351	1.952	91.159			
12	.292	1.620	92.779			
13	.274	1.522	94.301			
14	.249	1.386	95.687			
15	.239	1.329	97.016			
16	.207	1.149	98.165			
17	.199	1.105	99.270			
18	.131	.730	100.000			

Extraction Method: Principal Component Analysis.

Component 1: Classroom-Specific Teacher Skills. The six items that made up Component 1 accounted for 23.5% of the total variance. The component consisted of

questions related to creating a class website; filtering of inappropriate Internet material; preparation of computer-based, self-guided materials for student use; reviewing of educational software; integrating technology with an otherwise traditional academic lesson; designing and delivering activities that use adaptive technologies. The overall mean for the component was 3.15 with a standard deviation of 1.5. This suggests that pre-service teachers consider themselves only marginally confident in these skills, with many falling below the "neutral" mark.

Component 2: Professional Development and Curriculum Planning: The seven items that made up Component 2 accounted for 21.6% of the total variance. The component consisted of questions relating to integrating technology with an otherwise traditional academic lesson; designing and delivering activities that use adaptive technologies; deciding when a computer might be useful or not as an instructional tool; applying computer technology to enhance one's own professional growth and productivity; using technology to collaborate with other teachers to solve classroom problems; using technology to encourage one's own lifelong learning; understanding and implementing a school district's acceptable use policy (AUP). The overall mean for the component was 3.99 with a standard deviation of 1.4. This suggests that pre-service teachers feel more confident in their ability to use technology for professional development and curriculum planning.

Component 3: Routine Applications and Basic Operations. The five items that made up Component 3 accounted for 20.3% of the total variance. The component consisted of questions relating to overall computer competency; using a word processor

to produce written assignments for students; creating documents with both text and graphics; using a computer to track student grades; using e-mail to contact other teachers for advice; using the Internet to develop lessons; having students use the Internet to complete assignments. The overall mean for the component was 4.74 with a standard deviation of 1.3. This suggests that many pre-service teachers are very confident in their ability to use computers for routine word processing, spreadsheet and Internet related tasks.

Instructional Delivery Format: What works and what doesn't?

It is the nature of the grounded theory to develop a comprehensive profile based on a variety of non-quantitative analytical methods (Strauss & Corbin, 1998). My primary data analysis approach for the interview portion of the study was the constant comparative approach described earlier. While one's initial data collection may be guided by previous findings, the constant comparative analysis is primarily an exploratory method designed to organize observations around emergent themes and schemas. As such, I present observations made both within cases and across cases. My insights and observations are supported through the use of interview summaries and direct quotes from the individual instructors. Individuals were not identified unless a comment or quote was specific to a particular discipline; and then instructors were identified only by their discipline and not by name or pseudonym. A more formal discussion of the impact of the findings from the interviews (combined with the results of the previous survey) on the development of an explicit pedagogy of technology are presented in the next chapter.

Prior to conducting the interviews, I had expected to find that GTAs generally had limited (but not zero) technology skills because they were not education technology graduate students. I expected the faculty to have even fewer skills because they were mature adults who did not grow up as technology natives (Vail, 2005). I also assumed that I would encounter faculty that resented the push to integrate technology in their classes and that were quite content “handing off” their lab classes to their graduate teaching assistants. Given the lack of formalized training in educational technology, NCATE and ISTE standards, and technology integration, I expected the content-specific instructors to relegate “ed tech” issues to the lab sections only, and to allow GTAs to handle the bulk of the technology-related instruction.

Finally, I predicted that these classes were not integrating technology in a meaningful, discipline-specific way. If anything, I thought they would address basic computing skills and not pedagogically relevant issues. If my previous assumption that GTAs would assume responsibility for the technology lab sections held true, their lack of knowledge about pedagogical issues as they relate to educational technology should preclude their ability to integrate technology in a manner consistent with the NCATE and ISTE standards. After completing the analyses, I found that in some ways I was correct in my predictions, but in many others, I was not.

Syllabi and course materials

After reviewing the course materials and syllabi, I found some of my initial hunches were accurate. In all of the materials provided for the four different methods courses and technology labs, I found no mention of the NETS-T or NETS-S. There was

no evidence of an explicit pedagogy of instructional technology education. Nor was there any information regarding national standards for teachers regarding technology use beyond vague, discipline-specific directives to use technology in K-12 classes. For example, the math education state standards include requirements that K-12 students use computers, calculators and other relevant forms of technology. While minimally informative in terms of the skills new teachers need to master, the materials did provide limited evidence that instructional technology was viewed as a necessary component of pre-service teacher education.

Lab class content

Here too, I was correct in my assumption of what often occurs in the lab sections. In most cases, discipline-specific content was mentioned in the lab, typically in the form of questioning strategies or as an introduction to a new topic. “Remember when we were talking about asking questions? What sort of questions could you ask your students while they look at this website?” However, the reverse was not often true. In most cases, little or no educational technology, beyond actual use of PowerPoint or a particular technology-based software, was ever introduced in the lecture portion of the courses. This bias was made explicit by one instructor who said, “The cross-over is [mainly] from methods to technology. The crossover in that direction is about big ideas about teaching and learning. The cross-over from the technology section into the methods is simply the use of software.” When two of the instructors reported using a discipline-specific technology in the lecture portion of their course, it took the form of a “show and tell”

approach. The software was merely demonstrated. There were no requirements to use the technology, to assess the technology or to formally reflect on the technology.

Moreover, it seemed that while the instructors were able to identify relevant websites and software that K-12 students could use, they had difficulty identifying any teacher-specific technologies that might be relevant to their particular discipline. None of them appeared to teach non-instructional uses or issues related to technology that teachers might need to know. It was clear from our conversations that the four instructors viewed technology as an instructional tool used primarily as an alternative teaching technique in the K-12 classroom. They seemed unaware that there are technologies and issues related to technology that are important when training pre-service teachers. Examples might include grade-book programs (a teacher-specific technology), virtual professional communities (listservs and discussion groups) or the issues related to Internet filtering (i.e. the advantages and disadvantages of using such products, their impact on appropriate (as opposed to inappropriate) informational access, and the ethics that underlie Internet use in public education). Put simply, there was no direct evidence in the interviews or in the course materials to suggest that an explicit effort was made in either lecture or lab to discuss technology beyond instructional uses. Of course, that is not to say that such issues were not discussed. Because I did not attend any sections of these courses as part of the study, my information was limited to the interviews and course materials.

Although the perspective of technology as primarily a teaching tool was a broadly consistent finding across the four courses in general, it should be noted that the instructional uses taught were not always simplistic or trivial. Three instructors included

more detailed instructional uses of technology than I had expected. For example, one instructor explained that he had recently finished a manuscript describing three different types of Internet activities with three different levels of involvement. He discussed these activities with his students in the methods class and required each student to design a lesson following his second model. The comparison of three different Internet activities carried overtones of how different technologies or technological techniques can alter levels of student involvement - perhaps providing a more sophisticated look at technology as a teaching tool. However, it is important to note that this assignment and the related discussion were completely separate from the lab class, as was another assignment involving the development of a video-based lesson. In contrast, this instructor's lab sessions dealt primarily with the use of PowerPoint as a teaching tool, yet no particular assignment was tied to the topic in lab or lecture portion of the course. More importantly, no effort was made in either forum to discuss instructional technology as having pedagogical value or impact beyond the instructional tool.

Instructors' opinions of educational technology

There was a general consensus among the participants that while technological skill was important, it is not absolutely necessary in order to be a good teacher. While most of the instructors acknowledged that technology has a place in today's classrooms, many were ambivalent regarding any absolute or naturally inherent value of using technology in education.

One instructor mentioned that "computers are important, but not indispensable; social context is important and computers can isolate people." However, the same

instructor later stated that “K-12 students are doing interesting things with computers and they (the computers) will become indispensable.” It seems that university instructors perceive a real pedagogical potential for technology, but are wary about new teachers being seduced into thinking that the Internet, educational software, and other technologies can replace traditional teaching skills. This ambivalence was evident in the following comment: “Above all, pedagogy is the most important part., ...[yet], technology can make students more self-directed.” I found this perspective to be consistent across the four instructors, both in terms of their characterization of educational technology and in the way they approached the integration of technology into their own classes. They all seemed philosophically committed to the idea of integration, but each had made instructional decisions that realistically compromised that integration to varying degrees.

Several instructors asserted that the use of technology in K-12 schools must be justified as teachers are “short on time” and often technologies, such as the Internet, are simply not very important for some subjects such as mathematics. Again, it seemed clear that a commitment to appropriate technology use and integration was shared by these instructors. Yet, the actual integration of technology primarily hinged on student exposure to hardware and/or software, on basic skills and only occasionally, on implicit instruction through the use of modeling via assignments that required some form of technology use (e.g. lesson planning using Internet resources). In most cases, educational technology use seemed incidental to lessons that were designed with a different content and focus. Nowhere did I find evidence of instruction that used the discipline-specific

content to highlight a lesson or a point related explicitly to technology use. Only the reverse was true – technology was used to highlight the content.

Another theme that arose was that of technology prominence in higher education, and in TEP in particular. “Technology [in TEP] should be as prominent as it is in the schools”, said one instructor. Another stated, “Some see (technology) as an add-on, others see it as integral. I’m somewhere in the middle.” At least one instructor mentioned that other topics such as inclusion and multiculturalism were beginning to take precedence and to “squeeze-out” the topic of technology in his methods class. Along the same lines, I was told,

“My experience from teaching and talking with other colleagues is that at this point, at least in this place, there really is no vision of how technology should be integrated into both the preparation of teachers and the teaching of subject matter, and I say that because a lot of it seems ‘jury-rigged’. We have people looking over our shoulders and we have to make sure we have certain things in the pot and clearly technology is one of those things that is indispensable now, we can’t have a teacher program and not have that. So, we’re going to have it, but at the same time not enough attention or resources (are) paid to it so that experts can come in and train people and develop the kind of curriculum that really responds to the wide range of needs that there are.”

Overall, the comments regarding the value of technology in teacher education suggest that while there is agreement that the use of technology can enhance one’s teaching, its use must be taught carefully to ensure that new teachers use it wisely. However, how to accomplish this does not benefit from the same consensus. There appears to be doubt about the ability of TEPs to deliver technology education, and it would seem that this is due, at least in part, to a lack of a common understanding of the phrase “technology integration”, both in practical and pedagogical terms.

Personal and professional use

Following the evidence from Larry Cuban's (1998, 2001) work, I assumed that TEP instructors had generally positive attitudes and experiences related to technology use in their personal and professional lives, regardless of how much they actually used it in their classrooms. I found this to be true. Every instructor listed a variety of applications that they used on a regular, if not daily, basis. These programs included word processors, spreadsheets, e-mail, web-browsers, presentation software, statistics programs, image editing, overhead projectors, video cameras, digital videodiscs, and videocassette recorders. Not one participant suggested that these were unpleasant experiences. In fact, some described the fun they had recently experienced after purchasing a new computer or digital camera for their homes. However, their personal and professional uses of technology did not overlap well with their instructional needs. They appeared to be distinct experiences and despite possible instructional uses, none of the instructors suggested any connection between their personal or professional uses of technology and applications to their classes. Therefore, technology fluency in their private and professional lives did not translate to instructional application, consistent with Cuban's observations.

Planning to use technology

Despite the fact that the accompanying lab classes were intended to be "technology labs" for the purpose of meeting NCATE requirements, every participant was careful to note that technology should only be used when it is an improvement over other methods. Not only did they attempt to explicitly convey that sentiment to their pre-

service teacher students, but they ascribed to it in their own course planning. Given the academic calendar, only so much time is available for instruction. The participating instructors fell into two categories: those who taught their own lab classes, either by choice or necessity (no teaching assistant assigned), and those who turned over the lab responsibilities to their GTAs. Instructors who had GTAs teaching their labs, made no formal plans to use or integrate technology. In fact, one of those instructors explained that competing academic topics like inclusion and multiculturalism tended to trump technology integration in the lecture portion of his course.

For the most part, I found that all four instructors tended to plan their methods classes first and then developed a few (if any) technology activities to supplement the lecture content in the time remaining.

“The planning decision was not necessarily where I can put technology, but as I’m thinking about the [subject] and the pedagogy that I was trying to get across to the students, in what ways can technology help me do that better than if I didn’t use technology. Because I always figure if all else fails, we don’t have to do any technology really, but where it’s useful, where there is an expectation that they will be facile with the stuff. That’s where I try to make sense.”

In the remaining cases, instructors left all technology decisions up to the teaching assistants and rarely, if ever, even attended the labs. One instructor said about his GTA, “She had already taught the class before and planned the syllabus. She decided on the specifics and made her own modifications.” As a result, the experience of the teaching assistant played a significant role in what actually transpired in the lab sessions. I found there was no “middle ground,” either the instructor or the teaching assistant did all of the planning. Neither the planning nor the actual teaching for the lab was a shared activity.

Communication

Along the same lines, I found that if a GTA was to teach an integrated educational technology lab session, communication was essential. Even in the case where the experienced teaching assistant was left to her own devices and apparently managed quite well, the instructor did not communicate with her about how he could adjust his class to compliment her lab. The result was an obvious and unfortunate disconnect between the methods course content and the technology lab activities. Although methods instruction and educational technology were both taught, no integration between the two occurred. And the key component that was missing was communication.

Communication is a two-way street – critical to the connection between lecture and lab; between discipline-specific content and instructional technology education. Whether it was the experienced teaching assistant piloting the lab on her own or the experienced instructor that was assigned a novice teaching assistant, when there was little communication between both parties regarding the activities and topics, it was unlikely that the classes were well-integrated. Again, the greatest connection between lecture and lab occurred when the instructor did not just “hand off” the lab to a teaching assistant.

