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Sustainable faculty development: issues in technology for teacher education

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Sustainable faculty development: Issues in technology for teacher education

by

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For the Major Program

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CHAPTER 1. GENERAL INTRODUCTION

Background

The introduction of technology into the classroom is one of the most significant trends in education. Cuban expresses doubts about technology compatibility in the classroom, questions how technology enhances student learning (1986), and concludes that technology in the American classroom tends to be oversold and underused (2001). An increasing body of literature, however, argues that technology provides K-12 schools and teacher education programs with a new vision for necessary reform (Becker, 1994, 2000; Dede, 1998; Means & Olson, 1994, 1997). In addition, with increasing accessibility in both K-12 schools and postsecondary institutions (NCES, 2000, 2002), the major concerns in educational technology have moved away from hardware- and software-related issues. Instructional strategies, professional development, and continuity of administrative support have emerged as the new issues (Fatemi, 1999; Office of Technology Assessment, 1995; Willis, 1993).

People tend to teach the way they were taught (Bennett, 1991). To meet the challenge of preparing our children to function in a civilization created by the rapid development in technology, teacher education programs are responsible for training teachers who are competent in working with technology to facilitate student's mastery of sophisticated knowledge (Barron & Goldman, 1994; Dede, 1998, Moursund & Beilefldt, 1999; CEO Forum on Education & Technology, 2000). However, according to a 1998 survey conducted by the U.S. Department of Education (1999), while teachers are increasingly expected to incorporate technology into their classroom practice, only about 20% of teachers reported feeling well-prepared to integrate educational technology into classroom instruction. In the 2000 report of the National Center for Education Statistics (NCES, 2000), only 44% of new teachers feel well-prepared to use technology in their teaching practice. Traditional education programs have not adequately provided preservice teachers with modeling and experiences in technology integration (Carlson & Gooden, 1999; Moursund & Beilefldt, 1999; OTA, 1995; NCATE, 1997). Therefore, approaches to transform teacher education programs in order to provide adequate modeling in technology integration through faculty development have drawn great attention in the area of technology in teacher education. The Preparing Tomorrow's Teachers to Use Technology (PT3) grant projects have substantially supported and facilitated faculty as they advance in incorporating technology into their teacher preparation courses (Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003; Thompson, Schmidt, & Davis, 2003). Faculty adoption of technology into curriculum is the key in transforming the teaching and learning in teacher education program (Sprague, Kopfman, & Dorsey, 1998). Among the faculty development approaches to familiarize the faculty with basic technology skills and to further advance effective application strategies in technology integration for their teacher preparation courses, one-on-one technology mentoring stands out as a way to meet specific individual faculty needs as opposed to the traditional one-shot-fits-all group workshop (Beisser, 2000; Thompson, Hansen, & Reinhart, 1996). Given the need for faculty development in technology in teacher education programs and my research interest in understanding successful strategies of faculty technology development, I have chosen the area of faculty technology development in teacher education programs for my dissertation work.

Dissertation Organization

This dissertation is organized into five chapters. Chapter 1 is the general introduction in which the background and the significance of the research topics are addressed. Chapter 2, Chapter 3, and Chapter 4 consist of three published or publishable papers respectively. Each published or publishable paper is related to my research interests in the area of technology in teacher education. Chapter 2, "Faculty Technology Mentoring Programs: Major Trends in the Literature," was published in the *Journal of Computing in Teacher Education, Volume19*, Summer 2003. Chapter 3, "Reflecting with One Technology-using Teacher Educator: Discovery of a New Pedagogical Approach," and Chapter 4, "Issues of Sustainability of Faculty Use and Integration of Technology in Teacher Education: A First Look," are also to be submitted for publication.

Chapter 2 summarizes the literature related to one-on-one technology mentoring programs in higher education institutions and in K-12 environments nationwide. It provides what others have done in the area of one-on-one technology mentoring. Themes are identified to illustrate characteristics of successful mentoring programs. Although this published paper has co-authorship, I identified the appropriate research, drafted the whole article, and worked with suggestions from Dr. Thompson and Dr. Schmidt. I am the primary researcher and author in this published paper.

Chapter 3 describes an in-depth study of a faculty member's intensive and extensive involvement with the mentoring program over a period of eight years. It focuses on a faculty member's pedagogical shift because of her skills and relationship with technology and her involvement in the mentoring program at a midwestern university. Pseudonyms were used throughout the chapter for confidential reasons.

Chapter 4 presents results from a large scale survey study of what teacher education faculty members with experience in the use and integration of technology see as issues and barriers to their continued use and integration of technology. For this study, an online survey based on the findings of a case study was developed to gather quantitative data on a larger scale to help define the issues of sustainability of faculty use and integration of technology in teacher education programs. In addition, this research identifies effective faculty development practices and provides information on breaking down barriers to faculty's continued technology integration.

The three published or publishable papers in Chapter 2, Chapter 3,and Chapter 4 can be summarized as the following:

- Chapter 2 summarizes what has been done by others and identifies emerging themes of one-on-one mentoring programs national wide.
- Chapter 3 depicts a pedagogical shift of an exemplary technology-using teacher educator through her eight-year journey with the one-on-one faculty technology mentoring program.
- Chapter 4 deals with issues of sustainability for future implementation of faculty development in technology.

The references for each paper are included immediately following each respective paper; supplemental material for the third paper (Chapter 4) is included in the appendices at the end of the dissertation.

Following these three papers is the general conclusion in Chapter 5. The general conclusion summarizes the major findings and results of the studies described in the papers and identify common themes from the three papers. Chapter 3 and Chapter 4 contain relevant literature review to each of the research problems stated as well as detailed accounts of the methodology used and results that were obtained followed by discussion. These two papers may need to be shortened to meet publication requirements.

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CHAPTER 2. FACULTY TECHNOLOGY MENTORING PROGRAMS: MAJOR TRENDS IN THE LITERATURE

A paper published in the Journal of Computing in Teacher Education[1]

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Abstract

This paper provides a review of the literature that documents technology mentoring models used in higher education and K-12 schools. Various mentoring models from teacher education programs and K-12 schools are described. After summarizing the mentoring models, a description of commonalties found among these mentoring programs are shared. Despite the variety of technology mentoring models, effective programs include common elements. These elements include providing visions for technology use, individualizing technology support, breaking down hierarchical structure, establishing collaborative relationships, establishing learning communities, and providing mutual benefits for mentors and mentees.

Introduction

The effectiveness of technology in school settings relies on how successfully teachers integrate technology with their educational purposes and curricula (MacArthur & Malouf, 1991; Means & Olson, 1997). In the 21st century, emphasis on technology has increased and the demand for technologically literate teachers has been on the rise as well (Ely, Blair, Lichvar, Tyksinski, & Martinez, 1996). To adequately prepare teachers, teacher preparation institutions need to equip faculty so they can effectively model technology use and integration strategies in their courses (Munday, Windham, & Stamper, 1991; Zehr, 1997).

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Many teacher education institutions have identified the need for faculty development in the area of technology use and integration. While many colleges of education require one stand-alone technology course for their students, few teacher education programs have faculty who are modeling instructional methods that integrate computer technology in the classrooms (Handler & Marshall, 1992; OTA 1995). According to Staman (1990) and Wetzel (1993), faculty identified lack of knowledge about software, schedule conflicts, limited vision of technology integration, and lack of administrative support as obstacles to effectively integrate technology into their curricula. A survey conducted by Carlson and Gooden (1999) to understand how the professors of preservice teachers modeled the use of technology found that word processing was the instructional application used most consistently by the professors on a regular basis. Clearly, this result suggests the challenge for continuing faculty development in the area of technology integration.

Addressing this urgent need to model effective technology integration in teacher education, several institutions have adopted one-on-one technology mentoring programs to better meet the specific needs of individual faculty member. Prior research has shown that one-shot workshops without on-going individual support often fail to meet the specific needs of most educators; instead, one-on-one technology mentoring models show promising results with faculty professional development in terms of developing technology integrated curriculum (Beisser, 2000; Thompson, Hansen, & Reinhart, 1996).

This paper summarizes the literature on technology mentoring models used in higher education and K-12 schools. In addition, the paper summarizes similarities found among the models and identifies themes that are_emerging from research on these models. This review will provide opportunities to learn from existing programs the key elements in successful mentoring programs.

Models of Mentoring Programs

Based on the challenge of offering appropriate high-quality professional development experiences for faculty, several higher education institutions have developed mentoring models that pair faculty members with graduate or undergraduate students who have a technology background. Various mentoring models have been adopted based on institutions' emphases on enhancing technology integration throughout a teacher education program or K-12 curriculum. Some models offer multiple intensive training of guided lessons on particular software packages followed by one-on-one mentoring support. Other models include a graduate or undergraduate course in which the fieldwork assignment involves pairing students with faculty members interested in using technology in their courses. This type of mentoring model has also been extended to the K-12 environment where the focus has been on overcoming barriers to technology use in the classroom. Almost all of these models have included a younger adult as mentor as opposed to the traditional "hierarchical transfer of knowledge and information from an older, more experienced person to a younger less experienced person" (Zachary, 2001, p. 1).

The mentoring relationship provides professional development support along with the opportunities to practice modeling integration of technology throughout the curriculum. Reviewing the literature on teacher education mentoring programs revealed that there are different models for implementing mentoring programs. The following sections describe the major models currently used in teacher education programs.

Graduate Students as Mentors

Iowa State University College of Education adopts the approach of recruiting graduate students as mentors through a graduate course "Technology and Teacher Education." For the field component of this course, each graduate student is paired with a faculty member and they spend approximately one hour per week working on technology-related learning tasks. This model also caters to a more individualized approach to professional development because each faculty member involved focuses on their specific needs (Zachariades & Roberts, 1995). Individual attention is given to each faculty member to facilitate the process of technology integration. The pairing, in most cases, becomes true partnership and collaboration (Stewart, 1999; Thompson et al., 1996). The instructor of this technology course organizes the program and sets aside time for a weekly seminar in which student mentors exchange experiences, solutions, and pedagogical thoughts. This model features sustainability because the course is offered regularly as part of a graduate program.

The Graduate School of Education at George Mason University, through the Instructional Technology program, offered a similar course. Before beginning their mentoring experience, graduate students enrolled in " Faculty Development in Instructional Technology." Efforts were made to pair students' technology abilities with faculty members' desired skills. Graduate students worked with the faculty members as the faculty became comfortable with technology and began to develop materials to be used in courses. Based on the finding that more than one semester of intensive assistance is needed for faculty members to continue using technology in their courses, plans are being made to continue connecting one-on-one mentoring with an existing course (Sprague, Kopfman, & Dorsey, 1998).

New Mexico State University College of Education initiated a pilot faculty mentoring program in 1996. Five volunteer faculty members and five graduate students, who were technology users, were matched by area of interest and expertise. Students met with their faculty mentees and received graduate credits as part of an internship course. Graduate students also met with the project director every other week for investigation of software and solutions to faculty's questions. (Gonzales, Hill, Leon, Orrantia, Saxton, & Sujo de Montes, 1997; Gonzales & Thompson, 1998).

Instead of offering course credits, the University of New Mexico College of Education hired graduate students as Tech Guides for one-on-one support in helping faculty gain computer knowledge. In addition, these Tech Guides were available to present technology integration lessons in methods courses. Each Tech Guide was assigned to five faculty members and worked intensively with them on an individual basis one or two hours per week. Results indicated that faculty members began to acquire technology application skills and to integrate technology with the support from the Tech Guides (Bramble, 2000).

Another mentoring program involved special education graduate students who served as technology mentors for part of their graduate assistantship in a large mid-western university. Nineteen faculty members and nine graduate students were selected in this eight-week pilot program. Graduate students received two sessions of intensive training on using PowerPoint prior to their mentoring activities. The first session sought to introduce graduate students to PowerPoint. The second session was designed to familiarize graduate students with further PowerPoint practice guided by the faculty learning packet. Faculty members also participated in a group training session featuring demonstrations of PowerPoint capabilities and were provided a learning packet. Using the scripted lessons in the learning packet as guidelines in the one-one-one mentoring activities that followed, student mentors and faculty members were allowed to work in their own office, using their own computer. This model features a combination of multiple session training and one-on-one mentoring activities to support faculty use of technology in teaching and professional development (Smith & O'Bannon, 1999).

Undergraduate Students as Mentors

Not all colleges and universities have a graduate program in technology; so the use of undergraduate students as technology mentors is a viable option for some institutions (Beisser, Kurth, & Reinhart, 1997).

The University of North Texas utilized their PT3 (Preparing Tomorrow's Teachers to Use Technology) Capacity Building Grant to provide technology integration mentoring during the spring of 2000. The new course, " Technology Integration Mentoring," was designed so undergraduate students could work one-on-one with inservice teachers in an authentic classroom environment. In this model, undergraduate students met together three times during the semester and communicated via a class listserv. A class web site was set up for resource links to technology and curriculum. The rest of the class time was spent in a classroom paired with an inservice teacher out of their own selection or by arrangement. The final face-to-face class meeting focused on presentations of undergraduate students' collaborative work with the inservice teachers. A major characteristic of this model is the two-way mentoring where the undergraduate students are considered the technology experts, but they also learned classroom management and curriculum from inservice teachers (Tyler-Wood, Christensen, Arrowood, Allen, & Maldonado, 2000).

The Carson-Newman College Teacher Education Department started a mentoring program using elementary and secondary education undergraduate students to mentor the faculty. This model consisted of four stages: 1) large group planning sessions, 2) small technical sessions, 3) one-on-one mentoring sessions, and 4) a final large group session for project sharing. Students' commitment was in the form of a one-hour course. Course requirements included 35 hours in planning and implementing large and small group sessions as well as preparing for and meeting in one-on-one sessions with the faculty. Faculty agreed to allocate time to meet with mentors, to share projects with other faculty, and to participate in an evaluative interview. Elements of this mentoring programs included one-on-one relationships, mentoring techniques training, communication with the program director, and formal commitments of both student mentors and faculty mentees (Milligan & Robinson, 2000).

In Canada, the University of Regina Faculty of Education initiated a reciprocal mentoring model in which technologically skilled education students organized workshops offered to faculty members and provided one-one-one assistance following the workshops. As reciprocal mentors, faculty and students worked together to learn from each other in making educational connections utilizing the technology skills of the students and pedagogy expertise of the faculty (Browne, Maeers, & Cooper, 2000).

Models Extended to K-12 Environments

According to Dwyer (1998), frequent planned collaborative activities as conducted in the form of on-the-job mentoring have the potential to facilitate structural change in school environment and transform school cultures.

Recognizing the need for support for successful technology use in K-12 school environments, the University of Maryland collaborated with the Prince Georges County

Public Schools by establishing a computer mentoring program. This program was designed to prepare experienced computer-using teachers to serve as mentors for other teachers in their schools. In this case, a course, "Leadership in Computer Applications," was offered to inservice teacher mentors. Each mentor worked with one to five mentees from his or her school. In addition to regular meetings, mentors were available informally because they were teaching in the same school. This program's purpose was to increase the knowledge of the technology-integrated curriculum and to establish sustainable collegial relationships in K-12 environments (MacArthur, Pilato, Kercher, Peterson, Malouf, & Jamison, 1995).

Franklin, Turner, Kariuki, and Duran (2001) present another model of mentoring efforts between higher education and K-12 schools. This university/K-6 partnership develops strategies to overcome barriers of technology use in schools. The pairing of instructional technology graduate students as mentors and elementary school teachers as mentees leads to the development of technology expertise and ideas for technology integration in the existing curriculum. This mentoring model provides a cost-effective way to provide professional development for teachers who have difficulty obtaining technology support for technology use.

Secondary School Students as Mentors

The well-known Generation www.Y mentoring model, originated in the Olympia School District, Washington, in 1996, features the extensive involvement of students as collaborative partners with their teachers. As the project title implies, Generation www.Y focuses on today's new generation of youth who contribute their technology expertise as they become leaders in bringing technology to the classroom and the community. This program has developed and implemented an instructional technology support model that included the extensive and authentic involvement of secondary students (grades 8-12). The 18-week course teaches students technology, collaboration, and project development skills prior to their mentoring a teacher during regular school days. These students maintain school networks and support their teachers as they integrate technology into their curriculum-based projects and lesson plans. It is one of the most extensive student mentoring programs in the nation (Generation www.Y, 2001).

The University of Texas at Austin conducted project CIRCLE in collaboration with the Austin Independent School District and the Eanes Independent School District. This project used technology network tools to establish an online learning alliance within high schools and to explore innovative constructivist uses of technology in the classroom. A virtual learning community based on the constructivist model of learning was established between project schools and the university for collaborative and intellectual work. Training sessions on how to use the specific collaborative learning tools were offered to teachers as well as to selected student mentors. Student mentors served as on site technology mentors for teachers and fellow students. The findings indicate that student mentors can be an effective technology resource and support system for teachers who are implementing new technology tools and applications (Resta, 1998).

Different mentoring models have been adopted based on institutions' needs to enhance technology integration throughout a teacher education program or K-12 environments. Some models include one technology course where students are paired with faculty members interested in using technology in their courses. Some are pilot programs to match graduate or undergraduate students with faculty members or inservice teachers in a reciprocal mentoring relationship. Some offer a combination of multiple sessions and one-on-one mentoring activities. There are other mentoring programs embedded in large-scale projects aimed to help change teacher practice and help to incorporate technology into the existing curriculum. Despite the variety, successful mentoring models have common themes that are discussed in the following section.

Emerging Themes from the Literature on Mentoring Models

Despite the variety of technology mentoring models, effective programs include common elements. These elements clearly emerged from a careful review of the mentoring models and the process established for each. These elements include providing visions for the use of technology in teaching and learning, individualizing technology support (personal fit), breaking down hierarchical structure, establishing open dialogue and collaborative relationships, providing mutual benefits for mentors and mentees, and establishing learning communities. The presence of these elements seems critical to establishing and maintaining successful mentoring programs.

Providing Visions for Technology Use

Educational change has proved difficult to achieve. Educators' beliefs either assist change in practice or inhibit innovation brought by technology implementation (Schuttloffel, 2000). Therefore, visions of potential technology integration across curriculum are keys to potential change in the teacher educator's belief in university classroom practice. According to Papert (1980), change in education can be facilitated with the successful integration of computer technology. However, such change in education cannot occur only by using one-size-fits-all models of professional development, especially when it comes to technology integration in teaching and learning. In one-on-one mentoring programs described in the literature, visions in successful technology integration are provided through collaborative efforts among participants. Most faculty or inservice teacher mentees in these programs indicate that they have developed a deeper level of understanding and a higher level of confidence in the use of technology. One teacher mentee stated:

> I think I have more confidence about managing it all now. I had ideas about using the technology but this has given me an opportunity to see the graduate student at work with the students, so I know it can be done . . . even with my class. (Franklin et al., 2001, p. 28)

This in turn strengthens "their personal and teaching related use of computers, attitudes toward educational computing, and interest in learning more about educational technology" (Generation www.Y, 2000, Executive Summary, p. 14). One faculty mentee in the School of Education at New Mexico State University mentioned:

> I began as what can be referred to as a 'technophobe,' but I was lucky to receive encouragement and support from technology professionals. I started using computer technology as a word processor . . . I began to move more rapidly across the bridge from personal use to uses of technology for teaching reading. (Gonzales & Thompson, 1998, p. 167)

Individualizing Technology Support

Teaching must start where the learner is (Hunt 1961, p. 268). Each person has a unique learning curve with respect to technology. One-on-one mentoring offers individualized technology support that is usually provided on site. Each content area requires its own creative way to integrate technology into curricula, so it is often difficult to provide specific content integration ideas during large group workshop sessions. Moreover, the one-on-one mentoring programs give the mentees time to work at their own pace. The opportunity for graduate student mentors at Iowa State University to address specific needs of faculty mentees in their own areas of interest and pedagogical beliefs was identified as a strength in the one-on-one mentoring program (Thompson et al., 1996). The student mentor devises his/her instruction to fit the style, the skill level, and personal interest of the faculty mentee. As one mentee indicated:

> Importantly, our one-to-one mentorship provided a risk-free atmosphere to ask rudimentary questions about files, folders, menu bars, and how an application works . . . . Eventually, he [student mentor] introduced more complex productivity tools to present and organize information, in particular, those which would relate to my social studies methods course . . . . (Beisser et al., 1997, p. 4)

Faculty members like the fact that they have one-on-one support and their technology needs can be addressed individually and directly.

Breaking Down Hierarchical Structure

These mentoring models are typified by a lack of hierarchy in which leadership is from within rather than from above. Instead of a top down, one-way approach, a shared sense of common goal, opportunity, motivation and reward between the mentor and the mentee is the prevailing mentoring paradigm among these cases. Because of the lack of hierarchy, student mentors feel comfortable approaching faculty members with comments and work closely with faculty to solve problems, share knowledge and gain expertise. In most cases, mentors and mentees are able to "form not only professional but a personal friendship, too" (Beisser et al., 1997, p. 325).

These technology mentoring models, unlike traditional models in which mentors usually have "absolute authority" (Philips-Jones, 1982), focus more on collaborative efforts.

Technology as a facilitator of hierarchical change moves institutions or schools toward a learning community to "involve students as co-creators and co-owners of the curriculum, who bring needed skills and resources to the table" (Generation www.Y, 2000, p. 13).

Establishing Open Dialogue and Collaborative Relationships

Mentoring is a very dynamic and interactive experience. It is also a great way to promote collaboration among mentors and mentees to integrate technology in courses. Most case studies in mentoring programs emphasize open dialogue for both mentor and mentee to express their feelings, knowledge, and expectations. In most models, mentors and mentees started with a formal needs assessment like the "Individual Mentoring Plan" (MacAuther et al., 1995, p. 50) or informally wrote up a set of goals (Gonzales et al., 1997; Sprague et al., 1998; Thompson et al., 1996). A mutual respect and trust developed during the mentoring process as the mentor and mentee worked collaboratively to integrate technology into curricula. This kind of partnership often resulted in collaborative projects. In the case of the University of North Texas model, preservice teachers (the mentors) showcased their work with classroom teachers (the mentees) in their final face-to-face class meeting (Tyler-Wood et al., 2000).

Providing Mutual Benefits

Most mentoring models are set up as a reciprocal relationship in which the faculty mentee learns about integrating technology into their courses and the student mentor learns more pedagogical expertise in certain fields. Because the mentoring process is dynamic, the roles of student mentors gradually change and evolve. Therefore, the benefits for education students as mentors include the opportunity to establish connections with faculty members, to learn about pedagogy expertise from them, and to better understand how faculty members can successfully integrate technology to their courses. The faculty mentees are able to visualize and conceptualize how technology could be used in the classroom through the brainstorming process with help from mentor's technology experiences (Beisser, 2000; Browne et al., 2000; Gonzales et al., 1997; Sprague et al., 1998; Stewart, 1999; Thompson et al., 1996). In K-12 environments, student mentors were offered "an authentic, multidisciplinary, project-based experience of doing valuable work . . .teachers receive individualized support for integrating technology in their particular classroom" (Generation www.Y, 2000, p. 13). In addition, providing students with an authentic learning environment provides them with opportunities to practice skills of leadership and communication.

In project CIRCLE, teachers indicated that one of the important benefits for student mentors was the improved behavior and boost of self-esteem for those previously labeled as " disengaged from the learning process" (Resta, 1998, p. 6). An international student described in her case how being involved in the mentoring program brought her a sense of belonging to the graduate community. Mentoring program provided a chance to build connections with the faculty members and to be engaged in authentic course development work (Chuang, in press).

Establishing Learning Communities

Learning communities established by mentoring relationships encourage collaboration, communication, and team work and provide on-going support in both technology and pedagogy for both mentors and mentees. Learning communities emerging from a nurturing and supportive environment allow members to exchange ideas, share experiences, and learn together to accommodate individual learning styles (Stephen & Evans, 2000). In these mentoring models, learning communities exist within the mentors' group, between mentors and mentees, and in the alliance of participating institutions of the mentoring programs.

The structure of the mentoring communities is not linear or hierarchical. Instead, these communities are asymmetric and connected by interaction and collaboration. In models where mentoring occurs as the field component of a course, learning communities are built on means of communication, such as listserve, e-mailing, and face-to-face regular meetings (MacArthur et al., 1995; Sprague et al., 1998; Thompson et al., 1996). Mentors get in touch with other peer mentors and share experiences and find solutions for technical and pedagogical problems within these learning communities. At New Mexico State University, one of the participating faculty members felt that "being a part of a faculty mentoring team usually developed a sense of belonging to the broader community of those committed to using educational technology" (Gonzales & Thompson, 1998, p. 169). Historically, K-12 teachers tend to be isolated from their peers so developing a learning community among teachers through mentoring programs is particularly important. This is also the emerging theme found in the extended mentoring models to K-12 environments (MacArther et al., 1995).

Conclusions

Most one-on-one mentoring programs have been successfully providing faculty in higher education and teachers in K-12 environments with expertise and support they need to use and integrate technology. Characteristics such as providing visions, individualizing technology support, breaking down hierarchical structure, establishing open dialogue and collaborative relationships, and providing mutual benefits for mentors and mentees are important parts of most successful models. In addition, successful programs tend to emphasize the creation of learning communities among and between mentors and mentees. The characteristics of successful mentoring programs described in this paper should provide a useful framework for educators who are or will be implementing mentoring programs.

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CHAPTER 3. REFLECTING WITH ONE TECHNOLOGY-USING TEACHER EDUCATOR: DISCOVERY OF A NEW PEDAGOGICAL APPROACH

A paper to be submitted to the Journal of Research on Technology in Education

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Abstract

This study reports on a one-on-one faculty technology mentoring program and its impact on a teacher educator's role and use of technology over time. The faculty member studied tells the story of an eight-year journey into technology integration. A grounded theory approach was utilized to relate and integrate the stages experienced by an exemplary technology-using teacher educator who moved from limited knowledge and use of technology to learning to apply basic applications in the classroom and to integrating innovative technology. The researcher also investigates the roles of technology, the technology mentoring program, and the community of learners in changing this educator's pedagogical beliefs toward a more constructivist approach. This paper exemplifies the complex and multi-faceted change possible in professional practice and illustrates what this change is like for a faculty member involved over a period of time in a faculty technology mentoring program.

Introduction

Technology has created enormous opportunities for both K-12 environments and teacher education programs in institutions of higher education, yet challenges exist. Cuban (1986) and Cohen (1988) express doubts about technology compatibility in the classroom. They assert that technology is either adapted to traditional teaching styles or discarded if it cannot be adapted. These critics state that the mainstream instructional methods remain much the same in classrooms, unaffected by the technology revolution. Cuban concludes that technology in the American classroom tends to be oversold and underused (Cuban, 2001). Over time, many efforts to reform education have involved attempts to introduce technological innovations into teaching and learning. The reluctance of teachers and teacher educators to adopt educational technology results in unused, underutilized, or even misapplied technologies and the loss of opportunity to transform the classroom (Cohen, 1988, Cuban 1986, 2001; Hodas, 1993). An increasing body of literature, however, argues that technology provides K-12 schools and teacher education programs with a new vision for necessary reform (Becker, 1994, 2000; Dede, 1998; Means & Olson, 1994, 1997). Dede (2000) further argues that the discussions of technology in education should not concentrate on comparisons of efficiency of technology as instructional tools to standard existing approaches for teaching conventional content. Instead, the goal of technology in education especially with the advancement of more sophisticated computers and telecommunications should focus on how to reach essential educational objectives in higher-order skills and collaborative knowledge generation (Bransford, Brown, & Cocking, 1999; Dede, 2000). With these newly developed and sophisticated technology tools, exciting new structures for active classrooms and authentic learning and student-centered, collaborative learning environments are now made possible to enrich curricula, enhance pedagogy, increase links between schools and society, and empower students (CTGV, 1997; Jonassen, 1995; Linn 1997; Riel, 2000). Therefore, teacher education programs and teacher education faculty have to respond to the need of technology-enhanced curriculum to meet the challenge of preparing children for twenty-first century civilization.

This study explores the complex and multi-faceted change in pedagogical approaches of a teacher education faculty member involved in a one-on-one faculty technology mentoring program over eight years. It also reflects how a teacher education faculty member responds to the need of technology-enhanced and technology-integrated curriculum across teacher preparation courses with provided support. Relevant change theories such as the Concerns-Based Adoption Model (CBAM) (Hall & Hard, 1987, 2001) and the Integrated Technology Adoption and Diffusion Model (Sherry, 1998; Sherry, Billig, Tavalin, & Gibson, 2000) emphasize that change is a process rather than an event. Therefore, it is best studied with qualitative research paradigms to reveal the multifaceted relationships of a change process. One such research paradigm is grounded theory (Glaser & Straus, 1967; Strauss & Corbin, 1998). A grounded theory approach allows theoretical categories to emerge from the data and explains how an individual responds to problems in various conditions. The results are thus grounded in the real world contexts.

The section that follows provides a review of the literature related to one-on-one faculty technology development in colleges of education and to change theories such as CBAM and the Integrated Technology Adoption and Diffusion Model. The theme related to the impact of one-on-one technology mentoring on the faculty member's pedagogical beliefs in how technology can be integrated into curriculum seems to be crucial to understanding the effectiveness of one-on-one mentoring as a faculty development approach. Therefore, the purpose of the study was to look at the process of a faculty member's change in pedagogical approach in her teaching because of her involvement with the technology mentoring program. Results are organized according to a visual model derived from the data analysis procedure based on the grounded theory coding paradigm (Strauss & Corbin, 1998).

Review of the Literature

This literature section starts with the importance of professional development in colleges of education. Then it continues with how the one-on-one technology mentoring program emerges as a faculty development approach. Relevant change theories are also reviewed. Both the CBAM and the Integrated Technology Adoption and Diffusion Model provide a systematic examination of professional development of individuals going through changes.

