Integrating Technology into Teacher Education: Navigating the Complexity of Institutional Change

Kelly S. Shapley, Ph.D.
Aprile D. Benner, M.S.
Amy M. Pieper, M.A.
Pamela J. Way, Ph.D.

www.tcer.org

Sharla L. Snider, Ph.D.
Vera T. Gershner, Ph.D.
Texas Woman's University

Paper presented at the annual meeting of the American Educational Research Association, Chicago, Illinois, April 24, 2003

Integrating Technology into Teacher Education: Navigating the Complexity of Institutional Change

Learning and Integrating New Knowledge and Skills (LINKS) is a three-year technology project designed to integrate established and emerging technologies into the teacher preparation curriculum at the Texas Woman's University (TWU). The project is supported by a U.S. Department of Education implementation grant—Preparing Tomorrow's Teachers to Use Technology (PT^3). During its third year, the LINKS program has informed the redesign of the teacher education program at TWU to address future teachers' technology proficiencies. These proficiencies are recommended by the National Council for the Accreditation of Teacher Education (NCATE), delineated by professional associations, required by Texas public schools, and in 2002, assessed by the Texas Examination of Educator Standards (TExES) teacher certification exam. In addition to supporting preservice teachers' performance and responsibilities in coursework and field-based locations, LINKS supports on-going changes in university faculty involvement and roles and technology curriculum content and delivery. Because TWU strongly supports technology integration in its teacher education program, and as a result of LINKS' success, many project components have been incorporated into the teacher education program in anticipation of the grant's conclusion.

Background

Recent efforts at many universities, similar to TWU, have centered on technology integration. A 1990 survey of 282 colleges revealed that "almost all" are attempting to integrate technology into programs to enable teacher education students to "function in the information age" (as cited in Faison, 1994). Still, rapid technology advances make it difficult to keep pace and outcomes have been mixed. In 1995, a report from the Office of Technology Assessment (OTA) found that, as a whole, teacher education programs are not preparing graduates to use technology as a teaching tool (OTA, 1995). Not surprisingly, more recent reports also suggest that new teachers entering classrooms are unprepared to use technology to its full potential (CEO Forum on Education and Technology, 2000). Furthermore, both new and experienced teachers continue to struggle with technology integration. According to a recent study by NCES (2000), although 66% of teachers report using computers or the Internet for instruction, most lessons fail to involve complex inquiry, exploration, or problem-solving activities. Moreover, only 33% of teachers feel either "well prepared" or "very well prepared" to use technology.

The challenge for higher education institutions, particularly colleges of education, has been to create an environment that allows preservice teachers to employ a variety of technology tools. The debate now centers on the best means to integrate technology into teacher education programs. Approaches range from simply encouraging students to use email to more advanced programs designed to infuse technology into all aspects of the teacher education curriculum. Innovations that have been implemented with varying degrees of success include electronic contacts via email, listservs, Internet, and dialogue (Blake, Holcomb, & Foster, 1998; Brindley, Fleege, & Graves, 2000; Buss, 2001; Casado, 2001; Cohen & Jacobson, 2000; Guha, 2001; McIntyre & Tlusty, 1995; Way & NEIREL, 2001; Weigel, 2002); virtual workshops and add-on coursework (Simmons & Linnell, 1998; Veen, Lam, & Taconis, 1998; Way & NEIREL, 2001;

Wood, Willoughby, Specht, Stern-Cavalcante, & Child, 2002); as well as comprehensive, integrated approaches (Drazdowski, Holodick, & Scappaticc, 1998; Parker & Farrelly, 1994; Schrum & Dehoney, 1998). Concerns about individual attitudes and perceptions that pose significant barriers to technology have also been the focus of research efforts (Berge & Muilenburg, 2001; Blake, Holcomb, & Foster, 1998; Buhendwa, 1996; Groves & Zemel, 2000; Judge, 2001; Medcalf Davenport, 1999; Smithey & Hough, 1999; Strudler & Wetzel, 1999, White & Meyers, 2001).