This is not to say that having distinct instructors will ultimately lead to a disconnect between course content and technology. Rather, it is the absence of a set of common goals, a shared vision, and reliable, ongoing discourse between instructors that threatens to undermine technology integration in this lecture/lab format.

Graduate teaching assistants

I have already mentioned how important the teaching assistants' technology skills are, as well as the need for communication with the instructor. However, it remains to be said that despite mastery and fluency in both technology and teaching skill, a GTA's employment is relatively temporary. In the TEP under study, as in many TEPs, graduate students that are employed as teaching assistants serve a limited term (in this case a 2-year term). This is just about enough time to build up a working relationship with the instructor and to hone a set of pedagogically-relevant technology skills before their employment ends. Furthermore, it is rare that GTAs assigned to a course will overlap for any meaningful period, resulting in the need for each new GTA to reinvent the course. As such, there is no "passing of the baton". A progression of trial-and-error teaching methods are thrust upon naïve pre-service teacher cohorts. The result is an alarmingly inconsistent teaching method, and questionable success in terms of new teachers meeting national and state educational technology standards.

As it also happens, graduate students may not always be studying the particular discipline of the curriculum area to which they are assigned. In fact, they may be assigned over multiple areas, working with several instructors in many different classes. When comparing the different teaching assistants of this particular TEP, I noticed a correlation between the subject area experience of the teaching assistant and the nature of the course content included in the lab classes they taught. Those that were teaching outside of their subject-area specialty tended to rely on generic applications such as presentation software and webpages, while those that taught in their specialty area were

more likely to introduce their students to discipline-specific hardware, software and websites. As might be expected, in the cases where the instructors themselves taught the lab sessions, the hardware and software were even more discipline-specific, perhaps because they had more time to acquire the knowledge and skills regarding relevant technologies.

Integration versus Connection

The TEP under study was early in the process of integrating technology into the teaching methods courses within the secondary education program. Data collection occurred during the third year of integration. I felt that this was an important time to study since all TEPs planning to introduce technology integration would benefit from the experiences of others who had done the same. I had hoped that three years would be enough to allow the instructors time to develop an “integration style or approach” but not time enough to become entrenched and inflexible. Of course, there are many ways to integrate technology. The TEP under study chose to integrate by adding a technology lab to the teaching methods courses – in some ways a logical and pragmatic approach. In many ways, it proved to be a reasonable approach. However, the limitations and barriers to successful technology integration became apparent quickly. Still, even for those TEPs that might choose an alternative approach to technology integration, the lessons learned in the present study could prove valuable.

First and foremost, I found that the term “integration” was not as appropriate as “connection”, simply because the methods class and lab section were clearly separate, with varying degrees of connection between them. I found this lack of connection

between lecture and lab to be the case across three of the four instructors: especially for those two who had GTAs assigned to teach their labs. Students in these labs were simply guided through the workings of a particular program, or witnessed some sort of demonstration of a particular CD-ROM or website. Students were able to take some time and explore specific software, but not with the goal of generating a product or completing an assignment. While some labs had more of a “show and tell” atmosphere than others, it was a clear trend that crossed the four different instructors’ courses. Perhaps the most impressive demonstration of technology-based lab activities involved an instructor that re-located his class to another lab with discipline-specific hardware and software. He even borrowed handheld devices from a local high school. However, despite this extraordinary effort to provide students with an opportunity to learn about advanced, discipline-specific technology products, there was no explicit engagement with course curriculum or with pedagogy for these students beyond “how to”. Again, the “show and tell” approach prevailed with little or no connection with the lecture portion of the course.

The overarching impression I had was that these “integrated” laboratory sections consisted primarily of demonstrations and hands-on experience with products, sometimes specific to the discipline, often not, and usually without any pedagogical emphasis specific to educational technology. As future teachers, these TEP students would have to instinctively derive their own methods of technology integration for their own classrooms later, as these “integrated labs” failed to model such integration for them. Furthermore, it is unclear whether these pre-service teachers would actually meet the standards set by the NETS-T.

As I perused the interviews, I became increasingly aware of a lack of a clear understanding of what is implied by the concept of technology integration on the part of the TEP instructors. One instructor attempted to clarify for me his understanding of the term “integration”:

“When we say our (program) is integrated that only means that I also teach that class as well as the regular methods section, so you have to consider what ‘integrated’ means. True integration would be that the kinds of things we talk about in the regular methods class get incorporated into the technology section, which I guess they do. These themes that I emphasize during the methods section, like teaching for understanding, filter their way into our technology section because I’m always asking my students to think about how this use of technology can facilitate understanding, not just roaming around on the web or playing a cool game. In that way there’s some integration of thematic emphasis between methods and the technology section. I just do a general integration of these themes; you could integrate assignments that cross-over between the two sections.”

It is important to recall that in only one class did assignments actually cross-over and that was the one in which a GTA was not assigned due to limited enrollment, and the instructor taught the technology lab course himself. That particular instructor explained that he connected his lab and methods classes so closely that one could not say. “OK, this is Thursday, that’s technology day.” He elaborated, “technology isn’t a content area, it’s something that needs to work in conjunction with the [subject area] and make it easier or better, or deeper.” Interestingly, the labs that had the greatest connection were both taught by the instructors themselves.

It is important to note that the instructor also failed to perceive a “content” for educational technology alone, particularly where teachers are concerned. This is clearly the result of being an expert in a content field, and not of instructional or educational technology. Educational methods instructors are typically charged with teaching teachers

how to teach children, not with the goal of providing future teachers with technology skills, best practices and knowledge that will permeate their professional lives.

In terms of connection between lecture and lab, classes that were simply handed off to the GTAs were not as well-connected. According to one instructor, “There was no connection between the lab and methods classes at all, except reminders about class.” When pressed, this instructor explained that he had never taught the methods class before, and that at the beginning of the quarter, he did not even know that the lab section existed and did not have enough time to properly consider how the classes would be integrated. He was fortunate that his GTA had taught the class before and was willing to design and teach the class herself. Clearly, this is a case of an experienced teaching assistant rescuing the lab but who has no input into the lecture portion of the course itself. Not all teaching assistants are so well prepared.

Technology Expertise

An additional component in the successful integration of technology into TEP methods courses is the degree to which the instructor is fluent with the technologies to be taught. I had expected to find teaching assistants with technology skills greater than both the faculty and the pre-service teacher cohort. As it turned out, this was the exception, and not the rule. According to the participants in the current study, the technology expertise of the individuals responsible for teaching lab sections varied greatly. One instructor confided that over the years teaching in the TEP, he found that many times the teaching assistants provided by the College of Education had little, if any, experience in his field of expertise or with technology. In fact, his pre-service students generally knew

more about technology than his teaching assistants. As a result, he has simply let the teaching assistants focus on basic computer applications like PowerPoint and creation of webpages while he discussed technology in the methods class. In the future, however, this instructor expressed an intention to teach the lab class himself. In fact, he had even gone so far as to change the quarter in which it is typically taught so that it would fit his busy schedule. This sentiment about teaching assistants having less computer experience than the pre-service students was echoed by one other instructor. In only one case, did an instructor praise his teaching assistant as having more skills than himself, yet he estimated that approximately 30-40% of his students were just as skilled. Clearly, the technical skills and experience of the teaching assistant and instructor play an important role in the connection between technology lab and methods class.

Perception of student skills prior to instruction

When asked how prepared the pre-service students were to engage in technical activities, the instructors were generally positive. It seems that each year, more and more of the students have a strong background in using technology. I noted that when describing their students, many of the participants began by explaining the percentage of students that could create webpages. That skill appears to be recognized as the pinnacle of technical proficiency. This was further demonstrated when I asked if any remediation of skills was necessary: "They had no idea about html." One participant explained his expectations and surprise on the topic:

"Almost surprising, I guess I was surprised, but maybe shouldn't have been . . . how little direct web design experience the students had coming in. I kind of figured 'these kids will be techies, they'll be giving me html coding tips and stuff,' and it hasn't happened. In fact, both years that I've

taught the course, in each class there was one person who was highly experienced, but pretty much everybody else was not. So, that surprised me. They all were really interested and appreciated the fact that we were going there because they did realize that is an expectation that most schools will have, that new students coming out will have the capacity to do web design or something. I think the perception of how much technology is happening in schools is much greater than the reality, so they were concerned that they would walk into an interview and the principal would say 'are you prepared to do your classroom webpage?' And now they can say, 'yes, I can do that.' They were pleased about that, so that was a good thing."

I think it is important to note that all of the instructors interviewed assessed student preparedness to study educational technology in terms of technical and computing skills, rather than from a pedagogical perspective.

Perception of student skills after instruction

Participants differed in their estimations of how well-prepared their students would be to use technology once they entered teaching careers. One instructor commented that he didn't think his students would be able to use much technology in their first year of teaching due to the extra preparation required and the nature of a first-year teacher's schedule. The remaining participants were hopeful, but not certain. "My wish is that they are able to go into a classroom and be able to use as much technology as they want to. I don't think they'll be able to go in and start using huge amounts of technology, but my intent was to introduce them to a lot of things. It is kind of like technology by inquiry: give them some hints of things to do and let them take it in certain directions. I hope they have some understanding, but also curiosity." "I suspect they are better prepared than they would have been otherwise, but my feeling in that regard is that one of the best ways to learn what you need to learn is to learn it on site."

Only one instructor mentioned skills beyond applications. He stated that his students had improved their html and PowerPoint skills sufficiently, but not their pedagogy of when or how to use technology to improve instruction. Yet even this observation failed to touch on the depth of technology education as recommended by NCATE and ISTE. I had expected the TEP instructors to confirm this limited viewpoint for their students; I was surprised (and disappointed) to find they too suffered from the same limited vision.

Anticipated Changes to the Course

All of the participants shared with me some of their plans for altering the course in the future. In addition to wanting to take on a greater role in the lab sessions, each instructor described an activity or assignment that they were considering adding to the class. These ranged from new hardware and software to increased use of video. As for technical support and equipment needs, I found only minor concerns about lab facilities and staff. The two most frequent requests were for each classroom to have a wireless laptop that could travel around the room and a fixed-focus data projector. Three professors requested each. I was surprised to note that an Internet connection for each classroom was cited as being a minor concern and not very important. Finally, one instructor mentioned that he had toyed with the idea of introducing an electronic message board for his students when they were off-campus, in their field assignments. He had tried to implement one in the middle of the quarter and had mixed results. The prospect of having one in place before the quarter began appealed to him.

In general, the primary changes mentioned by the TEP faculty revolved around modest equipment goals rather than pedagogical issues. Most did not see pre-service teachers as wanting or needing sophisticated technology knowledge or skills outside instructional uses. One instructor seemed to think that the TEP had little to offer a pre-service teacher regarding technology education. "...[Students] can learn something here at the university, but until they go to a school and get a job and see what are the needs of the particular situation and what materials are available, then I think they can (better) learn there."

Summary

Through an exploratory principal components analysis of the survey data from 180 participants, three components emerged: 1) Classroom-specific Teaching Skills; 2) Professional Development and Curriculum Planning; 3) Routine Applications and Basic Operations.

- 1) *Classroom-specific Teaching Skills* accounted for 23.5% of the total variance. The overall mean of 3.15 fell just below the midpoint of the 6-point Likert scale. This result demonstrates a need for focused pre-service technology training on classroom-specific teacher skills.
- 2) *Professional Development and Curriculum Planning* accounted for 21.6% of the total variance. An overall component mean of 3.99 suggests that pre-service students feel reasonably confident in their ability to use

technology to collaborate with other teachers, to encourage lifelong learning, and to plan lessons and activities.

- 3) *Routine Applications and Basic Operations* accounted for 20.3% of the total variance. The overall component mean of 4.74 suggested that pre-service students already feel highly skilled in basic computer applications. There appears to be little need for these topics to be addressed in pre-service technology training.

Ten major themes or impressions emerged from the interviews with the TEP educational methods/technology faculty:

- 1) *National Standards*. Although they were informed about state-based K-12 technology standards within a particular content area, the TEP educational methods/technology faculty seemed grossly unaware of national standards for educational technology for teachers and students (NETS-T and NETS-S), particularly those related to areas other than instructional support.
- 2) *Applications-Based Curriculum*. The content of instructional technology education continues to be viewed as primarily applications based, particularly among TEP faculty who are not trained in educational technology.
- 3) *Positive Computing Experiences*. Consistent with Larry Cuban's findings, the participants shared positive personal use experiences with technology outside the classroom, yet did not see its utility in their own subject areas.

- 4) *Shared Vision for Technology in Education.* All four TEP faculty shared the view that technology has an important place in education, but that it does not have a content specific unto itself, and that technology alone does not justify its use in the classroom. It must improve K-12 instruction.
- 5) *Technology as Secondary Curricula.* If the TEP faculty explicitly planned technology experiences for their students at all, it was only scheduled in support of methods course content. None of the instructors considered instructional technology goals (i.e. NETS-T or NETS-S) independent of content curriculum when developing lab class activities. Little attention was paid to the pedagogical value or impact of instructional technology.
- 6) *Graduate Teaching Assistants and Communication.* Faculty often deferred lab instruction to their teaching assistants without a great deal of communication regarding their expectations. As a result, very little integration occurred.
- 7) *Integration versus Connection.* Lecture classes and lab sessions were typically distinctly separate classes, therefore looking at the “connection” between labs and lectures seemed more appropriate than discussing “integration.” Greater involvement on the part of faculty in lab classes resulted in greater connection.
- 8) *Technology Expertise.* Faculty were generally skilled in technology use, however, graduate teaching assistants were not. Often, the pre-service students had stronger technology skills than the teaching assistants.