The Importance of Professional Development in Colleges of Education

The important issues for the evolution of school curriculum are not the availability and affordability of sophisticated information technology. Instead, the primary barriers to altering curricular and pedagogical practices are psychological, political, and cultural (Dede, 2000; Fullan, 1993; Means & Olson, 1994). According to the recent report from the National Center for Education Statistics (Kleiner & Farris, 2002), 99% of public schools and 87% of the instructional rooms of public schools in the U.S. had Internet access in 2001. As a result of advanced technology, new forms of representation and visualization of interactive models of course content make possible a broader and more powerful repertoire of pedagogical strategies (CTGV, 1997; Riel, 2000). However, according to a comprehensive review of the literature on information and technology, Willis and Mehlinger (1996) conclude that much of the literature on information technology and teacher education reveals the lack of knowledge of effective use of technology in education for preservice teachers and emphasizes a need for teacher education programs to provide preservice teachers with training to use and integrate technology in educational settings. In addition, to adequately prepare teachers, teacher preparation institutions need to equip faculty so they can model technology use and integration strategies for preservice teachers in their courses (Munday, Windham, & Stamper, 1991; Zehr, 1997). According to a survey by Milken Exchange (1999), however, most teacher education faculty members do not model the use of technology in their teacher preparation courses.

Research has identified obstacles to the effective integration of technology into the curricula for the College of Education faculty as lack of knowledge about software, schedule conflicts, limited vision of technology integration, and lack of administrative support (Baron & Goldman, 1994; O'Bannon, Matthew, & Thomas, 1998; OTA 1995; Strudler, McKinney, & Jones, 1995). Therefore, professional development in technology for faculty in teacher education institutions plays a vital role in modeling pedagogical strategies of technology integration in classroom teaching for preservice teachers. Sprague, Kopfman, and Dorsey (1998) argue that an effective faculty development program is key to the appropriate modeling of technology use and integration strategies in teacher education programs.

In response to the need of faculty development in technology for teacher education programs, several teacher education institutions have adopted one-on-one technology mentoring programs to meet the specific needs of each faculty member. Research findings from these mentoring programs indicate that a one-on-one technology mentoring program has the potential to support teacher educators' personal use of technology and facilitate the implementation of desired changes in their teaching practices (Gonzales & Thompson, 1998; Stewart, 1999; Thompson, Hanson, & Reinhart, 1996).

Faculty Technology Mentoring Programs

The mentoring process in the teaching profession usually places student apprentices in the real world, where a practicing teacher and a professional from an education institution provide support and serve as mentors during student teaching (Evans 2000; Janas, 1996). Teacher induction programs often include a mentoring component for the first-year teachers who are then guided or supported by mentor teachers who are often the experienced and veteran inservice teachers (Fullan, 2001). However, one of the underlying assumptions of several technology mentoring programs is that young people bring an exciting expertise to the program and thus the young people are the technology mentors (Chuang, Thompson, & Schmidt, 2003). Young people are natives in the world of technology, whereas more advanced generations are immigrants to this digital world. For younger generations, technology is a natural tool that has always been there (November, 2001).

According to Carroll (2000), the knowledge transmission mode, in which the student learns from the teacher, cannot represent all learning modes in the information technology era. Teachers, and teacher educators as well, are required to adopt the role of the learner. Therefore, it is not surprising to find that most of the mentoring models adopted by higher education institutions have included a younger adult, in most cases, a student, as a mentor as opposed to the traditional "hierarchical transfer of knowledge and information from an older, more experienced person to a younger less experienced person" (Zachary, 2001, p. 1).

Various mentoring models have been adopted based on the institution's emphasis on how to enhance technology integration in a teacher education program or K-12 curriculum. For example, the Graduate Schools of Education at George Mason University and at New Mexico State University both offered graduate student credit hours to pair a student's technology abilities with a faculty member's desired skills and areas of interest. Graduate students worked with the faculty members as the faculty became comfortable with technology and began to develop materials to be used in courses (Gonzales & Thompson, 1998; Sprague et al., 1998). Instead of offering course credits, the University of New Mexico College of Education hired graduate students as Tech Guides for one-on-one support in helping faculty gain computer knowledge and support in technology integration in methods courses (Bramble, 2000). There are also examples of undergraduate students serving as technology mentors to assist the faculty in increasing their comfort level of technology use (Beisser, Kurth, & Reinhart, 1997; Milligan & Robinson, 2000). Research indicates that one-on-one technology mentoring facilitates the move by faculty from the personal use of computer applications to the integration of technology into their teaching (Thompson, Hansen, & Reinhart, 1996). A literature article identifies six key themes in a successful mentoring program (Chuang, Thompson, & Schmidt, 2003). These elements include:

- providing a vision for the use of technology in teaching and learning
- individualizing technology support
- breaking down hierarchical structures
- establishing open dialogue and collaborative relationships
- providing mutual benefits for mentors and mentees
- establishing learning communities

The presence of these elements appears to be critical to establishing and maintaining successful mentoring programs.

The Faculty Technology Mentoring Program at Iowa State University

The faculty technology mentoring program at Iowa State University (ISU) began in 1991 with the offering of the graduate course, "Technology in Teacher Education." This course included readings and discussions on issues in technology in teacher education and a field component. For the field component, students were asked to mentor a teacher education faculty member for one hour each week during the semester. In class, discussions were centered on both the readings and the students' mentoring experiences.

In the early 1990s, the Department of Curriculum and Instruction in the College of Education at ISU began to develop approaches for working with faculty to assist in their use of technology in the teacher education program. The department, however, has never required faculty participation in technology development activities. Some faculty members chose to wait years before participating in the program. Faculty members begin their work with technology mentors based on their desire and readiness, an important factor in the success of the program.

An important feature of this mentoring program is that the faculty members define their needs, and the mentors respond to those needs. The mentoring relationships in this program also move away from traditional roles in which faculty teach students. The pairings in this mentoring program involve people who are more experienced with technology (students) teaching people who have less experience (faculty). These reverse-role relationships tend to turn into powerful learning experiences for both mentors and mentees (Stewart, 1999; Li, 2001). Given its twelve years of existence, a website has been developed to document and archive artifacts and research resources related to the faculty technology mentoring program (http://www.public.iastate.edu/~mstar/mentor/home.html).

Because this study deals with what changes are like for a teacher educator, relevant theoretical frameworks on how people evolve in their change process are reviewed in the following section. Both Concerns-Based Adoption Model (CBAM) and The Integrated Technology Adoption and Diffusion Model provide a developmental framework that allows a systematic examination of models of learning and the change process from a learner's perspective.

Relevant Theoretical Frameworks

The Concerns-Based Adoption Model (CBAM)

The Concerns-Based Adoption Model (CBAM) is a framework that has implications for the practices of professional development. It indicates that any innovations are results of change and that supporting people in change is critical during the change process. The change facilitator could be anyone who "assists various individuals and groups in developing the competence and confidence needed to use a particular innovation" (Hall & Hord, 1987, p. 11). Change facilitators are responsible for offering strategies to probe and intervene in the process through three diagnostic dimensions: Stages of Concern, Level of Use, and Innovation Configuration. In addition, several tools and techniques are used to measure the three diagnostic dimensions (Table 1). Ellsworth (2000) clarifies that CBAM operates through strategies offered by a change facilitator who supports the implementation of change, but the focus is on the concerns of the individuals receiving the support. Especially in CBAM, the Stages of Concern dimension contains a learning characteristic as an individual moves from the self concern to the task concern and then to the impact concern focus of an innovation. It offers an approach to the study of change by focusing on the needs of individuals (the intended adopters) and describing their growth over time (Hall & Hard, 1987, 2001).

The Integrated Technology Adoption and Diffusion Model

In the Integrated Technology Adoption and Diffusion Model, Sherry (1998) describes a learning and adoption trajectory in teachers. It consists of individual, technological,

Table 1.

Dimensions of CBAM

Names of the Dimensions	Focus	Measuring Tools
Stages of Concern	Intended adopter's feelings and effects	One-legged interviews Open-ended concern statement Stages of Concern Questionnaire
Levels of Use	Intended adopter's behaviors	Long-term observations Interview protocol
Innovation Configurations	Characteristics of innovations Various operational forms of the change	Innovation Configuration Map

organizational, and instructional elements for the practice of a professional development in technology for teachers. This model presents a cyclic process in which teachers evolve from learner to adopter of educational technology, to co-learner, and finally, to a reaffirmer or rejecter. This model integrates the adoption process with the learning process of the intended adopters (teachers) and expands to include the fifth stage, teachers as leaders (Sherry et al., 2000), as a result of findings from evaluation of several technology initiative school-based projects. To progress and reach the reaffirmer stage, and eventually the leader stage requires effective strategies through professional development (Sherry & Gibson, 2002). This Learning/Adoption Trajectory is aimed to go beyond the linear limitations of the traditional adoption models, to incorporate external factors and ultimately to "make visible both the patterns and the context of involvement of the various players and parts of the system" (Sherry & Gibson, 2002). Sherry et al. (2000) identify five stages of Leaning/Adoption Trajectory:

Teacher as Learner

This stage in the learning/adoption trajectory model is an information-gathering stage in which "teachers learn the knowledge and skills necessary for performing instructional tasks using technology" (p. 2). Effective professional development strategies in this stage include demonstrations of promising use of technology by peers rather than one-shot workshops by outside experts. Training sessions should stress the alignment of technology and curriculum standards. Teachers must make time for training exercises that will improve their understanding about technology and its use in the classroom.

Teacher as Adopter

In this stage of the learning/adoption trajectory model, "teachers progress through stages of personal and task management concern as they experiment with the technology, begin to try it out in the classroom, and share their experiences with their peers" (p. 2). During this stage, accessible technology support is very crucial in helping teachers on their journey of learning to teach with technology. Online resources, on-site technology support, peer technology mentoring, and open lab workshops are possible ways to establish mechanisms to deal with technical problems as teachers incorporate technology in the classroom.

Teacher as Co-learner

In this teacher as co-learner stage, "teachers focus on developing a clear relationship between technology and the curriculum, rather than concentrating on task management aspects" (p. 2). In this stage, workshops need to include strategies for enhancing instruction and integrating technology into curriculum. Effective professional development strategies include collegial sharing of exemplary products and innovative ideas of technology integration and use of students as informal technical assistants.

Teacher as Reaffirmer

In this stage, "teachers develop a greater awareness of intermediate learning outcomes. They begin to create new ways to observe and assess impact on student products and performances, and to disseminate exemplary student work to a larger audience" (p. 2). Administrative support is important as teachers develop awareness of immediate learning outcomes of students such as greater student engagement and increased metacognitive skills in technology-based active learning.

Teacher as Leader

In this stage, "experienced teachers expand their roles to become active researchers who carefully observe their practice, collect data, share the improvements in practice with peers, and teach new members. Their skills become portable" (p. 2). The reaffirmer goes on to take on a leadership role, assisting with the trouble shooting, serving on technology planning committees, and planning workshop sessions at schools. They often become the change agents for their colleagues. Effective professional development strategies in this stage include incentives for co-teaching on-site workshops, release time to allow peer coaching and outside consulting, and support from a network of teacher-leaders.

Purpose of this Study

This paper provides an in-depth study of a technology-using faculty member and her involvement with the faculty technology mentoring program. The researcher wants to know what it is like for a professor to adopt the role of learner and to learn technology skills from a graduate student mentor. Therefore, this study seeks to understand and to investigate the changing role of a technology-using teacher educator who has been an active participant in the faculty technology mentoring program in the Department of Curriculum and Instruction at ISU. The researcher is also interested in whether her mentoring experience has had any impact on her belief in pedagogy. The questions of interest are:

- Is there a shift of pedagogical beliefs because of the teacher educator's intensive involvement with the reciprocal process of the faculty technology mentoring program?
- If there are changes made in her pedagogical beliefs, then how has she implemented the desired changes in her teaching?

Methodology

Because the researcher is also the instrument, it is important for social researchers to reflect on the self in the process of conducting a qualitative inquiry (Lincoln & Guba, 2000). Interpretations are subject to the researchers' ideologies, cultural backgrounds, and professional experiences. Because of this widespread effect of the researcher as instrument throughout the study, the researcher of this study has to make explicit her professional experiences and life events to enable the readers to examine through what lenses the researcher reads the data. Following that, a description of the participant's professional experience with faculty technology development illustrates "purposeful sampling" (Patton, 1990), which emphasizes sampling for information-rich cases. Data collection was through qualitative interviews, field observations, personal journals, artifacts, class syllabus and lesson plans, students' assignments, students' evaluation forms, the participant's WebCT (an online learning platform) course site, and drafts of her action research project. Data were collected and analyzed according to the coding procedures for grounded theory research. A visual model is created to allow the researcher to analyze the data under a framework that integrates structure and process.

About the Researcher

The researcher entered the faculty technology mentoring program by taking the course entitled "Technology in Teacher Education" as a first-semester doctoral student in the Department of Curriculum and Instruction. She earned her master's degree in Curriculum and Instructional Technology in 1994 from the State University of New York at Albany. Prior to entering the doctoral program in pursuit of her Ph.D., she was an EFL (English as a Foreign Language) teacher in a high school in Taiwan. Although she was a teaching assistant of an undergraduate course, "Introduction to Instructional Technology," being a technology mentor to a faculty member was something she had never considered before. As an international student, it was somewhat overwhelming to picture herself as a technology mentor to the faculty in the beginning. However, it turned out to be a very fulfilling experience, which indeed provided an opportunity to make connections with the faculty in the department. She continued to work with the faculty through the Preparing Tomorrow's Teachers to Use Technology (PT3) grant project as a technology mentor to help them with the necessary support to develop materials and ideas for integrating technology into their teacher preparation courses. Dr. Jones was one of the faculty members with whom she worked in the fall semester in 2001 through the PT3 grant project.

At the time of this investigation, the researcher had completed her doctoral course work in Curriculum and Instructional Technology, and was no longer a technology mentor for Dr. Jones. The researcher's mentoring experience inspired her to investigate the faculty's changing roles in the mentoring process as she wanted to understand the "teacher educator as learner" phenomenon, to uncover the meaning of the faculty technology mentoring program, and to delineate the process of how changes happen. In qualitative studies, rather than trying to hide the biases or "subjectivities" of the researcher, Peshkin (1988) argues that the researcher's subjectivity "can be seen as virtuous, for it is the basis of researchers making a distinctive contribution, one that results from unique configuration of their personal qualities joined to the data they have collected" (p. 18). There are, of course, several possible biases that can result from the research process when the researcher is the interviewer and was once a technology mentor to the participant. While the researcher tried to separate herself from her previous technology mentor role when interviewing the participant, it was sometimes unavoidable to reflect together with the participant on particular projects with which both were involved, such as the streaming video project. While the recounting of familiar stories triggered memories of working with Dr. Jones, the researcher was careful to bracket these memories and the feelings they recalled to allow the voice of the participant to be heard.

About the Participant: Dr. Jones

Dr. Jones is a faculty member with a joint appointment in the departments of Curriculum and Instruction and Foreign Languages and Literatures at a midwestern university. Her teaching responsibilities include an undergraduate elementary school foreign language methods course for preservice teachers. Dr. Jones's involvement with the faculty technology mentoring program spanned eight years, beginning in 1994. In the year 2000, she applied for and was named as a Tech Scholar through the Tech Scholars program in which she worked with graduate student mentors to develop course materials and ideas for technology integration. She was also given release time and a stipend as a Tech Scholar. Her comfort level with technology increased as she developed her technology skills and adopted technology as an important component of her professional career. As she recalled, her first mentor in 1994 advised her on a new hardware purchase, which was her incentive for moving to the Mac platform. Over the years, Dr. Jones progressed in several computer software applications and even taught her methods course on the Iowa Communication Network (ICN), a fiber optic communication system used for distance learning purposes. She is now handling email via Eudora (an email management software application), using a handheld for a daily organizer, searching on the Internet, creating PowerPoint presentations, and using WebCT (an online learning platform).

Data Collection

Data were collected through various sources: qualitative interviews, field observations, Dr. Jones's journals, artifacts, class syllabus and plans, students' assignments, students' evaluation forms, the Dr. Jones's WebCT course site, drafts of Dr. Jones' action research project, and case studies of Dr. Jones's previous mentoring experience written by her graduate student mentors. Specifically, four audio- or video-taped interviews of approximately one hour in length over a four-month period of time were conducted in the fall 2002 semester. During the same period of time, three formal class observations were made in which Dr. Jones and her class were videotaped. One observation was made in an informal setting during lunch with another graduate student and Dr. Jones. A follow-up interview was conducted in the fall 2003 semester. Materials, such as class plans, students' assignments, and students' evaluation forms, were collected with the collaboration of Dr. Jones. She also facilitated the researcher's access to the WebCT course site. Artifacts such as digital video clips were collected to add to the data sources.

Dr. Jones designed an action research project to analyze the impact of the changes in her foreign language methods course in the spring 2002 semester and she continued with the action research project in the fall 2002 semester. As one means of evidence, she kept a journal documenting her journey with respect to exploring the impact of selected technologies on student learning and her teaching practice. Interviews, class observations, class materials, artifacts, the reflective journal kept by Dr. Jones, drafts of Dr. Jones action research project and case studies from Dr. Jones' mentors were all included as data sources. The one-on-one interviews, however, were the primary source of data.

These were methods that helped to check or triangulate the evidence of the data according to Lincoln and Guba (1985). Triangulation is a strategy commonly employed by the researcher to ensure the internal validity of a qualitative study. Denzin (1970) presented an extensive discussion on triangulation identifying four common types of triangulations: multiple investigators, multiple data sources, multiple theories, and multiple data collection methods to confirm findings. The strategies of multiple investigators, multiple data sources, and multiple data collection methods are the most three commonly employed by qualitative researchers (Merriam & Associates, 2002). Although the author is the main researcher in this study, she constantly sought advice from her major professor to validate data materials and to confirm emerging themes from the study.

Data Analysis

Data were collected and analyzed according to qualitative research guidelines for grounded theory research. Grounded theory was first developed by Glaser and Strauss in the early 1960s as a methodology for inductively generating theory (Patton, 1990). The mode of inquiry in grounded theory is inductive with an interest in theory generation rather than theory testing (Charmaz, 2000). Strauss and Corbin (1998) defined grounded theory as, "… theory that was derived from data, systematically gathered and analyzed through the research process. In this method, data collection, analysis, and eventual theory stand in close relationships to one another" (p. 12). A very important aspect of conducting a grounded theory study is that the researcher does not begin with a grand theory in mind to test the data. Rather, the researcher allows the theory to emerge from the data to resemble the reality of those who live it (Strauss & Corbin, 1990, 1998). The basic data analysis procedure in grounded theory is the constant comparative method. Meaningful units of data identified by the researcher are compared to generate tentative categories and properties, the basic elements of a grounded theory. A key to this approach is the idea of theoretical sampling. Theoretical sampling indicates "maximizing opportunities for comparing concepts along their properties for the similarities and differences enables researchers to densify categories, to differentiate among them, and to specify their range of variability" (Strauss & Corbin, 1998, p. 202).

This study specifically implemented the procedures of open, axial, and selective coding. Data started to emerge from the first interview and were coded in a sequence of analytical steps. As initial and continuous insight occurred during open, axial, and selective coding, connections were then seen between and among categories and properties (Strauss & Corbin, 1990, 1998). According to Strauss and Corbin (1998), in using open coding, the data should be first analyzed line by line to discover the relationships among concepts, events, and themes and to sort them into appropriate categories based on the relationships (see Table 2). The process of open coding continued as the researcher developed analytical categories in

Table 2.

Initial Coding from the Open Coding Process

Category	Emerging concepts/events/themes
Tech Hardware/Software	Platform (Mac/PC); Filemaker Pro; Initial limited use of internet; PowerPoint phenomenon; Difference between low tech (overhead projector) and high tech(PowerPoint); Pros and cons of Internet; Webpage story of Oregon
Use of Technology	Fax/Computer; ICN; Smart Classroom
Level of Technology	Summer Institute(higher level of technology)
Technology Support	CTLT; Mentor Linda; Mentor Jamie; Mentor Hsueh-Hua
Pedagogy Support	Learn from Grad student (Beth; Ed)
WebCT Journey	Started with the help of mentor; Scanning; progress with Linda; the use of e-reserve; grade; rich website with digital video clips
Exposure to constructivism	No constructivist teacher in Foreign Language Teaching; linear aspects of language learning; make attempts to go constructivist; Power of constructivist teaching/student ownership of knowledge
Digital Video Clips	Equipment support from CTLT; iMovie editing raw tapes; start to use video clips in constructivist approach; Video clips technology down time; Streaming video
Student Feedback	Action Research; Evaluation of use of video clips and chat room in WebCT; Factors changing evaluation

Table 2 (continued)

Category	Emerging concepts/events/themes
Dissemination	Foreign language methods course; College peer faculty sharing the transforming moments
Student population	Cohort student group; Students complaining of heavy working load; Groups with off-campus sites
Power of Constructivism	Student ownership; Inquiry; Use of video clips in WebCT; Technology and pedagogy; Shift of pedagogy because of technology

terms of their specific properties and dimensions. Properties are "the general or specific characteristics or attributes of a category" (Strauss & Corbin, 1998, p. 117) whereas dimensions refer to " the location of a property along a continuum or range" (p. 117). Through delineation of properties and dimensions, the researcher differentiated each analytical domain derived from categories which emerged from the initial open coding process (see Table 3). For example, in the one-on-one mentoring program domain, properties include levels of the mentee's (Dr. Jones') use of technology and her relationships with the mentors. Dimensions of levels of the mentee's use of technology range from personal technology skills, to management use of technology and instructional use of technology. The property of relationships with the mentors has dimensions varying from mentor as instructor, mentor as co-learner, and mentor as technology resource connector. Following that was the axial coding process. In this stage, the researcher began the process of reassembling data that were fractured in open coding and built up the dense relationships (subcategories) around the axis (the overarching category). Table 4 presents an overview of the axial coding.

Table 3.

Analytic Domains Derived from Open Coding

Analytic Domains Properties	Dimensions
One-on-One Mentoring Experiences	
Levels of mentee's use of technology	Personal technology skills; Management use of technology; Instructional use of technology
Relationships with mentors	Mentor as instructor: Mentor as co-learner; Mentor as technology resource connector
Act of Teaching	
Use of technology	From low tech to high tech
Knowledge of pedagogy	Linear to nonlinear; Teacher-centered to student-centered; Delivery mode to scaffolding mode
Student populations	Undergrads cohort vs. non-cohort; On campus students vs. off-campus students; Student with teaching experiences vs. student without teaching experiences
WebCT	
Type of use	From limited use to full integration
Development over a long period of time	Mentors; CTLT; ITC
Technology Problems	
Type	Hardware vs. software
Outcomes	Trouble-shooting herself; Trouble-shooting with mentor
Support Resources	
Technology	Mentor; CTLT; Students
Pedagogy	Grad students; Peer faculty
Constructivism	
Goal: Inquiry mode of learning	CD-rom to streaming video
Student ownership of knowledge	Passive to active

Table 4.

Overarching Categories and Subcategories Derived from Axial Coding

Overarching Categories	Subcategories
The Power of Constructivism	Knowledge of Pedagogy
	Use of Technology
	Act of Teaching
	Conduct Action Research Project
	Feedback from Students
One-on-one Mentoring Program	WebCT Site
	Technology Development with the Help of Mentors
	Digital Video Clips
Connected Support	Technology Support
	Pedagogy Support
	Learning Community Support

To organize relationships among categories, Strauss and Corbin (1998) suggest an organizational scheme or a coding paradigm that allows the researcher to analyze the data under a framework in which structure and process are integrated. The basic components of the paradigm are conditions, actions/interactions, and consequences. There are three types of conditions: causal, intervening, and contextual. It is most important to focus on the complex interweaving of the conditions that lead up to a problem or issue. The responses people give to the issues, and the incidents or problems they experience are referred to as actions/interaction or strategies. Consequences are outcomes of actions and interactions as individuals employ strategies to respond to issues that arise. This organizational scheme also guides the process of the axial coding to systematically develop and relate categories.

A visual coding paradigm illustrating the process of how a technology-using teacher educator made changes in pedagogical approaches was developed as the researcher integrated and refined the major categories in the stage of selective coding (see Figure 1). A very crucial decision to make at this point of data analysis is the identification of a central idea (Strauss & Corbin, 1998). The central idea or the central phenomenon, "the power of constructivism" (see Figure 1), was determined based on the guidelines proposed by Strauss (1987), who emphasizes that the central category is the central concept under which all other categories can be related, subsumed, and integrated to grow in depth and in explanatory power. After the outline of a visual model was proposed, the researcher began to trim off the excess and fill in the poorly developed categories. For example, the subcategory, "learning community support" emerging in the axial coding (see Table 4) was then expanded into "the mentoring program," "Center for Technology in Teaching and Learning (CTLT)," "faculty," and "graduate and undergraduate students" to be included on the contextual conditions in the visual model.

Finally, the visual model was validated by comparing it to raw data and was presented to the participant for her reactions, as a theory grounded in the data should be recognizable to the participant. Dr. Jones agreed with most of the concepts and the relationships represented in the model as the researcher explained to her the coding process. Dr. Jones added one concept of technology uptime, which later was developed into a new category, "discovery of use of new technology," as one of the intervening conditions of the process of how she made changes in her pedagogical approaches.

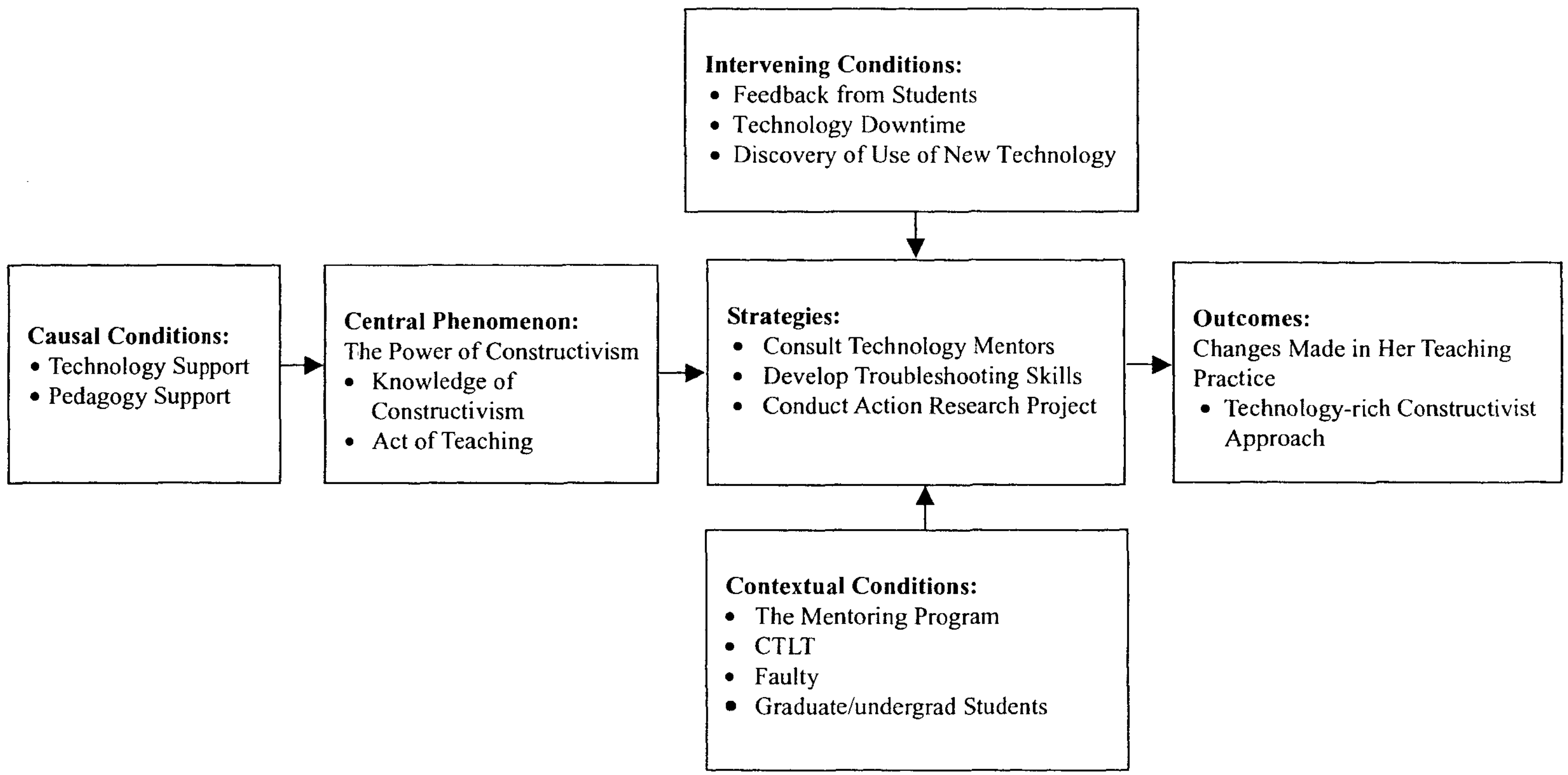

Figure 1. A visual diagram illustrating the process of a technology-using teacher educator in changing pedagogical approaches

The Results

Central Phenomenon (The Power of Constructivism)

Knowledge of Constructivism

Constructivism as a learning theory stresses the importance of the individual's own building of knowledge and is rooted in the philosophical paradigm that there is no absolute truth. Instead, truth or knowledge is relative and subject to each individual's experiences within his or her own context. Both Vygotsky's focus on social interaction and Piaget's ideas on cognitive adoption have contributed in grounding constructivism by providing a psychological theory of learning (Fosnot, 1996). Bruner (1986) developed from them a concept of scaffolding that is based in modeling instruction and direct instruction. Others, like Cambourne (1988), emphasize the constructive nature of learning in scaffolding. The synthesis of these theories provides a basis for a psychological theory of constructivism. When applied in the classroom, constructivism emphasizes that there is no ready-made knowledge, and learning is a constructive activity that the students themselves have to carry out.