- 9) *Perception of Student Skills*. Faculty generally discussed students' skills in terms of specific applications, rather than instructional uses. The ability to create a webpage was frequently cited as the ultimate example of being technology savvy.
- 10) *Anticipated Course Changes*. Several instructors expressed an interest in taking on a greater role in future lab sessions.

Overview

In the next chapter, I examine the results of each investigation in greater detail. First, I compare the survey results with the NETS-T and provide a list of recommendations regarding the appropriate curriculum content of pre-service technology courses. Further, I make a case for the use of principal components analysis as a method of program assessment and for making curriculum development recommendations. Second, I present a cross-case analysis of the interviews, comparing the relative levels of success and technology integration within each instructor's class, resulting in a list of recommendations for successful technology integration based upon the lessons learned from these cases. Finally I draw broad conclusions about the development of a pedagogy of educational technology, citing evidence from both investigations.

Chapter V

Discussion and Recommendations

The primary focus of the discussion is to reflect and elaborate on the results of the two independent investigations that make up the current study. It is my intention to provide a synthesis of the findings of each investigation and present specific recommendations based on the information that was provided by the target populations. Furthermore, I will attempt to integrate the results of the two studies and find common ground in terms of making sense of the results. My goal is to find a meaningful “take-home message” that can help to establish guidelines for TEPs regarding curriculum and format for educational technology courses for prospective teachers. Primarily, I intend to use the descriptive data and grounded theory from the present study to develop an organized and directive plan for the development and implementation of TEP curricula and course format that will facilitate the development of a shared vision and a pedagogy of educational technology. As I have stated previously, educational technology is poised to join the current educational reform movement, but a pedagogy of educational technology in higher education is lacking. It is the ultimate goal of the current study to provide a preliminary road map for the development of that pedagogy that will provide education technology with an identity and a path for the future.

Course Content: What to teach versus what not to teach?

The primary purpose of the principal components analysis was to reduce the NETS-T from six very specific standards into a smaller set of global components based

on participant responses, not on any particular theoretical framework. However, it was important that there be a logic and a common sense about these global components. The three components that were finally identified reflected major categorical topics that are based on the NETS-T and that are required by NCATE of educational technology courses. Interestingly, even the three components can be reduced to two broader categories: Routine applications and basic operations, and teacher-specific skills. However, within the teacher-specific skills category, two distinct classifications emerged: teacher-specific skills with direct instructional influence and teacher-specific skills with more indirect influence. The three final components were:

- 1) *Classroom-Specific Teacher Skills*
- 2) *Professional Development and Curriculum Planning*
- 3) *Routine Applications and Basic Operations*

Every test item loaded on at least one of the three final components; overlap was minimal. By examining the components, and comparing and ranking them, we can identify areas of educational technology curriculum that are most needed and others that are quite likely unnecessary.

Component 1: Classroom-Specific Teacher Skills. The test items that constitute Component 1 relate to technology skills generally restricted to educators. They can be viewed as classroom-specific skills that allow new teachers to develop and organize technology-based instructional activities and materials. These skills are not content or curriculum issues (those appear in Component 2), nor are they routine computer applications such as word processing, sending email, internet searching (those appear in

Component 3). Rather they are very specific to the “behind the scenes” efforts of teachers as they related to the use of technology in their instructional activities. These items related more to the process of preparing to use technology in the classroom, rather than technological curriculum content and non-instructional uses. More specifically, the items included skills such as creating a class website; filtering of inappropriate Internet content; preparation of computer-based teaching materials; reviewing educational software; integrating technology into a lesson, and designing activities that utilize assistive technology.

None of these classroom-specific, instructional skills are abilities that a tech-savvy, non-educator would possess. Certainly, they are not what one would consider typical technology skills. The “whiz-kids” mentioned earlier do not have these skills, nor are these skills typical in normal public uses of technology. They are skills that both technology natives (Vail, 2005) and technology immigrants lack equally. In fact, those individuals that might have “tested out” of their educational technology course (Wienke, 2002) would be unlikely to pass that section of an exit exam, if written properly. They are unique and essential to the role of a teacher and should not be considered common knowledge, especially given their low overall mean in the survey. They are composed of questions mapped across the NETS-T. What they share is their focus on teacher content knowledge as it relates to instructional uses of technology, consistent with the view of Mehlinger and Powers (2002). Shulman (1987) identified seven different categories of teacher knowledge: content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their

characteristics; knowledge of educational contexts; knowledge of educational ends, purposes, and values. This component (1) aligns nicely with Shulman's notion of pedagogical content knowledge defined as the set of instructional techniques and practices requiring technology, as opposed to general pedagogical or curriculum knowledge, or even content knowledge about technology itself.

Educational technology as a whole has yet to truly define their pedagogical content knowledge. Shulman (1986) defined this specific type of knowledge as

The most regularly taught topic in one's subject area, the most useful forms of representations of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, ways of representing and formulating the subject that make it comprehensible to others. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons.

Given that this component accounts for the greatest variance and had the lowest mean, just below neutral, it clearly represents the area of greatest need in terms of curriculum content for teacher educational technology courses. In many ways, the pedagogical content knowledge needed by new teachers becomes the content knowledge for the educational technology professor. Put simply, prospective teachers are not all future computer teachers; we hope they will become computer-using teachers. And yet, many TEPs focus their educational technology courses on computer applications, and not on what future teachers need to know about effectively using technology in the classroom. This needs to change.

The issues covered in Component 1 deserve a more prominent role in the pre-service education curriculum. ISTE has not ignored these needs. They recommend that teachers acquire the ability to develop and deliver instruction using technology in ways that enhance learning. However, ISTE fails to rank this area of knowledge any higher, in terms of priority, over other types of technology-related issues or knowledge. ISTE has simply provided an unranked list of necessary skills for teachers. However, the results of the current survey suggest that some ranking of the components may be appropriate and necessary. A mean of only 3.15 and a standard deviation of 1.5 strongly demonstrate that pre-service students feel very lost when it comes to actually using technology in an instructional context. Other components will reveal that students do not necessarily feel naïve about all technology use, but they are uncertain when it comes to classroom-specific uses. Myhre (1997) suggested that many pre-service teachers do not view computer skills as a necessary part of teaching; this finding was consistent from pre-service teachers both before and after their traditional educational technology course was completed. Myhre actually found that pre-service teachers considered technology less useful after completing their educational technology course. This negative attitude may be mitigated by an increased focus on the NETS-T (and specifically, classroom-specific teacher skills) rather than the primary focus on the NETS-S that is the current trend.

The abilities that would come from a clear pedagogical content knowledge of educational technology in higher education meet the more general requirements of the principles and standards for content pedagogy set forth by the Interstate New Teacher Assessment and Support Consortium (INTASC, 1992). INTACS is “a consortium of

state education agencies and national educational organizations dedicated to the reform of the preparation, licensing, and on-going professional development of teachers. Created in 1987, INTASC's primary constituency is state education agencies responsible for teacher licensing, program approval, and professional development. Its work is guided by one basic premise: An effective teacher must be able to integrate content knowledge with the specific strengths and needs of students to assure that *all* students learn and perform at high levels” (INTASC, 2005).

According to INTASC (1992), “The teacher understands the central concepts, tools of inquiry, and structure of the discipline(s) he or she teaches and can create learning experiences that make these aspects of subject matter meaningful for students.” In short, the ability to use technology in an instructional context should be foremost for TEPs when setting goals and objectives for an educational technology course for pre-service teachers. These are skills that prospective teachers lack, and that they clearly perceive as a need for their future jobs. TEPs would be well advised to focus immediate and specific attention on these particular skills in their educational technology courses. In particular, emphasis should be given to those items within the component that averaged below 3.5 and that represent items of highest priority according to student ratings. They are (in order of decreasing confidence):

Item 19 (M=3.44; SD=1.42): Designing, delivering and assessing learning activities that require the use of adaptive technologies.

Item 13 (M=3.25; SD=1.43): Designing a unit or lesson that integrates a variety of software, applications, and technological learning tools into an otherwise traditional academic lesson.

Item 8 (M=2.82; SD=1.55): Developing an Internet Web site.

Item 9 (M=2.49; SD=1.42): Screening out inappropriate material from students' computers.

Item 10 (M=2.26; SD=1.32): Preparing complex, self-guided instructional materials on the computer.

Component 2: Professional Development and Curriculum Planning. The test items that constitute Component 2 relate to technology skills that apply to educators when they are not actually teaching students. Not all of a teacher's technology-related skills are manifest explicitly in the classroom. Teachers frequently engage in professional development and planning activities that do not translate directly into classroom instruction. These activities, while virtually invisible to K-12 students, can exert a strong indirect influence on a teacher's classroom activities and instruction. Often the students remain quite unaware of the teacher's efforts in these areas unless the teacher fails to develop these skills. Lesson planning, deciding when technology would enhance or detract from instruction and planning accordingly; using computers to further one's own professional development and lifelong learning; understanding a school district's AUP; using technology to collaborate with other teachers to solve problems are all examples of activities that occur outside of the instructional class period, and are all good examples of

technology-relevant skills and behaviors that, while not immediately visible in one's classroom instruction, are very important to new teachers. The results from the survey suggest that these skills cluster together, and although the mean ($M=3.99$, $SD=1.4$) was slightly higher than that of Component 1 and above the scale midpoint (3.5), there was still considerable lack of confidence in these skills for many students.

Interestingly, while many new teachers fail to recognize the importance of lesson planning in general, the current participants did note their minimal preparedness in this area as it relates to technology use. In higher education, it is not unusual to hear students complain that the pre-service teaching curriculum is too far removed from actual instructional practice. Many prospective teachers state that the heavy emphasis on lesson planning, theories of instruction, assessment, and philosophies of education (to name a few) are not as valuable as actual in-school experiences like student teaching. While these complaints are sincere, they are often made by pre-service teachers who simply do not yet have enough experience in classroom management to fully appreciate the value of pedagogy and methodology. Learning to become a teacher involves more than subject area knowledge and knowing "what works in the classroom". Despite this typical lack of interest in lesson planning, the responses from the students in the current study emphasize their own discomfort in the use of technology in the lesson planning process. Along similar lines, Monk (1994) and Begle (1979) found that mathematics methods courses had a greater positive effect upon future teacher performance than did additional coursework in mathematics content. Whereas pre-service teachers may not immediately see the application of or need for the skills that compose Component 2 (and to a lesser

degree, Component 1), they were easily made aware of their own limitations where these skills are concerned via a simple survey. With this in mind, I have two recommendations where Component 2 skills are concerned. First, I recommend raising pre-service teacher awareness of their limited skills where Components 1 and 2 are concerned using a brief pre-course survey. And second, I recommend that the pre-service curriculum attend to these specific Component 2 topics. Moreover, I would urge TEPs to move beyond routine technology skills to find a context in which to nurture pre-service teachers in the use of technology for their own development and planning activities.

INTASC (1992) cites both professional development and lesson planning goals for new teachers. INTASC cites its lesson planning goals as: “The teacher plans instruction based upon knowledge of subject matter, students, the community, and curriculum goals”. These goals coincide with ISTE’s objective (ISTE, 2000) regarding planning and designing learning environments. “Teachers plan and design effective learning environments and experiences supported by technology. Teachers design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of students.”

Curriculum planning has long been part of teacher education. It has a prominent role in the training of pre-service teachers nationwide. In fact, many TEPs include “Curriculum” as part of their formal departmental designation. It should come as no surprise that curriculum and lesson planning should be the focus of any national teacher standards movement. However, where technology education is concerned, many TEPs fail to meet the goals set by ISTE and NCATE (Coughlin and Lemke, 1999; Milken

Exchange on Teacher Education, 1998). Therefore, TEPs would be well-advised to determine the degree to which technologies that enhance curriculum planning are being taught in their educational technology courses, and they should set clear expectations regarding lesson planning using technology for those courses.

While lesson planning, in general, already holds a prominent position in many TEPs, direct instruction in professional development skills and strategies does not, perhaps because it appears more relevant to in-service rather than pre-service teachers. Teacher educators should recognize not only that this topic is important, but that technology can greatly enhance access to professional development activities.

In addition to lesson planning activities, INTASC (1992) also cites principles and standards for the use of technology in professional development. Their professional development goals are formally stated, “The teacher is a reflective practitioner who continually evaluates the effects of his/her choices and actions on others (students, parents, and other professionals in the learning community) and who actively seeks out opportunities to grow professionally.” These goals are consistent with the NETS goals (ISTE, 2000) that state “teachers demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies”. Here too, professional development may not appear as important to the new pre-service teacher as actual classroom experience. But once again while the prospective teacher may find it hard to see far enough into the future to recognize the importance of having well-established technology skills that would facilitate their own professional development, it falls to the

TEP to ensure exposure to relevant technologies such as listservs, on-line journals and distance education opportunities for in-service teachers.

It is important to note that the resulting components were not completely orthogonal; there was minimal overlap of survey items in components 1 and 2. Two of the eighteen test items loaded on both components. The principal components analysis revealed that these two components are more closely correlated than one might assume *a priori*. I decided to examine these two survey items and determine why this overlap might have happened.

Interestingly, these two items had the lowest means in component 2 and were the only two items that fell below the scale midpoint (3.5). Question number 13 asked pre-service students to estimate their confidence in designing a lesson that actively integrates a variety of software and learning tools into an otherwise traditional lesson. The mean for item 13 was only 3.25, slightly below the midpoint on the Likert scale. Given its rather low ranking, a significant proportion of the surveyed students were not confident in their planning ability. While this skill obviously falls into the component about lesson planning (component 2), there is some sense to it loading on component 1 (instructional uses) as well. Without confidence in actually teaching a lesson that involves a variety of technologies, one cannot be expected to be able to plan such an activity.