Dr. Jones notes, for example, that she has had occasional informal conversations over several years with a technology graduate student with whom she worked about the relationship of technology to a constructivist philosophy of teaching. Two years ago she had several in-depth conversations with another technology graduate student who came to seek assistance in locating for her doctoral research a school where foreign language teachers were using a constructivist approach in the classroom. She reports that she was surprised when none could be found, and she began reflecting on constructivism and technology in foreign language education. Her conversations with graduate students ultimately inspired her to make changes toward what she believes to be a meaningful and appropriate use of technology integration in teaching. Dr. Jones described her learning experience in constructivism as follows:

> I remember borrowing from Beth [a graduate student] videotapes on constructivism and how surprised I was it [constructivism] really seemed to be in the questioning strategies of the teachers and in their organization of the class. I tried to think more about the questions I would ask as I focused on the digital videotapes. I tried to make other parts of the course more constructivist too. (Interview, October 21, 2002)

She continued to express her understanding of constructivism as applied in teaching practice:

> I really do believe in the power of the constructivist, and not just lecturing. And I've always had pair and small-group work and reporting and it's really more of them [students] coming up with their ideas and shaping them rather than their ideas fitting in a preconceived mold that I have in my pocket that I pull out. (Interview, November 7, 2002)

In her journal, she pondered the idea of constructivist teaching:

> Constructivist teaching seems to be posing good questions that encourage students to explore and discover on their own . . . . I hadn't seen it quite in that way . . . now today, I am ready to begin to put the first class together so I will have my first opportunity to try to make the class more constructivist. (Dr. Jone's Journal, November 4, 2001)

Based on her newly-acquired knowledge of constructivism, she took on a journey of the unknown, hoping for transforming moments in her teaching practice.

Act of Teaching

When applied in the classroom, constructivism emphasizes that there is no ready-made knowledge, and learning is a constructive activity that the students themselves have to carry out. Dr. Jones frequently recalls the finding of students' "ownership" of their knowledge construction. In constructivism, the human mind is viewed as a creator of symbols used to represent reality constructed by each individual. For social constructivism influenced by Vygotsky, constructivists believed that knowledge is constructed socially using language, and thus different social experiences result in multiple realities. Constructing knowledge is a social linguistic process with a gradual advancement of understanding built upon prior knowledge resulting in multiple dimensions of the truth (Spiro, Feltovich, Jacobson, & Coulson, 1991). Vygotskian principles in the classroom emphasize that learning and development are social and collaborative activities and therefore learning should take place in meaningful context in which knowledge can be applied. On the other hand, Piaget's theory of intellectual growth had the primary influence on the development of the current constructivist position. Piaget first emphasized the process of conceptual change as interactions between existing cognitive structure and new experiences (Wadsworth, 1978). Piagetian principles in the classroom focus on the freedom given to learners to understand and construct meaning at their own pace through personal experience with assimilation and accommodation stages to achieve equilibrium. Piaget also emphasized learning should take place among collaborative groups with peer interactions in natural settings (Wadsworth, 1978). Both principles encourage educators to recognize that learning is an individual process. In other words, students should be able to declare their ownership of their knowledge.

In a constructivism classroom, students are viewed as ones who act on events within his or her own environment and actively construct meaning out of the events. In addition, students are encouraged to demonstrate their autonomy and initiative (Brooks & Brooks, 1993). Dr. Jones carefully scaffolded her students' experience with the digital video clips through the way she organized the activity and through the guiding questions she prepared. She set the scene with the "controlled analysis on a particular topic," and she discovered that her students took on "ownership" of their knowledge through the use of the digital video clips. Thus, in her narrative, Dr. Jones connected herself to constructivism when using technology in teaching, although she did not include the word "constructivism" in her early narrative.

> So it's [the course] more organized in many senses. Actually this semester, for the first time when they used it [the digital video clip], I saw them up in front of class, talking about their clip and they showed that little segment to demonstrate their points. It's just . . . there was so much . . . they had so much ownership over what was happening. That never ever has happened in the class. They analyzed on their own, and this was more controlled analysis on a particular topic. So I did organize those clips around certain topics. I think it would be almost impossible to teach without these clips, and that's classroom management [one topic of the video clips]. (Interview, November 7, 2002)

According to Wilson (1996), a constructivist classroom is "a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuits of learning goals and problem-solving activities" (p. 5). Dr. Jones' classroom corresponded to several features of constructivist learning environments as defined by Wilson, such as students working in pairs, using a variety of tools from traditional blackboard and chalks to laptops and digital technology, and using guided questions in facilitating students to achieve learning goals.

Conditions (Causal, Intervening, and Contextual)

There are three types of conditions in the visual model: causal, intervening, and contextual. Conditions formed the structure in which a phenomenon was embedded and helped to explain why one person had a certain outcome or chose a certain set of strategies. It was most important to focus on the complex interweaving of the conditions that led up to a problem or issue that a person responded to with strategies, and that resulted in the outcomes (Strauss & Corbin, 1998).

Causal Conditions

Causal conditions represent a set of events that affect the phenomenon, and may have direct or indirect influences on strategies that the respondent employed. Causal conditions may affect one another and may combine in various ways along different dimensions. The two primary types of causal conditions that emerged from the data were technology support (the one-on-one mentoring program) and pedagogy support.

Technology Support

Faculty identified the lack of technology support as a key barrier of technology integration across the curriculum and of the effective utilization of educational technologies in the classroom (Leggett & Persichitte, 1998). Technology support provides solutions to hardware- and software-related problems. Dr. Jones reported that although she had additional outside influences on her growth as a technology user through the years, her main stimulus for change occurred through the technology mentoring program and the supportive environment within the department. Dr. Jones's involvement with the faculty technology mentoring program spanned eight years. Her comfort level with technology increased as she developed her technology skills and adopted technology as an important component of her professional career. Her first mentor in 1994 advised her on a new hardware purchase, which was her incentive for moving to the Mac platform. As with other faculty members who had little experience with technology, Dr. Jones recalled a moment of frustration during this time:

> She [the mentor] advised me to get a laptop with a monitor and keyboard so I could use the laptop in other places and use the monitor and keyboard in the office, which I liked [to do]. She [the mentor] helped define what to purchase and helped me learn how to use it. The whole idea of the Mac [apple computer] and the folders [for storing documents] was foreign to me. I had prepared some documents for my course and then I couldn't find them on my computer when I needed them. I remembered feeling quite frustrated! She [the mentor] had to walk me through the concept of folders, which now makes all kinds of sense. That was a moment of frustration, I remember. (Interview, October 21, 2002)

Over the years, Dr. Jones progressed in several computer software applications and even taught her methods course on the Iowa Communication Network, a fiber optic communication system used for distance learning purposes. Her mentor in Fall 2001 described Dr. Jones' relationship with technology as follows:

> Dr. Jones is an intermediate computer user. She appears confident and comfortable using computers. She is experienced in handling email via Eudora [an email management software application], searching on the Internet, organizing and managing documents, using Word processing, creating simple PowerPoint presentations, recording students' grades via computer, and using WebCT [an online

> learning platform] to facilitate her classroom teaching. Dr. Jones has a positive attitude toward technology. She often expresses her enthusiasm about integrating technology into her courses. (Case study by Dr. Jones' mentor, Fall 2001)

With her technology mentor in Fall 2002, they exchanged ideas and set up a common vision of how the digital video clips could be utilized in class. They decided on burning the video clips in Quicktime file format on CD ROMs. Later, they found that those video digital files are too huge to be burned on CD ROMS. They consulted staff members from the Center for Technology in Learning and Teaching (CTLT) in the College of Education and the Instructional Technology Center (ITC), a university level technology support center, for potential technology solutions. Streaming video formats thus became a viable option. Dr. Jones and her mentor went to the ITC to explain the whole pedagogical concepts to a staff person in ITC. The staff person then identified appropriate software applications to compress the file to fit on CD ROMs and provided help in locating the server to host these streaming video files.

Although Dr. Jones had access to university level technology support, it is the technology mentor from the one-on-one technology mentoring program who connected her to other technology support resources.

Pedagogical Support

It is worth noting that although technology support seems significant in the process of technology integration, pedagogical support is the other important half necessary to realize the vision. Dede (1998) suggested that effective integration of new and emerging technologies requires simultaneous innovations in pedagogy, curriculum, assessment, and school organization. Successful technology integration does not result from isolating and focusing solely on technology issues, but rather from infusing technology into the overall curriculum. These demands compound the difficulties of effectively integrating technology into daily practice. Dr. Jones had access to pedagogical support mainly through formal and informal interactions with graduate students, peer faculty, and graduate student technology mentors. In particular, Dr. Jones truly appreciated the opportunity to dialogue with others about a constructivist teaching philosophy. She described her supporting resources as follows:

> The graduate students that I work with are taking courses with the tech group. I have an awareness of this constructivist approach, probably through Ed [a research assistant]. We had a long car ride to Nebraska for our research so we had time to talk. Actually, it was through Ed that I first became aware of the constructivist approach among the technology faculty here . . . . I've said to Beth [a graduate student who has done her dissertation on the constructivist classroom] that we should just get together this fall and talk about constructivism . . . . I'm interested in it. It does mean for me a shift from the instructor being the source of all information to the understanding of the students constructing knowledge from the experiences and materials that they have. (Interview, December 2, 2002)

In her journal, she described her connections to constructivist foreign language teaching to a faculty member who was known as an expert on constructivism philosophy applied in instructional design. "I told Jeff [a faculty member] about my plans just the other day and told him Beth had inspired me by her search for constructivist foreign language teachers without success."

The one-on-one technology mentoring program also provided supportive and extended pedagogical resources. In Dr. Jones' involvement with the mentoring program, she also encountered pedagogical issues of technology integration in her course. Linda, one of Dr. Jones' mentors, described a pedagogical negotiation with Dr. Jones in Fall 2000 when they were trying to move course materials online. She wrote:

> One dilemma Dr. Jones faced was her temptation to put everything online. She tended to simply convert the whole course pack of material into a web version with WebCT. She showed me the course pack and asked me about how she could scan each page and put them into WebCT. I realized that was a common problem of faculty in designing online courses. They are not familiar with the strengths of different media. I worried about this approach. (Case study by Dr. Jones' mentor, Fall 2000)

Later, Linda continued to describe how this issue was resolved and how Dr. Jones was able to adjust to the online learning environment:

> I brought it to our CI 610 class [the course related to the mentoring program] for discussion. It was wonderful to have this group to talk about problems, generate ideas, and share resources. Both classmates and the instructor helped me analyze my problem and provided suggestions. . . . We started a list of "what ifs" from the perspective of her students. After some discussion, Dr. Jones realized that putting everything online would only produce an "electronic page turner" and that the purpose of technology was to enrich and enhance her instruction instead of simply serving as an alternative delivery method. . . . Though she was enthusiastic about technology integration, she struggled to learn the strength of the web and to adjust to the online learning environment. (Case study by Dr. Jones' mentor, Fall 2000)

Both technology and pedagogical supports were woven together to make a solid, connected support guiding Dr, Jones' journey to a new teaching approach.

Intervening

Intervening conditions mitigate or alter the influence of causal conditions on the phenomenon (Strauss & Corbin, 1998). Examples of primary intervening conditions derived from the data include feedback from students, technology downtime, and discovery of use of new technology.

Feedback from Students

Early efforts to introduce preservice teachers to technology were addressed by offering stand-alone technology course with an emphasis on computer literacy and basic skills (Frisbie, Harless, & Brunson, 1991; Troutman & White, 1991). However, it quickly became apparent that stand-alone technology courses were of limited value to preservice teachers, primarily because this approach failed to provide a model of technology integration in the classroom (Callister & Burbles, 1990; Krueger, Hansen, & Smaldino, 2000). Thus, unless preservice teachers are offered an opportunity to see and evaluate the effective use of technology modeled in the classroom, they are likely to graduate with limited professional skills in finding, selecting, and implementing appropriate technology use in their content areas (Moursund & Bielefedlt, 1999). Therefore, what do preservice teachers expect from a technology-rich class? Is the technology component of a class an overlap of the existing content? How would viewing video clips of elementary school foreign language classes taught by master teachers and dialoguing with a partner in response to guiding questions affect their understanding of elementary school foreign language teaching practices? Those were important questions to be answered for Dr. Jones in order to understand the extent to which her new teaching approaches and her modeling of technology integration influenced the preservice teachers' learning. In addition, feedback from Dr. Jones' students played a crucial role in her pedagogical negotiation process.

As part of her action research project, Dr. Jones conducted the evaluation of the use of digital video clips systematically and sought advice from her technology mentor on the open-ended instrument. In addition, the department conducted end-of-semester course evaluations as part of evidence in faculty annual reviews. The routine end of semester course is more about the evaluation of the course and the instructor as a whole while the evaluation of the use of digital video focuses on a particular technology component coupled with new applications in a course. From the evaluation of the use of digital video clips, students reported that they felt more responsibility on their side when they were not spoon-fed knowledge as they used to. Dr. Jones recalled her reactions to these feedback comments,

> I remember particularly a student that said, "this seems more like a graduate course." I don't know if any one else said it, but I think it was the whole, new approach. It wasn't just the video clips, it's the whole course . . . . It could be the change in [student] population that made the difference. But the other thing was just the approach to constructivism. I think that approach and the materials that I collected for analysis perhaps were too high caliber for some students on some tasks. And so that, I think, is what is being reflected here . . . maybe some of the readings were pushing them a little bit. I'm not really changing a whole lot how I'm doing it this year. Somehow this group seems to respond to the constructivist approach. (Interview, December 2, 2002)

In addition, the use of different technology presentation formats, e.g., CD-ROM and streaming video, had an impact on how students perceived technology could facilitate learning. Students seemed to prefer the streaming video format, because of easy online access, to trying to locate a disk (CD ROM) and they could watch streaming video later if they chose to. Easy access to the Internet and high-speed Internet connections on campus obviously affected the preference choice by students. Dr. Jones had off-campus students with whom she had to make other arrangements. For example, she would have a CD-ROM available for them if they could only use a dial-up Internet connection.

Technology Downtime

Technology downtime refers to any unexpected technology failure due to known or unknown reasons. It can range from hardware issues such as a dysfunctional projector and computer hardware problems to software ones, such as the compatibility issue of different platforms and software application problems. Dr. Jones had frustrating moments when technology did not work as planned or when an unexpected technology problem occurred. She mentioned:

> "That could be fraught with problems . . . I'm just thinking right now because what kind of computers, what kind of connection . . . these are all problems. I remember when I taught in a different ICN classroom, they didn't have a new computer and I couldn't use my PowerPoint. When the technology isn't working, it's a problem. It's kind of frustrating." (Interview, October 21, 2002)

She also recalled one specific occasion that technology did not work well.

> There were a lot of problems with the videotape. I remember the first time I used it I made about eight little clips. Not all the laptops work with iMovie, so I had to learn that, and I had to learn how to hook up the digital video, how to use it as a VCR, and then after the first class, the sound cut in and out for half the students. Well, it was a problem with sound. (Interview, October 21, 2002)

Discovery of Use of New Technology

Contrary to the technology downtime as a barrier to her journey of integrating technology in the classroom, Dr. Jones mentioned the concept of "technology uptime," which refers to either an easier access of class materials, better presentation formats, or innovative teaching methods inspired by newly-developed technology. One good example was the discovery of the e-reserve service. Dr. Jones found that she did not have to make copies of the assigned reading materials, arrange them in a folder, and place the folder in a book shelf for reserved materials in the CTLT for each individual student to check out and make a copy for themselves. With e-reserve, the required reading documents are made available online and the quality is "fabulous," according to Dr. Jones. The Smart Classroom equipped with a smart board, a teacher station computer, laptops for individual student use in class, and wireless Internet connection provided tools to implement new presentation formats in her teaching, such as the analysis of video clips through streaming video. Persichitte and Caffarella (1999) indicate that the most salient concern of the faculty who are high-end users of technology in their teacher preparation courses is the rapid development of hardware and software in educational technologies, along with the new applications for classroom instruction. Thus, "technology uptime" for Dr. Jones means the environment in which she works not only builds hardware/software infrastructures, but also provides a potential human infrastructure (Lawton, 1997) that challenges her to develop effective instructional environments.

Contextual

Contextual conditions intersect to create circumstances in which people respond through strategies (Strauss & Corbin, 1998).

The Mentoring Program

The technology mentoring program at ISU provides on-site and individual technology support and necessary links to relevant sources as well. Although it seems to be perceived that during mentorship, mentees and mentors are the only persons involved and related to each other, one of the key elements in an effective technology mentoring program is the establishment of learning communities that encourage collaboration, communication, and team work (Chuang et al., 2003). During the eight years of active involvement in the mentoring program, Dr. Jones extended the relationship built between faculty mentees and student mentors to other graduate students and staff in the department. Interconnected relationships that stretched to include more people who were not officially as mentees or mentors in the mentoring program ultimately diminished the boundary of a mentoring program. For example, Dr. Jones's technology mentor would also be a staff member in the Center for Technology in Learning and Teaching (CTLT). The graduate students she worked with in the national foreign language resource center were part of the graduate student technology cohort from which she had a technology mentor each year she chose to participate as a faculty mentee. Therefore, the following contextual conditions are more or less associated with this causal condition, "the mentoring program."

Center for Technology in Learning and Teaching (CTLT)

The Center for Technology in Learning and Teaching (CTLT) at ISU is located in a technology-rich learning and research environment with state-of-the-art technology tools and a collection of hardware, software, and instructional materials. It aims to meet the teaching, learning, research, and outreach needs of the faculty, staff, and students in the College of Education. From its initiatives, the CTLT is designed to be more than a physical space and adopts several inter-connected structures to enhance faculty development, teacher education courses, field experience in technology integration and teacher education. Among these inter-connected structures are a technology mentoring program for faculty, a faculty technology scholar program, a school-based technology integration model, and an educational computing minor for undergraduate students (Thompson & Schmidt, 2002). Dr. Jones had participated in both the technology mentoring program and the faculty technology scholar program, which strengthened her link with the CTLT and caused her to view the CTLT as more than a physical place to check out equipment or seek technology assistance. Dr. Jones also had students who pursued an educational computing minor or who were involved with a technology cohort program. Dr. Jones often referred to individual persons as she mentioned her relationship with the CTLT.

> I worked with Cindy [a project coordinator and graduate student]; she was very helpful . . . it was just this project with WebCT. It [WebCT] was new; she had a lot of experience. She was willing to help me . . . I remember James [the CTLT lab manager and also a graduate student] helping me and he was my mentor. James was my mentor. That fall I remember taking my class for practicum into the lab. When I got there, I realized that I had to use Smart board. I meant I had seen it used in the summer institute but I never thought what I had to do to use it. It's a moment of panic. James helped me through and some other people in CTLT. The next summer, we were going to have a children's demonstration class right across the street in the child development lab that summer 2000. I remember Dee [the CTLT associate director] mentioned getting digital video cameras and this was only two weeks before the class started . . . . The next summer 2001, we were off campus. We were in Princeton with

> our institute. I wanted to videotape again and the CTLT provided and Jamie helped me get the mic [microphone], a clip on mic [microphone] and a system that I would take to Princeton. Amazingly, it worked and it worked quite well. I remember taking digital pictures of the connections and sending them back to James to see if I had them right (laughing) but that's how it worked. (Interview, October 21, 2002)

Peer Faulty, Graduate Students and Undergraduate Students

Learning to use technology and to infuse it into the curriculum in a meaningful way requires ongoing support from a connected community of learners who use technology. For Dr. Jones, these support resources are not just technology-related, but also pedagogy-related. The support is built upon connections with other learners. For example, one peer faculty member reminded her of the potential of using an Internet search when she required her students to incorporate curriculum standards of different content areas in foreign language classes. She remembers the peer faculty member said, "There are lots of places [in the Internet] that have that [curriculum standards]." She concluded that it was an example of "I have all the technology to do it… but I don't have habit of the doing it." She mentioned a very inspirational moment in a focus group interview with other faculty in the Tech Scholar program in which she had the opportunity to hear what other peer faculty had utilized technology to enhance their teaching practice and the impact on student learning.

> I've always wanted to sit down with Mike [a peer faculty member]. I thought that was really wonderful when the PT3 faculty were being evaluated by RISE and we could hear what everybody was doing. Mike was doing these great web searches and finding all this great information. I have never had the luxury of really doing that except to find some teeny-tiny specific thing. (Interview, November 22, 2002)

She described her supporting resources from graduate students as follows:

> The graduate students that I work with are taking courses with the tech group. I have an awareness of this constructivist approach, probably through Ed [a research assistant]. We had a long car ride to Nebraska for our research so we had time to talk. Actually, it was through Ed that I first became aware of the constructivist approach among the technology faculty here . . . . I've said to Beth [a graduate student who did her dissertation on the constructivist classroom] that we should just get together this fall and talk about constructivism . . . . I'm interested in it. (Interview, October 21, 2002)

Even during the time when the course related to the mentoring program is not offered, the learning community continues to exist and intergenerational collaborative learning occurs. This partnership model, in which the faculty work collaboratively with students, is very powerful. It is worth noting that although technology support seems significant in the process of technology integration, pedagogical support is the other important part necessary to realize the vision. Dede (1998) suggested that effective integration of new and emerging technologies requires simultaneous innovations in pedagogy, curriculum, assessment, and school organization. Successful technology integration does not result from isolating and focusing solely on technology issues, but rather from infusing technology into the overall curriculum. These demands compound the difficulties of effectively integrating technology into daily practice. Dr. Jones truly appreciated the opportunity to dialogue with graduate students about a constructivist teaching philosophy:

> I think it's a fairly large transformation to move from just using technology in your course as you've always taught it, to transforming your course . . . . And I maybe never

> would have gotten to that point if I hadn't had the conversations [with Beth and Ed, both graduate students]. (Interview, October 21, 2002)

Dr. Jones was also surprised to find out that the undergraduate students in her class were very comfortable working with technology in spite of their different levels of technology skills. Some were even very responsive to the idea of constructivism in the classroom.

> For some reason, this group is a lot more responsive and seems to know about constructivism, amazingly. There're a lot of cohort students [technology cohort] this year. There must be five or six at least out of 15 students sand they're [technology cohort students] very knowledgeable, all about education, and very confident. They really are taking to the idea of action research and the constructivist approach. In fact, when a topic kind of moves me away from that [constructivism], like last night's topic, because I haven't thought of how to make it constructivist. I found a few people almost a little disappointed. (Interview, December 2, 2002)

Strategies

The response people give to the issues, incidents, or problems they experience are referred to as strategies (Strauss & Corbin, 1998). Strategies Dr. Jones cited that she used as she moved towards a technology-rich constructivist approach were consulting technology mentors, developing trouble shooting skills, and conducting an action research project in her own class.

Consult Technology Mentors

Dr. Jones participated in the one-on-one mentoring program over eight years starting in 1994. In the year 2000, she applied for and was named as a Tech Scholar through Tech Scholars Program at ISU. Tech Scholars is a program connected with ISU's Preparing

Tomorrow's Teachers to Use Technology (PT3) grant. Specifically, this Tech Scholars program provides teacher educators with the necessary support to study and work one-on-one with a technology mentor to develop materials and ideas for integrating technology into courses. With her involvement with the one-on-one faculty technology mentoring program, her relationship with these graduate student mentors evolved from mentor as instructor, mentor as co-learner, to mentor as a resource connector. Her comfort level with technology increased as she developed her technology skills and adopted technology as an important component of her professional career. As she recalled, her first mentor in 1994 advised her on a new hardware purchase, which was her incentive for moving to the Mac platform. Each year she sought advice from her new mentors as new technology emerged, and she also had hands-on guidance from them with newly released software applications. Over the years, she has moved from personal use of the computer to technology integration in her courses. Therefore, the role of the technology mentor evolved as well. In the early years, the mentors' role was primarily as an instructor to guide her through different software programs or to show her how to connect the cables and wires. Later, she sought help from her technology mentors for setting up new technology devices such as a handheld, but she also brainstormed ideas with her mentors as she encountered instructional design dilemmas. Linda, one of her mentors, who helped her with the grade book on WebCT (an online learning platform), was actually learning to use the new WebCT version at the same time. In Linda's case report, she described how she and Dr. Jones worked together to conquer the new challenge.

> Since Dr. Jones and I both used WebCT 1.3, we were not worried about learning a new version. We thought that learning the new version was going to be a smooth update of skills. However, we were wrong. After we looked at the new WebCT, we were

troubled by some major changes in the interface. We couldn't apply much of what we already knew about the old WebCT to the new one. Old familiar terms had changed. I was not able to give clear guidance without first learning and trying the program by myself. Dr. Jones seemed uncomfortable about the new WebCT too, because she couldn't find the buttons and areas to perform her familiar tasks such as adding students to courses and uploading or downloading files. Fortunately, our positive attitude saved us. We encouraged each other and decided to learn the new WebCT version . Dr. Jones said that she would not be so "easily frustrated." She found some related workshops on campus to attend, and I spent some time exploring WebCT with the help of an online tutorial. (Case study from Dr. Jones' mentor, Fall 2000)

With Linda, Dr, Jones reported that she had to relearn WebCT. Linda guided her in putting her grades on WebCT. "That was the first time WebCT made sense to me," she said. They worked together to make Dr. Jones' WebCT site an effective tool to facilitate her teaching practice. For example, Linda suggested putting the reading materials online by scanning documents in a graphic format, but Dr. Jones was not satisfied with the quality. Later, they found the e-reserve service provided by the library and included that in her WebCT course site so her students had access to reading materials online. "They do a fabulous job. They are the best scan quality that I've ever seen. Incredible! That makes a really good sense [of WebCT]," Dr. Jones said.

Technology mentors were also resource connectors for Dr. Jones. One recent example is the use of streaming video on her WebCT site. During the development of streaming video clips, her mentor was the person who sought out on-campus resources for producing streaming video and available server space to host the streaming video files. Her mentor actually went with her to the ITC (Instructional Technology Center) at the university to dialogue with the ITC personnel on the use of streaming video and to go through the procedure of streaming video making.

Develop Troubleshooting Skills

To troubleshoot means to isolate and diagnose the source of error. Dede (2000) argues that hardware/software troubleshooting is a very useful skill for educators with respect to technology use and integration. Dr. Jones was consciously involved with the troubleshooting process by either watching other people troubleshoot or by learning to troubleshoot herself. She saw the value of making technology work in her becoming more constructivist in nature. In Dr. Jones' journal, she had detailed descriptions of how she developed her troubleshooting skills by her own experiences with technology, by watching other people troubleshoot, and by receiving help from technology mentors or other graduate and undergraduate students.

> Hsueh-Hua came today to work with me on the digital camera. How important to trouble shoot! My computer would not recognize the camera . . . . We found the digital camera wasn't charged up well. It ran out of power. The ibooks [in room N121] all need to have their sound changed to accept the digital movie sound and the sound has to be turned up on them. (Dr. Jones' Journal, October 15, 2001)

Dr. Jones also worked on her own to resolve unexpected technical problems.

> About a half hour before the class, I decided to try out the links to the streaming videos on WebCT and found that I hadn't included the Internet address to the streaming video clips! I began redoing the assignment, so I had to go in and add the hyperlinks to each Internet address. Then, as sometimes happens late in the afternoon, I was knocked off of WebCT and could not get back on. Fortunately, I had the presence of mind to put the

> document, ready for the web on my zip disk. I went up to the classroom and tried to get on WebCT there. Five minutes before the class I was able to do so and was able to upload the document and try it out. It worked. . . . I felt really good about having resolved this problem. (Dr. Jones' journal, November 21, 2001)

Conduct Action Research

Recently teaching practitioners have commonly adopted action research as a way to empower the K-12 teachers and teacher educators (practitioners) to become change agents and possibly policy makers on a smaller scale (e.g., in their own classroom) or on a larger scale (e.g., in an educational reform movement). It has provided great potential for K-12 teachers and teacher educators to see themselves not just as teaching machines but as living human beings, constantly interactive and reflective with their physical and mental teaching environments for positive change (Reason & Bradbury, 2001). As a way to reflect her teaching practice and to assess the students' learning outcomes when using a technology-rich constructivist approach, Dr. Jones conducted an action research project on the methods course that she taught. She felt that her action research project helped her to respond to her students' feedback. Most importantly, she said, "It was helpful for me to see the evaluation of their [students'] thinking and where they began with the digital video and when they ended it up. That's powerful and that's great. That is the reflective teacher concept" (Interview, September, 21, 2003).

Literature has shown that action research is iterative and cyclical in its nature (Hopkins, 1985; McNiff, 1998). The basic components include plan, action, observe, reflect and then revised plan, action, observe, reflect, which goes on and on until satisfying results are reached. The crucial ingredient is the critical reflection process. Action researchers reflect on their previous experiences in the initial planning, in the research observations, in the action, and in the overall reflection. The reflection determines the directions of the action research. The ultimate goal of action research is the change brought by action, and not just a change, but a change for the good. Dr. Jones has employed her action research project as one of strategies to respond to problems, events, and issues that occurred as she moved toward a technology-rich constructivist teaching approach.

Outcomes

Technology-rich Constructivist Approach

Computer-related technology in the classroom has evolved over time. In the early 1980s, CBE (Computer-Based Education), CBI (Computer Based Instruction) and CAI (Computer Assisted Instruction) were terms referring to any use of the computer in "drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications" (Cotton, 1991). They are basically supplements to conventional instructional procedures, which implies that the leaning objectives are clearly identified and stated and exist apart from the learners themselves. From the 1990s, primarily due to advancement of communication technology and its capability to provide an interactive environment, constructivism within the context of technology-mediated education has contributed to the vision of "authentic, challenging tasks as the core of education reform" (Means & Olson, 1997, p. 4). Therefore, when Dr. Jones said, "I think it would be almost impossible to teach without these clips," she makes the point that many educational technology educators advocate that the presence of technology facilitates a transition to greater emphasis on constructivist- and project-based learning, which is not possible to achieve just through lectures (Means & Olson, 1997; Sprague & Dede, 1999).

According to Means and Olson (1997), in educational technology "rosy predictions about making teachers' jobs easier" tend to be naïve (p. 20). The early stage of integrating technology into the curriculum, the gaining of technical skill, is followed by the teachers' need to follow up and be able to "select, adapt, or design technology-enhanced materials" (Means & Olson, 1997, p. 20). Moreover, new demands on teachers' content knowledge and the new role of technology-integrated curriculum design are concerns that have been raised by those who hesitate to involve themselves in educational technology. Therefore, those "a-ha" moments when technology "made sense to me" are very crucial in motivating both teachers and teacher educators to continue learning more about educational technology and integrating technology into teaching and learning. These moments represent a deeper level of understanding and a higher level of confidence in personal and professional uses of technology.

Dr. Jones clarified that in Fall 2001 she and her mentor struggled together through a new version of WebCT and had to "relearn WebCT." But during this stage, her WebCT site also grew richer. She was extremely pleased that her mentor helped her develop an attractive home page featuring a scanned original painting and original buttons, since she, as a visually-oriented person, did not like the WebCT graphics. During this time, she began to ask students to post selected assignments on WebCT. In Summer 2000 and Summer 2001, she had used a new departmental digital video camera to videotape children's foreign language classes offered through the NFLRC. With her mentor's help in Fall 2001, she began to explore the idea of digitalizing selected video clips to make them a component of the WebCT site for her foreign language methods course. Her original idea in videotaping the classes was to give students access to real elementary school foreign language classes taught by a master teacher. However, she began to see the possibility of moving beyond accessibility, in which students would view the clips passively, to using the video clips in a dynamic teaching environment. She prepared five or six clips around a topic addressed in class and assigned pairs of students to view each short clip and analyze it in response to guiding questions she developed. Through the guiding questions, students were asked to relate what they viewed in the clip to the theory and research they had been examining, to report their results both in writing and orally to the class, and to select and show a short segment to the class to illustrate their conclusions. With the technology of streaming video and the collaborative efforts of her student mentor, the whole idea turned out to be another significant experience in her journey as a technology user. Dr. Jones states:

> It was a transforming moment for me when I used the digital video clips for the first time and I saw how they make students take on ownership of their knowledge. This is so powerful! This had never happened in my class in this way ever before. They analyzed on their own, and this was controlled analysis on a particular topic. I see that technology previously was a tool for me. It's still a tool, but it has reshaped my whole thinking now. Before, my thinking was static on how I would teach, and technology fit in. Now technology is reshaping how I think and reshaping how I teach. And with this new way of teaching, it's clearly facilitating student learning. I could not do the things I'm doing now in class without technology. (Interview, December 2, 2002)

This example of Dr. Jones' experience with technology illustrates that instructional technologies are not solely hardware- and software-related issues. Instead, they are a complex combination of the instruction delivered and the equipment used. Technology alone does not transform teaching but rather the meaningful use of technology in an appropriate context has the power to transform teaching and learning (Means & Olson, 1994).

Berenson and Snyder (1991) used the concept of spiral change to illustrate the complex combination of technology skills and content expertise in professional technology development in schools. In Dr. Jones' involvement with the faculty technology mentoring program as professional development, a spiral of change started with 1) mentors/mentees building knowledge of new technology tools, and 2) the gradual adoption of a constructivist approach to teaching, which encourages students to construct their own knowledge with available technology (e.g., the digital video clips). The spiral continues and more knowledge-building occurs as increasing use of collaborative learning, class discussions, probing questions, and student-generated problem solving are used in class. The analysis of the video clips requires students to respond to the questions proposed, to identify a segment of the video to show and clarify the points to the class, and to explain what they have learned. The video clips in streaming video format are the highlight of Dr. Jones' WebCT site, and those clips serve as a prominent landmark in her pedagogical shifts to a constructivist approach. She had reached a new point on her WebCT journey:

> I've been happy with what has happened so far. I think that I really would not want to leave WebCT, and [I] would not want to go back to a paper syllabus. I can really see that connectivity to the [library] e-reserve and to the Internet links. The students now are dialoging about the readings online and having rich online discussions. (Interview, December 2, 2002)

In the Integrated Technology Adoption and Diffusion Model, Sherry (1998) describes a learning and adoption trajectory in teachers who go through four distinct stages as they develop expertise in information technology. This model presents a cyclic process in which teachers evolve from learner, to adopter of educational technology, to co-learner, and finally to a reaffirmer or rejecter. Based on Dr. Jones's WebCT project, we found that she has also experienced the four-stage cycle in the leaning and adoption trajectory model. To progress and reach the reaffirmer stage requires effective strategies through professional development (Sherry et al., 2002). Dr. Jones first took on the role as a learner of WebCT through ongoing professional development (the mentoring program) instead of through a one-shot workshop by an outside expert. The mentoring program provided accessible technical support. She also used other graduate students as informal technical assistants and pedagogical consultants. Finally, the discovery of students' ownership of knowledge and the active engagement of knowledge-building turned her into a reaffirmer.

Discussion

This study sought to understand further the process of how an exemplary technology-using teacher educator moved towards a technology-rich constructive approach in her teaching practice. It is obvious that the process is complex, multifaceted, and dynamic due to the interwoven relationships of equipment used, pedagogy utilized, instructions delivered, and support available. According to the visual model in Figure 1, conditions interwove with one another and influenced the strategies that Dr. Jones employed and the changes made in her teaching practice. The following subsections will describe: 1) how the contextual conditions interacted to form a learning community in response to the reactions/strategies that Dr. Jones employed due to intervening conditions, and 2) how the findings relate to relevant change theories, such as CBAM and the Integrated Technology Adoption and Diffusion Model.

Learning Communities

"A learning community is a collaborative where participants contribute equally, exhibit parity, and focus on continual reflection and inquiry" (Hord as cited in Seals, Campbell, & Talsma, 2003, p. 92). Carroll (2000) distinguishes a learning community from a community of learners: "A learning community learns as a community—unlike a community of learners in which each individual is engaged in his or her own learning" (p. 6). Therefore, the emergence of a learning community lays the foundation of a community of learners who could thus work collaboratively. Each member of the collaborative is in the position of learning within the community, drawing on the expertise of other group members, and is therefore identified as a community of learners in learning communities (Sergiovanni, 1994). In classrooms as learning communities, according to the educational philosophy of a community of learners with a sociocultural approach (Vygotsky, 1978) emphasizing learning and development, the students and the teachers collaboratively share responsibility and ownership for guidance and learning (Dewey, 1966; Rogoff, 1994; Rogoff, Matusov, & White, 1996). Thus, students are responsible for managing their learning independently while working with others collaboratively. Teachers take on new roles as guides or facilitators as opposed to the traditional educational philosophy in which teachers are the sages on the stage. Carroll (2000) emphasizes the two way learning of invention and knowledge generation in which "young and old learn to collaboratively construct new knowledge" (p. 4).

In K-12 environments, the most well known example of intergenerational collaboration is the Generation WHY initiative in Olympia, Washington (Generation www.Y, 2001). In this initiative, collaborative learning teams of teachers and students combined their respective knowledge and expertise to construct new multimedia and web-based learning activities. With the context expertise from the teachers' side and technology savvy students, some of the distinctions between the roles of students and teachers are fading, and instead, they are all learners in a learning community.

As for Dr. Jones, she constantly viewed herself as a reflective learner through her participation in the mentoring program, her interaction with undergraduate and graduate students through research projects, and her own action research project. The faculty technology mentoring program at ISU provided an illustration of intergenerational collaborative efforts of a learning community in higher education institutions where everyone is a learner and learns from each other with different levels of areas of expertise (Li, 2001; Stewart, 1999). As a faculty mentee of this mentoring program over a period of eight years, Dr. Jones experienced the two-way learning of invention and knowledge generation as she proceeded to move towards a technology-rich constructivist approach in her teaching practice through her intensive and extensive participation of the mentoring program. A multi-directional faculty technology mentoring process of a learning community at ISU is illustrated in the model below (see Figure 2).

In this model, new knowledge is built on a socially dynamic learning environment in which each group of people interacts with one another. Each individual shares beliefs, successes, and even challenges that arise from technology within a community of collaborative learners. The structure of the mentoring communities is not linear or hierarchical. Instead, these communities are asymmetrical and connected by interaction and collaboration. Therefore, one major theme which emerged from the contextual conditions in the visual model (Figure 1) of how Dr. Jones changed in pedagogical approaches was the learning community. For Dr. Jones, the mentoring program, CTLT staff, peer faculty, and graduate and

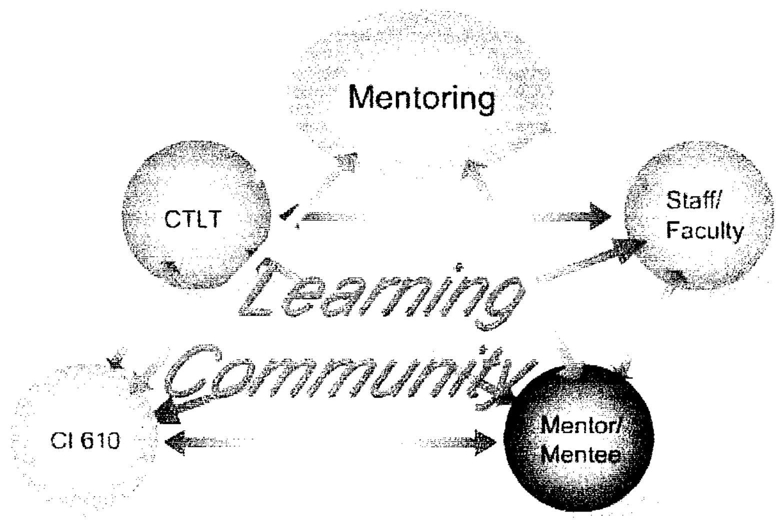

Figure 2. Learning community model of mentoring program at ISU

undergraduate students were the sub learning communities of the learning community in which she lived (Figure 3). It is worth noting the individual sub learning communities do not operate independently of each other. Instead, the multiple interactions among them lay the foundation of the learning community, established through all contextual conditions.

According to Davis (1998), the development of technology in education occurs in phases rather than in one smooth transition. Educational reform, when technology is involved, takes an extended period of time and requires significant resources to come to fruition because in the initial phase, it is "an unknown journey" (p. 257). A supportive environment with some counseling is appropriate and essential, which implies helping individuals "to make links with associated and relevant resources" (p. 256). One of the key elements in an effective technology mentoring program is the establishment of learning communities that encourage collaboration, communication, and team work (Chuang et al., 2003). In addition, learning communities emerging from a nurturing and supportive environment allow members to

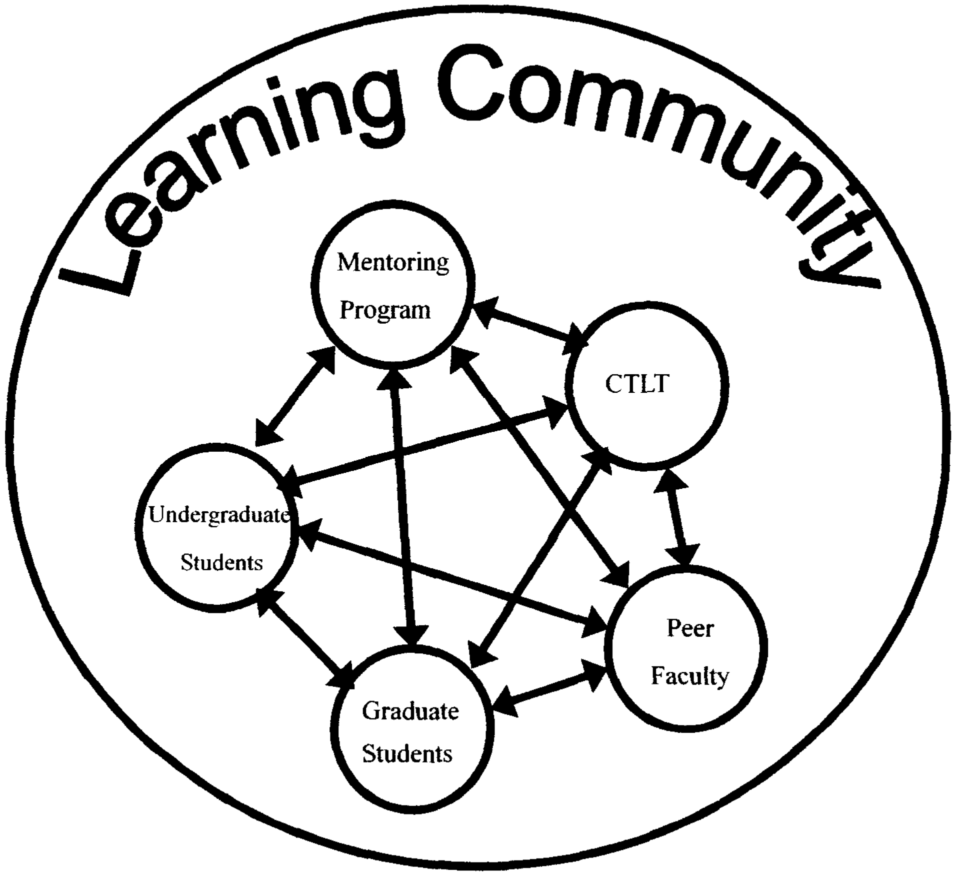

Figure 3. Interactions within the learning community of Dr. Jones

exchange ideas, share experiences, and learn together to accommodate individual learning styles. At ISU, the mentoring program is built upon an emerging learning community. Relationships built between faculty mentees and student mentors extend to other graduate students and staff in the department. Learning to use technology and to infuse it into the curriculum in a meaningful way requires ongoing support from a learning community of connected learners who use technology. Dr. Jones' location in a learning community in which substantive discussions on pedagogy and timely assistance in technology were available ultimately had a profound influence on her philosophy of teaching and her use of technology.

Relationship of the Findings to Relevant Theories and Literature

CBAM (Concerns-Based Adoption Model)

The previous discussion illustrated the interdependence and interaction of each learner in a learning community of a technology mentoring program. The technology mentoring program as a faculty development approach seeks to prevent interventions imposed by others, a common criticism of technology development programs. Instead, the focus of the professional development is each individual learner's (faculty) perceived need. This mentoring program is a good illustration of the Concerns-Based Adoption Model (CBAM) in which "change is a process not an event" (Hall, 1978, p. 1). CBAM as a professional development framework has a focus on how an individual intended adopter grows over time in moving from self to task, and then to impact concern focus. The Stages of Concern dimension of CBAM has an implication of learning characteristics, although it has been widely used as a diagnostic tool for probing individual intended adopter for appropriate interventions (Hall & Hord, 1987, 2001). The Levels of Use dimension depicts the behaviors of an intended adopter as he or she approaches innovation. Instead of using these two dimensions as diagnostic tools in assisting the implementation of the technology-initiative innovation in Dr. Jones' case, the researcher aims to provide a general profile of her stages of concern and her levels of use of technology in her eight–year journey in the mentoring program (see Table 5). Thus, the learning process of Dr. Jones in the mentoring program can be revealed and associated with respective behaviors in the innovation of technology integration of her own teaching practice. According to Hall and Hord (2001), although a linear correspondence between motivation (Stages of Concern) and Levels of Use is intuitively logic, human behaviors and emotion and the dynamic during times of change is very complex, and

Table 5.

Stages of Concern and Levels of use in CBAM in Relation to Dr. Jones' Mentoring Experience

Stages of Concern	Levels of Use	
Stage 6. Refocusing (Impact)	Renewal	Streaming Video/Chat Room
Stage 5 Collaboration (Impact)		
Stage 4 Consequence (Impact)		
Stage 6. Refocusing (Impact)	Integration	Digital Video Clips
Stage 5. Collaboration (Impact)		
Stage 6. Refocusing (Impact)	Refinement	WebCT grade/e-reserve
Stage 4.Consequence (Impact)		
Stage 3. Management (Task)		
Stage 4.Consequence (Impact)	Routine	WebCT in general
Stage 3. Management (Task)		
Stage 2. Personal (Self)	Mechanic	ICN, PowerPoint
Stage 3. Management (Task)	Preparation	Mac Platform/Filemaker Pro
Stage1. Informational (Self)		
Stage1. Informational (Self)	Orientation	Mac Platform

therefore concerns at more than one stage at the same time are likely to occur as Table 5 shows.

As stated by the technology mentoring program director, the participation of the faculty technology mentoring program is on a voluntary basis. Typically, a faculty member starts in the mentoring program with a specific instructional need in mind. One of the important features of the mentoring program is that faculty define their needs and mentors respond to these needs (Thompson, in press). We could later see the line of level of use moving upward gradually as Dr. Jones involved herself in the mentoring program. She chose to be a faculty mentee and she had her first orientation on the Mac platform, with guidance from her mentor. Since then, she has had a student mentor every year when the mentoring course affiliated with the mentoring program is offered. When her stages of concern remained in the self level, her level of use of technology was primarily "exploring its value orientation" and " preparing for the first use of the innovation" (Hall & Hord, 2001, p. 82). She mentioned that her mentor had to "walk her through the whole folder concept of the Mac" and provided detailed guidance on the purchase of hardware. At the same time, she was also concerned with issues of efficiency and management as she adopted Filemaker Pro (a database management software package) to keep track of several projects. Later, she used PowerPoint slides in the ICN (Iowa Communication Network) classroom. The mentor not only helped her become familiar with PowerPoint, but walked her through the equipment in the ICN classroom. She then started to "prepare for the PowerPoint for my ICN class that fall." At this level of use, she focused more on the short-term day-to-day use of technology and the skills required to fulfill her duties without much reflection on how to meet students' needs.

When her stage of concern was on task, she began to weigh the advantages and disadvantages of scanning a document online because of the poor quality of scanned documents and the time required to scan. As she worried that the poor quality of the scanned documents might discourage the students from accessing her WebCT course site, she was also in the stage of concern—impact. When her mentor helped her to put grades onto WebCT, she began her refinement level of use of technology in which the impact of WebCT (the Consequence Stage) on her students increased because of the easy and immediate access to grades by the students (the Management Stage). E-reserve service provided by the library and the links made to her WebCT course site initiated her thoughts on how to use technology to enhance her teaching and to benefit students learning (the Refocusing Stage). The next year, she began to videotape a children's demonstration class, which was taught by an experienced immersion Spanish teacher in a summer institute. With the equipment support from CTLT, she videotaped the class for eight days with a digital camcorder and carefully selected and edited eight clips using iMovie (an audio-video editing software). She then identified four topics for which she selected five to eight short clips of three to nine minutes each. She then had them all burned on CD ROMs. Later, when a new semester began, she collaborated with her technology mentor and brainstormed how these digital video clips could be utilized to enhance her students' understanding of an elementary foreign language classroom. Her stage of concern at this time was on the impact stage in which she " examines new development in this field and explores new goals for self and the system" (Hall & Hord, 2001, p. 81).

Researchers found that most changes in education take at least three to five years to reach implementation at a high level and promote a supportive working environment for teachers to grow in learning and classroom practice, and to improve students' learning outcome (Darling-Hammond, 1996; Little, 1982; McLaughlin & Talbert, 1993). Each person's level of use and success with a change is influenced by the facilitation he or she receives. If no support or facilitating interventions are offered, many will never implement the innovation and will remain at the non-user level. For technology initiative innovations, the issue of implementation is compounded by evolving technology, a person's relationship with technology, the instructional values associated with the way technology is used, and the activity structures (Means et al., 1994, 1997). As Dr. Jones said, "it would not be possible without the support [from the mentoring program]," as she pointed out one great motivation in moving her upward in terms of level of use of technology and in sustaining the innovation.

The Integrated Technology Adoption and Diffusion Model

According to Roblyer (2003), a brief history of computers in education can be roughly divided into two eras, those before 1994 belong to "the Pre-Microcomputer Era" and those after 1994 belong to "the Internet Era" (p. 9). In the Internet Era, the Information Superhighway becomes an expressway for education and continues to evolve with the rapid development of World Wide Web (WWW) and online learning technologies. In fact, those technologies have evolved faster than traditional research change models can deal with them. Traditional models often ignore external factors such as rapid worldwide evolution of Information Technology (IT) and change facilitators within a networked community (Sherry 1998; Sherry & Gibson, 2002). Therefore, the Integrated Technology and Diffusion Model (Sherry, 1998; Sherry et al., 2000) describes a cyclical process of technology adoption in which teachers evolve from learners to adopters, to co-learner, to a reaffirmer/rejecter. A fifth stage was added on for those reaffirmers to become leaders. Because of its cyclical nature, this learning/trajectory model has no definite close-bound linear starting and ending points. Dr.

Jones' eight-year journey of technology adoption with the technology mentoring program illustrates several cyclical processes of change with different levels of technology and IT programs. However, while a cycle is a course or series of events that occur regularly and often leads back to the starting point, Dr. Jones proceeded in her adoption of digital video clips with a different cycle from her previous technology adoptions, such as the Mac platform and WebCT. She actually skipped stages of adopter and co-learner and reached reaffirmer stage, continuing on as a leader among colleagues in the use of streaming video. This finding was supported by a study of technology integration by the College of Education faculty. In Hagenson's (2001) study of investigating the integration and diffusion of institutional technology into teaching by the College of Education faculty at a Midwestern university based on the Integrated Technology and Diffusion Model, she found that faculty sometimes skipped stages if they were extremely innovative and if they were experienced with technology. Her study suggests that learning and utilizing technology was an ongoing process that continued to grow every day with new ideas and was not a linear, one dimension process (Hagenson, 2001). Sherry et al. (2000) advocate the idea of a cyclical process of technology adoption process by the teachers, and they emphasize the presence of appropriate professional development strategies in each cyclical stage for eventually moving teachers to the leadership role in technology infusion. For Dr. Jones, the in-time support of pedagogical knowledge on constructivism and the availability of technology mentors and technology resources from a learning community were the two effective professional development strategies. These two strategies are not an "advertising campaign" at the earlier strategies that inform the faculty of possible educational practice using technology, but rather they are support from the learning communities, an effective professional development strategy, at the later reaffirmer and leader stages. It also explains the skipping stage phenomenon of Dr. Jones' adoption of digital video clips.

It is interesting to find that a successful mentoring program is capable of providing effective professional strategies to meet faculty at different stages in the cyclical process of technology adoption. For those newcomers, technology mentors have to focus on demonstrations of promising practices so newcomers can gather information and learn skills for performing necessary tasks with technology. As a result of changes made in their teaching, the establishment of learning communities with connected support of pedagogy and technology allows innovative and experienced technology-using faculty members to concentrate on their students' learning outcomes.

Conclusion and Recommendations

The complex relationships among pedagogical beliefs, instructional practices, and the use of technology make it clear that using technology as a tool to promote needed reform in education is not easy to achieve. This study uncovered some aspects of how an exemplary technology-using educator developed over time in technology and pedagogy over eight years of involvement in a sustainable faculty technology mentoring program. These aspects are closely linked to a technology-rich constructivist approach in teaching and learning. The final integration of findings lead to the construction of a theory grounded in the data related to a teacher education faculty member's discovery of a new pedagogical belief in constructivism in the classroom.

The researcher analyzed the collected data following the procedures of open, axial, and selective coding of the systematic design of grounded theory (Strauss & Corbin, 1990, 1998). Using a suggested coding paradigm from Strauss and Corbin (1998), a visual model was built to facilitate the theoretical integration of the sorted categories based on the findings from the open and axial coding procedures. This visual model helped to address the central phenomenon of the power of constructivism for Dr. Jones as she made changes in her teaching approach to become more constructivist in nature.

Given the need to provide effective professional technology development for the faculty as a means of providing appropriate modeling in teacher education program, the one-on-one technology mentoring program provides a viable option for an effective faculty development approach. However, based on the findings from this study, focusing solely on technology does not produce the desired changes needed in pedagogical reform in teaching teacher-preparation courses. The focus of training in a faculty technology development program must be based on solid principles of instruction rather than merely on the acquisition of technological skills. In addition, change takes time, and thus a faculty technology development program has to be sustainable over time. A community of support faculty and staff in both technology and pedagogy is needed. This study provides a positive example of what is possible in faculty development given a sustainable, long-time faculty mentoring program and the creation of a community of support.

Despite the fact that there was only one participant in this inquiry, the resulting theory of the power of constructivism in changing a teacher educator's pedagogical approaches offers valuable information to address the need of effective faculty development in technology for teacher education. For the administrative level, this study provides insights in leadership approaches, especially in facilitating the establishment of learning communities with technology initiative innovations in teacher education. For the teacher education faculty members, it exemplifies what is possible to achieve in technology integration with available resources. Two recommendations are proposed for further research to contribute to the field of faculty technology development in teacher education.

First, as the participant continues to advance in her exploration in technology for teaching and learning purposes, following research to further examine how she employs the constructivist approach with various technology tools such as online synchronous and asynchronous chat is highly recommended. It will then reveal to what extent the participant sticks to the principle of the constructivist approach or how she has to adapt ideas inspired by constructivism to fit different technology tools. It is an important area to understand as emphasis on constructivism in teaching with technology is heavily represented in related literature (Duffy & Cunningham, 1996; Jonassen, Howland, Moore, & Marra, 2003). Secondly, this study yielded results based on one participant's perspective in her involvement with an on-going one-on-one technology mentoring program. Further research is recommended to include other faculty mentees from different content areas such as language arts, social studies, math education, and multicultural education for additional grounded theories of a sustainable one-on-one mentoring program for the teacher education faculty members. Results from such studies can inform the plan and implementation of faculty technology development programs on pedagogical beliefs and instructional practice for advanced technology-using teacher educators.

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CHAPTER 4. ISSUES OF SUSTAINABILITY OF FACULTY USE AND INTEGRATION OF TECHNOLOGY IN TEACHER EDUCATION: A FIRST LOOK

A paper to be submitted to Educational Technology Research and Development

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Abstract

This research project identifies issues in, and barriers to the faculty's continued use and integration of technology in teacher education programs. The purpose of this study is to investigate how to encourage faculty members who have made significant use of technology to continue to use technology in their teacher preparation courses and to sustain efforts in making technology an essential component across the curriculum in teacher education programs. A case study was conducted with six faculty members who had applied for and been named as Tech Scholars in the College of Education at a midwestern research university. This qualitative case study revealed what these six faculty members saw as issues in, and barriers to their continued use and integration of technology. These issues were time, technology downtime, meaningful use of technology, and the need for a community of support staff and faculty. An online survey of a variety of indicators based on the findings of the case study was developed to gather quantitative data on a larger scale to help define the issues of sustainability of faculty use and integration of technology in teacher education programs. In addition, this research project helps to identify effective faculty development practices and provides information on breaking down barriers to faculty's continued technology integration.

Introduction

People tend to teach the way they have been taught (Bennett, 1991). It is unrealistic to expect preservice teachers to replace traditional, comfortable instructional approaches after years of exposure to instruction using traditional methods. Research has identified that the increasing frequency of the faculty's modeling of technology use contributes to preservice teachers' increasing opportunities with technology-rich, meaningful learning environments (Beck & Wynn, 1998; Brush et al., 2003; Moursund & Bielefedlt, 1999; OTA, 1995; Persichitte, Tharp, & Caffarella, 1997). In addition, successful faculty professional development programs for use and integration of technology can lay the foundation for systematic and sustainable change in teacher education institutions for the purpose of preparing preservice teachers to teach with technology. One of the important goals of teacher education programs, according to the National Council for Accreditation of Teacher Education (NCATE) professional standards, is to "prepare candidates who can integrate technology into instruction to enhance student learning" (NCATE, 2002, p. 4). In addition to developing the ongoing interest in cultivating the technology expertise of preservice teachers, creating the opportunities for the teacher educators to integrate technology into their teaching is one of the intentions of the new standards. Related literature reveals that with the increasing availability and accessibility of educational technology in K-12 environments, colleges of education have to investigate and consider critically how technology can be integrated throughout the curriculum in the teacher preparation programs (Fulton, Glenn, Valdez, & Blomeyer, 2002; Persichitte, Caffarella, & Tharp, 1999; Pollegrino & Altman, 1997; Willis, 2001).

Review of the Literature

In the early 19th century, new machines, new sources of power, and new ways of organizing work transformed the United States from an agricultural nation to an industrial power. Schools established routines of organizational and classroom practice by 1900 (Kaestle, 1983). Therefore, starting from the early nineteenth century, we have begun to see the presence of various tools in the name of technology in the classroom. Technological innovations have left their marks on education (Cuban, 1986; PBS, 2001). In the educational domain, educational technology refers to any technology used as a tool and "every bit of educational value that comes from technology derives directly from the purposeful application of technology by human beings" (Education Technology Leaders Summit, 1997, p. 5). Means et al. (1993) emphasize that "educational technologies are not single technologies . . . . These technologies may employ some combination of audio channels, computer code, data, graphics, video, or text" (p. 11). Many also argue that technology has provided education with the tools for needed reform when viewing technologies as learning tools that engage and support learning (Becker, 1994; Jonassen, 1996; Means & Olson, 1997; Pearlman, 1989). For the purpose of this study, the following sections provide a review of the current status of technology in education, of technology in teacher education, and of the need for effective faculty development to realize the vision of widespread integration of technology across the teacher education curriculum.