For example, a science teacher who wishes to create a lesson plan that will teach her students to analyze data using a spreadsheet's statistical package, must have enough experience with the tool and with its use in the classroom to know:

- 1) which specific lesson is most appropriate for integrating the tool

- 2) how to make appropriate choices for the chosen lesson
- 3) deciding the parameters of the assignment
- 4) allocating enough time for the lesson
- 5) appropriate forms of assessment.

The success of her lesson planning will depend on how fluent she is with these skills that come into play long before she ever teaches her students. Effective lesson planning with technology (Component 2) is tied to a high level of in-class teaching skill using technology (Component 1). The two are reciprocal skills that enhance each other. This logical link is demonstrated by the dual loadings on Components 1 and 2 for this item.

Question number 19 asked about pre-service teachers' confidence in their ability to design, deliver and assess learning activities that require the use of adaptive technologies. Key to this survey item are the abilities of "designing activities" and "delivering instruction". Important to note here is that the survey questions were written without the benefit of pre-existing component analyses. To discriminate these two aspects of the question, the item would need to be divided into 2 separate survey questions. More importantly, the purpose of item 19 was to address issues related to assistive technology fluency, not "design and delivery". While this item may appear, at first glance, to fit best with the other content-related items in Component 3, assistive technology would appear to be a different kind of content – one that relies more heavily on unfamiliar technologies. Therefore, it would appear that the pre-service teachers lacked the content of assistive technology as well as pedagogical skill. Maushak, Kelley, and Blodgett (2001) advocated for additional attention to be paid to adaptive technologies in the pre-service curriculum.

While it may be argued that such information might best be delivered in courses that deal exclusively with issues related to students with disabilities such as special education, it also fits well with an educational technology course. Furthermore, ISTE (2000) cites the use of “technology to enable and empower learners with diverse... abilities”, and “to support... strategies that address the diverse needs of students” as two of the technology goals included in the NETS-T. While it is important to recognize that while the content of assistive technology is essential to pre-service teacher training, it is equally important to emphasize the pedagogical abilities related to that content (specifically lesson planning and classroom implementation), as evidenced by the dual loading of Item 19 on components 1 and 2.

The fact that these two items loaded on two components does not diminish their importance, rather it emphasizes them. Their dual loading suggests that they are complex and span both planning and teaching scenarios. Furthermore, their relatively low average ratings suggest that pre-service students are unprepared to address these issues before they complete their education technology course. Therefore, both items represent areas that warrant attention by TEPs and educational technology instructors.

Component 3: Routine Applications and Basic Operations. The test items that constitute Component 3 relate to everyday uses of computers such as e-mail, word-processing, spreadsheet use and searching the Internet. It is important to note at the onset that the nature of the items that clustered together was that they were familiar, everyday applications and operations. Uncommon technologies, such as those specific to adaptive technology, failed to be included in Component 3. In terms of Shulman's (1986, 1987)

work, Component 3 is best categorized as content knowledge (specifically knowledge of computer applications and operations), not pedagogical content knowledge (how to teach using computers) or even general pedagogical knowledge (simply how to teach). Rather, the items included in Component 3 represent those skills and activities traditionally associated with “computer literacy”.

Survey items with the highest means and smallest standard deviations fell into this component, including: using e-mail to contact other teachers (mean = 5.53, SD = 1.06) and using a word-processor (mean = 5.31, SD = 1.04). Clearly, most pre-service students are fairly savvy when it comes to frequently used computer applications. E-mail and word-processors are everyday tools used by most college students in both their academic and private lives. The overwhelming majority of pre-service students do not need any sort of instruction in the operation of these applications. Less than 10 years ago, this was not the case.

In the past, it was appropriate to offer instruction in word-processing or e-mailing for all but the most “geeky” of students. Today, it is the rare student that needs instruction in these skills. As such, it is my opinion that the pre-service curriculum should abandon topics such as the applications found in the Microsoft Office suite. For those few students who are deficient in these skills, most universities and colleges offer remediation outside the normal academic curriculum. Of course, we know very well that changes to TEP curricula are difficult and slow. There is a long history of teacher education embracing its traditional roots, and being resistant to curricular change (Goodlad, Soder, and Sirotnik, 1990). However, the current suggestion to abandon routine applications and basic

operations is rooted in the empirical data gathered in the present investigation. Furthermore, this suggestion is not antithetical to the recommendations made by ISTE and NCATE since relative fluency with common technologies seems to be the mainstream rather than the exception, and opportunities for remediation usually already exist. More importantly, the elimination of basic skills from the curriculum would create time and opportunities to include other less familiar kinds of technology and pedagogical issues.

As first mentioned in chapters 1 and 2, computer literacy (aka content knowledge) is often over-emphasized in pre-service technology courses (Mehlinger & Powers, 2002). The results of the current survey demonstrate that pre-service students do not need a great deal, if any, instruction in these basic operations. While it is true that ISTE (2000) recognizes these skills as a necessary component of good technology instruction, they represent only a very small subset of the technological skills and abilities encompassed in NETS-S, NETS-T, and NETS-A. Each of these three sets of standards (for students, teachers and administrators) venture well beyond mere computer literacy into other areas such as problem solving, curricular development, professional development, communications, support services, etc.

One of the primary purposes of a comprehensive set of national technology standards is to explicitly draw attention to issues beyond computer literacy and to enlighten non-technologists about some of the other important issues surrounding instructional technology. Similarly, the National Council of Teachers of Mathematics (2000) standards are designed to alert non-mathematicians to the fact that math teachers

are interested in students being able to do more than simply solve mathematical equations, and the members of the National Association for Sport and Physical Education (2004) want non-members to know that physical education teachers want children to do more than play sports. Every major instructional field has their respective national organizations and associated comprehensive standards. These standards serve to form a common language among practitioners – an important part of a shared vision. They also serve to inform state-level standards development and adoption. In the case of technology, ISTE seeks to acknowledge that being able to use a computer is important, but such computer literacy does not represent the entire spectrum of standards and objectives for technology education.

Darling-Hammond et al. (2005) discuss the infusion of technology in teacher education programs as a means to help pre-service teachers develop a curricular vision with respect to the use of technology for learning. Specifically, they state that pre-service teachers need to develop a "set of ideas about how their students should be able to use technology within particular disciplines." And "in the world of teaching, general fluency is probably best thought of as a deep, workable understanding of the use of standard productivity tools for the work of teaching. Teachers also need a number of specific fluencies in the use of technological tools that are coupled to their specific domains of expertise." The three components revealed in this investigation served to organize many of these fluencies into three broad categorical designations that can help TEPs to assess and reorganize their approach to educational technology.

Guidelines for Pre-service Technology Course Content

In light of the principal components analysis and the research cited previously, I offer the following guidelines for teacher educators concerning selection of educational technology content for their classes:

- 1) Do not place a great deal of emphasis on the "how to" of using computers, especially for everyday tasks such as word-processing, e-mailing and Internet searching. Students generally know how to use computers today. Instead provide an alternative avenue of remediation for those few students who lack these skills.
- 2) Be sure to place an emphasis on classroom-specific teacher skills with technology as it is used in actual instruction. Course content ought to include technologies used by professionals in the your students' chosen fields. For example, if one is teaching instructional technology to future math educators, identify what technologies the community of mathematicians uses and provide the students the opportunity to experience the "technological tools of the discipline in ways that are consistent with the broader community of practice" (Darling-Hammond, et. al., 2005).
- 3) When teaching students about lesson planning, recognize that technology can play a useful role before classroom instruction ever begins. Teachers weigh many decisions when planning curricula. One important decision that they should weigh is whether or not technology would be beneficial to

their instruction, and if so, what role it will play in terms of student and/or teacher use.

- 4) Be sure to impress upon the students the importance of professional development opportunities once they have graduated and become in-service teachers. At the same time, demonstrate the opportunities for professional development afforded by technology, including workshops, on-line courses, listservs, professional on-line societies, and various resources available on the Internet.

Principal Components Analysis as Needs Assessment

In terms of needs assessment, the present survey provides insights into important aspects of teacher training. The results suggest the importance of using direct sampling methods to assess pre-service teachers' skills and to identify curricular needs. One important benefit of the present study was the ability to collapse a variety of technology integration skills into "super-categories" which can be used for curriculum design and program assessment purposes. The three emergent components may prove useful in guiding curricular decisions for current university technology instructors. Attention to these "super-categories" may help maximize time spent on areas of greatest need, thereby helping to produce greater fluency with new skills regarding technology use and integration. For example, the present population demonstrated reasonable confidence with basic technology skills and a lack of confidence in their ability to use technology to instruct children. While student mastery of basic skills may not reflect true expertise, it is

usually sufficient for the average K-12 teacher. Yet, many TEP instructors assume a fundamental lack of basic skills and postpone instruction of pedagogical uses of technology (if they are even aware of it themselves). The present findings could help guide the university technology instructor's curriculum development away from basic skills (a very brief review might suffice) and toward the introduction of more sophisticated uses such as creation of a class website, filtering of Internet content, and utilizing adaptive technology.

Of course, as technologies change so too will the specific skills and knowledge encompassed within each principal component. Frequent, regular sampling will allow timely detection of shifts in the pre-service teachers' needs. Certain questions may need to be added or dropped. The recent availability of USB flashdrives, the sudden popularity of podcasting and blogging are examples of skills that may soon become so commonplace that they too will require only minimal attention in an education technology class. If educational technology instructors remain current with technological advances, and if they utilize brief initial surveys with their new students, they should be able to incorporate these new technologies, and shift increasingly common skills out of the main course content.

Will the components themselves change? Interestingly, unlike the specific skills and technologies included in the current survey, the nature of the emergent components seems less dependent on the technology of the times. It is likely that prospective teachers' interests will continue to fall into the broad categories of direct and indirect classroom-specific teacher skills, and basic technology skills. And it would seem reasonable the

nature of the classifications that emerged in the present study will have a degree of staying power. Likely changes include the specific skills and technologies associated with each. Furthermore, the current survey did not explore discipline-specific technologies, such as GPS (global positioning satellite), graphing calculators or music composition software such as Finale, because such questions did not represent interests found in the NETS-T. However, in circumstances where educational technology course are taught in a discipline-specific format, such questions would seem useful and important. Thus it is likely that component 3, under such a situation might also divide along lines of general basics skills and discipline specific skills. What the present investigation does suggest is that students are ready and eager for additional technology skills. Not only can we use brief survey methods to identify pre-service student needs, we can eliminate unnecessary instruction, use the additional time to focus on appropriate uses of these technologies, and begin this needed instruction earlier.

Instructional Delivery Format: What works and what doesn't?

The shift from the survey of NETS-T-related issues to the question of how to best deliver instructional technology curriculum highlighted how much the instructors of educational technology, like their students, are very much a cohort themselves. They may teach different subject areas, but they have similar goals, similar challenges and despite the different content areas – very similar students. Spending an hour with each of the four instructors produced interesting viewpoints regarding the successes and difficulties faced by these professors who have taken on the challenge of technology integration, often

before many of their peers, and without the benefit of clear guidelines or recommendations from ISTE or NCATE. In short, most of these instructors were forced to invent the wheel on their own, and I am grateful for their willingness to share their experiences. From their responses, I was able to glean important and meaningful information about what worked for these professors, and what did not. From their revealing insights, I was able to identify several broad conclusions and make suggestions for teacher education programs that are considering implementing a course structure like the one I examined.

As summarized in the results, ten major impressions emerged from the interviews conducted. When viewed together, I found some of my preconceptions to be accurate, while others were dispelled. Overall, the data from the ten global impressions could be summarized into 6 broad themes. In general, the targeted instructors were positive about technology, yet they were unclear about how to achieve real technology integration. This was combined with a profound lack of preparation on the part of graduate teaching assistants (regarding technology integration, the NETS-T and NETS-S, familiarity with relevant technology for the discipline), a serious disconnect between lecture and lab (no explicit instructional delivery format to ensure integration), a lack of real discipline-specific hardware and software support from the education and content departments, and a rudimentary awareness of the NETS, at best, by both GTAs and professors (hence no standards-based curriculum for educational technology). Finally, there was an absence of a shared vision about the role of instructional technology in pre-service teacher education.

Theme 1: Instructor Preparedness

First, it is important to point out that in three of four cases, the courses had two instructors: a professor and a graduate teaching assistant (GTA). I would further point out that it is a myth that TEP faculty are not skilled or interested in technology, and that the younger doctoral students are. The data suggest that the instructors were, in fact, quite skilled and very interested in technology both in and out of the classroom. Furthermore, the GTAs may actually need a fair amount of remediation before they are really prepared to teach a fully integrated technology lab course. The faculty generally presented their technology integration as a work in progress. They recognized some of the weaknesses caused by the disconnect between their lectures and labs, and had plans (ranging from loose to well conceived) to improve that link. Two of the four instructors felt that their assigned teaching assistant was virtually unprepared to deliver instruction related to the technologies specific to the discipline. One professor (who had never taught the course before) felt fortunate to have been assigned a teaching assistant who had taught the class previously, and felt that her experience was invaluable since he was completely unaware of the lab course until shortly before classes started. Furthermore, she knew of appropriate websites and informational technologies that were useful for their mutual students. What struck me was how aware this professor was that he was truly lucky to have that particular assignment. Clearly, there was a risk that he may have been assigned a teaching assistant with no experience, and he knew it. Finally, the last professor was responsible for his own lab section primarily due to enrollment limitations. Should the enrollment in his course increase in the future, he would certainly be assigned help and

using the same methods used to assign GTAs to the other instructors. So it is reasonable to assume no specific attention was paid in the past, nor would it be paid in the future, to GTA knowledge or skills associated with instructional technology within any given discipline.