Current Status of Technology in Education

Several influences have contributed to shaping the way technology is perceived in the educational domain. It is widely believed that information technology is transforming the global economy. Learners in the twenty-first century require not just a large amount of knowledge, but also the ability to acquire new knowledge, to solve new problems, to employ creativity, and to engage in critical thinking, as economists see a dramatic shift in jobs moving workers toward the role of problem identifiers, problem solvers, and team workers (CEO Forum on Education & Technology, 2001; Reich, 1991). Ely (1996) identified trends in educational technology based on journal articles, major annual conventions of professional associations, and dissertations from five universities in related fields. One of the major trends in 1995 was the increasing availability and accessibility of computer technology. According to Ely (1996), computers were pervasive in schools and higher education. Networked technology communications like the World Wide Web (WWW) became the fastest growing technology applications in education. Thus, some experts have viewed technology as a tool to support this transformation of preparing children for the future (Chen et al., 2000).

Many argue that technology has provided education with the tools for needed reforms to engage learners in personal and socially co-constructed meaning-making and problem-solving learning environments (Becker, 1994; Bransford, Brown, & Cocking, 1999; Jonassen, Howland, Moore, & Moore, 2003; Means & Olson, 1997; Pearlman, 1989). Specifically, networked communication technology provides connections within schools and also to a larger community, breaking down traditional time and space boundaries. Students can work on authentic, challenging tasks collaboratively between groups or individuals who otherwise could not be reached without the use of technology (Dede 1998; Roschelle, Pea, Hoadly, Gordin, & Means, 2000). Technology also makes available dynamic interactive visuals featuring rich problem situations and promotes learners' higher-order thinking skills (Cognition and Technology Group at Vanderbilt, 1997; Hickey, Moore, & Pellegrino, 2001). Tom Carroll (2000), the founding director of Preparing Tomorrow's Teachers to Use Technology (PT3), proposes that communication technologies have the potential to initiate learning communities with no boundaries and to support two-way interaction that makes it possible to collaboratively construct the new learning experience and knowledge. Therefore, profound change needs to be made in teacher education programs to meet the demand for teachers prepared to educate the twenty-first century learners.

Technology Integration in Teacher Education

Willis, Thompson, and Sadera (1999) provide a historical review of research in the field of information technology in teacher education and advocate an emerging professional discipline in educational technology, information technology, and teacher education (ITTE), a newly recognized scholarship focus. There is an increasing need, either from economic force or pedagogical advocacy, to increase the amount of quantity and quality of instruction on technology use and integration that preservice teachers receive during their teacher preparation training stage. However, Willis and Mehlinger (1996) in their literature review article explicitly stated that ". . . teacher education, particularly preservice, is not preparing educators to work in a technology enriched classroom" (p. 978). They argue that teacher education institutions have not successfully addressed the challenge of incorporating technology into teacher preparation curriculum. This is also echoed in national reports with respect to technology and teacher education (CEO Forum on Education & Technology, 2000; Moursand & Bielefeldt, 1999; OTA 1995).

Assuming that this lack of preparedness is linked to current teacher education programs, the United States government initiated Preparing Tomorrow's Teachers to Use Technology (PT3) program in 1999. PT3 applicants were challenged to propose solutions to issues of technology in learning and teaching, and professional development in technology for teacher education faculty and the connections of the teacher education programs to K-12 schools. According to Ertmer (2003), "this [PT3 program] was not so much a program designed to provide greater access to technology as one designed to transform teacher preparation programs into the 21st century" (p. 125). One of the prominent goals of the PT3 program is to ensure that preservice teachers will graduate with an understanding of how to create and deliver high-quality technology-infused lessons that engage their students in learning (PT3, 2003).

Barriers to Effective Technology Use in Teacher Education Institutions

Effective use of technology in college of education classrooms relies on a combination of factors: facilities, technical support, professional development, and leadership and administrative support (Strudler, McKinney, & Jones, 1995). Topp, Mortensen, and Grandgenett (1995) and Baron and Goldman (1994) identified several obstacles to infusing technology into teacher education programs. Among them were the lack of faculty training, no clear expectation that faculty will incorporate technology in academic activities, and lack of technical support. Dusick (1998), in her literature review article on what influenced faculty members' use of computers for teaching, proposed two major categories of factors—personal factors and environmental factors—that hindered the effective use and integration of technology in educational settings. According to Dusick (1998), personal cognitive factors included faculty attitude, anxiety, self-efficacy, willingness to make the time commitment and to face the risks of changes, competency, beliefs, and lack of knowledge. Environmental factors included supportive administration, access to technology, sharing of sources, accessibility, and availability of support staff. Likewise, many of the barriers identified by the faculty when they tried to integrate technology into their courses include both personal factors, such as time constraints, limited vision of technology's potential for teaching, and lack of knowledge about software and hardware, and environmental factors, such as limited access to hardware and software, and lack of institutional recognition (Abdal-Haqq, 1995; Cornell, 1999; Ennis & Ennis, 1996; Faseyitan, 1996; Gilbert, 1995; Maddux, Cummings, & Torres-Rivera, 1999; OTA, 1995).

Technology faculty development is the key in moving faculty toward successfully modeling the integration of technology in the preservice classroom. The survey of 416 teacher preparation institutions across the United States by the International Society for Technology in Education (ISTE), commissioned by the Milken Exchange on Education Technology suggested that the preservice teachers' exposure to appropriate educational technology should be increased to prepare them adequately for today's classroom (Moursund & Bielefeldt, 1999). Specifically, the results of the survey study implies that there is inconsistency between what teacher-training faculty know about technology and what they are training teachers to do in their courses.

University faculty members realize the importance of proper modeling and effective usage of technology within teacher education courses, but this kind of modeling is not common throughout teacher preparation courses. Without proper and adequate modeling and integration of technology with teacher education courses, preservice teachers are not gaining the support and training they need for their future classrooms. Bielefeldt (2001) emphasizes professional development as a helping agent in all four factors that influence the IT preparation of new teachers. Efforts to integrate educational uses of technology into teacher preparation courses have also received considerable funding support from the Preparing Tomorrow's Teachers to use Technology (PT3) grant program to assist teacher preparation faculty as they learn to integrate technology into their teaching (PT3, 2002).

Faculty Technology Development Approaches

Recent investment in hardware and software (MDR, 2002; NCES, 2002) and the avocation of ubiquitous computing in education (Inkpen, 1999; Soloway et al., 1999) make technology in the classroom a common phenomenon. However, technology infrastructure alone does not guarantee the realization of technology and education reforms in ways of linking the instructional uses of technology to the teaching and learning goals (Carroll, 2000; Ely, 1995). Cuban's criticism of oversold and underused technology in K-12 schools and in higher education institutions to a large extent reflects the lack of corresponding human infrastructure to match the expensive technology resources (Cuban, 2001). One of the areas identified and emphasized by the PT3 program is the development of skills and the improvement of modeling capabilities of the faculty who teach prospective teachers (PT3, 2002).

Growing out of the urgent need to equip the faculty of teacher preparation courses better, many higher education institutions have sought effective faculty development approaches to enhance faculty technology expertise and develop technology integration strategies. Technology workshops or learning sessions commonly are found among the approaches to the faculty technology development (Bullock & Schomberg, 2000; Rowe, 1999; Rups, 1999; Star, 2001). In addition, several institutions have adopted one-on-one technology mentoring programs to meet the specific needs of each faculty member (Beisser, 2000; Gonzales & Thompson, 1998; Thompson, Hansen, & Reinhart, 1996).

Various mentoring models have been adopted based on institutions' emphasis on how to enhance technology integration throughout a teacher education program and on how to develop the faculty's technology expertise (Chuang, Thompson, & Schmidt, 2003). Some models are a combination of workshops followed by one-on-one technology mentoring (Smith & O'Bannon, 1999). Other models focus on the one-on-one pairing in which each faculty member is paired with a student mentor or technical personnel (Stewart, 1999; Thompson et al., 1996). Despite different approaches, all aim to serve as effective faculty technology development to tackle the barriers that hinder the faculty's technology use and integration in their teacher preparation courses.

Faculty development is an important component of building and maintaining human capital and should be treated as long-term big projects instead of one-time sporadic events (Birman, Desimone, Porter & Garet, 2000; Strudler & Wetzel, 1999). Professional development for technology use for teacher and teacher educators alike have to go beyond training with its implications of learning skills. Furthermore, it should provide new insights into teachers' and teacher educators' own teaching practice and pedagogical beliefs to connect the human infrastructure with technology infrastructure (Grant 1996; Vojtek & Vojtek, 1997). Faculty development in technology is difficult because of the rapid pace of change with technology and telecommunication and it is even more challenging due to its pedagogical and catalytic rationales associated technology use in education (Ely, 1995; Means & Olson, 1994; 1997).

Grant (1996) specifies principles for professional development in a technological age. She emphasized an approach toward the establishment of a professional community of teachers in extending a vision of technology as an empowering tool in teaching and learning. Becker and Riel (2000) provide survey data to address the importance of the connection with peer faculty and other groups of personnel. They found that teachers who collaborated with other teachers, and attended professional conferences demonstrated exemplary use of technology. Recently, cohort learning has been viewed as one of many terms now in use to emphasize that learners should learn in groups rather than individually. Exemplary technology cohort models improve collaborative learning to enhance preservice teachers, university faculty, and practicing teachers to identify areas and strategies for designing technology integrated curriculum (Smith & Robinson, 2003; Thompson et al., 2003). Learning communities are another expression of the idea (Seals, Campbell & Talsma, 2003). The idea is that learning is a social activity (Vygotsky, 1978) and that cohort groups is one way to achieve a higher lever of social interactions and activities in teacher education (Willis, 2001).

Issue of Sustainability

With the recent flow of funding from various sources to support technology innovations in education, such as the Technology Innovation Challenge Grant (TICG) and another bigger-scale project initiative, Preparing Tomorrow's Teachers to Use Technology (PT3), there is an increasing emphasis on how to sustain technology innovation initiatives (Sherry & Gibson, 2002). Likewise, after devoting time, energy, and resources to planning, coordinating, and implementing technology workshops or technology mentoring programs for the teacher education faculty, a key concern is how to sustain the efforts to support the faculty by effective modeling of technology use and integration across the curriculum. Century and Levy (2001), drawing from their research on sustainability of school reform efforts, propose five strands that demonstrate the complex factors contributing to the meaning of sustainability and the context and contents that would affect sustainability. Specifically, they call them "five lessons," or emerging themes, that arose from the research in sustaining reform. The five lessons were:

- Sustainability isn't just maintenance of a program.
- Programs go through stages as they move toward sustainability.
- Contextual conditions influence the sustainability of programs.
- Factors expected to affect sustainability do so in unexpected ways.
- Intangible and sometimes invisible factors affect sustainability in pivotal, dramatic ways.

The appearance of these five themes seems to be very crucial to sustain educational reform efforts.

Statement of the Problem

To better prepare teachers in the information age, teacher preparation institutions need to equip faculty to model technology use and integration strategies effectively in their courses, so preservice teachers can learn from the instructor's seamless computer-related technology integration in teaching (Brush, 1998; Cooper & Bull, 1997; Munday, Windham, & Stamper, 1991; Parker, 1997; Pellegrino & Altman, 1997). Professional development in technology for faculty in teacher education institutions plays a vital role in establishing technology integration in classroom teaching as a model for preservice teachers. Sprague, Kopfman, and Dorsey (1998), and Strudler et al. (1995) argue that an effective faculty development program is key to the appropriate modeling of technology use and integration strategies in teacher education programs.

Some of the research in the field of technology in teacher education study the effects of computer access and usage (Albion, 2001; Dougherty, 2000; Farenga & Joyce, 1996). Other survey studies investigate the current status of technology use in teacher education (Laffey & Musser, 1998; Maushak, Kelley, & Blodgett, 2001; OTA, 1995; Savenye, Davidson, & Orr, 1992; Schmidt, 1995). A number of studies report on efforts to infuse technology across teacher education curriculum or provide diffusion of technology innovation models (Brush et al., 2003; Strudler & Wetzel, 1999; Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003; Stuhlman, 1998; Thompson, Schmidt, & Davis, 2003; Thompson, Schmidt, & Hadjiyianni, 1995). One common theme from these research findings is that, despite the availability of computers, the teacher education faculty are in need of comprehensive planning, professional development, and follow-up support to realize the vision of widespread technology integration. Thus, some research specifically identified the potential barriers involved for the faculty to begin using computer-related technology. The obstacles included lack of knowledge about software and hardware, limited visions of technology integration, schedule conflicts, and lack of administrative support (Baron & Goldman, 1994; Dusick, 1998; O'Bannon, Matthew, & Thomas, 1998; OTA, 1995; Strudler et al., 1995). However, little is known about how to encourage the faculty members who have made significant use of technology in their teacher preparation courses to continue to use technology. Therefore, there is an increasing emphasis on exploring how to sustain efforts in providing modeling of technology use and integration for preservice teachers by the teacher education faculty, and further, to transform teaching and learning in education (Willis, Thompson, & Sadera, 1999).

Within an innovation, Rogers (1995) defined adoption as a decision either to make full use of an innovation available or to reject adoption of an innovation. One of the features of adoption is reversibility, and "such decisions can be reversed at a later point; for example, discontinuance is a decision to reject an innovation after it has previously been adopted" (Rogers, 1995, p. 21). Rogers also depicted five steps in the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation. Previous research on barriers to the adoption of technological innovation among teacher education faculty addressed the first three steps in the innovation-decision process, from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject. This study shifts the focus, and lays the emphasis on the forth stage (implementation) and the fifth stage (confirmation) when individuals (teacher education faculty) put the technological innovation to use and seek reinforcement of an innovation decision that already has been made. Therefore, it is important to understand what the technology-using teacher education faculty members see as issues and barriers to their continued use and integration of technology in their teacher preparation courses, and to address these issues to reinforce an innovation decision and avoid reversibility.

Purpose of Current Study

Previous studies revealed that faculty identified time constraints, lack of access to software and hardware, lack of administrative and technology support, and inadequate training in using computer-related technology as barriers to their use and integration of technology in teacher education programs (Abdal-Haqq, 1995; Cornell, 1999; Dusick, 1998; Ennis & Ennis, 1996; Faseyitan, 1996; Gilbert, 1995; Maddux, Cummings, & Torres-Rivera, 1999; OTA, 1995). This research study aims at identifying issues in, and barriers to, the faculty's continued use and integration of technology in their teacher preparation courses on a broad scale. Although earlier studies focused on the attitudes of general faculty members' conceptions of barriers to the use and integration of technology in their courses, this research study deals mainly with what the teacher education faculty with experience of use and integration of technology consider as issues and barriers to their continued use and integration of technology in teacher preparation courses. In addition, the researcher investigates how different faculty technology development approaches assist faculty in breaking down those barriers to their continued use and integration of technology in their teaching practice and seeks to understand what the characteristics of an effective faculty technology development program are.

Research Questions

The purpose of this study is to investigate what faculty with experience in the use and integration of technology in their courses see as issues and barriers to their continued use and integrate of technology, and to provide solutions to the issues and barriers defined by them. Therefore, the research questions that are addressed in this study include:

1) What do the technology-using teacher educators in this study see as significant issues and barriers to their continued use and integration of technology in teacher preparation courses?
2) What is the relationship between the issues and barriers defined by the technology-using teacher educators in this study and the respondents' personal and professional backgrounds?
3) How effective are the two faculty development approaches, specifically the one-on-one mentoring program and the group workshops, as reported by the technology-using teacher educators in this study?"

Methods

Case Study

A pilot case study was first conducted with six technology-using teacher education faculty members at a midwestern research university. Findings from this case study served as indicators to inform the development of a survey instrument to collect data on a large scale.

Participants

Participants of this case study included six faculty members in the College of Education at a midwestern research university who applied for and were named as Technology Scholars (Tech Scholars) starting the year 2000. The Tech Scholars' Program is affiliated with the PT3 grant project. The Tech Scholars' Program provides teacher educators with the necessary support to study and work one-on-one with a technology mentor, to begin developing materials and ideas for integrating technology into teacher preparation courses. Workshops also are provided to promote the effective use of technology in teaching and learning through the Tech Scholars' Program. Table 1 provides a general profile of these six Tech Scholars. They are from different content areas in the department of Curriculum and Instruction. Two of these six Tech Scholars are in the field of Language and Arts. The other four are in the areas of Special Education, Mathematics Education, Foreign Language Education, and Multicultural Education, respectively. The number of years each has taught in higher education and the experience in technology use and integration in their teacher preparation courses varies. They have used technology for various purposes in their courses. They all have been involved with the one-on-one faculty technology mentoring program for some time. Several of them also have participated in technology workshops (see Table 1).

Data Collection

A structured interview with each individual Tech Scholar was conducted by the researcher. An open-ended questionnaire of ten items concerning issues and barriers to technology use in their current and future teacher preparation courses was distributed to these faculty members before the interview (see Appendix A). The interviews were audio-taped and transcribed by the researcher. The transcripts were coded initially for case analysis, and

Table 1.

Profile of Tech Scholars

	Dr. A	Dr. B	Dr. C	Dr. D	Dr. E	Dr. F
Gender	Female	Male	Female	Female	Female	Female
Years of Teaching in Higher Education	9	8	7	17	8	19
Semesters of Use of Technology in Courses	4	6	8	10	13	10
Use of Technology in Course Management	Yes	Yes	Yes	Yes	Yes	Yes
Use of Technology in Information Seeking	Yes	Yes	Yes	Yes	No	No
Use of Technology in Course Delivery	Yes	Yes	No	Yes	Yes	Yes
Use of Technology in Course Instruction	No	No	Yes	Yes	Yes	Yes
Use of Technology in Student Project	Yes	Yes	No	Yes	No	No
Use of Technology (Others)	No	No	Yes	No	Yes	Yes
Group Workshop Experience	Yes	Yes	Yes	Yes	Yes	Yes
One-one-One Mentoring Experience	Yes	Yes	Yes	Yes	Yes	Yes

emerging themes were identified. The results of this case study served as important indicators of an online survey on a large scale. For this case study, data were collected through in-depth interviews with each faculty member named as Tech Scholar through the Technology Scholars' Program. Each interview began with a specific grand-tour question to allow the researcher to understand what a typical technology using/integration class is like, and then moved to ten open-ended questions. Specifically, the interviews with these six technology scholars were used to investigate what they considered barriers to their continued use of technology and higher levels of technology integration. Class participant observations, and artifacts such as their WebCT sites and publications on integrating technology into their content areas, were also collected to triangulate or check the accuracy of the data (Lincoln & Guba, 1985). The constant and comparative method of Glaser and Strauss (1967) served as a guide to analyze the data. Issues and barriers to advanced use of technology for the faculty were identified and categorized through the constant and comparison data analysis. The findings from this case study helped guide the development of an online survey instrument used to collect both quantitative and qualitative data.

Procedure of Development of Survey Instruments

Findings from the Case Study

When asked about the difficulties in achieving their goals in technology integration in their teacher preparation courses, most of the Tech Scholars agreed that time constraints and hardware/software issues are two main difficulties. Commitment to make time to get acquainted with new technology and to make good use of technology is a big concern for them. Technical problems were sometimes frustrating, too. Given that rich experience in technology integration in their teacher preparation courses, these six Tech Scholars have also identified what they think are the barriers and issues for their continued use of technology in their course. Those issues and barriers include:

- time
- technology downtime
- meaningful use of technology
- need for a community of supportive staff and faculty

Time

The commitment and investment of time in the use of technology is huge for most of these six faculty members. Research found that the amount of time required was the most common barrier reported by teacher educators in their attempts to use and integrate technology (NCATE, 1997; OTA, 1995; Quick, 1999). However, these Tech Scholars also identified other related issues in addition to the personal investment of time in acquiring technology skills. One mentioned the advancement of communication technology actually changes the time structure of traditional classrooms. Students had access to him 24 hours a day and seven days a week via communication tools like email rather than only during fixed office hours.

Technology Downtime

Technical problems were repeatedly brought up as a barrier by most of the Tech Scholars. These problems could range from a broken projector to a new operating system in a computer. However, they seemed to find ways to resolve the issues. They learned how to troubleshoot.

Dede (2000) argues that hardware/software troubleshooting is one of the useful skills for educators with respect to technology use and integration. Most of the Tech Scholars also mentioned that both the Tech Scholars program and the mentoring program provided necessary incentives and support in conquering some technical obstacles.

Meaningful Use of Technology

The goal-setting stage actually was the most challenging part for most of these Tech Scholars. They had to align each particular technology to the overall curriculum and their specific content area. Their goal was to achieve seamless technology integration. Thus technology would not dictate the content and would not interfere with teaching itself. Meaningful use of technology was the major concern for these Tech Scholars. It was also a new issue, in addition to the common hardware and software accessibility issue.

Need for a Community of Support Faculty and Staff

The establishment of a learning community that can provide the faculty with both technology and pedagogy support contributes to technology being used to the transformation of teacher education program. Most of these six Tech Scholars appreciated the accessible technology support, valued the opportunities to exchange ideas with other faculty members and, most of all, and identified the need to develop a cohort of learners. Research finds that the establishment of learning communities with appropriate counseling is essential for the faculty to make necessary connections in respect to technology infusion into the curriculum (Chuang et al., 2003).

Design of Survey Instrument

This survey was developed throughout the entire Fall 2002 semester, and revision work followed through Spring 2003 after the case study was completed. Following the case study results, an initial draft of the survey was created and shared with the researcher's major professor. After some revisions, the complete draft of the survey instrument then was shared with one faculty member in Curriculum and Instruction and the director of the Research Institute for Studies in Education at Iowa State University (ISU). Based on the feedback, additional changes were made. An online survey instrument of 43 questionnaire items then was developed (see Appendix B). According to Fraenkel and Wallen (1996), a common way to obtain content-related validity is to have competent individuals "render an intelligent judgment about the adequacy of the instrument" (p. 156). The web-based survey instrument was created for online delivery using PHP (HTML embedded scripting language used to create dynamic Web pages). The online survey was tested using multiple platforms, including both PC and Macintosh operating systems and a variety of browsers, to ensure the web-based survey would display effectively using either Netscape Communicator or Microsoft Internet Explorer. The web-based survey was subject to a number of revisions and tests to improve its design and validity. Two faculty members, two staff members, and four graduate students at ISU, each of whom actively uses technology in their work, reviewed the web-based interface. Revisions then were made to the design and format of the online instrument with regard to loading time, ease of use, time to complete, and item representation.

The final web-based survey questionnaire consists of three sections. The first section was designed to gather demographic information of each participant's academic background, years of technology use and integration in teaching, and years of experience with faculty development. The second section was designed to address the first research question, "What do the faculty who have had experience with the use and integration of technology see as issues and significant barriers to their continued use and integration of technology in teacher preparation courses?" The second section contained four sub-categories based on the findings from the previous case study: time, technology downtime, meaningful uses of technology, and the need for a community of supportive faculty and staff. Thirteen questions with Likert rating options on a six-point continuum were developed in the second section. Two open-ended questions also were included, to allow a broader perspective for each participant. The third section was designed to address the research question, "How effective are the two faculty development approaches, specifically the one-on-one mentoring program and the group workshops, as reported by the technology-using teacher educators in this study?" The third section contained sixteen questions with Likert options on a six-point range. Two open-ended questions also were added to this section for the participants to define more specifically what they considered as key characteristics of an effective faculty technology development program.

Research identifies several benefits of using the Web for data collection. These benefits include a faster response, protection against data loss, easy transfer of data for analysis, cost saving, convenience for the respondent, and the possibility of wider graphic coverage (Carbonaro & Bainbridge, 2000; Schillewaert, Langerak, & Duhamel, 1998).

Factor analysis was used to address the issue of construct validity. Section II of the survey contained four dimensions, with four items for the dimension of time, three items for the dimension of technology downtime, two items for the dimension of meaningful use of technology, and four items for the dimension of need for a community of support staff and faculty. Section III of the survey contained two dimensions, with eight items for the first dimension (group workshops) and eight items for the second dimension (the one-on-one mentoring program). The questionnaire items in Section III were eight paired items in each of the two dimensions (see Table 2). A summary of the factor analysis results shows that there was one factor in each of the four dimensions in Section II of the survey, and that each of the two dimensions in Section III contained two factors. As measured by eigenvalues and factor loadings, these results showed a relatively high degree of construct validity (see Appendix C). In addition, as Table 3 suggests, all dimensions had fairly high values of Cronbach's standardized item alpha, indicating a high order of scale reliability.

Table 2

Dimensions in Section II and Section III

Dimension	Item	Description
Section II		
• Time	11	The amount of time necessary to learn how to run the equipment/ hardware.
	12	The amount of time necessary to learn how to use software applications.
	13	The amount of time necessary to respond to students' e-mail or posting on online forums.
	14	The fact that time spent on use and integration of technology is not rewarded in the tenure promotion system.
• Technology Downtime	15	The dysfunction of technology equipment in the classroom where I am teaching.
	16	Software problems (e.g., different versions, different platforms, or software compatibility.
	17	The amount of time spent on hardware/software troubleshooting.
• Meaningful Uses of Technology	18	Difficulty in finding meaningful uses of technology in my content area.
	19	Difficulty in keeping the use of technology from interfering with my teaching.
• Need for a Community of Support Faculty and Staff	20	The lack of technical support.
	21	The lack of content and pedagogical support to align technology to curriculum.
	22	The lack of administrative support in technology implementation.
	24	The lack of a learning community of faculty and staff to support technology integration.

Table 2 (continued)

Section III		
•Group Workshops	26	Group workshops are effective in learning to run the equipment/hardware.
	27	Group workshops are effective in learning to deal with software related issues.
	28	Group workshops are effective in learning how to do hardware/software troubleshooting.
	29	Group workshops are effective in learning how to use/integrate technology into your content area in a meaningful way.
	30	Group workshops are effective in helping find appropriate applications of technology in your courses.
	31	Group workshops are effective in providing technology support.
	32	Group workshops are effective in providing content and pedagogical support in integrating technology.
	33	Group workshops are effective in helping establish a learning community to support technology integration.
•One-on-one Technology Mentoring Program	34	One-on-one technology mentoring programs are effective in helping run the equipment/hardware.
	35	One-on-one technology mentoring programs are effective in helping deal with software related issues.
	36	One-on-one technology mentoring programs are effective in helping learn how to do hardware/software troubleshooting.
	37	One-on-one technology mentoring programs are effective in helping learn how to use/integrate technology into your content area in a meaningful way.

Table 2 (continued)

• One-on-one Technology Mentoring Program (continued)	38	One-on-one technology mentoring programs are effective in helping find appropriate applications of technology in your courses.
	39	One-on-one technology mentoring programs are effective in providing technology support.
	40	One-on-one technology mentoring programs are effective in providing content and pedagogical support in integrating technology into your courses.
	41	One-on-one technology mentoring programs are effective in helping establish a learning community to support technology integration.

Table 3.

Values of Reliability of Dimensions in Section II and Section III

Dimensions	Standardized item alpha
Time (Section II)	.7727
Technology Downtime (Section II)	.9047
Meaningful Uses of Technology (Section II)	.7461
Need for Community of Support Faculty and Staff (Section II)	.8569
Group Workshops (Section III)	.8460
One-on-one Technology Mentoring Program (Section III)	.9109

Online Survey

Data Collection

To begin the survey process, in Spring 2003 a letter of request was sent via email to each PT3 project director/coordinator through the PT3 project directors or coordinators emailing list asking for a list of one to four technology-using teacher educators in each institution (Appendix D). The PT3 program is one of the largest federally-supported programs focusing specifically on preservice teacher education (see www.pt3.org). Since the program's inception in 1999, PT3 has provided funding to 441 teacher-training institutions throughout the United States. Efforts to integrate uses of technology into teacher education programs have received considerable funding support from PT3 to assist teacher preparation faculty as they advance in integrating technology into their teaching.

Thirty-three PT3 directors/projectors replied with a list of one to four potential survey takers as requested. Then, each recommended faculty member was contacted to gain his/her consent to complete the online survey. A letter with the survey URL had been sent via email to each of the potential survey takers to gain their informed consent in taking this Web-based survey (Appendix E). A second email message was sent two weeks later as a friendly reminder for those potential survey takers who had not yet taken the online survey. In April 2003, a third email message was sent to the potential survey takers as a final call for participation in the online survey. During the online survey data collection period, two respondents encountered technical problems and would not submit the data online. Therefore, they sent a Word document attachment via email. The rest of the respondents completed the survey and then submitted the data online to a database hosted at ISU. A total of 62 faculty members from 31 higher education institutions took the survey. Post-survey follow-up telephone interviews of five faculty members were conducted in Fall 2003 after the researcher had finished the quantitative data analysis. An email letter was sent to one randomly selected respondent from each of the 31 institutions, asking for volunteer participants for the post-survey interview. Five faculty members replied to the email and volunteered to participate in the post-survey interview. The qualitative data from the post-survey telephone interview, along with comments from the open-ended questions on the online survey, provided rich description and helped to set the quantitative data into human contexts.

Data Analysis

The analysis of the survey data is generally quantitative in its approach. Data were analyzed for all the variables using the appropriate SPSS 11.0 statistical procedures to determine descriptive statistics with respect to respondents' personal and professional profiles. Descriptive statistics were used to present measures of central tendency such as mean, median, and standard deviation for each item in Section II of the survey instrument. In addition, factor analysis was used to determine factoring loadings from thirteen questionnaire items in Section II of the survey instrument, to answer the first research question, "What do the technology-using teacher educators in this study see as significant issues and barriers to their continued use and integration of technology in teacher preparation courses?" Qualitative data from post-survey interviews provided specific examples to illustrate issues and barriers in contexts based on the categories as a result of the factor loadings in Section II. In addition, qualitative data from questionnaire item 24 and item 25 were coded into different categories of issues and barriers that the respondents perceived.

One-way analysis of variance (ANOVA) was used to examine the relationship between the issues and barriers reported by the respondents and their personal and professional backgrounds (research question 2). The ANOVA helps to answer the question, "Are there any differences among the groups?" (Abrami, Cholmsky, & Grodon., 2001p. 256). In addition, multiple comparison procedures were used to identify where there were differences between issues and barriers reported by the respondents and the personal and professional backgrounds after the omnibus null hypothesis of no difference in group means had been rejected.

Factor analysis also was used to determine factor loadings from the eight paired times in Section III to answer the third research question, "How effective are the two faculty development approaches, specifically the one-on-one mentoring program and group workshops, as reported by the technology-using teacher educators in this study?" The factor analysis examined the quantitative data from Sections II and III. The items were submitted to a factor analysis, with the number of factors to be maintained and determined by eigenvalues greater than one. The resulting factors then were rotated by the varimax procedure to approximate simple structure. The paired T-test statistic procedure was used to examine whether there were significant differences between two faculty development approaches as reported by the respondents who had both one-on-one mentoring experience and group workshop experience. The participant responses to the open-ended questions in the survey were coded and analyzed to provide some insights to the quantitative results. Specifically, qualitative data from item 42 in the survey instrument and data from the follow-up telephone interviews were analyzed to reveal what the participants defined as key characteristics of an effective faculty technology development program. The follow-up telephone interviews provided more detailed comments that illustrate the themes emerging from the survey data.

Description of the Respondents

Personal and Professional Backgrounds

A letter of request with the survey URL was sent via e-mail to the 121 faculty members identified as technology-using teacher educators by the PT3 project directors/coordinators to gain their consent to gather background information and complete the online survey (Appendix E). These data were then submitted to a database stored on a server at ISU. Out of the 121 faculty members who were contacted, 62 responded to the online survey. One of the respondents took the survey twice. After reviewing the data, the researcher decided to count the one which had the questionnaire items answered completely and to discard the one that was not completed by the same respondent. Another respondent did not complete the survey. The researcher decided to eliminate these two responses. Thus, a total of 60 faculty members from 31 colleges or universities responded to the survey so the final response rate was 49.6%. Based on the categories as defined by the 2000 Carnegie Classification (McCormick, 2001), the group responding to the online survey was dominated by Doctoral/Research Universities. Of those 60 respondents, 24 (40%) were from Doctoral/Research Universities Extensive, 13 (21%) were from Doctoral/Research Universities Intensive, 19 (31%) were from Master's Colleges and Universities I. One was from a Baccalaureate Colleges/Liberal Arts institution, one was from the Specialized Institutions/Schools of art, music, and design, respectively, and 2 were from Specialized Institutions/Teachers college (see Figure 1). Of the five faculty members who participated in the post-survey follow-up telephone interviews, one was from a Doctoral/Research University Extensive, one was from a Doctoral/Research University Intensive, and three were from Master's Colleges and Universities I.

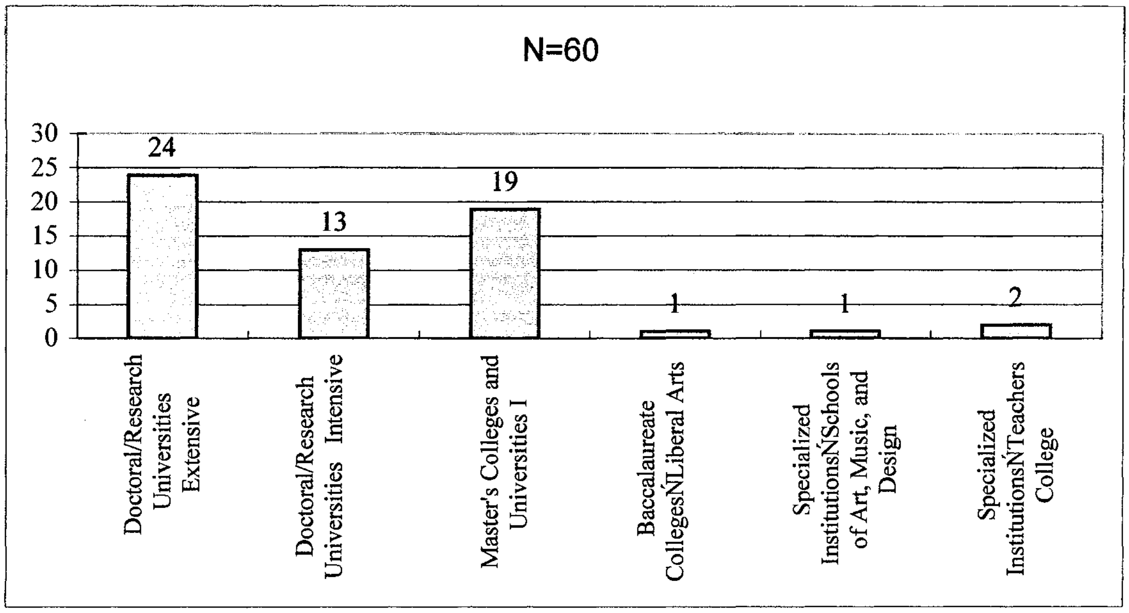

Figure 1. Respondents' institutions profile

The demographic information about the 60 respondents from 31 higher education institutions showed that 37 respondents were females and 23 were males. Respondents were asked to indicate their years of teaching experience in higher education and their academic rank. About one-third of the respondents (31.7 %) had between 2 and 5 years of teaching experiences in higher education. One-fifth of the respondents (20%) had years of teaching experience in higher education of 6 to 10 years. Slightly more than 26 percent (26.6%) of the respondents had 11 to 15 years of teaching experience in higher education. Eight percent (8.4%) of the respondents had 16 to 20 years of teaching experience in higher education. Thirteen percent (13.3 %) of the respondents had more than 20 years of teaching experiences in higher education (Figure 2). According to the respondents' years of teaching experience, Figure 2 shows that the sample is skewed to junior faculty.

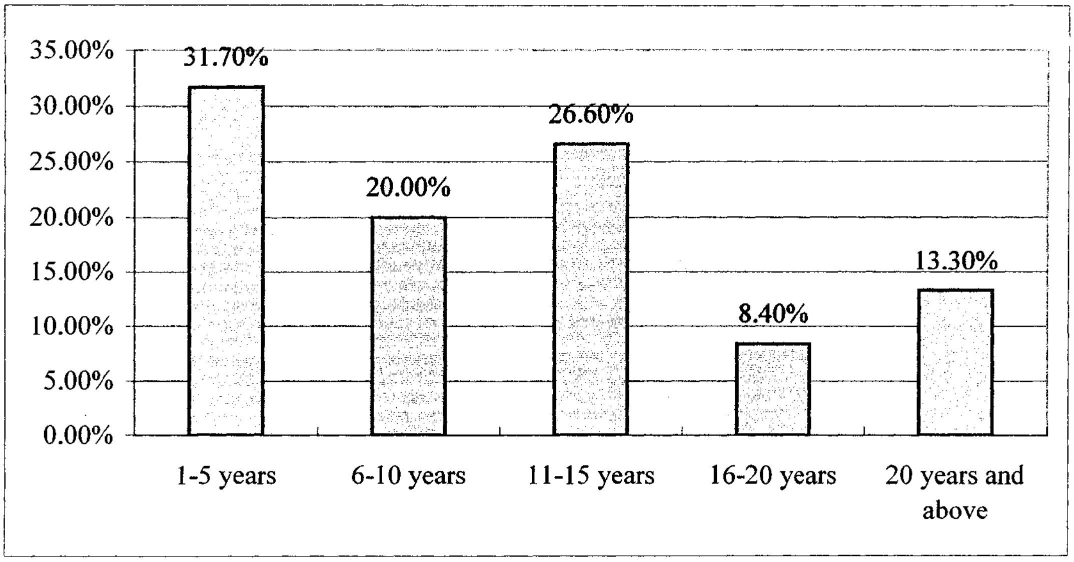

Figure 2. Respondents' years of teaching experience in higher education

With respect to their academic rank, 13.3% (n=60) of the faculty members who responded were temporary instructors and 13.4 % (n=60) were adjunct professors. About one-third of the faculty members, 35% (n=60), taking the survey were assistant professors, 18.3 % (n=60) were associate professors, and 20%(n=60) were professors (Figure 3).

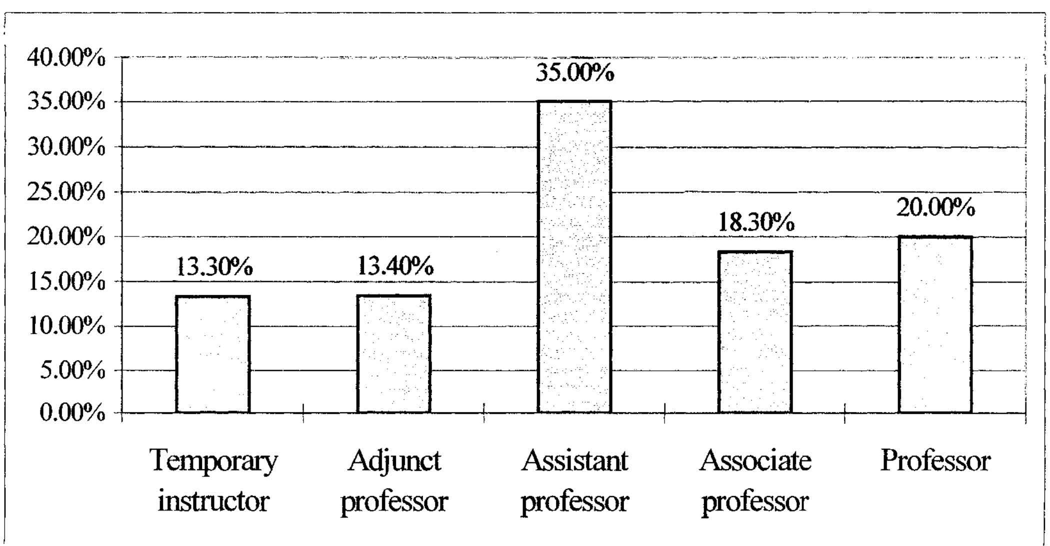

Figure 3. Academic rankings of respondents

The respondents were asked to report the average undergraduate and graduate class size that they taught. Twelve respondents reported that they were not teaching undergraduate courses at the time of taking the survey. Fourteen respondents had an average undergraduate class size of 21 to 40. Twenty-eight respondents had an average undergraduate class size of 20 or below 20. Five respondents had an average undergraduate class size between 41 and 80. One respondent reported an average undergraduate class size of 125. Ten respondents were not teaching graduate courses at the time of taking the survey. Ten respondents had an average graduate class size of 1 to 10. Twenty-four respondents had an average graduate class size of 11 to 20. Sixteen respondents reported that they had an average graduate class size of 21 to 30.

With respect to the years of technology integration, half of the respondents (50%, n=60) reported that they had 1 to 5 years of technology integration experience. Twenty eight percent (28.3%, n=60) of the respondents had 6 to 10 years of technology integration experience. Thirteen percent (13.4%, n=60) of the respondents had 11 to 15 years of technology integration experience.

Respondents were also asked to report whether or not they use technology the five ways suggested in questionnaire item 10. The five categories of technology use in courses are 1) course management, 2) information seeking, 3) course delivery, 4) course instruction, and 5) student projects. The answers were very positive. Ninety-three percent (93.3%, n=60) of them reported that they used technology for the purpose of course management. Almost ninety-nine percent (98.8%, n=60) of them used technology for the purpose of information seeking. Ninety percent (90%, n=60) of them used technology for the purpose of course delivery. Slightly less than eight-seven percent (86.6 %, n=60) of the respondents reported that they used technology for the purpose of course instruction. Interestingly, a relatively high percentage (78.3%, n=60) of the respondents reported that they used technology for all of the five purposed ways on this survey item. One faculty member reported using technology for the assessment purpose.

Faculty Technology Development Experiences

The majority of the respondents (90%, n=60) had group workshop experience. Many (72%, n=60) reported that they had one-on-one mentoring program experience. However, an overwhelming majority of the respondents (97%, n=60) reported that they were self-taught.

Those 43 respondents who had one-on-one mentoring program experience as a faculty development approach were asked to identify who served as the technology mentors in the mentoring program. Many reported that their technology mentors were tech support persons on campus (60.4%, n=43). Sixteen respondents (37.2%, n=43) reported that they had students as the technology mentor. Twenty-one respondents (48.8%, n=43) reported that they had other faculty members as their technology mentors. Eight respondents (18.6 %, n=43) reported that they had tech persons from off-campus as their mentors. Two respondents reported that they had K-12 school teachers as their technology mentors. One faculty member reported that he had the grant facilitator as his technology mentor.

Participants were also asked to indicate the person who helped to facilitate use and integration of technology in their courses. A majority of the respondents indicated that technology support persons helped them (63.3%, n=60). Fifty percent (50%, n=60) reported that they had help from faculty colleagues. Twenty-three percent (23.35%, n=60) indicated that students helped them. Eight percent (8%) of them indicated that they had help from an administrator. One respondent reported that the grant facilitator helped to facilitate use and integration of technology in his courses. Two respondents indicated they had help from K-12 school teachers. Ten respondents indicated they were self-helped. One reported that she had help from a listserv.

Half of the respondents (50%, n=60) indicated their faculty colleagues were the most influential person who facilitated their use of technology in courses. Thirty-five percent (35%, n=60) of them reported that the technology support person was the most influential person. Fifteen percent (15%, n=60) of the respondents reported that students were the most influential person. Six percent (6%, n=60) of them reported that the administrator facilitated their use and integration of technology in their course. Fifteen percent (15%, n=60) of the respondents indicated that they themselves were the most influential person that facilitated their use of technology in their courses. One reported that his dissertation advisor was the most influential person. Two reported that the K-12 school teacher was the most influential person. One faculty member indicated that she was most influenced by reading journals and examples of technology integration in her use of technology in her courses.

Results

Issues and Barriers to Faculty's Continued Use and Integration of Technology

The purpose of the second section of the questionnaire was to assess how significant the respondents see each questionnaire item as an issue and barrier to their continued use and integration of technology into their courses. Participants were asked to respond to items using the following Likert scale: 1 = Very significant; 2 = Significant; 3 = Partially significant; 4 = Partially insignificant; 5 = Insignificant; and 6 = Very insignificant. Responses to each item were ranked, and, along with mean scores and standard deviations, are reported in Table 4.

Item 12, "the amount of time necessary to learn how to use software applications," had the lowest mean response (2.50), which indicated a response between "significant" and

Table 4.

Results of Responses to Section II

Survey Items	Mean	SD	Rank
11. The amount of time necessary to learn how to run the equipment/ hardware.	2.77	1.294	2
12. The amount of time necessary to learn how to use software applications.	2.50	1.142	1
13. The amount of time necessary to respond to students' e-mail or posting on online forums.	2.95	1.599	3
14. The fact that time spent on use and integration of technology is not rewarded in the tenure promotion system.	3.73	1.803	6
15. The dysfunction of technology equipment in the classroom where I am teaching.	3.77	1.370	7
16. Software problems (e.g., different versions, different platforms, or software compatibility).	3.48	1.408	4
17. The amount of time spent on hardware/software troubleshooting.	3.63	1.288	5
18. Difficulty in finding meaningful uses of technology in my content area.	4.88	1.316	12
19. Difficulty in keeping the use of technology from interfering with my teaching.	4.93	1.219	13
20. The lack of technical support.	4.48	1.455	10
21. The lack of content and pedagogical support to align technology to curriculum.	4.53	1.384	11
22. The lack of administrative support in technology implementation.	4.30	1.660	8
23. The lack of a learning community of faculty and staff to support technology integration.	4.35	1.624	9

"partially significant." To determine whether there were statistically significant differences in the mean responses of item 12 and other items in Section II, t tests were performed. The t-test outcomes revealed that there are statistically significant differences ($p < .05$) between item 12 and all other items in Section II (Table 5). Among all the issues and barriers included in Section II, respondents ranked the time required to learn software applications as the most important barrier. Item 19 "difficulty in keeping the use of technology from interfering with

Table 5.

T-test Results of Item 12 and Other Items in Section II

Compared Items	Mean	SD	t	Sig. (2-tailed)
Item 12-Item 11	-.27	.918	-2.250***	.028
Item 12-Item 13	-.45	1.545	-2.256***	.028
Item 12-Item 14	-1.23	1.845	-5.179***	.000
Item 12-Item 15	-1.27	1.582	-6.200***	.000
Item 12-Item 16	-.98	1.662	-4.583***	.000
Item 12-Item 17	-1.13	1.371	-6.402***	.000
Item 12-Item 18	-2.38	1.530	-12.063***	.000
Item 12-Item 19	-2.43	1.430	-13.176***	.000
Item 12-Item 20	-1.98	1.761	-8.724***	.000
Item 12-Item 21	-2.03	1.657	-9.507***	.000
Item 12-Item 22	-1.80	2.090	-6.673***	.000
Item 12-Item 23	-1.85	1.981	-7.232***	.000

***$p<.001$

my teaching," had the highest mean response (4.93), which indicated a response very close to "insignificant." T-tests revealed that there are statistically significant differences between item 19 and all other items except item 18 (Table 6). Except for item 18, respondents ranked the difficulty in keeping the use of technology from interfering with teaching as the least important barriers among the items in Section II.

After a varimax rotated factor analysis was conducted, 4 factors emerged from the 13 questionnaire items from the second section of the survey: software/hardware difficulties,

Table 6.

T-test Results of Item 19 and Other Items in Section II

Compared Items	Mean	SD	t	Sig. (2-tailed)
Item 19-Item 18	.05	1.111	.349	.729
Item 19-Item 20	.45	1.712	2.036*	.046
Item 19-Item 21	.40	1.392	2.225*	.030
Item 19-Item 22	.63	1.841	2.665***	.000
Item 19-Item 23	.58	1.680	2.689***	.000
Item 19-Item 15	1.17	1.739	5.198***	.000
Item 19-Item 16	1.45	1.692	6.639***	.000
Item 19-Item 17	1.30	1.544	6.523***	.000
Item 19-Item 11	2.17	1.564	10.730***	.000
Item 19-Item 12	2.43	1.430	13.176***	.000
Item 19-Item 13	1.98	1.873	8.202***	.000
Item 19-Item 14	1.20	1.885	4.932***	.000

*$p<.05$

***$p<.001$

support, curriculum integration, and time (Table 7). In addition, all four components had fairly high values of the standardized item alpha, indicating a high order of scale reliability. The software and hardware difficulties component had a standardized item alpha value of .9047, compared to .8550 for the support component, .8011 for the curriculum integration component, and .7727 for the time component.

This factor structure, which accounted for 75.5% of the variance, yielded a more interpretable pattern of loading after a varimax rotation. Respectively, the software and hardware difficulties factor accounted for 20.6% of the variance, the support factor for 19.1%, the curriculum integration for 17.9 %, and the time factor for 17.7%. These four factors were quite close in their contribution to overall variation in responses among the respondents to the issues in and barriers to the faculty's continued use and integration of technology.

Qualitative data from the post survey telephone interview with five faculty members provided several specific examples with respect to the 4 factor components that emerged from the 13 questionnaire items from the second section of the survey (see Table 8).

Data from the open-ended questions in item 24 Section II with respect to other issues or barriers to the respondents' continuing to use/integrate technology into their courses were coded and analyzed. Close to one-fourth of the respondents (13, n=60) reported other issues and barriers than those stated in the previous questionnaire items with Likert scales. The post-survey interview also provided some insights and additional comments. Additional issues and barriers raised were policy, rapid technology advancement, students' expertise in and access to technology, funding support, effect on students' learning, and subject-specific technology (see Table 9).

Table 7.

Factor Loadings for Items in Section II

Variables Questionnaire Items	Factor 1	Factor 2	Factor 3	Factor 4
Software/Hardware Difficulties				
Item 15. The dysfunction of technology equipment in the classroom where I am teaching.	.905	.136	0.04590	.168
Item 16. Software problems (e.g., different versions, different platforms, or software compatibility).	.884	.226	0.06935	0.06127
Item 17. The amount of time spent on hardware/software troubleshooting.	.829	.106	.150	.307
Support	.187	.885	0.09540	0.07982
Item 22. The lack of administrative support in technology implementation.				
Item 23. The lack of a learning community of faculty and staff to support technology integration.	0.08388	.830	.315	0.05592
Item 20. The lack of technical support.	.347	.638	.372	-0.04989

Note. Extract Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 8 iterations.

Table 7. (continued)

Curriculum Integration				
Item 18. Difficulty in finding meaningful uses of technology in my content area	.104	.214	.860	0.03206
Item 19. Difficulty in keeping the use of technology from interfering with my teaching.	-0.002819	.110	.757	.221
Item 21. The lack of content and pedagogical support to align technology to curriculum.	.182	.440	.712	-0.07652
Time				
Item 13. The amount of time necessary to respond to students' e-mail or posting on online forums.	0.06536	0.08633	-0.05.074	.831
Item 14. The fact that time spent on use and integration of technology is not rewarded in the tenure promotion system.	.135	.302	0.01187	.748
Item 11. The amount of time necessary to learn how to run the equipment/ hardware.	.345	-.287	.261	.691
Item 12. The amount of time necessary to learn how to use software applications.	.217	-.317	.415	.615

Table 8.

Specific Examples from Post-survey Interview with Respect to the Four Factor Components

Categories of Four Factor Components	Examples from Post-survey Telephone Interview
Hardware and Software Difficulties	Parts of it [an online platform] are quirky. I wish I could respond easier to their assignments without having to download, save them, type it on theirs, and reload it. I wish there was an easier way to give feedback.
	The other thing is getting access to the software for K-12 students that I would like to teach and that's always going to be an issue of funding.
	I find that many people [pre-service teachers] still don't know how to use the software they do have.
	A more frequent problem for us is the college decides they are going to upgrade the operating systems on all of the CPUs in the college and then all of a sudden our wonderful software collection is incompatible with the new operating system on the computers.
	They [IT departments] are not educators, and so their thoughts are if Windows 2000 was good, then Windows XP is better. They want to move to a single platform college, and they want to be all IBM or all PC compatible. Well, the educational community is still fairly to a great degree a Mac platform so if we were to operate at the college' on only PC platform, we wouldn't be training students to work in the field.
	The one that has been most frustrating to me as an instructor is we adopted [a new email system]; the email system is not handling the attachments like it should. [It] has been a real frustration with trying to do the natural communication processes necessary for classes. Hardware[is] just the usual thing of trying to keep it up to date... having G3s now and some of the places and wanting G4s and some of that stuff.
	I have tons of literacy-based software that I cannot install to share with my computers.

Table 8. (continued)

Support	Pedagogical support is tough because a lot of times the people making those decisions know nothing about technology. Understanding our need to have access to lots of different varieties of technology to show to the preservice teachers is important but there has been no vision in that area. I think it is a very important thing to be able to have a network of people that you can go to depending on the different problem that you are having. In many cases if you go to just one person you're not going to find the answer you need to know how to pin point the problem. Administrative support is okay because they usually defer that support over to the general technical support that the university has and so I don't have to get permission to do the basics.
Curriculum Integration	I don't think we're doing a very good job of integrating from college of education to college of arts and sciences classes. We're working on that but are on a very low level. I think of integration right now although some things are happening ... like they have a van called physics and chemistry on wheels that they go out to the schools and do demos and have a huge summer camp here and stuff ... so at least I have seen some progress for our collaboration. We need to increase the collaboration between arts and science and college of education. My problem is the other people in my department aren't as focused on integrating technology as I am, and so what happens is I say, "Oh let's do it this way!" and they say, "Cathy, why don't you try it and let us know how it goes." I feel like I have to field test everything and then make a case for why it makes a difference, which isn't necessarily a bad thing. It is just the way it seems to be in our department – I am in the language and literature department. I think that there is kind of a bias that real reading doesn't involve technology, like you can't sit and curl up with a good laptop.

Table 8. (continued)

	What the administration needs to do now is to express why they choose to do this portfolio online and make sure people understand it. Without that, people don't quite understand what technology integration is and why they are doing it. And in many cases people see that putting a portfolio online is technology integration. It's not really, in essence, it is a tool to get people to use technology but it certainly isn't teaching with technology; it's just using it as a container.
Time	Time is so massive. Grants are a huge time to write, and people in math and science and technology, educational technology get overwhelmed with the number of grants that the university or college thinks we might be competitive in ... but there's usually the number of people actually writing the grants are in the areas where it's kind of high profile for grants like technology or math and science literacy. To a point, there are just a few of those people, and we get overwhelmed with trying to keep up with the grant opportunities that surface. It's [technology] not something that you can just pick up as you go and it's going so fast that you need to devote some time. For instance, I am auditing a course this semester on integrating technology in language arts and social studies because my field is reading – my field isn't technology but I need to make the effort to find out what's going on there so that my instruction is relevant to the teacher for the future.

Table 9.

Additional Issues and Barriers

Categories of Issues/Barriers	Descriptions
Policy	Current lack of policy regarding distance learning within our University is an on-going issue with those of us who teach web-based courses. The platform decisions at the college...a sense on the part of the institution that we should be a PC only environment, and the strong belief on the part of faculty with current field experience (I am also an urban public elementary school teacher) that we must maintain a dual platform, given the frequent use of Macintosh computers in elementary school settings.
Rapid Technology Advancement	Just keeping up with emerging technology, staying current.
Access to Technology	Students' access to technology. Easy access to effective subject specific technology. Off campus sites at which I teach don't often have the same equipment available to me as the campus - I have to alter plans or make adjustments. Not enough smart classrooms in which to teach.
Funding	I worry about the probable lack of support now that the PT3 funds have been exhausted. Funding is a growing concern in our state. Since budget cuts are severe, less operational funding is available. I have worked hard to fund software and equipment purchases.

Table 9. (continued)

Students' Technology Proficiency	Students' expertise [in technology].
	Students come with different levels of technology information and I have to teach some basic skills before they can be integrated into the classroom tech use.
Effect on Students' Learning	Another barrier is developing the background knowledge of how to integrate it into the course content without it taking a significant amount of time away from other content to be addressed.
	Influence of K-12 use of technology (Are they keeping up?) What's important out in the schools?
	Knowing the effect on learning is also an issue that faculty may not realize.

Data from another open-ended question, item 25 in Section II, were related to what the respondents described as the most significant barrier to their continued use of technology in their courses. Forty-two respondents described what they considered to be the most significant barrier to their continued use of technology in their courses. Twenty-six of them (62%, n=42) described their most significant barrier was the time issue. Specifically, seventeen respondents reported the increasing demand on the amount of time spent to learn new technology and to plan for meaningful ways to explore new possibilities to integrate technology was the most significant barrier. One wrote, "don't have time to get online during the week for syn[synchronous] or asyn[asynchronous] discussions. Another respondent described that the most significant barrier was "time to get technology policy compliance from vendors for my off-campus site."

Seven respondents reported that the most significant barrier was the lack of reliable and accessible equipment. One of them described, "teaching space with available technology . . . another college decision . . . to move from the single computer in each classroom to a lab structure . . . and the lab needs to be reserved well ahead of time and often with conflicts. [There is] no opportunity for spontaneous teachable moments to demonstrate when technology is the right tool/integration,"

Six respondents described the most significant barrier related to the support issue, (e.g., funding, administrative, and technology). Two faculty members reported that lack of reward in tenure promotion was the most significant barrier. One respondent stated, "I am still relatively unconvinced that using technology within my courses represents a substantial improvement over what we can accomplish without technology." Two respondents reported that students' low technology proficiency was a significant barrier. Appendix F contains a detailed description of the faculty responses to this open-ended question.

Relationship between Issues and Barriers Defined by the Respondents and their Personal and Professional Backgrounds

A series of one-way ANOVAs was conducted to determine if there were statistically significant differences between the respondents' personal and professional backgrounds and the issues and barriers in their continued use and integration of technology (Section II of the survey), specifically, the relationships between their personal and professional backgrounds—the respondents' years of teaching in higher education, their institution types, their academic rankings, the average class size of undergraduate students and graduate students, their years of use and integration of technology—and the rating from their responses to the second section of the survey. The results of the ANOVA tables (Appendix G) showed that there were no statistically significant differences within the groups except for the average undergraduate class size, the issues related to the lack of content and pedagogical support (item 21), and the lack of a learning community of faculty and staff to support technology integration (item 23). Table 10 shows a statistically significant difference of one way ANOVA within the groups between the average undergraduate class sizes and item 21 and item 23. Contrasts showed that differences existed between group 1 (average undergraduate class size 1 to 20, $n = 14$) plus group 3 (average undergraduate class size above 40, $n = 6$) together and group 2 (average

Table 10.

One Way ANOVA within the Groups Between the Average Undergraduate Class Sizes and Item 21 and Item 23

Items		Sum of Square	df	Mean Square	F	Sig
Item 21	Between groups	12.810	2	6.405	3.465*	.040
	Within groups	83.190	45	1.849		
	Total	96.000	47			
Item 23	Between groups	19.336	2	9.668	3.688*	.033
	Within groups	117.976	45	2.622		
	Total	137.313	47			

Note. Group 1 (average undergraduate class size 1 to 20, $n = 14$); Group 2 (average undergraduate class size 21 to 40, $n = 28$); Group 3 (average undergraduate class size above 40, $n = 6$).

$^*p < .05$

undergraduate class size 21 to 40, $n = 28$). Respondents in group 2 felt that the lack of content and pedagogical support to align technology to curriculum and the lack of a learning community of faculty and staff to support technology integration was not as significant an issue as those in group1 and group 3 together (see Table 11).

Table 11.