Recommendation #1: GTA Hiring Practices and Assignments. I recommend that careful attention be paid in the hiring and placement of teaching assistants with respect to technical skills and subject-area proficiency.

Theme #2: Communication between Instructors and GTAs

A second issue relates to the degree of communication between the faculty member and the GTAs. In the two cases where the GTA actually taught the lab, the GTAs were left to their own devices, regardless of their technology knowledge or lack thereof. No efforts were given to collaboration with the faculty member in terms of planning, creating assignments, or ensuring a content-based connection between the lecture portion of the course and the lab. Laboratory teaching format and content were the responsibility of the GTAs in these two cases. One attended lecture regularly and knew enough to deliver reasonably good technology instruction, the other taught basic skills like PowerPoint. In the other two cases, no GTA instruction was involved – one instructor took over the lab because the GTA was totally unprepared to teach. He merely had the GTA attend the lab class and participate as one of the students. Perhaps it was his plan to have her take over in another quarter after experiencing the lab as a student, but he never made that clear during the interview. As mentioned previously, the last

instructor had no GTA with whom to plan lessons. This gross lack of communication led to unreliable technology integration across the board. Nothing about the departmental policies was designed to ensure technology integration would be effective and meet the goals set by ISTE and NCATE. GTAs appeared to be assigned based on their knowledge of the content area, and not with regard to their technology skills. And in the most unfortunate case, there was no GTA with knowledge of the subject area or technology. A GTA was assigned with a background in education foundations, and then left to develop her own lab class. So it is not surprising that she taught only basic skills. In all three cases in which a GTA was assigned, there was virtually no meaningful interaction between instructor and GTA on the topic of technology integration with course content.

Recommendation #2: Communication between Instructor and GTA. Clearly, it would be preferable to assign GTAs with some degree of mastery in the subject area and with some knowledge of technologies appropriate to the discipline. While this may sound like wishful thinking, it is not unreasonable to expect or require that there be more communication and collaboration with the primary instructors. Once teaching assistants are hired, they should not be expected to simply design and teach the technology labs on their own. To create a separate lab class with its own syllabus and instructor is not in the spirit of “technology across the curriculum.” Such courses are very similar to a single stand-alone educational technology class except that these lab classes are less standardized from one subject to the next, and in the cases that I examined, less comprehensive in scope. If a teaching assistant is to be left to teach the lab session on her/his own, they must be experienced in the subject area if any discipline-specific

hardware or software is to be included. They must get guidance and instruction from their assigned faculty member. They must be able to communicate with the instructors early on and throughout the quarter. In order to improve connections between the methods classes and lab sessions, assignments that specifically require technology use should be developed well in advance so that the syllabi match well enough to complement each other. The more the instructor is involved with the GTA in designing and delivering instruction in the lab, the better.

Theme #3: Insufficient Support for Integrated Technology Courses

A third issue arose when one instructor informed me that he was forced to relocate his lab due to the lack of appropriate facilities and available technologies. A second instructor was forced to bring in his own software in order to demonstrate current relevant technologies due to a lack of available software. Of the remaining two instructors, one had a GTA who relied primarily on relevant websites available on the Internet, and the other had a GTA who only taught basic technology skills such as PowerPoint. Therefore, while there were three instructors who attempted to utilize area-specific technologies, two of them had insufficient support in terms of hardware and software; the third succeeded because he relied exclusively on readily available public information.

In the first case, the instructor was given a lab that had sufficient computers for his students. However, his interest in demonstrating more discipline-specific technologies was met by a lack of equipment. This instructor moved his lab to the subject-area

department (away from the education department's computer lab) and he also had to borrow equipment from a local high school. It rapidly became apparent that this TEP had taken the initiative to create technology lab classes to accompany their subject-area methods courses, but it had not yet invested in discipline-specific hardware and software that would allow instructors to accomplish the goals of NCATE and ISTE.

Certainly, general-use labs are of value, but it is important to note that appropriate discipline-specific software and hardware can greatly enhance educational technology integration. Computers loaded with the Microsoft Office Suite are simply not sufficient in all cases, and do not allow the TEP to take full advantage of segregating students into content-specific cohorts for their methods and technology courses. Although one GTA was able to make use of publicly available, Internet-based information, not all disciplines rely exclusively on such easily accessed technologies. Whereas English, social studies, foreign language, science, elementary educational technology courses might make good use of Internet based information systems, these systems do not represent the entire spectrum of discipline specific technologies. Temperature probes, localized weather stations, GPS, CAD systems, music composers and analyzers, video editing, statistical packages, graphing calculators, mapping programs, CD-ROM based simulations, CD-ROM databases, etc. - all represent the technologies that instructors would benefit from having. Yet most education departments do not have an expendable budget large enough to invest in such infrequently used systems.

Recommendation #3: Utilize available resources to augment technology purchases. TEPs need to determine which methods courses attract the largest number of

pre-service teacher candidates. It is here that their limited dollars should be invested in terms of Internet-independent technologies. Many schools will find that the bulk of their technology funds may be allocated to elementary education. Whenever possible, it would pay to purchase technologies that

- a) are not readily available elsewhere on campus, or in the immediate community
- b) would have overlap in terms of elementary, middle and high school use
- c) produce a variety of experiences or lessons (as opposed to one or two)
- d) are frequently used in K-12 education.

Furthermore, TEPs should formally establish technology relationships with other university departments – particularly those that provide primary training for secondary education students. Many science, social studies, PE, music, art and foreign language departments have equipment and or labs that could be used as part of the educational technology training. So too do local school districts, libraries and other community businesses and offices. Relationships with these departments and organizations must be formally fostered and nurtured in order to maximize educational benefits for their pre-service cohorts. The ultimate goal of TEPs should be to facilitate exposure to state of the art technologies and to make use of on-campus and local technology availabilities whenever and wherever possible – in short, network!

Theme #4: Lack of awareness of the NETS

None of the interviewees mentioned anything related to the NETS. Most of the instructors' goals were based on their own personal awareness of relevant technologies,

usually guided more by interest than academics. As such, there was absolutely no evidence of a standards-guided curriculum where the technology labs were concerned, regardless of whether the lab was taught by a GTA or by the instructor of record. Furthermore, there were no consistencies across the labs in term of curriculum – the same basics were missing. Assessment technologies such as rubrics, grade-book software, Internet filtering, professional development, lesson planning, concept mapping, etc. - all were missing from the technology labs. In all cases, there was no evidence that pre-service teachers were even provided with the list of standards and performance indicators for teachers as they related to technology.

I should point out that some of the NETS-T standards were covered, but outside the context of national standards, such as the importance of using technology to enhance learning environments, to support learner-centered teaching strategies, or to develop students' higher ordered skills. However, when these issues were covered, they were nearly always correlated with a single NETS-T standard (Standard III: Teaching, Learning and the Curriculum,) but without the benefit of being embedded in the context of the larger goal of a national standards movement. Moreover, the remaining five standards were virtually absent, save for the one instance of a GTA teaching Powerpoint (Standard I: Technology Operations and Concepts). Put simply, there was no indication that a set of nationally accepted standards – particularly those associated with the national accrediting counsel for this particular TEP program (NCATE) – was providing any direction for the educational technology lab courses.

Recommendation #4: Use the NETS-T to guide TEP curricula. Not all institutions of higher education that certify teachers belong to NCATE or use their standards. However, the standards and performance indicators set forth by ISTE and NCATE can serve as a guide for what teachers need to know. Certainly, if a TEP is accredited by NCATE, then using their formalized standards to set the TEP goals and objectives for technology education is logical and obvious. But for those programs that rely on alternative accreditation, the NETS-T can provide a model for how to set one's own goals and objectives. For that matter, even in the case of individual instructors, knowledge of the NETS-T can assist in the development of a logical course curriculum that has direction, purpose and logical justification. In fact, ISTE publishes a variety of materials suitable for use in instructional technology courses. Their use can help orient pre-service teachers to all the NETS (for students, teachers and administration). In addition to recommending the use of the NCATE standards to guide the overall framework of instructional technology courses, I also urge TEPs to make specific overtures to train their faculty in the goals and standards of ISTE's NETS-T. Granted, new teachers should also know the NETS-S, but university faculty must understand the distinction between the NETS-T and NETS-S, and design their courses accordingly.

Theme #5: Awareness of how to achieve integration

In general, it was clear that the four instructors had failed to integrate technology to the degree that they had hoped. Each expressed frustration and a lack of confidence in GTA expertise in general. They also noted that there were things they wanted to do

differently in the future. Perhaps the most overarching impression I formed was that all four of these instructors felt isolated from the other methods instructors, and without a direction or sense of purpose where technology education is concerned. Despite a desire to deliver effective technology instruction, all were lost in the task of re-inventing the wheel. None discussed the possibility of collaboration with other faculty, none mentioned using national standards to direct their curriculum, none expressed any confidence in the future experiments that they had planned to improve technology integration in lecture and lab. One said he would abandon the GTA and teach the lab himself, another said he would try different websites, or different possible assignments. But there was no evidence of a systematic approach to curriculum content, or to empirically determining what the students actually needed. In short, post hoc, intuition-based patches to the curriculum were all that the instructors had to offer.

It was here, more so than anywhere else, that I began to see the futility of their charge. Reliance on trial-and-error methods, particularly when long term follow-up assessment of the efficacy of one's teaching methods do not exist, are the slowest path to any educational goal. It became clear that these instructors needed a roadmap, a set of clearly-stated goals and objectives that they could utilize when developing lessons and activities for their lab classes, for when they were training their GTAs, for use in their lectures in order to ensure real technology integration. I realized how valuable a survey comparable with the one used in the previous investigation would be for these instructors. Similarly, I could see how a list of technology goals for teachers would help them develop their own goals (with reference to student needs). I began to realize I was "on to

something”. If the four instructors in this TEP were experiencing such isolation and difficulty with the technology integration, I assumed that they were not alone. Higher education faculty nationwide are at risk for similar difficulties.

Recommendation #5: Adopt regular needs assessments for pre-service teachers, in-service TEP faculty in the NETS, and provide professional assistance in technology integration. The recommendation to assist TEP faculty in their technology integration is three-fold. All three aspects are critical to the success of technology integration. First, instructors need to know what their new students can and cannot do where technology is concerned. If they need remediation, find support (e.g. recommend a basic computing skills course before enrolling in educational technology). Second, they need to be knowledgeable about the goals and objectives for technology training for teachers as set by the TEP. Whether these goals are those adopted by NCATE, or established by the TEP itself, the faculty responsible for the direct instruction of technology for teachers must be made aware of these standards and versed in them. The best way to achieve this is through faculty in-service training which can also decrease the sense of isolation that faculty may experience when left to their own devices. Being a part of a cohort of faculty trained in the ISTE standards will provide a community for these instructors, allowing them to extend support and ideas to each other, and providing feedback to the TEP about their successes and failures. Finally, I highly recommend that TEPs provide professional assistance to their faculty in the integration aspects of their methods/educational technology lab courses. In particular, any TEP that wishes to make a serious commitment to technology integration would be well-advised to consider hiring an education

technology instructor with expertise in teacher education. In particular, this person should have knowledge of the NETS, be aware of the needs of both teachers and K-12 students, and should be someone who is prepared to train university faculty in integration techniques that best fit the integration model adopted by the TEP. If the TEP has integrated their subject based-methods courses with technology labs (as the TEP in the current study did), the “ed tech” expert could offer in-services on issues like establishing links with other departments or community resources or on assessing student needs, or on creating activities that integrate technology. If, on the other hand, a stand-alone lab class is preferred, this individual could focus on the ISTE standards that all new teachers need such as the role of technology in professional development, lesson planning, assessment, and the social, ethical, legal and human issues related to technology in education.

In truth, the content of educational technology is quite broad, as evidence in the survey results of the previous study. And while the current trend has been to push for technology integration, I would recommend that most TEPs consider a two-part sequence of technology classes with one part being a stand-alone class with students from all teaching areas, and the other class an integrated technology lab within the students’ content area methods courses. This first class could be taught by the “ed tech” expert and would cover primarily Component 2 (Professional Development and Curriculum Planning) skills. He/she might also cover other technology topics that would benefit all students like adaptive technologies, assessment, and Internet filtering. In the second course, the cohort could be divided into subject-area groups where their instructors (directly or indirectly aided by the expert) could introduce skills associated primarily with

Component 1 (Classroom-specific) skills, and discipline-specific technologies. In conclusion, to ensure effective technology integration, TEPs must make a concerted effort to determine the needs of their students, to educating their faculty, and to providing both groups with expert professional support.

Theme #6: Lack of a shared vision for educational technology

Perhaps the most profound realization that arose from the interviews with the four instructors was the lack of a clear, shared vision for what technology education and technology integration should look like in practice. There were similarities among the courses, some imposed by the formal course arrangements and other based on some minimally shared view of the usefulness of technology in general. But a real shared vision, one that provides direction and purpose to technology education was glaringly absent. I believe this shortcoming is the main cause of the lag in educational technology with respect to the current educational reform movement (Darling-Hammond & Bransford, 2005). Among the instructors, a few shared perspectives were evident. First, most of them believed that the primary content of education technology should reflect the content of the subject area. For example, the science instructor's lab class focused exclusively on science technologies. The math instructor's technology lab focused on math-related technologies. The only case in which an instructor taught outside the field was the GTA who taught power point – again no evidence of a separate and specific content for “ed tech” itself. Clearly, none of the instructors were aware of a content specific to educational technology for pre-service teachers.