Contrast Test Between Group 1 plus Group 3 Together and Group 2

Items		Contrast	Values of Contrast	Std. Error	t	df	Sig. (2 –tailed)
Item 21	Assume equal variances	1	2.19	.839	2.610*	45	.012
	Does not assume equal	1	2.19	.905	2.422*	15.561	.028
Item 23	Assume equal variances	1	2.69	.999	2.692*	45	.010
	Does not assume equal	1	2.69	1.176	2.287*	11.526	.042

Note. Group 1 (average undergraduate class size 1 to 20, $n = 14$); group 2 (average undergraduate class size 21 to 40, $n = 28$); group 3 (average undergraduate class size above 40, $n = 6$). Contrast coefficients, group1=-1; group 2=2; group 3= -1.

$^{*}p<.05$

Effectiveness of Faculty Development Approaches

Section III of the survey was designed to allow the respondents to assess the effectiveness of two faculty development approaches, specifically one-on-one mentoring and group workshops in helping the technology-using teacher educators deal with emerging issues and barriers in use and integration of technology in their courses. There were eight paired items in each of the two subsections, one-on-one mentoring programs and group workshops, and only respondents who have participated in either or both of the two faculty development programs responded to the questionnaire items. Respondents who had participated in either one of the two faculty development programs responded only to the subsection of faculty development approaches that corresponded to their faculty development experiences. Those who had participated in both approaches were asked to respond to both subsections in the third section. Participants were asked to responded to items using the following Likert scale: 1 = Strongly agree; 2 = Agree; 3 = Partially agree; 4 = Disagree partially; 5 = Disagree; 6 = Strongly disagree.

A total of 57 respondents assessed the effectiveness of group workshops, while 44 assessed the effectiveness of the one-on-one mentoring program in Section III. After a varimax rotated factor analysis was conducted, two factors were extracted from the one-on-one mentoring program, and two similar factors were extracted from the group workshops subsections. The two factors that emerged were the effectiveness of faculty development approaches dealing with technology hardware and software issues and the effectiveness of faculty development approaches dealing with technology integration support issues (Tables 12 and 13). In addition, all four components have fairly high values of the standardized item alpha, indicating a high order of scale reliability. The technology hardware

Table 12.

Factor Loadings for Section III Group Workshops Subsection

Variables (Questionnaire Items)	Factor 1	Factor 2
Content Integration-centered Issues (Item 32)	.864	.120
Content Integration-centered Issues (Item 29)	.840	.318
Content Integration-centered Issues (Item 33)	.802	.276
Content Integration-centered Issues (Item 31)	.778	0.009073
Technology-centered Issues (Item 27)	.137	.911
Technology-centered Issues (Item 26)	0.08265	.902
Technology-centered Issues (Item 28)	.214	.812
Technology-centered Issues (Item 32)	.356	.407

Table 13.

Factor Loading for Section III One-on-one Mentoring Program Subsection

Variables (Questionnaire Items)	Factor 1	Factor 2
Technology-centered Issues (Item 36)	.947	.145
Technology-centered Issues (Item 34)	.946	.155
Technology-centered Issues (Item 35)	.921	.225
Technology-centered Issues (Item 39)	.883	.249
Content Integration-centered Issues (Item 40)	.256	.859
Content Integration-centered Issues (Item 41)	-0.03610	.845
Content Integration-centered Issues (Item 38)	.470	.714
Content Integration-centered Issues (Item 37)	.606	.608

and software issues component in the group workshops subsection of Section III has a value of the standardized item alpha, .8084. The technology integration support component in the group workshops subsection of Section III has a standardized item alpha value of .8665. The technology hardware and software issues component in the one-on-one mentoring program subsection of Section III has a standardized item alpha value of .9641. The technology integration support component in the one on one mentoring program subsection of Section III has a standardized item alpha value of .8441.

In the group workshops subsection, the technology-centered factor accounted for 33.2% of the variance and the content integration-centered factor for 36.3%. In the one-on-one subsection, the technology-centered factor accounted for 50.9 % of the variance among the items, and content integration-centered factor accounted for 31.1%. This means that almost 51% of the variation in responses among respondents to the items measuring the effectiveness of one-on-one mentoring programs could be attributed to the technology hardware and software factor, while 31% of the variation could be attributed to the technology integration and support factor.

The highest mean response (M = 3.56, SD = 1.053) among the eight questionnaire items in group workshops was item 31, regarding the effectiveness of group workshops in providing technology support technology. T-test outcomes revealed that there are statistically significant differences between item 31 and all seven other items in the group workshops subsection in Section III except for item 28 (Table 14). The t-test results indicated that respondents ranked the effectiveness of group workshops in providing technology support the lowest, compared with the seven other items excluding item 28 regarding the effectiveness of group workshops in learning how to do hardware/software troubleshooting.

Table 14.

T-test Results of Item 31 and Other Items in the Group Workshops Subsection of Section III

Compared Items	Mean	SD	t	Sig. (2-tailed)
Item 31-Item 32	.47	1.403	2.546*	.014
Item 31-Item 33	.96	1.476	4.937***	.000
Item 31-Item 30	.65	1.445	3.391**	.001
Item 31-Item 29	.49	1.403	2.643*	.011
Item 31-Item 28	.09	1.366	.485	.630
Item 31-Item 27	.67	1.327	3.792***	.000
Item 31-Item 26	.79	1.372	4.343***	.000

*$p<.05$

**$p<.01$

***$p<.001$

The highest mean response (M = 3.00, SD = 1.431) among the eight questionnaire items about the one-on-one mentoring program was item 41, regarding the effectiveness of one-on-one mentoring in helping establish a learning community to support technology integration. The t-test outcomes revealed that there are significant differences between item 41 and all 7 other items in the one-on-one mentoring subsection in Section III (Table 15). The t-test results indicated that respondents ranked the effectiveness of one-one-one mentoring in helping to establish a learning community to support technology integration the lowest compared with other seven items.

Forty-three respondents who had faculty development experiences in both the one-on-one mentoring program and group workshop responded to the items in the third

Table 15.

T-test results of item 41 and other items in one-on-one mentoring subsection of Section III

Compared Items	Mean	SD	t	Sig. (2-tailed)
Item 41-Item 40	.48	1.248	2.532*	.015
Item 41-Item 39	1.11	1.701	4.342***	.000
Item 41-Item 38	.66	1.493	2.928**	.005
Item 41-Item 37	.77	1.583	3.328**	.002
Item 41-Item 36	1.14	1.733	4.349***	.000
Item 41-Item 35	1.20	1.622	4.925***	.000
Item 41-Item 34	1.23	1.737	4.687***	.000

**p<.0*

***p<.01*

****p<.001*

section of the survey. Paired t-tests were conducted using the responses reported by these 43faculty members to determine any differences of effectiveness in addressing issues of technology use and integration in their courses between the two faculty development approaches, specifically the one-on-one mentoring program and the group workshops. Significant differences were found between these two approaches for all but one item related to the effectiveness of helping establish a learning community to support technology integration assessed by these 43 respondents (see Table 16).

The most pronounced differences among these were paired items 28 and 36, "effectiveness in learning how to do hardware/software troubleshooting" ($t = 8.134, p < .05$), paired items 31 and 39, "effectiveness in providing technology support" ($t = 6.737, p < .05$);

Table 16.

Paired t-test of Items in Subsections on Group Workshops and the One-on-one Mentoring Program in Section III

Compared Items	Mean	SD	t	Sig. (2-tailed)
Item 26-Item 34	.93	1.223	4.989***	.000
Item 27-Item 35	1.07	1.078	6.508***	.000
Item 28-Item 36	1.60	1.294	8.134***	.000
Item 29-Item 37	.86	1.627	3.468**	.001
Item 30-Item 38	.70	1.520	3.009**	.004
Item 31-Item 39	1.56	1.517	6.737***	.000
Item 32-Item 40	.58	1.867	2.042*	.048
Item 33-Item 41	-.42	1.967	-1.396	.170

*$p<.05$

**$p<.01$

***$p<.001$

and paired items 27 and 35, "effectiveness in helping software-related issues" ($t = 6.508, p < .05$). In paired items 28 and 36,"effectiveness in helping learn how to do hardware/software troubleshooting," the workshop group had a mean response of 3.49 with SD = 1.369 while the one-on-one mentoring group had a mean response of 1.88 with SD = 1.238. The significant difference ($t = 8.134, p < .05$) implied that one-on-one mentoring was considered more effective in dealing with hardware/software troubleshooting than the group workshop approach as perceived by these 43 education faculty members. In paired items 31 and 39, "effectiveness in providing technology support," the group workshop group was rated with a mean response of 3.47 and SD = 1.077, while the one-on-one mentoring program group had a mean response of 1.91 with SD = 1.192. The statistically significant difference ($t = 6.737$, $p < .05$) also indicated that one-on-one mentoring was considered more effective than the group workshops as a faculty development approach to provide technology support. In paired items 27 and 35, with ratings from the group workshops (Mean = 2.88, SD = 1.138) and the one-on-one mentoring program (Mean = 1.81, SD = 1.2), the statistically significant difference ($t = 6.508$, $p < .05$) implied that the one-on-one mentoring program generally is more effective than group workshops in dealing with software-related issues.

Although not as pronounced as the three paired items in the previous paragraph, t-test results from paired items 26 and 34 ($t = 4.989$, $p < .05$), paired items 29 and 37 (t = 3.468. $p < .05$), paired items 30 and 38 ($t = 3.009$, $p < .05$), and paired items 32 and 40 ($t = 2.042$, $p < .05$) indicated there were statistically significant differences between the effectiveness of the group workshop approach and the one-on-one mentoring program perceived by these 43 respondents. The one-on-one mentoring program generally is more effective than group workshops in dealing with hardware-related issues (items 26 and 34) and use/integration of technology into the content areas in a meaningful way (items 27 and 37). The t-test results also indicated that the one-on-one mentoring program generally is more effective than group workshops in finding appropriate applications of technology (items 30 and 38) and providing content and pedagogical support in integrating technology (items 32 and 39). The only paired test that did not yield a statistically significant difference was items 33 and 41 with respect to the effectiveness of helping establish a learning community to support technology integration. With paired item 8 rating from group workshops (M = 2.58, SD = 1.349) and from the one-on-one mentoring program (M = 3.00, SD = 1.447), the statistical result ($t = -1.39$,

$p = .170$) indicated that there was no difference in the effectiveness of the group workshop approach and the one-on-one mentoring program in helping establish a learning community to support technology integration.

Data from the open-ended question, Item 42 in Section III, suggest the key characteristics of an effective faculty development program are as shown in Table 17. Appendix H contains a detailed description of the faculty responses to this open-ended question.

Table 17.

Key Characteristics of an Effective Development Program from the Open-ended Question, Item 42

Categories of Key Characteristics of an Effective Development Program	Number of Responses for Each Category
Availability of tech support, administrative support, hardware/software support	21
Increase of faculty's interests and belief in technology integration and faculty's participation in planning and implementation of faculty development programs	6
Access to peer discussion, conceptual ideas, creative applications, and convenient and collaborative opportunities	8
Availability of mentorship and pedagogically and technologically versed mentors	12
Opportunity for research/evaluation of technology integration work	2
Opportunity for cyclical and ongoing training	4
Access to a combination of workshops and one-on-one support	7
Released time	4
Reward/Incentive	4

Discussion of the Results

These survey results and an analysis of the qualitative data from the open-ended questionnaire items and the post-survey interviews provided useful insights into the sustainability issues for faculty development in technology for teacher education. The profile of the respondents indicated a relatively junior faculty group who had adopted technology in their teaching. The four factors associated with issues and barriers to their use and integration of technology were perceived almost equally important by the respondents. In addition, the survey results reinforced the importance of human infrastructure in realizing the widespread of technology integration in teacher education.

A Relatively Junior Faculty Profile

In general, the faculty members responding to the survey were relatively new in their careers and in their use of technology. Most of them had experimented with technology in the following areas: course management, information seeking, course delivery, and course instruction and student projects. Most of them were very positive about the potential of technology use in education. Studies of the relationship between age and technology use are important to understanding the integration of new technologies in education. In elementary and secondary public schools, Rowand (2000) found that new teachers were more likely than veteran teachers to use information technology for a wide variety of instructional activities. However, according to Kiernan (2000), established professors were more inclined than their untenured colleagues to use information technology due to doubt about the quality and effectiveness of online teaching among faculty and administrators in higher education. Therefore, there is an advocacy to provide tenure/promotion incentives to faculty members who redesign their courses to include technology as teaching tool to assist student leaning and develop their scholarship around instructional technology uses (Haysbert, 2003; Young, 2002).

In addition, 90% of the respondents had group workshop faculty development experience, 72% of them had one-on-one mentoring faculty development experience, and 58 out of 60 (97%) of them reported self teaching with respect to technology. The respondents were in general very positive in their attitude toward technology and were highly motivated to adopt technology in teaching. Research revealed a number of reasons for the minimal use of computers by university faculty. Among the reasons, attitudes toward technology were influential and a positive attitude toward technology motivated the faculty's use of technology (Mitra, Steffensmeier, Lenzmeier, & Massoni, 1999).

Given the faculty profile that suggests relatively junior technology-using faculty, continuous faculty professional development and administrative support especially in tenure promotion are crucial to sustain their efforts in integrating educational uses of technology in their careers. Faculty development for these technology-using teacher educators should provide opportunities for the participants to familiarize themselves with curriculum, social, and pedagogical contexts to deal with many broader dimensions of technology integration in teaching. In addition, they should be encouraged to take on leadership roles and to be involved with the decision and implementation process for technology initiatives in teacher education programs. Shared leadership involving the end users, the faculty in this case, in the planning, decision-making, and implementing phrases of technology initiative innovations will help bring out desired change for effective use of technology in teacher education (Drazdowski, Holodick, & Scappaticci, 1998; Fullan, 2001; Willis, 2001).

Barriers and Issues Perceived by the Technology-using Teacher Education Faculty

Four factors based on the factor analysis procedures emerge from the 13 questionnaire items from the second section of the survey: software/hardware difficulties, support, curriculum integration, and time. According to the factor analysis loadings from Section II of the survey, the four factors account for almost equal variance of the responses for issues in, and barriers to the teacher education faculty's continued use and integration of technology in their courses. Thus, it implies that the four factors are almost equally important to the respondents' perception of barriers and issues in their continued use and integration of technology in their courses.

Research has repeatedly identified lack of time as a major barrier that hindered the faculty use of technology (Dusick, 1998; Dusick & Yildirim, 2000), and time required is also the number one barrier most K-12 teachers face when attempting to infuse technology in the classroom (OTA, 1995). However, the results of this study indicate that the teacher education faculty who responded to the survey perceived other barriers and issues as prominent as the time issue. Creative and flexible solutions are needed to provide more time for teacher education faculty to use technology in their courses. The teacher education faculty also need to be situated in an environment where they are provided with supportive staff and administration, reliable technologies, shared resources, and pedagogical ideas in order to continue their efforts to integrate educational use of technology (Abdal-Haqq, 1995; Cornell, 1999; Ennis & Ennis, 1996; Faseyitan, 1996; Gilbert, 1995; Maddux, Cummings, & Torres-Rivera, 1999; OTA 1995). In fact, these four factors (variables) revealed complex combinations of environmental factors and interactions of environmental and personal factors.

Software and hardware difficulties included the malfunction of equipment, new versions of software applications, different platforms such as the PC platform and the Mac platform, and the low levels of faculty members' troubleshooting skills. These issues could be addressed by an institutional support system for technology and improved levels of troubleshooting skills by the faculty members. Dede (2000) argues that hardware/software troubleshooting is one of the useful skills for educators with respect to technology use and integration.

Curriculum integration was also a challenge for the teacher education faculty members who participated in this study. Ertmer (2003) argues, "taking faculty to the point where they are comfortable using technology does not equate to taking them to the point where they can use technology in innovative and transformed ways " (p.125). The transformation stage of achieving a higher level of technology integration takes more than good technical skills and reliable technologies. The amounts and kinds of collaborative structures available, opportunities for observing and interacting with peer faculty and disseminated exemplary models contribute greatly to successful technology integration (Campbell, 2002; Seals, Campbell, & Talsma, 2003).

Barriers and issues identified by the respondents reflected to a large extent the nature and complexity of technology in teacher education. The teacher education faculty's personal beliefs can be changed as they experience the power of teaching and learning with technology when provided with modern technologies. Meanwhile, their personal commitments might also be diminished as they encounter unfriendly environmental barriers. Although skill training may initiate changes in faculty's uses of technology, additional scaffolds are needed to support and sustain the types of meaningful changes being promoted and the opportunities to reflect on current practices and beliefs. These scaffolding supports will enhance the faculty's commitment to sustain the desired changes made in their teaching.

The Importance of Human Infrastructure

It is important to build a human infrastructure, (Lawton, 1997; Vojtek & Vojtek, 1997) as well as physical and technology infrastructures, to realize the widespread technology integration. Ely (1995) argues that technology itself is "amoral" (p. 5) and it is with human interactions that technology creates values. The rise and fall of the past media technology could be attributed to its "adds on" limitation in instructional use and " they are rarely integral to the process of teaching/learning" (p. 6). To address the importance of human infrastructure, results of this study provide several insights to effective strategies for long-term sustainable faculty development approaches.

Faculty respondents with both one-on-one mentoring and group workshop experiences reported that the one-on-one mentoring program was more effective than the group workshops in meeting individual needs in improving technology proficiency/skills, in troubleshooting, and in meaningful technology integration. The faculty members with one-on-one mentoring experience perceived software and hardware issues as the primary concern and the content integration-centered issues as the second concern when they worked one-on-one with their mentors. However, the faculty members with group workshop experience perceived hardware and software issues and content integration almost equally as their concerns when they attended workshops.

In general, a one-on-one mentoring program as a faculty development approach could be a viable solution in meeting the challenge of rapid technology advancement. Related studies show its effectiveness in meeting individual faculty members' needs in acquiring technology proficiency skills (Gonzales & Thompson, 1998; Stewart, 1999; Thompson et al., 1996). One-on-one mentoring programs are often conceptualized as providing in-time and on-site technology support, which is an advantage over the group workshops. However, the one-on-one technology mentoring approach alone did not seem to adequately address the content technology integration. Results of this study showed that a one-on-one technology mentoring program did not seem to go too far beyond technical assistance and often focused on acquiring technology skills. Based on the results of this study, group workshops, although not as effective as the one-on-one mentoring in providing technology support, could still offer the faculty opportunities to engage in "hands-on" training sessions, and if appropriately planned and implemented, group workshops could yield positive effects. Several respondents proposed the combination of one-on-one assistance following group workshop sessions as a more favorable approach. Research on the technology mentoring programs reveals the possibility of a similar combined model of mentoring programs and concludes that in addition to individualized technology support, a successful technology mentoring program should include such elements as providing visions for technology use, breaking down hierarchical structure, and establishing learning communities (Chuang et al., 2003).

Results from this study on the effectiveness of faculty development approaches reveal the potential of including the idea of cohort or learning communities into the plan of faculty development. There are examples in the literature of cohort learning communities in technology in several universities. At the University of Technology in Sydney, Australia, the faculty initiated an instructional technology reading program. Interested members read selected papers on classroom technology integration in advance, reflected on, and raised issues in their monthly meeting (Schuck, 2002). Michigan State University established

"Design Communities" as one way of their faculty development approaches. The faculty members as designer in these Design Communities created their own teaching environments, and raised issues of technology integration that they encountered. Teaching assistants and other graduate assistants then worked with the faculty members for technology solutions (Zhao, n.d.). Ellis (2004) provided an example of a faculty learning community consisting of three teacher education faculty members and the Director of Instructional Technology Services at a small, Midwestern, liberal-arts university. They teamed together using participatory action research to investigate their own practice with hopes of coming to an understanding of ways to remove some barriers to technology literacy and pedagogical issues.

Previous research identified the establishment of learning communities as one of the key themes in a successful one-on-one technology mentoring program (Chuang et al., 2003). The importance of connecting to other peer faculty was reflected in the survey results. Fifty percent of the respondents reported that their faculty peers helped them and were the most influential persons in facilitating their use and integration of technology in their courses. Thus, they indicated that the one-on-one mentoring approach should not confine each pair to working in isolation, and group workshops should incorporate social interaction elements into training sessions. This was also echoed in the responses to the key characteristics of an effective faculty technology development program.

In summary, results of this survey study indicated that the one-on-one mentoring program was more effective than group workshops in meeting individual needs in improving technology proficiency/skills, troubleshooting and meaningful technology integration than group workshops. However, for this particular group of respondents, to achieve the transformation stage of technology integration takes more than routine professional technical training provided either by the one-on-one technology mentoring program or by group training sessions. Results of this study also imply that cohort faculty groups emerging from learning communities have the potential to take the faculty who are comfortable using technology with their students in the courses to the point where they can use technology in innovative or transformed ways.

Recommendations for Further Research

Due to the relatively junior faculty profile and a homogenous group of respondents participating in this study, there were rarely statistically significant differences found between the respondents' personal and professional backgrounds and the barriers and issues they assessed. Although there is similar research on comparisons of adopting patterns and characteristics of university faculty who integrate computer technology for teaching and learning (Jacobsen, 1998), there is little known about the adopting patterns of teacher education faculty with respect to use and integration of technology in their teacher preparation courses. Further research is recommended that would include heterogeneous groups of respondents in the design of the survey instrument to identify the gaps of issues and barriers between different groups of teacher education faculty that have various comfort levels in using technology in their courses. Findings from such studies will provide strategies for faculty development approaches to meet the needs of teacher education faculty groups that have various levels of experience with technology use and integration. In addition, these findings will help to understand why some faculty members stay on track while others give up midway. This concept is based on Roger's (1995) diffusion of innovation research that provides an approach to discussing the differences between early adopters and others.

The individual concept or definition of technology integration can vary a great deal. Interviews are recommended to provide rich and thick materials to understand the degree to which the teacher education faculty members participate in teaching with technology. The five generic terms of ways of technology use in item 10 of the survey instrument appear to be broadly defined, and they neglect the wide variation of meanings and definitions by individual respondents. Qualitative data of detailed and thick descriptions of specific examples of how the teacher education faculty members teach with technology will allow individual differences to emerge. Analysis of these data can better reflect the relationship between their technology use and the issues and barriers perceived by the teacher education faculty respondents.

Findings from this study reveal the complex and intervening relationship between personal and environmental factors that influence the faculty's use and integration of technology in teaching. Future research focusing on collecting data from the respondents through interviews, observations, and artifact collections will contribute to exploring and proposing a model to illustrate the complex relationships among personal and environmental factors that influence the faculty use and integration of technology.

Conclusion

Results from both the initial case study and the survey study provide valuable recommendations for the leaders who wish to sustain technology in teacher education. Those recommendations emphasize the need to include the technology-using teacher education faculty in leadership roles for the planning and implementation of technology innovations, and also emphasize the need to establish learning communities where faculty can collaborate, communicate, and support each other.

In summary, the results provide insights to what the technology-using teacher education faculty perceive as fundamental issues and barriers that hinder their efforts in achieving the goal of integrating technology in teacher education. In addition to the issues that were extracted from factor loadings: hardware and software difficulties, support, technology integration, and time, all of which have been extensively documented in the literature, other issues were explored. Additional issues included administration decisions in policy making, rapid technology advancement, sustainable funding, students' technology proficiency, and the effect on student's learning. Results also indicated the complexity of the intervening relationship among the issues and barriers. With respect to the faculty development approaches in facilitating the faculty use and integration of technology, one-on-one mentoring was generally perceived as more effective than the group workshop approach. However, both approaches seemed to fail to adequately address the need for establishing learning communities to draw on peer expertise as the faculty work to solve authentic problems.

This study provides a first look at the technology-using teacher educators ' perceptions and perspectives on their continued use of technology in their teacher preparation courses. It also has important implications given the heavy investment in technology infrastructure in teacher education and the importance of the effective technology integration in teacher education. The lack of matching human infrastructure to physical and technology infrastructure was linked to the insufficient practice of technology integration by the teacher education faculty. This study pinpoints some of the intervening factors that prohibited the teacher education faculty from continuing their work with technology. This study further highlights the need for peer faculty connection in meeting the challenge of using technology in an innovative and transformed manner.

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CHAPTER 5. GENERAL CONCLUSIONS

As faculty development in technology for teacher education continues to play a key role in realizing effective use of technology in teacher education, it is important that our understanding of effective faculty development approaches also continues to grow. Two major approaches to faculty development programs are the one-on-one technology mentoring program, and the group workshop. One-on-one mentoring programs are a fairly recent phenomenon, and the underlying assumption of most one-on-one technology mentoring programs is that in reciprocal mentorship, the new generation brings an exciting expertise in technology to the collaboration with the veteran teachers or teacher educators. From the literature review article in Chapter 2, "Faculty Technology Mentoring Programs: Major Trends in the Literature," we find that several one-on-one mentoring programs relate to the advocacy of a mode of learning where intergeneration collaboration takes place. Chapter 3 in this dissertation, "Reflecting with One Technology-using Teacher Educator: Discovery of a New Pedagogical Approach," reveals a grounded theory of an exemplary teacher educator's extensive and intensive involvement in the mentoring program. Chapter 3 presents the complex relationships among pedagogical beliefs, instructional practices, and the use of technology. In addition, a technology-rich course has to be based on solid principles of instruction to promote needed reform in teaching and learning. Chapter 4, " Issues of Sustainability of Faculty Use and Integration of Technology in Teacher Education: A First Look," provides insights to what the technology-using teacher education faculty perceive as fundamental issues and barriers that hinder their efforts to continue achieving the goal of technology integration in teacher education. Results from this large scale survey study also imply the complexity of the intervening relationships among the issues and barriers. Key findings from this dissertation and recommendations for further research are discussed in the following sections.

Key Findings from the Dissertation

Chapter 2 provides a review of the literature that documents technology mentoring models used in higher education and K-12 schools. After summarizing the mentoring models, a description of commonalties found among these mentoring programs are shared. Common themes of effective technology mentoring programs include providing visions for technology use, individualizing technology support, breaking down hierarchical structure, establishing learning communities, and providing mutual benefits for mentors and mentees. Chapter 3 in the dissertation uncovers some aspects of how an exemplary technology-using educator developed over time in technology use and pedagogy over eight years of involvement in a sustainable faculty technology mentoring program. These aspects are closely linked to a technology-rich constructivist approach in teaching and learning. Findings from this qualitative study lead to the construction of a theory grounded in the data related to a teacher education faculty member's discovery of a new pedagogical belief in constructivism. Chapter 3 provides a positive example of what is possible in faculty development given a sustainable, long-time faculty mentoring program and the creation of a community of support.

Chapter 4 provides a first look at the technology-using teacher educators' perceptions and perspectives on their continued use of technology in their teacher preparation courses. The respondents perceived the four factors associated with issues and barriers to their use and integration of technology, software/hardware difficulties, support, curriculum integration and time, almost equally important. With respect to the faculty development approaches in facilitating the faculty use and integration of technology, the one-on-one mentoring program was generally perceived as more effective than the group workshop approach. However, both approaches seemed to fail to adequately address the need for establishing learning communities drawing on peer expertise as the faculty work to solve authentic problems. This study also has important implications given the heavy investment of technology infrastructure in teacher education and the increasing awareness of the need to assess teacher education faculty to advance in their technology integration. Among the implications are the lack of matching human infrastructure to physical and technology infrastructure and the lack of peer faculty connection to work collaboratively to meet the challenge of using technology in an innovative and transformed manner. In addition, results emphasize the need to include the technology-using teacher educator faculty in the planning and implementation of technology innovations.

Recommendations for Further Research

This dissertation focuses upon identifying effective approaches for faculty development programs and understanding approaches and issues of sustainability in faculty technology development for teacher education. Results reveal that faculty development needs to go far beyond technology skill training. Further qualitative studies on pedagogical beliefs and instructional practice for advanced technology-using teacher educators will be of great value to inform the plan and implementation of faculty development in technology for teacher education. In addition, participants with diverse personal and professional backgrounds are needed to understand the phenomena of a sustainable technology mentoring program.

The individual concept or definition of technology integration can vary a great deal. Extensive and intensive interviews are recommended to provide rich and thick materials to understand the degrees to which the teacher education faculty participate in teaching with technology. Qualitative data of detailed and thick description of specific examples of how the teacher education faculty members teach with technology will allow individual differences to emerge. Analysis of these data can better reflect the relationship between technology use and the issues and barriers perceived by the teacher education faculty respondents. Future research that explores how a faculty cohort can be incorporated into a faculty development approach and that investigates what factors contribute to the establishment of learning community are also areas worthy of study.

Faculty development in technology for teacher education is clearly an area that will continue to play a key role in realizing the widespread technology integration across teacher education curricula. Considerable research needs to be done in order to better assess the progress being made in technology integration by the teacher education faculty and to assist them in advancing in their efforts to make technology an essential component in their teacher preparation courses.

APPENDIX A: AN OPEN-ENDED QUESTIONNAIRE FOR THE TECH SCHOLARS

Iowa State University

Center for Technology in Learning and Teaching

Tech Scholars' Program

This questionnaire is a pilot study and designed to identify issues and barriers of the faculty's continued use of technology in their teacher preparation courses. The results will be used for the design of an online survey on a national scale to investigate the effective faculty development approach to continued technology use in teacher education courses.

We are interested in knowing about how you achieved the goal of integration of technology and what the issue and barriers are in your continued use of technology in your future teacher preparation courses.

Your responses and feedback will be highly valued. As stated, the result of this pilot study will serve as important indicators of an online survey later on a national scale. No individual respondents will be identified in reports coming out of this study. Thank you for your assistance with this research.

Specific grand tour question:

In order for me to find out more about what a typical technology-integrated class is like for you in your teacher preparation course, I would like for you to describe in detail what a typical technology integrated class is from the preparation to the end of the class time. I am interested in as much detail as you can give me. Please go step by step through the class including the preparation stage.