Second, all of the instructors made at least one comment regarding “technology for technology’s sake”. To summarize, the four instructors agreed that educational technology should only be used when it could improve upon traditional methods or when it would allow the teacher to do something that he/she could not do otherwise. Their comments imply a value-laden judgment, one that focuses on practicality, and fails to acknowledge that some topics are used or taught because they enhance our education in a general way. The views put forth by these instructors imply that technology is only useful as a tool to teach other things. Because they seemed to be unaware of the national standards movement for technology education, and of the NETS in general, they appeared to have a very limited perspective on the role of technology in education. I should note that none of the faculty rejected the notion that technology might have a broader role in education – that topic was never addressed directly. Rather they were asked to comment only on their own views of technology in education, and they were not prompted to comment on the standards movement or on the NETS, specifically. This is important because I also had the impression that these faculty members were open to new ideas. So while a shared vision had not yet developed; the potential for it was present. However, in general, university faculty are overworked and underpaid. Finding time and the motivation for educational technology in-services would be a challenge. At many comprehensive universities and research I institutions, very little emphasis and support are given to the development of undergraduate education and certification programs. The main responsibility for the development of a nationally shared vision for educational technology will fall into the hands of TEPs nationwide.

Recommendation #6: Develop and implement a reward structure that will provide incentive motivation and a foundation for the emergence of a shared vision for educational technology. Tomei (2002) suggested that an overhauling of TEP infrastructure would be necessary to implement the changes needed regarding technology use in teacher education, and in higher education, in general. Technology use should be considered in tenure and promotion decisions; monetary incentives or release time might be needed; realistic technical support must be in place; and technology experience may need to come into play during hiring decisions. These challenges are both intimidating and difficult to achieve, in part because such changes cannot be directives from upper administration – a top-down strategy will not succeed (Kerr, 1991). I suggest that an overhauling may be the wrong approach. Rather I would like to see an evolution of the reward structure in TEPs that begins by encourage existing faculty to seek information and assistance in developing this shared vision.

Limitations of the current study

The results from the current study reflect the nature of the methods used to gather the data. As such, the results and the recommendations put forth by the author must be viewed with those methods and their limitations in mind. First and foremost, it is important to recognize that the data were generated from a select group of individuals, namely from a cohort of pre-service teachers from a four-year, comprehensive university, and from four faculty instructors of secondary education pre-service teachers. These instructors taught subject-area methods of teaching courses in which technology was integrated into the curriculum. They were not educational technology faculty. The

participants in the two studies were from different TEPs. As such, the recommendations made may reflect only those issues made apparent by the individuals included in the survey or the interviews. It is likely that other groups of students and faculty from other TEP programs might reveal other strengths and weaknesses that would be important and meaningful. This does not mean that the findings are limited to the institutions under study; rather it merely urges caution when viewing the data and the recommendations as complete and thorough.

Second, while the survey attempted to thoroughly address the relevant issues highlighted by the NETS-T, the interview portion of the study was designed as an in-depth study of a very small sample of faculty instructors and relied heavily on self-report. It was therefore not intended to be representative of all TEP programs. It is possible that the perspective gained in the interviews may have also benefited from alternative methods such as interviewing students, or from actually attending integrated lecture and lab sessions. Specific evidence of integration may not have emerged in the interviews, even if it had occurred in the classroom. Such observations were not feasible in the present study. This lack of direct observation potentially limits the scope of the study in terms of the extent of technology integration. I would encourage future studies to consider adding an observational component to any replications or extensions of the present work.

Third, the results from the survey may reflect important temporal aspects that could change over time. It is likely that over time some specific items on the survey might be dropped or modified. Technologies or skills that are currently novel and contemporary may soon become commonplace, e.g. webpage design will likely move

from Component 1 (classroom-specific teacher skills) to Component 3 (routine applications and basic operations). Furthermore, it is possible that the NETS-T (or any other set of technology standards for teachers) could change over time as well. As a result, the nature of the emergent components are likely to change over time. The current results suggest several broad and useful categories that can be used to help direct TEP curriculum content. It would, however, be erroneous to assume that these categories will remain unchanged in the long run. Confirmatory surveys intended to verify (or reject) the accuracy and relevance of the current survey results (and recommendations) for any given TEP's student needs is recommended. This will be particularly important as time passes. However, I hope that the large picture has greater staying power. New teachers will always be faced with the need to learn what their students must learn as well as the technologies and associated behaviors that apply more directly to the teacher alone – those with only indirect impact on student learning. As such, while the details of some examples presented here may become dated and outmoded, the more generic recommendations put forth should have greater longevity. It is likely that pre-service teachers will continue to need classroom-specific technology skills, professional-development technology skills, technology-related curriculum planning skills, as well as knowledge of routine applications and basic operations. What is critical to remember is, that while these broad, organizational categories for teacher training will continue to be relevant, the specific technologies that constitute these categories may change over time.

Fourth, it is critical to note that the current recommendations do not include implementation guidelines. It is clear that every TEP will need to review the

recommendations and find viable solutions that fit their budgets, their faculty expertise and their student needs. Not every school will place similar value on each of the recommendations. They are presented here without ranking in terms of importance. But that is not to say that the recommendations are presented as equally important. As each TEP reviews the recommendations, they will be viewed within the context of each existing program with its own unique strengths and limitations. As such, the current recommendations will carry different weights at varying institutions. This is understood.

Finally, it is important to note that the present investigation was intended as a logical first step toward encouraging the field of educational technology to develop an identity, a unified mission and a formal pedagogy. It was not designed to address all possible issues and approaches that might serve as valuable in the development of a shared vision for educational technology. In the long run, it will be necessary to continue the process of self-definition and self-discovery for the field of instructional technology and technology integration. Future investigations may need to look at the role of textual and virtual course materials, the need for and the effect of faculty development and staff training in educational technology skills, goals and standards, and the effect of incentive systems to encourage continued growth by non-expert instructors, just to name a few.

In closing, the purpose of outlining the limitations of the current study is to highlight the parameters that govern the generality of the findings beyond its initial scope, and to encourage future investigations to move beyond this initial attempt to quantify and qualify the nature of educational technology goals, practices and needs. Whereas the findings from the present investigation have provided valuable insights into

the needs of pre-service teachers and of TEP programs wishing to integrate technology into their content curriculum, it is important to look ahead to expansion beyond the current study and to find new directions for future investigators.

Conclusions

What is needed is a coordinated effort in higher education that involves faculty, departmental chairs, TEP directors, deans and accrediting agencies like NCATE. If TEPs will adopt curriculum standards and make them known to their faculty, if they will encourage instructors to develop curricula that are guided by those standards, and if they will provide the technical, informational and integration support that educational technology instructors need to implement small but meaningful changes in their classrooms, a shared vision will begin to emerge. As this vision evolves, it will begin to provide feedback. Student needs will change, faculty will discover those best practices that fit the program, and accrediting agencies will determine which methods fit with their requirements and make recommendations for needed improvements. This process must begin with the TEP and has the potential to develop more appropriate “ed tech” curricula, a more effective instructional delivery format, and an institutionally sound shared vision of educational technology.

General Summary

When taken together, the two investigations provide evidence that while a true pedagogy of educational technology has yet to emerge nationally, many of the requisite components of that pedagogy are in place and ready to be adopted. Previously, we

defined a pedagogy as the art, science or profession of teaching. And I have argued that any pedagogy consists of three fundamental dimensions:

- 1) A curriculum content
- 2) A delivery method or format
- 3) A shared vision.

Educational technology has been slow to join the current educational reform movement, at least in part, because of the lack of a pedagogy. The field simply has not developed an identity to the same degree that other disciplines like science education or special education have. I would argue that the present investigation has demonstrated that while national standards for educational technology exist in the NETS, awareness of the NETS by TEP faculty is low and the alignment between pre-service teacher needs and these standards may be minimal at best in many TEPS. Furthermore, the instructional delivery methods used at some institutions of higher education may be at odds with the curricular goal of promoting educational technology as its own discipline among pre-service teachers. The current study attempted to highlight some of the limitations to the development of that pedagogy, as well as to make recommendations to facilitate its development or evolution.

What our students need. Knowing what to teach in any university level course should be based on a set of predetermined objectives and knowledge of what prospective students already know. It's a pretty simple formula. The first investigation showed that one could make that determination by simply surveying incoming students. Furthermore,

the educational technology standards (NETS-T) set by ISTE and adopted by NCATE can be reduced to three very fundamental components:

- 1) Classroom-specific Teacher Skills
- 2) Professional Development and Curriculum Planning
- 3) Routine Applications and Basic Operations

Whereas the targeted students seemed reasonably confident in the skills associated with Component 3, a large number of them were in need of instruction in the skills associated with the other two components. Moreover, the use of survey methodology combined with principal components analysis was shown to provide a realistic mechanism for program assessment and future restructuring.

How to best teach what our students need. The second, qualitative study – interviews with four TEP faculty teaching content-specific methods combined with educational technology labs – produced detailed information regarding the efficacy of technology integration in a TEP with no accepted curriculum standards for technology. The results showed a cohort of faculty who, while committed to effective technology integration, failed to meet most of the goals and objectives set by ISTE and NCATE. Moreover, six major themes were derived from the interviews that provide insight into the shortcomings of the integrated classes that I studied. The six resulting themes included:

- 1) A genuine lack of instructor/GTA preparedness where the content of educational technology was concerned,

- 2) A serious lack of communication and course planning between the instructors and the GTAs,
- 3) Insufficient appropriate technology and poor resource management for the integrated technology courses,
- 4) A lack of awareness of the NETS, or of any educational technology standards on the part of all the instructors and their GTAs,
- 5) Content-area instructors were unaware of how to achieve effective technology integration,
- 6) A lack of a shared vision for educational technology among the content-area instructors.

The result of these limitations led to 6 major recommendations for improving educational technology instruction in TEPs that share characteristics with the target TEP.

Summary of General Recommendations

- 1) Careful attention should be paid in the hiring and placement of GTAs with respect to technical skills and subject-area proficiency,
- 2) Communication between the instructor and GTA is essential in terms of ensuring connection between content area lectures and technology labs,
- 3) TEPs must utilize available campus and community resources to augment technology purchases,
- 4) Use the NETS-T to guide educational technology curricula,

- 5) Adopt regular needs assessments for pre-service teachers, in-service “Ed Tech” faculty in the NETS-S and the NETS-T, and provide professional assistance in technology integration,
- 6) Develop and implement a reward structure that provides incentive motivation and a foundation for a shared vision for educational technology.

In the end, there was meaningful overlap between the two investigations. It became clear from interviewing the “Ed Tech” faculty that a needs assessment, such as the one I used in the survey research, was needed for their incoming students in order for them to plan their curriculum effectively. Both studies showed that a standards-based curriculum would benefit both students and instructors. Neither faculty nor the students were aware of the non-applications-based standards for educational technology for teachers set by ISTE and adopted by NCATE. As such, course content did not reflect those skills. It became obvious that both the TEP faculty and the pre-service teachers lacked a shared vision for the role of technology in education.

Summary of Limitations

It was noted that the results and recommendations from the current investigation must be viewed conservatively, this being only an initial attempt to define and quantify TEP goals, practices and needs for educational technology for pre-service teachers. Five broadly defined limitations were outlined: 1) modest and narrow sample populations potentially limit generality of the results and recommendations, 2) lack of direct observation in integrated technology lectures and lab sessions may have resulted in the failure to identify particular practices leading to effective or ineffective technology

integration, 3) time may change some of the specific skills included in the broad categories upon which the recommendations were based, 4) the current recommendations should not be viewed as having rank order, and 5) the current study was not intended to be a complete and thorough study of educational technology. Rather its main purpose was to serve as a valuable first step toward a broad movement in the development of a pedagogy of educational technology. The findings and recommendations must be viewed from this perspective, The importance or weight of any one recommendation must be assigned by individual TEPs when judged within the context of their own unique program. To do otherwise would be misguided. It is the hope of the author to encourage future investigators to use the present study as a “jumping off spot”; as a valuable first attempt to determine what modern pre-service teachers need in terms of educational technology training, and how best to provide it to them.

General Conclusions

Since a pedagogy requires both a content and an instructional method, the adoption of the national standards for educational technology is paramount to both. Importantly, a shared vision for educational technology will remain out of reach until the content and format issues are resolved. Efforts to adopt curriculum standards and to develop an instructional delivery format represent the roots of a developing shared vision. Ultimately, all three aspects of the pedagogy (curriculum, instructional format and shared vision) interact and lead to continued growth and development. Yet it seems that the initial steps toward such a pedagogy hinge on the adoption of a standards-based technology curriculum for pre-service teachers.

Overview

In the next and final chapter, I re-visit the goals of the present study; highlight the most salient findings; and provide suggestions for further investigations.

Chapter VI

Concluding Remarks

As described in the first three chapters, the main purpose of the current investigation was to answer two critical questions in order to support development of an explicit pedagogy of educational technology for teacher education programs. The first question asked, "What do pre-service teachers need to be taught about educational technology?" The second question asked, "What might effective technology integration actually look like in practice?" Through a combination of quantitative and qualitative investigations, I have attempted to shed some light on the answers to these questions.

I hope that my contribution, in terms of guidelines regarding technology course content and format, provides a piece of the puzzle needed to establish a shared vision that currently does not exist in my field. I would be pleased to learn, in the future, that teacher education programs have eventually shifted away from the skills-based course content and have carefully re-designed their courses to genuinely integrate technology. I suspect this change will not occur quickly, nor uniformly across the country. However, it needs to happen. I look forward to the time when a strong and focused pedagogy exists.

My investigations have revealed some important lessons regarding technology course content and format: most notably, I have empirically demonstrated that the over-emphasis on applications-based technology skills, so prevalent in TEPs, is probably inappropriate and that the NETS-T have more pressing areas to address, primarily the teacher-specific classroom use of technology, professional development and lesson planning. I now view the NETS-T not as a list of six items, but as three larger and more

global components, ranked in terms of urgency. My qualitative findings provide a glimpse into the workings of technology integration within a TEP, and the major limitations of that approach. I have been able to confirm Cuban's findings on faculty use of technology outside of the classroom while revealing a problematic reliance on graduate teaching assistants. Finally, I discovered that the intended focus on "technology integration" poorly represented the relationship between content-area lecture and technology lab. A better term might be "technology connection." This discovery is more than word-smithing, it reveals an inherent problem in organizing separate classes taught by separate instructors.

As the trend toward technology across the curriculum in teacher education classes continues, an examination of how instructors view technology and plan these classes is necessary. As state and national accrediting agencies place more responsibility on TEPs regarding technology use in the classroom, it is incumbent upon program directors and technology specialists to be aware of the necessary institutional and technical support for achieving successful technology integration. As policy is transformed into practice, we need to consider the role of teaching assistants and the content of lab sessions. By simply speaking with these instructors, my view of them and their classes has changed considerably. Rather than feeling pessimistic, I am encouraged that improving the technology labs appears to be an accomplishable task involving in-service faculty training, improved communication, standards-based curriculum planning, and increased faculty involvement. Just as the pre-service students do not need basic computer training,

neither do the faculty. However, both groups may benefit from increasing their pedagogical content knowledge as it relates to educational technology.

Recommendations for future directions

These are preliminary investigations into technology course content; pre-service students' confidence, the NETS-T, what occurs in teacher education methods courses that claim to integrate technology, and how instructors make curriculum decisions regarding technology integration. Although it may be difficult to generalize from these students and instructors to other TEPs, this study may serve as a useful tool for designing how pre-service technology classes are structured and taught.

In order to expand these studies, additional data should be collected from pre-service students at the conclusion of their programs to determine if their needs have been filled. To further investigate appropriate course content, I recommend conducting similar surveys regularly to determine if the components have changed. Regular use of surveys will require that they be updated regularly to include timely uses of classroom technology as they evolve. I will resist the temptation to look into my crystal ball and leave it to others to keep abreast of these changes. Finally, future surveys need to account for the demographics of the pre-service population. Are they “whizkids” or are they older, returning students with dated or limited technology skills? This will be an important consideration.

To further investigate technology integration, additional data should be collected from other sources including pre-service students, teaching assistants, classroom

observations and other TEPs. Further information is needed in terms of how the pre-service students view technology integration and whether or not they see themselves as practitioners of these methods. I can also see this investigation fitting an action research model in which a TEP class is analyzed and adjusted as it is being taught to maximize the connections between lab and methods class.

At some point, the cycle of the “apprenticeship of observation” should work to our benefit and new teachers will take for granted the many reforms that TEPs are currently trying to implement. By assessing pre-service and in-service teachers, we can determine when this cycle has become complete. In so many ways, we are trying to change tradition. At some point, we will succeed, at least I hope we will. Once we do, the vision will be shared, and a pedagogy of educational technology can begin to emerge.

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Appendix A: NETS for Students

Technology Foundation Standards for All Students

The technology foundation standards for students are divided into six broad categories. Standards within each category are to be introduced, reinforced, and mastered by students. These categories provide a framework for linking performance indicators within the Profiles for Technology Literate Students to the standards. Teachers can use these standards and profiles as guidelines for planning technology-based activities in which students achieve success in learning, communication, and life skills.

I. BASIC OPERATIONS AND CONCEPTS

- A. Students demonstrate a sound understanding of the nature and operation of technology systems.
- B. Students are proficient in the use of technology.

II. SOCIAL, ETHICAL AND HUMAN ISSUES

- A. Students understand the ethical, cultural, and societal issues related to technology.
- B. Students practice responsible use of technology systems, information, and software.
- C. Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

III. TECHNOLOGY PRODUCTIVITY TOOLS

- A. Students use technology tools to enhance learning, increase productivity, and promote creativity.
- B. Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

IV. TECHNOLOGY COMMUNICATION TOOLS

- A. Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- B. Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

Appendix A, continued

V. TECHNOLOGY RESEARCH TOOLS

- A. Students use technology to locate, evaluate, and collect information from a variety of sources.
- B. Students use technology tools to process data and report results.
- C. Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

VI. TECHNOLOGY PROBLEM-SOLVING AND DECISION-MAKING TOOLS

- A. Students use technology resources for solving problems and making informed decisions.
- B. Students employ technology in the development of strategies for solving problems in the real world.

(adapted from ISTE, 2000; 2002)

Appendix B: NETS for Teachers

Educational Technology Standards and Performance Indicators for All Teachers

Performance Profiles for Teachers

Building on the NETS for Students, the ISTE NETS for Teachers (NETS•T), which focus on pre-service teacher education, define the fundamental concepts, knowledge, skills, and attitudes for applying technology in educational settings. All candidates seeking certification or endorsements in teacher preparation should meet these educational technology standards. It is the responsibility of faculty across the university and at cooperating schools to provide opportunities for teacher candidates to meet these standards. The six standards areas with performance indicators listed below are designed to be general enough to be customized to fit state, university, or district guidelines and yet specific enough to define the scope of the topic. Performance indicators for each standard provide specific outcomes to be measured when developing a set of assessment tools. The standards and the performance indicators also provide guidelines for teachers currently in the classroom.

I. TECHNOLOGY OPERATIONS AND CONCEPTS

Teachers demonstrate a sound understanding of technology operations and concepts.

Teachers:

- demonstrate introductory knowledge, skills, and understanding of concepts related to technology
- demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.

II. PLANNING AND DESIGNING LEARNING ENVIRONMENTS AND EXPERIENCES

Teachers plan and design effective learning environments and experiences supported by technology. Teachers:

- design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners.
- apply current research on teaching and learning with technology when planning learning environments and experiences.
- identify and locate technology resources and evaluate them for accuracy and suitability.

Appendix B, continued

- plan for the management of technology resources within the context of learning activities.
- plan strategies to manage student learning in a technology-enhanced environment.

III. TEACHING, LEARNING, AND THE CURRICULUM

Teachers implement curriculum plans that include methods and strategies for applying technology to maximize student learning. Teachers:

- facilitate technology-enhanced experiences that address content standards and student technology standards.
- use technology to support learner-centered strategies that address the diverse needs of students.
- apply technology to develop students' higher order skills and creativity.
- manage student learning activities in a technology-enhanced environment.

IV. ASSESSMENT AND EVALUATION

Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies. Teachers:

- apply technology in assessing student learning of subject matter using a variety of assessment techniques.
- use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning.
- apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

V. PRODUCTIVITY AND PROFESSIONAL PRACTICE

Teachers use technology to enhance their productivity and professional practice.

Teachers:

- use technology resources to engage in ongoing professional development and lifelong learning.
- continually evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student learning.
- apply technology to increase productivity.
- use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning.

Appendix B, continued

VI. SOCIAL, ETHICAL, LEGAL, AND HUMAN ISSUES

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:

- model and teach legal and ethical practice related to technology use.
- apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.
- identify and use technology resources that affirm diversity
- promote safe and healthy use of technology resources.
- facilitate equitable access to technology resources for all students.

(adapted from ISTE, 2000; 2002)

Appendix C: NETS for Administrators

Educational Technology Standards and Performance Indicators for Administrators

I. LEADERSHIP AND VISION

Educational leaders inspire a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of that vision.

Educational leaders:

- A. facilitate the shared development by all stakeholders of a vision for technology use and widely communicate that vision.
- B. maintain an inclusive and cohesive process to develop, implement, and monitor a dynamic, long-range, and systemic technology plan to achieve the vision.
- C. foster and nurture a culture of responsible risk-taking and advocate policies promoting continuous innovation with technology.
- D. use data in making leadership decisions.
- E. advocate for research-based effective practices in use of technology.
- F. advocate on the state and national levels for policies, programs, and funding opportunities that support implementation of the district technology plan.

II. LEARNING AND TEACHING

Educational leaders ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching.

Educational leaders:

- A. identify, use, evaluate, and promote appropriate technologies to enhance and support instruction and standards-based curriculum leading to high levels of student achievement.
- B. facilitate and support collaborative technology-enriched learning environments conducive to innovation for improved learning.
- C. provide for learner-centered environments that use technology to meet the individual and diverse needs of learners.
- D. facilitate the use of technologies to support and enhance instructional methods that develop higher-level thinking, decision-making, and problem-solving skills.
- E. provide for and ensure that faculty and staff take advantage of quality professional learning opportunities for improved learning and teaching with technology.

Appendix C, continued

III. PRODUCTIVITY AND PROFESSIONAL PRACTICE

Educational leaders apply technology to enhance their professional practice and to increase their own productivity and that of others. Educational leaders:

- A. model the routine, intentional, and effective use of technology.
- B. employ technology for communication and collaboration among colleagues, staff, parents, students, and the larger community.
- C. create and participate in learning communities that stimulate, nurture, and support faculty and staff in using technology for improved productivity.
- D. engage in sustained, job-related professional learning using technology resources.
- E. maintain awareness of emerging technologies and their potential uses in education.
- F. use technology to advance organizational improvement.

IV. SUPPORT, MANAGEMENT, AND OPERATIONS

Educational leaders ensure the integration of technology to support productive systems for learning and administration. Educational leaders:

- A. develop, implement, and monitor policies and guidelines to ensure compatibility of technologies.
- B. implement and use integrated technology-based management and operations systems.
- C. allocate financial and human resources to ensure complete and sustained implementation of the technology plan.
- D. integrate strategic plans, technology plans, and other improvement plans and policies to align efforts and leverage resources.
- E. implement procedures to drive continuous improvement of technology systems and to support technology replacement cycles.

V. ASSESSMENT AND EVALUATION

Educational leaders use technology to plan and implement comprehensive systems of effective assessment and evaluation. Educational leaders:

- A. use multiple methods to assess and evaluate appropriate uses of technology resources for learning, communication, and productivity.
- B. use technology to collect and analyze data, interpret results, and communicate findings to improve instructional practice and student learning.
- C. assess staff knowledge, skills, and performance in using technology and use results to facilitate quality professional development and to inform personnel decisions.
- D. use technology to assess, evaluate, and manage administrative and operational systems.

*Appendix C, continued***VI. SOCIAL, LEGAL, AND ETHICAL ISSUES**

Educational leaders understand the social, legal, and ethical issues related to technology and model responsible decision-making related to these issues. Educational leaders:

- A. ensure equity of access to technology resources that enable and empower all learners and educators.
- B. identify, communicate, model, and enforce social, legal, and ethical practices to promote responsible use of technology.
- C. promote and enforce privacy, security, and online safety related to the use of technology.
- D. promote and enforce environmentally safe and healthy practices in the use of technology.
- E. participate in the development of policies that clearly enforce copyright law and assign ownership of intellectual property developed with district resources.

Appendix D: Use of the NETS by State

STU	TEA	ADM	STATE	STU	TEA	ADM	STATE
A	A	A	Alabama				Montana
R	R	R	Alaska	A	A	A	Nebraska
A	A	A	Arizona		A		Nevada
A	A	A	Arkansas	R	A	A	New Hampshire
		R	California	A	A	A	New Jersey
A	A		Colorado		A		New Mexico
A	A	A	Connecticut	A	A	A	New York
A	A	A	Delaware	A	A		North Carolina
	A		D of Columbia	A		A	North Dakota
A	A		Florida	A		A	Ohio
	A	A	Georgia	A			Oklahoma
A			Hawaii	A		A	Oregon
	A		Idaho			A	Pennsylvania
A	A	A	Illinois	A			Rhode Island
	R	R	Indiana	A	A		South Carolina
			Iowa		A	A	South Dakota
A	A	A	Kansas		A	R	Tennessee
A	A	A	Kentucky	R	A	R	Texas
A	A	A	Louisiana	A			Utah
		R	Maine	A	A	A	Vermont
A	A	A	Maryland	A	R	R	Virginia
A	A		Massachusetts	A	A	A	Washington
A	A	A	Michigan	A	A	A	West Virginia
A	A	A	Minnesota	A		A	Wisconsin
A	A	A	Mississippi			A	Wyoming
A	A	A	Missouri				

A = Adopted, Adapted or Aligned with
R = Referenced

Adapted from ISTE (2004)

Appendix E: Educational Technology Survey

Please read the following scenario and then answer the questions based on how you would feel if you were in that situation. Answer each of the 20 questions on the next pages by circling the number that most closely represents your feelings.

Scenario A

"We have just received word that a local school district has learned that they will have a new temporary school built over the summer. They will need to hire 50 new teachers to fill one-year positions. They have been given permission to hire teacher trainees who will be allowed to use the experience to waive their student teaching, and they will be paid. The district is located near your home and you have been selected as one of the new teachers. You have accepted a position, teaching children at the grade level of your preference. The principal has informed you that you will have a computer on your desk and access to a computer lab classroom. You will be allowed to select the type of computer and the specific programs.

Given your current computer experience,

1. How would you rate your overall computer competency?

<i>Not at all good</i>						<i>Very good</i>
1	2	3	4	5		6

2. How comfortable would you be preparing written assignments for your students using a word processor?

<i>Very uncomfortable</i>						<i>Very comfortable</i>
1	2	3	4	5		6

3. How comfortable would you be creating documents with both text and graphics (pictures or diagrams) for use by your students, their parents or your colleagues?