Questionnaire Items

1.Gender: Male Female

2.Years of teaching in higher education institutions:

3. How many semesters have you used any computer-related technology in your teaching in the teacher preparation courses?

4.How have you used technology in your courses?

Course management

Information seeking

Course delivery

Course instruction

Student Projects

Others. (please specify)

5. What kind of faculty development you have participated in building your technology skills?

Large group Workshop (more than 20 people)

small group workshop

One-one-one mentoring

6. What were the difficulties in achieving your goal in technology use/integration in teaching?

7. How did you overcome the difficulties in achieving your goal of integrating technology into your courses?

8. In your opinion, what are the issues and barriers in your continued technology use in your teacher preparation courses?

9. How have your use and view of technology changed over time?

10 .How do you anticipate that new technologies might change teacher education program?

APPENDIX B: AN ONLINE SURVEY INSTRUMENT OF FORTY-THREE QUESTIONNAIRE ITEMS

Questionnaire on Issues and Barriers to Advanced Faculty Use of Technology in Teacher Education

This questionnaire is part of a study to investigate and understand issues and barriers to advanced faculty use of technology. The goal of this study is to identify issues and barriers to faculty members' continued use of technology integration in their teacher preparation courses. We are interested in investigating the issues and barriers that faculty members who have used technology in teaching their courses have encountered, and in learning if those issues and barriers are significant enough to discourage continued use of technology integration by the faculty members. In addition, this research project will help identify effective faculty development practices in overcoming the barriers and sustaining the systematic technology innovation in teacher education programs. Knowledge we gain from your responses will provide useful information on minimizing the barriers to continued technology integration within teacher education programs.

For this study, you will be asked to complete a survey of 43 questions. This survey will take you no more than 30 minutes to complete. All the information you provide will be kept strictly confidential. Under no circumstances will your individual responses be released. Participation in this project is voluntary, and you are free to discontinue at any time. However, your professional experiences and opinions are crucial in helping us understand the issues and barriers that discourage faculty members' continued use of technology integration. Your responses will assist us in understanding how a faculty technology development program should be implemented to break down the barriers identified.

Thank you for your participation.

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Section I –Your Background

First Name: ________

Last Name: ________

Name of the Institution where you are currently teaching:

1. Gender: Female Male

2. Years of Teaching in Higher Education: years.

3. Current academic rank: Temporary Instructor Adjunct Professor Assistant Professor Associate Professor Professor

4. The average undergraduate class size that you teach: students.

The average graduate class size that you teach: students.

5. The number of years you have used/integrated technology in your courses:

years

6. Faculty technology development programs in which you have participated: (Check all that apply.)

i . Group Workshop

ii. One-on-one technology mentoring program

iii. Self Learn

iv. Others (Please specify)

7. ***Skip this item if you did not check one-on-one mentoring program in Item 6.*** If you check one-on-one technology mentoring program in Item 6, who is the technology mentor in the mentoring program that you have participated in? (Check all that apply.)	☐ i. Student ☐ ii. Faulty member ☐ iii. Tech support person on campus ☐ iv. Tech support person off campus v. Others (Please specify) ☐
8. The person who helped you facilitate use/integration of technology in your course: (Check all that apply.)	☐ i. Student ☐ ii. Faculty colleague ☐ iii. Tech Support Person ☐ iv. Administrator v.Others (Please specify) ☐
9. The most influential person that facilitated your use/integration of technology in your courses: (Check all that apply.)	☐ i. Student ☐ ii. Faculty colleague ☐ iii. Tech Support Person ☐ iv. Administrator v. Others (Please specify) ☐

10. Ways you have used technology in your courses: (Check all that apply.)

- i. Course management
- ii. Information seeking
- iii. Course delivery
- iv. Course instruction
- v. Student Projects

vi. Others (Please specify)

Section II

The following are issues and barriers you may have encountered in integrating technology into your course instruction. Please rate the issues/barriers as to how significant each is to your continuing to use/integrate technology into your courses.

Please use the following scale to rate your response:

1	2	3	4	5	6
Very Significant	Significant	Partially Significant	Partially Insignificant	Insignificant	Very Insignificant

Time

11. The amount of time necessary to learn how to run the equipment/ hardware.

1 2 3 4 5 6

12. The amount of time necessary to learn how to use software applications.

1 2 3 4 5 6

13. The amount of time necessary to respond to students' e-mail or posting on online forums.

1 2 3 4 5 6

14. The fact that time spent on use and integration of technology is not rewarded in the tenure promotion system.

1 2 3 4 5 6

Technology Downtime

15. The dysfunction of technology equipment in the classroom where I am teaching.

1 2 3 4 5 6

16. Software problems (e.g., different versions, different platforms, or software compatibility).

1 2 3 4 5 6

17. The amount of time spent on hardware/software troubleshooting.

1 2 3 4 5 6

Meaningful Uses of Technology

18. Difficulty in finding meaningful uses of technology in my content area.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

19. Difficulty in keeping the use of technology from interfering with my teaching.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

Need for a Community of Support Faculty and Staff

20. The lack of technical support.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

21. The lack of content and pedagogical support to align technology to curriculum.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

22. The lack of administrative support in technology implementation.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

23. The lack of a learning community of faculty and staff to support technology integration.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

Others

24. If there are any other issues or barriers to your continuing to use/integrate technology into your courses, please specify.

25. Please describe the most significant barrier to your continuing to use technology in your courses.

Section III

Effectiveness of Faculty Technology Development Programs

Please use the following scale to rate your response:

1	2	3	4	5	6
Strongly Agree	Agree	Agree Partially	Disagree Partially	Disagree	Strongly Disagree

Group Workshops

(If you have not participated in any technology workshops, you may skip this section and go to One-on-one Technology Mentoring Programs.)

26. Group workshops are effective in learning to run the equipment/hardware.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

27. Group workshops are effective in learning to deal with software related issues.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

28. Group workshops are effective in learning how to do hardware/software troubleshooting.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

29. Group workshops are effective in learning how to use/integrate technology into your content area in a meaningful way.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

30. Group workshops are effective in helping find appropriate applications of technology in your courses.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

31. Group workshops are effective in providing technology support.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

32. Group workshops are effective in providing content and pedagogical support in integrating technology.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

33. Group workshops are effective in helping establish a learning community to support technology integration.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

One-on-one Technology Mentoring Program

(You may skip this section if you have not participated in any one-on-one technology mentoring programs.)

34. One-on-one technology mentoring programs are effective in helping run the equipment/hardware.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

35. One-on-one technology mentoring programs are effective in helping deal with software related issues.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

36. One-on-one technology mentoring programs are effective in helping learn how to do hardware/software troubleshooting.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

37. One-on-one technology mentoring programs are effective in helping learn how to use/integrate technology into your content area in a meaningful way.

1 2 3 4 5 6

38. One-on-one technology mentoring programs are effective in helping find appropriate applications of technology in your courses.

1 2 3 4 5 6

39. One-on-one technology mentoring programs are effective in providing technology support.

1 2 3 4 5 6

40. One-on-one technology mentoring programs are effective in providing content and pedagogical support in integrating technology into your courses.

1 2 3 4 5 6

41. One-on-one technology mentoring programs are effective in helping establish a learning community to support technology integration.

1 2 3 4 5 6

42. In your opinion, what are the key characteristics of an effective faculty technology development program?

43. Additional Comments:

Submit

APPENDIX C: FACTOR LOADINGS OF THE FOUR DIMENSIONS OF SECTION II AND THE TWO DIMENSIONS OF SECTION III OF THE SURVEY INSTRUMENT

Section II Dimension: Time	
	Component
	1 Factor
Item 11	.857
Item 12	.799
Item 13	.745
Item 14	.680

Section II Dimension: Technology Downtime	
	Component
	1 Factor
Item 15	.934
Item 16	.918
Item 17	.898

Section II Dimension: Meaningful Use of Technology	
	Component
	1 Factor
Item 18	.900
Item 19	.900

Section II Dimension: Need for a Community of Support Faculty and Staff	
	Component
	1 Factor
Item 20	.843
Item 21	.766
Item 22	.853
Item 23	.883

Section III Dimension: Group Workshops		
	Component	
	Factor 1	Factor 2
Item 32	.864	.120
Item 29	.840	.318
Item 30	.802	.276
Item 33	.778	9.073E-03
Item 27	.137	.911
Item 26	8.265E-02	.902
Item 28	.214	.812
Item 31	.356	.407

Section III Dimension :One-on-one Technology Mentoring Program		
	Component	
	Factor 1	Factor 2
one on one 3	.947	.145
one on one 1	.946	.155
one on one 2	.921	.225
one on one 6	.883	.249
one on one 7	.256	.859
one on one 8	-3.610E-02	.845
one on one 5	.470	.714
one on one 4	.606	.608

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 3 iterations.

APPENDIX D: LETTER TO PT3 DIRECTORS/COORDINATORS

Dear PT3 Project Director/ Coordinator,

We are asking your help in obtaining data on an important sustainability issue for PT3 projects. We are conducting a survey designed to provide information on strategies for maintaining faculty use of technology. We plan to identify both barriers and solutions for faculty members who are currently using technology in their teaching. Previous research has shown the potential barriers involved for the faculty to begin using computer-related technology. However, we know little about how to keep the faculty members who have significantly used technology in their teacher preparation courses continuing to use technology. As part of a research project, National Survey on Barriers and Issues to Faculty's Continued Use of Technology, we have designed an online survey. We would like to have you recommend one to four technology-using faculty members in your institutions to participate in this online survey study.

The goal of this online survey is to identify issues and barriers to faculty's continued use of technology integration in their teacher preparation courses. This online survey takes approximately 20 minutes to complete. Participants will not be identified by name, and institution names will not be used in the reporting of the results. If you agree to provide a list of one to four technology –using faculty members in your teacher education program, we will be contacting each of them to gain their informed consent.

If you agree to provide a list of one to four potential survey participants, please email Hsueh-Hua (Shay Wa) Chuang at hhchuang@iastate.edu. Please also include contact information for faculty members so we will be able to contact them to gain their informed consent. If you have questions about this survey, please contact me at eat@iastate.edu. I am looking forward to hearing from you and appreciate your help in this important work.

Sincerely,

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APPENDIX E: LETTER TO POTENTIAL SURVEY TAKERS

Dr. _______,

Greetings from Iowa State University!

Currently, we are conducting a survey study on issues and barriers to faculty's continued use/integration of technology. You have been recommended as a technology-using teacher educator and, therefore, we would like to invite you to participate in this online survey. Please click on the following URL where the survey with informed consent is available. If you are unable to take the survey, please let me know. Your professional experience is very important to us and we appreciate your help in this important work. Thank you.

Survey URL

http://pc118081.chem.iastate.edu/mentor/survey.php

Sincerely,

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APPENDIX F: DETAILED DESCRIPTION OF THE RESPONDENTS' RESPONSES TO ITEM 25

Respondents' Written Description of the Most Significant Barrier to Their Continued Use of Technology in Their Courses:

Current lack of policy regarding distance learning within our University is an on-going issue with those of us who teach web-based courses.

in questions #22 and 23, this issue here is that these are important, but we have terrific administrative support, and a wonderful learning community - this is due to our PT3 grant

Students' access to technology, Sts' expertise

The most significant barrier to using technology is the time it takes to reserve the technology, make sure it's going to work, and troubleshoot during a lesson when something doesn't work. Another barrier is developing the background knowledge of how to integrate it into the course content without it taking a significant amount of time away from other content to be addressed.

I worry about the probable lack of support now that the PT3 funds have been exhausted. The summer grants were of great importance to me as I worked to learn new programs, develop technological applications for my courses, and read materials in preparation for writing about technology integration in my courses.

no other issues.

"Just keeping up with emerging technology, staying current.

Influence of K-12 use of technology (Are they keeping up? What's important out in the schools?"

It is not as much that I have trouble with these items as I know others that are much more troubled with it. The root of that might be that they are never given the time to pursue technology and its use. Also having immediate access to equipment is not alwasypossible and requires prearrangement often. Knowing the effect on learning is also an issue that faculty may not realize.

Easy access to effective subject specific technology.

Pepperdine has created opportunities to integrate technology- no real barriers

"Time is probably my greatest barrier. I need to find more time to refine my existing tech integration and I need to schedule time to explore new uses/integration.

Also, I need more time to meet with colleagues to explore/share tech content application."

One of the programs I use, WebCT, I find to be cumbersome and time consuming. I also find their workshops expensive.

I have a problem that you identified things as barriers, that are not barriers to me. For example, the use of technology is rewarded in my promotion & tenure. Many of the things you have listed as barriers are actually things that stimulate my use of technology such as wonderful tech support.

Off campus sites at which I teach don't often have the same equipment available to me as the campus - I have to alter plans or make adjustments.

Students come with different levels of technology information and I have to teach some basic skills before they can be integrated into the classroom tech use.

Funding is a growing concern in our state. Since budget cuts are severe, less operational funding is available.

We are fortunate to be fully supported in our efforts to integrate technology into Teacher Education Courses.

Office software does not reflect the technology lab.

Different classes require different uses of technology

I do not have and desperately need administration and leading faculty members who understand and want to promote using computers to teach...especially having the students use computers in my classes.

Not enough smart classrooms in which to teach.

Getting my hands on the technology and enough copies of it in lab settings where students can develop projects. My field is special education, and I have worked hard to fund software and equipment purchases.

The platform decisions at the college...a sense on the part of the institution that we should be a pc only environment, and the strong belief on the part of faculty with current field experience (I am also an urban public elementary school teacher) that we must maintain a dual platform, given the frequent use of Macintosh computers in elementary school settings

APPENDIX G: RESULTS OF THE ANOVA TABLES

One Way ANOVA within the Groups between Institution Types and Items in Section II

(Issue and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Groups	8.665	5	1.733	1.039	.404
	Within Groups	90.068	54	1.668		
	Total	98.733	59			
T2	Between Groups	9.484	5	1.897	1.517	.200
	Within Groups	67.516	54	1.250		
	Total	77.000	59			
T3	Between Groups	5.804	5	1.161	.432	.824
	Within Groups	145.046	54	2.686		
	Total	150.850	59			
T4	Between Groups	26.775	5	5.355	1.753	.138
	Within Groups	164.958	54	3.055		
	Total	191.733	59			
TD_1	Between Groups	15.030	5	3.006	1.696	.151
	Within Groups	95.704	54	1.772		
	Total	110.733	59			
TD_2	Between Groups	10.086	5	2.017	1.019	.416
	Within Groups	106.898	54	1.980		
	Total	116.983	59			
TD_3	Between Groups	11.878	5	2.376	1.491	.208
	Within Groups	86.055	54	1.594		
	Total	97.933	59			
Meaning 1	Between Groups	9.769	5	1.954	1.142	.350
	Within Groups	92.414	54	1.711		
	Total	102.183	59			
Meaning 2	Between Groups	11.973	5	2.395	1.707	.149
	Within Groups	75.760	54	1.403		
	Total	87.733	59			
NEED_1	Between Groups	14.945	5	2.989	1.467	.216
	Within Groups	110.038	54	2.038		
	Total	124.983	59			
NEED_2	Between Groups	10.815	5	2.163	1.144	.349
	Within Groups	102.118	54	1.891		
	Total	112.933	59			
NEED_3	Between Groups	21.174	5	4.235	1.617	.171
	Within Groups	141.426	54	2.619		
	Total	162.600	59			
NEED_4	Between Groups	23.291	5	4.658	1.900	.109
	Within Groups	132.359	54	2.451		
	Total	155.650	59			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (Doctoral/Research Universities Extensive, n = 24); Group 2 (Doctoral/Research Universities Intensive, n = 13); Group 3 (Master's Colleges and Universities, n = 19); Group 4(Specialized Institutions/Schools of art, music, and design, n=1); Group 5(Baccalaureate Colleges/Liberal Arts Institution, n=1); Group 6 (Specialized Institutions, n=2)

One Way ANOVA within the Groups between Academic Ranking and Items in Section II (Issue and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Groups	2.462	4	.615	.352	.842
	Within Groups	96.272	55	1.750		
	Total	98.733	59			
T2	Between Groups	7.228	4	1.807	1.424	.238
	Within Groups	69.772	55	1.269		
	Total	77.000	59			
T3	Between Groups	1.862	4	.466	.172	.952
	Within Groups	148.988	55	2.709		
	Total	150.850	59			
T4	Between Groups	7.658	4	1.915	.572	.684
	Within Groups	184.075	55	3.347		
	Total	191.733	59			
TD_1	Between Groups	10.726	4	2.682	1.475	.222
	Within Groups	100.007	55	1.818		
	Total	110.733	59			
TD_2	Between Groups	7.919	4	1.980	.998	.416
	Within Groups	109.064	55	1.983		
	Total	116.983	59			
TD_3	Between Groups	2.112	4	.528	.303	.875
	Within Groups	95.821	55	1.742		
	Total	97.933	59			
Meaning 1	Between Groups	2.923	4	.731	.405	.804
	Within Groups	99.260	55	1.805		
	Total	102.183	59			
Meaning 2	Between Groups	2.647	4	.662	.428	.788
	Within Groups	85.087	55	1.547		
	Total	87.733	59			
NEED_1	Between Groups	3.762	4	.941	.427	.789
	Within Groups	121.221	55	2.204		
	Total	124.983	59			
NEED_2	Between Groups	1.596	4	.399	.197	.939
	Within Groups	111.337	55	2.024		
	Total	112.933	59			
NEED_3	Between Groups	13.404	4	3.351	1.235	.307
	Within Groups	149.196	55	2.713		
	Total	162.600	59			
NEED_4	Between Groups	20.447	4	5.112	2.079	.096
	Within Groups	135.203	55	2.458		
	Total	155.650	59			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (Temporary Instructor, n = 8); Group 2 (Adjunct Professor, n = 8); Group 3 (Assistant Professor, n = 21); Group 4(Associate Professor, n=11); Group 5(Professor, n=12).

One Way ANOVA within the Groups between Years of Teaching in Higher Education and Questionnaire Items in Section II (Issue and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Group	.088	2	.044	.026	.975
	Within Groups	98.645	57	1.731		
	Total	98.733	59			
T2	Between Group	1.074	2	.537	.403	.670
	Within Groups	75.926	57	1.332		
	Total	77.000	59			
T3	Between Group	.019	2	.010	.004	.996
	Within Groups	150.831	57	2.646		
	Total	150.850	59			
T4	Between Group	7.284	2	3.642	1.126	.332
	Within Groups	184.449	57	3.236		
	Total	191.733	59			
TD_1	Between Group	3.696	2	1.848	.984	.380
	Within Groups	107.037	57	1.878		
	Total	110.733	59			
TD_2	Between Group	4.725	2	2.362	1.199	.309
	Within Groups	112.259	57	1.969		
	Total	116.983	59			
TD_3	Between Group	2.461	2	1.231	.735	.484
	Within Groups	95.472	57	1.675		
	Total	97.933	59			
Meaning 1	Between Group	4.424	2	2.212	1.290	.283
	Within Groups	97.759	57	1.715		
	Total	102.183	59			
Meaning 2	Between Group	.625	2	.313	.205	.816
	Within Groups	87.108	57	1.528		
	Total	87.733	59			
NEED_1	Between Group	4.725	2	2.362	1.120	.333
	Within Groups	120.259	57	2.110		
	Total	124.983	59			
NEED_2	Between Group	3.731	2	1.866	.974	.384
	Within Groups	109.202	57	1.916		
	Total	112.933	59			
NEED_3	Between Group	8.135	2	4.068	1.501	.232
	Within Groups	154.465	57	2.710		
	Total	162.600	59			
NEED_4	Between Group	10.978	2	5.489	2.163	.124
	Within Groups	144.672	57	2.538		
	Total	155.650	59			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (years of teaching in higher education between 1 and 10, n = 30); Group 2 (years of teaching in higher education between 11 and 20, n = 17); Group 3 (years of teaching in higher education above 20, n = 13).

One Way ANOVA within the Groups between Average Size of Undergraduate Students and Items in Section II (Issues and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Groups	.536	2	.268	.157	.855
	Within Groups	76.714	45	1.705		
	Total	77.250	47			
T2	Between Groups	1.110	2	.555	.410	.666
	Within Groups	60.869	45	1.353		
	Total	61.979	47			
T3	Between Groups	.405	2	.202	.075	.928
	Within Groups	121.512	45	2.700		
	Total	121.917	47			
T4	Between Groups	5.298	2	2.649	.771	.469
	Within Groups	154.619	45	3.436		
	Total	159.917	47			
TD_1	Between Groups	4.301	2	2.150	1.104	.340
	Within Groups	87.679	45	1.948		
	Total	91.979	47			
TD_2	Between Groups	.583	2	.292	.127	.881
	Within Groups	103.333	45	2.296		
	Total	103.917	47			
TD_3	Between Groups	1.726	2	.863	.480	.622
	Within Groups	80.940	45	1.799		
	Total	82.667	47			
Meaning 1	Between Groups	8.432	2	4.216	2.385	.104
	Within Groups	79.548	45	1.768		
	Total	87.979	47			
Meaning 2	Between Groups	5.301	2	2.650	2.068	.138
	Within Groups	57.679	45	1.282		
	Total	62.979	47			
NEED_1	Between Groups	6.408	2	3.204	1.480	.238
	Within Groups	97.405	45	2.165		
	Total	103.813	47			
NEED_2	Between Groups	12.810	2	6.405	3.465	.040
	Within Groups	83.190	45	1.849		
	Total	96.000	47			
NEED_3	Between Groups	17.039	2	8.519	3.008	.059
	Within Groups	127.440	45	2.832		
	Total	144.479	47			
NEED_4	Between Groups	19.336	2	9.668	3.688	.033
	Within Groups	117.976	45	2.622		
	Total	137.313	47			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (average undergraduate class size 1 to 20, $n = 14$); Group 2 (average undergraduate class size 21 to 40, $n = 28$); Group 3 (average undergraduate class size above 40, $n = 6$).

* $p<.05$

One Way ANOVA within the Groups between Average Size of Graduate Students and Items in Section II (Issues and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Groups	2.789	2	1.395	.830	.442
	Within Groups	78.991	47	1.681		
	Total	81.780	49			
T2	Between Groups	1.114	2	.557	.446	.643
	Within Groups	58.666	47	1.248		
	Total	59.780	49			
T3	Between Groups	3.337	2	1.669	.684	.510
	Within Groups	114.663	47	2.440		
	Total	118.000	49			
T4	Between Groups	4.716	2	2.358	.721	.492
	Within Groups	153.764	47	3.272		
	Total	158.480	49			
TD_1	Between Groups	1.629	2	.815	.445	.643
	Within Groups	85.991	47	1.830		
	Total	87.620	49			
TD_2	Between Groups	1.354	2	.677	.328	.722
	Within Groups	96.966	47	2.063		
	Total	98.320	49			
TD_3	Between Groups	1.459	2	.729	.500	.610
	Within Groups	68.541	47	1.458		
	Total	70.000	49			
Meaning 1	Between Groups	.351	2	.175	.089	.915
	Within Groups	93.029	47	1.979		
	Total	93.380	49			
Meaning 2	Between Groups	4.029	2	2.015	1.303	.281
	Within Groups	72.691	47	1.547		
	Total	76.720	49			
NEED_1	Between Groups	.248	2	.124	.059	.943
	Within Groups	98.232	47	2.090		
	Total	98.480	49			
NEED_2	Between Groups	1.539	2	.769	.417	.661
	Within Groups	86.641	47	1.843		
	Total	88.180	49			
NEED_3	Between Groups	.045	2	.023	.009	.991
	Within Groups	123.075	47	2.619		
	Total	123.120	49			
NEED_4	Between Groups	2.782	2	1.391	.504	.607
	Within Groups	129.718	47	2.760		
	Total	132.500	49			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (average graduate class size 1 to 10, n = 10); Group 2 (average graduate class size 11 to 20, n = 18); Group 3 (average graduate class size above 20, n = 22).

One Way ANOVA within the Groups between Years of Technology Integration and Items in Section II (Issues and Barriers to Faculty's Continued Use and Integration of Technology)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
T1	Between Groups	1.089	2	.544	.318	.729
	Within Groups	97.644	57	1.713		
	Total	98.733	59			
T2	Between Groups	1.050	2	.525	.394	.676
	Within Groups	75.950	57	1.332		
	Total	77.000	59			
T3	Between Groups	1.400	2	.700	.267	.767
	Within Groups	149.450	57	2.622		
	Total	150.850	59			
T4	Between Groups	1.089	2	.544	.163	.850
	Within Groups	190.644	57	3.345		
	Total	191.733	59			
TD_1	Between Groups	.650	2	.325	.168	.846
	Within Groups	110.083	57	1.931		
	Total	110.733	59			
TD_2	Between Groups	2.017	2	1.008	.500	.609
	Within Groups	114.967	57	2.017		
	Total	116.983	59			
TD_3	Between Groups	.272	2	.136	.079	.924
	Within Groups	97.661	57	1.713		
	Total	97.933	59			
Meaning 1	Between Groups	3.150	2	1.575	.907	.410
	Within Groups	99.033	57	1.737		
	Total	102.183	59			
Meaning 2	Between Groups	1.867	2	.933	.620	.542
	Within Groups	85.867	57	1.506		
	Total	87.733	59			
NEED_1	Between Groups	4.017	2	2.008	.946	.394
	Within Groups	120.967	57	2.122		
	Total	124.983	59			
NEED_2	Between Groups	2.606	2	1.303	.673	.514
	Within Groups	110.328	57	1.936		
	Total	112.933	59			
NEED_3	Between Groups	1.206	2	.603	.213	.809
	Within Groups	161.394	57	2.831		
	Total	162.600	59			
NEED_4	Between Groups	1.506	2	.753	.278	.758
	Within Groups	154.144	57	2.704		
	Total	155.650	59			

Note. T1=Item 11; T2=Item 12; T3=Item 13; T4= Item 14; TD_1=Item 15;TD_2= Item 16; TD_3= Item 17; Meaning 1= Item 18; Meaning 2= Item 19; Need_1= Item 20; Need_2= Item 21; Need_3= Item 22; Need_4= Item 23.

Group 1 (years of technology integration 1 to 5, n = 30); Group 2 (years of technology integration 6 to 10, n = 18); Group 3 (years of technology integration above 10, n = 12).

APPENDIX H: DETAILED DESCRIPTION OF THE RESPONDENTS' RESPONSES TO ITEM 12

Responses to Item 12, Key Characteristics of an Effective Faculty Development Program:

Finding the time to learn new technologies and design integrated instruction that takes advantage of these technologies.

I want to continue to find new and better ways to integrate technology. The opportunity and time to explore additional options is sometimes difficult.

none

Lack of equipment

"Planning time

Bringing students up to speed"

Reliable internet connection/ speed

Not being able to keep up with new applications and features; not having time to develop meaningful uses

Time required to learn new technologies and determine ways to integrate them into courses -- and the fact that that time is not considered in the tenure and promotion process.

The most significant barrier to my continued use of technology is the time it takes to plan for its use. If it didn't take so much effort beyond the planning for its use, it might be more easily incorporated.

It's difficult to list just one: Time, support funds, and continued moral support.
My most significant barrier to using technology is not having enough time to develop meaningful technology-based resources/materials/applications.
"Making/taking time to carefully plan for meaningful technology integration remains a barrier.

A concern (perhaps not a barrier) involves my tendency to ""ignore"" careful and thorough evaluation of/research on the results of my technology integration."
Course time - using technology in courses for instructional modeling and student projects takes time - planning and contact time.
If tech support diminished and equipment did not work I might use technology less.

My thinking about this matter places little or no weight on "barriers" or problems. Both Michigan State and my College are providing good support, starting with equipment and software. So my thinking runs along the lines of opportunities, affordances, and what's needed to take advantage of them.

No barriers - I teach technology in teachers so I always use it no matter what.

Access to functional equipment that doesn't require setting up and troubleshooting. I often bring my own stuff.

Amount of time it takes

Time, students' prior experience (or lack of), lack of reward

time (if problems are encountered)

Lack of student know-how to access technology resources provided by the instructor.

lack of time to explore new applications

Don't have time to get online during the week for syn or asyn discussions.

Time to plan curricula and develop appropriate media.

Lack of time considering teaching load

None, our University received and implemented a PT3 grant in technology, so we and the students are constantly implementing uses both in and out of the classrooms.

Time.

1. equipment malfunction
2. amount of time needed to learn new applications"

Time to get technology policy compliance from vendors for my off-campus sight.

Time. Though I probably am extremely busy because I have not yet developed my own set of lessons that are appropriate for this particular audience.

Time to learn new skills.

I am still relatively unconvinced that using technology within my courses represents a substantial improvement over what we can accomplish without the technology.

The continued presence of a subject -related grad student.

Lack of funding to acquire new equipment, software and other related resources.

Keeping up with new applications, and new software capabilities, are a continuing time challenge, but of course well worth the effort.

"Time---which is always stated as a factor.

One must model what it is they expect to receive from their students. It is time well spent."

personal lack of knowledge and time to learn

I need enough computers for all my students to use them in class. We need a wireless lab of laptops. To get that...well, I don't know how to get that here.

It takes time to learn to use it, and, as your survey suggested, is not something that is deemed as valuable in the tenure/promotion process as writing.

Lack of smart classrooms.

We have great tech support here. I just have to plan ahead to use it-- which sometimes means hauling projector and lap top to the class. 3 years ago I had access to neither-- but now I have a university issued lap top and a projector purchased for my use (grant $$$) We once had so few projectors that I had to compete for time-- but that is getting better.

teaching space with available technology...another college decision...to move from the single computer in each classroom to a lab structure...and the lab needs to be reserved well ahead of time…often with conflicts, no opportunity for spontaneous teachable moments to demonstrate when technology is the right tool/integration

Set-up time, lack of knowledge about how to trouble shoot effectively on the spot for every new issue, slow processing speeds, occasional internet failure

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