<i>Very uncomfortable</i>						<i>Very comfortable</i>
1	2	3	4	5		6

Appendix E, continued

4. How comfortable would you be using a computer to maintain your grades?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

5. How comfortable would you be using e-mail to contact other teachers for advice (i.e. for professional development)?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

6. How comfortable would you be using the Internet to develop lessons?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

7. How comfortable would you be having your students use the Internet as a resource to complete an assignment?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

8. How comfortable would you be developing an Internet Web site for your class?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

9. How confident are you that you can screen out inappropriate material from your students' computers?

Not at all confident 1 2 3 4 5 6 *Very confident*

10. How comfortable would you be preparing complex, self-guided instructional materials on the computer for your students (for example, HyperStudio, Web page design, etc...)?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

Appendix E, continued

11. How comfortable would you be using computers that are connected to a network?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

12. How comfortable would you be reviewing software and selecting age-appropriate and useful programs for your students?

Very uncomfortable 1 2 3 4 5 6 *Very comfortable*

13. How confident are you that you could design a unit or lesson that actively integrates a variety of software, applications, and technological learning tools into an otherwise traditional academic lesson (i.e. math, science, social studies, etc.)?

Not at all confident 1 2 3 4 5 6 *Very confident*

14. How confident are you that you could decide when a computer might be a useful technology and when it would be better to NOT use one, or to use some other instructional method?

Not at all confident 1 2 3 4 5 6 *Very confident*

15. How confident are you that you could apply computer technology to enhance your own professional growth and productivity?

Not at all confident 1 2 3 4 5 6 *Very confident*

16. How confident are you that you can rely on computer technology to collaborate with other teachers to solve problems in your classroom?

Not at all confident 1 2 3 4 5 6 *Very confident*

17. How confident are you that you can rely on computer technology to encourage your own lifelong learning?

Not at all confident 1 2 3 4 5 6 *Very confident*

Appendix E, continued

18. How confident are you that you will be able to understand, interpret and implement your school's acceptable use policies (AUP) on responsible, ethical and legal uses of technology in public education?

Not at all confident 1 2 3 4 5 *Very confident* 6

19. How confident are you that you could design, deliver and assess student learning activities that require the use of adaptive technologies?

Not at all confident 1 2 3 4 5 *Very confident* 6

20. How confident would you be if the principal designated you as the primary contact person for all the new teachers with respect to using computers on your campus?

Not at all confident 1 2 3 4 5 *Very confident* 6

Appendix F: Participant Interview Questions Mapped to Primary Research Questions

"There are four general categories of questions that I have for you, they deal with your methods class and how you integrate technology, your own technology use outside of the classroom, technology and secondary teachers, and technology in teacher education in general."

Questions about their methods classes:

1. How do instructors plan for and actually integrate technology in their classes?
 - "Does technology play a role in your class, outside of the computer lab?"
 - "How do you plan for and actually integrate technology in your methods class?"
 - "What sort of activities or assignments do you include that require the use of technology?"
 - "How prepared are your students to engage in your planned activities given their previous technology preparation or experience?"
 - "Do they require remediation of basic skills?"
2. How discipline specific is the context of technology used in their classes?
 - "How discipline specific is the technology used in your class?"
 - "How about the context in which it is discussed and used?"

Appendix F, continued

3. How much do these instructors rely on teaching assistants to handle technology instruction and integration?
 - “What role does your teaching assistant play in technology instruction and integration in your methods class?”
 - “Why is this?”
4. What support, assistance or equipment do they and would they find valuable?
 - “What support or equipment do you find valuable in accomplishing this integration?”
 - “Is there anything that you imagine would help you?”

Questions about their own technology use:

5. How do they use technology for personal and professional tasks?
 - “How do you use technology for professional activities?”
 - “What about personal uses?”
 - “Is it generally a positive experience?”
 - “Would you be happy to reduce the role of technology in your life?”

Questions about technology and secondary teachers:

6. According to the instructors, how is technology useful for secondary teachers of their subject areas? In what ways?
 - “In what ways do you feel technology is important to secondary (subject area) teachers?”

Appendix F, continued

- "How prepared are your students to effectively use technology in their future classrooms?"
- "Are there any aspects of technology preparation that you believe your students are not receiving in their program?"

Questions about technology in teacher education:

7. How do the instructors view technology and its use in teacher education?
 - "What is your opinion of technology in teacher education in general? Is it important? Intrusive? A welcome addition? A necessary evil?"
 - "In what way does your use of technology in your methods class compare with technology use in teacher education in general?"
 - "Technology integration is the trend in teacher education programs today. As an instructor of an integrated methodology course, how do you feel about this nation-wide trend?"
 - "In your opinion, what should be the role, if any, of stand-alone technology courses in teacher education?"

CURRICULUM VITA

Ian James Loverro***EDUCATION***

- In Progress **University of Washington**
Ph.D. Curriculum and Instruction
- Emphasis in Educational Technology and Communication
 - Cognates: Science Education, Leadership and Policy Studies, Information Science
- June 1998 **Central Washington University**
M.Ed. Education
- Master Teacher
- Jan 1996 **Washington State OSPI**
Continuing Teaching Endorsements
- Computer Science, Science, Social Studies, Political Science
- 1993 - 1995 **O'Farrell Community School, Center for Advanced Academic Studies: A California Charter School**
San Diego Unified School District
- T.E.S.A. Certification (Teacher Expectations and Student Achievement)
- May 1993 **San Diego State University**
California Clear Teaching Credentials:
- Life Science, Mathematics, Social Studies, Photography
- June 1991 **University of California, San Diego**
Political Science (B.A.)

TEACHING EXPERIENCE

- June 2003 – present **Central Washington University**
EDCS 316: Educational Technology
EDEL 468: Advanced Problem Solving Techniques for Middle School Mathematics
EDF 301: Introduction to Education

TEACHING EXPERIENCE, continued

- Sept 2000 - June 2003 **University of Washington**
 Educational Technology for the Graduate Teacher Education Program
- Three-quarter graduate course sequence for elementary education
 - Electronic portfolio course
 - Co-teach secondary methods for science, English and social studies
- June 1998 - 2001 **Central Washington University**
 Adjunct Instructor/Field Supervisor
- Introduction to Education
 - Educational Technology
 - Education Statistics
 - Science Education
 - Student Teaching
- 1996 - 1998 **Central Washington University**
 Graduate Teaching Assistant
- Foundations of Education
 - Education Statistics
- Substitute Instructor
- Methods of Teaching
 - Education Technology
 - Science Education
- Guest Lecturer
- Educational Technology
 - Multicultural Education
 - Research Methods
- 1996 - 1998 **Ellensburg School District 401**
 Substitute Teacher
- Oct 1993 - June 1995 **O'Farrell Community School, Center for Advanced Academic Studies: A California Charter School**
San Diego Unified School District
 Middle School Teacher
- Advanced Science - 7th & 8th

TEACHING EXPERIENCE, continued

- Sept 1993 - Oct 1993 **Alexander Graham Bell Junior High School**
San Diego Unified School District
 Junior High School Teacher
 - Opportunity School, Decision Making Skills for at-risk students
- Jan 1993 - Jun 1993 **Mira Mesa High School, San Diego Unified School District**
 Student Teacher
 - US History 11th
 - Advanced US History 11th
- Sept 1992 - Dec 1992 **William Howard Taft Junior High School**
San Diego Unified School District
 Student Teacher
 - US History 8th
 Teaching Assistant
 Computer Lab Technician
- Sept 1991 - Dec 1992 **Clairemont High School**
San Diego Unified School District
 Teaching Assistant
 - Graphic Arts
 - Industrial Arts
 - Industrial Technology Laboratory

TEACHING-RELATED EXPERIENCE

- 2003 **Central Washington University**
Center for Teaching and Learning
 - LiveText guest lectures and class demonstrations
- 1999 **Central Washington University**
Center for Teaching and Learning
 - Beginning PowerPoint Workshop, Instructor
 - Advanced PowerPoint Workshop, Instructor
 - Web Page Design Workshop, Instructor
- Spring 1997 **Ellensburg School District 401**
 Consultant to ESD 105/Share 105 Program
 Classroom Assistant
 - Biology & Advanced Biology

TEACHING-RELATED EXPERIENCE, continued

- 1995 - 1996 **Central Washington University, Housing Department**
 Computer Lab Teaching Assistant
 Summer Lab Manager
- 1988 - 1995 **Mission Bay Aquatic Center**
 Adjunct PE faculty San Diego State University
- Head Sailing Instructor
 - Youth Water Sports Counselor Ages (5-15)

COMPUTER/TECHNOLOGY CONSULTING

- 2004 – present **Central Washington University, Dia de los Ninos**
 • Technology Consultant
- 2003 - present **South East Sound Student Teaching (SESST)**
 • Webpage Manager
- 2001 **1minutelearning.com**
 • Online and CD-ROM curriculum migration and development
- 1998 - 2000 **Central Washington University**
 Technical Assistant to the President
- Strategic Plan Executive Summary, Editor
 - President's Web Page, Manager
- 1996 **Central Washington University, Science Education Department**
 Technology consultant for Eisenhower Grant-funded Summer
- Workshop, Technology Consultant
 - *Assisted rural teachers in designing curricula to meet the Washington State Essential Learning Benchmarks in Science.*
- 1997 - 1998 **Central Washington University**
 Computer Technology Purchasing Consultant for Departments of Education building re-model.
- 1998 **Central Washington University**
 Technology Mentor to Curriculum and Supervision Department

COMPUTER/TECHNOLOGY CONSULTING, continued

1996 - 1998 **Central Washington University**
 Computer Technology Consultant to faculty and graduate students

1996 - present **Ellensburg Community**
 Emergency Home Computer Technology Consultant

PROFESSIONAL SERVICE

2005 – present **Central Washington University, Mac Users Group**
 • Chapter President

2005 – present **Phi Delta Kappa**
 • Chapter President

2003 – 2005 **Phi Delta Kappa**
 • Chapter Foundation Officer

2003 – present **Central Washington University, Faculty Senate**
 • Department of Education, Senator

2003 – 2004 **Central Washington University**
 • Search Committees for Middle School Specialist, Field Supervisor, and Library Media Specialist

2002 **University of Washington**
 • Professional Education Advisory Board (PEAB)
 Technology Consultant

2001 - 2003 **American Educational Research Association**
 • National Conference Proposal Reviewer

2001 **National Association for Research in Science Teaching**
 • 2002 NARST National Conference Proposal Reviewer

Summer 1996 **National History Day High School Competition**
 • Washington State Finals, Judge

PROFESSIONAL SERVICE, continued

1993 - 1995

O'Farrell Community School, San Diego Unified School District

- Guidance Committee to revise the Homebase Teacher's Guide
- Library/Media Center Committee

CONFERENCES/WORKSHOPS ATTENDED

2005

Integrating the Teacher Development Preparation for ELL Students Across the Curriculum
Ellensburg, WA.

2005

Western Psychological Association Conference
Portland, OR.

2004

Intel Teach to the Future Workshop Series
Ellensburg, WA.

2004

American Educational Research Association Conference
San Diego, CA.

2003

LiveText Assessment Conference
Orlando, FL.

2001

American Educational Research Association Conference
Seattle, WA.

2000

Office of the Superintendent of Public Instruction
Meeting of Washington State teacher educators
Seattle, WA.

1998

Association for Behavior Analysis International Conference
Orlando, FL.

1993

Northern California Association for Behavior Analysis Conference
Clairemont, CA.

PRESENTATIONS AND PUBLICATIONS

- Ramirez, A., Madley, S., & Loverro, I. (1997) The curriculum director's view: HB 1209 - How are we doing? *Curriculum in Context*, 24, 21-23.
- Loverro, I. (2001) Preparing and Editing Digital Images, *Presentation to the University of Washington*, College of Education Design Laboratory.
- Loverro, I. (2001) Careers in Education: Graduate Study and Careers in Education Technology, Panel Discussant, *University of Washington Career Fair*, Seattle, WA.
- Loverro, I. & Williams, W. A. (2002) What Do Pre-Service Teachers Actually Need from their Education Technology Classes? - An Exploratory Principal Components Analysis. *American Educational Research Association*, New Orleans, LA.
- Loverro, I. (2002) Acceptable Use Policies: What Role Do Teachers Play? *National Educational Computing Conference*, San Antonio, TX.
- Loverro, I. (2003) WebQuery: Putting Inquiry Back in the Quest. *National Educational Computing Conference*, Seattle, WA.
- Loverro, I. (2004) WebQuery: The Quest for Inquiry Continues. *National Educational Computing Conference*, New Orleans, LA.
- Loverro, I. (accepted, pending revisions) Integration of technology by instructors of secondary education methods courses. *Journal of Technology and Teacher Education*.
- Loverro, I. & Williams, W. (accepted) iSight: Videoconferencing Hardware and Software for Your Classroom. *National Educational Computing Conference*, San Diego, CA.

Manuscripts in preparation

- Loverro, I. (dissertation in progress) Toward a pedagogy of educational technology for teacher education programs. Doctoral Dissertation. University of Washington.
- Loverro, I. (invited submission) How to turn a webquest into a webquery and raise the level of student inquiry. *Learning and Leading with Technology*. International Society for Technology in Education.
- Loverro, I. & Williams, W. A. (manuscript in preparation) What do pre-service teachers actually need from their education technology classes? - An exploratory principal components analysis.

Manuscripts in preparation, continued

Loverro, I. (manuscript in preparation) From programmed instruction to computer-aided instruction.

PROFESSIONAL ORGANIZATIONS

- | | |
|----------------|--|
| 2000 - present | Association for the Advancement of Computing in Education
• Society for Information Technology and Teacher Education
SIG |
| 2000 - present | International Society for Technology in Education
• Computing in Teacher Education SIG |
| 1998 - present | Phi Delta Kappa |