The technology standards movement currently provides direction for teacher education on several levels. The International Society for Technology Education (ISTE, 2002) has specified national educational standards for students and teachers. More precise guidance for teacher preparation institutions is offered through the CEO Forum on Education and Technology's *Teacher Preparation StaR Chart: A Self-Assessmsent Tool for Colleges of Education* (2000). The tool provides standards and progress benchmarks on university and college of education leadership, infrastructure, curriculum, faculty, and students.

Purpose of the Study

This paper describes how the LINKS PT^3 project has evolved over three years to support technology infusion into teacher education at TWU. Findings reveal the experiences of a cohort of preservice teachers who participated across three terms (fall 2000, spring 2001, and fall 2001), groups of preservice and post-baccalaureate students who enrolled in newly-created online courses in spring 2002, and university faculty. In addition, using the CEO Forum's StaR Chart as a conceptual framework, investigators examine factors contributing to the institutionalization of project objectives. Researchers monitored changes in participants' technological proficiency over time, implementation concerns (Concerns-Based Adoption Model—Hord, Rutherford, Huling-Austin, & Hall, 1987), levels of technology use, and perceptions of the quality and usefulness of learning experiences. The primary research questions were as follows:

- How did LINKS support technology infusion into teacher education, and to what extent did preservice teachers build their technological proficiencies and understanding of curricular integration?
- How did LINKS support university instructors, and to what extent did instructors build proficiencies for technology integration?
- What progress was made toward the infusion of technology into the university as a whole?

The Teacher Education Program at TWU

The Professional Development Center (PDC) in the College of Education and Human Ecology manages the field-based teacher education program at TWU. To assist in achieving an optimal learning experience, the PDC combines university-based instruction with student field-based experiences in 11 north Texas school districts. Specifically, the PDC targets 44 schools in 6 rural, 3 suburban, and 2 urban school districts. Each semester, approximately 200 future teachers enroll in traditional university coursework in educational theories and methodologies, and then

have the opportunity to apply these theories and methodologies in the local school districts. Prior to fall 2001, preservice teachers experienced the technology curriculum as they progressed through three phases—Intern I, Intern II, and Residency—during their field-based placements. Beginning in fall semester 2001, TWU initiated an integrated approach to technology course requirements for all undergraduate students earning their foundation certifications. Two new undergraduate courses, Education 3001 (EDUC 3001—Integrating Technology for Effective Learning) and Education 4001 (EDUC 4001—Integrating Technology into Instruction and Assessment), are now completed concurrently with other professional preparation courses during the first and second semester of the undergraduate teacher education sequence. Working in collaboration with the College of Arts and Sciences as well as the School of Library Information Sciences, the integrated technology teacher education courses are preceded by two specific courses designed to aid in the development of preservice teachers' technology skills (i.e., foundations for technology and information literacy skills). In addition, LINKS activities have also been extended to the post-baccalaureate teacher preparation program through an online course, Education 5131 (EDUC 5131—Integrating Technology into Assessment and Instruction).

Learning and Integrating New Knowledge and Skills (LINKS)

The LINKS PT^3 project was initially designed to enhance the teacher preparation program at TWU by ensuring systemic integration of technology into the curriculum. The project has addressed the technology needs of future teachers by supporting their development as well as the associated development of their mentor and supervising teachers and university instructors. The project evolved from TWU's existing TechTrek technology integration curriculum within the teacher education program. Technology competency indicators were based on the Texas Education Agency's (TEA's) five Learner-Centered Proficiencies for Texas Schools (learner-centered knowledge, learner-centered instruction, equity in excellence for all learners, learner-centered communication, and learner-centered professional development), the Examination for the Certification of Educators in Texas (ExCET)—which has now become the TExES, the Texas Essential Knowledge and Skills (TEKS), and the Professional Development Appraisal System (PDAS). The curriculum was further enhanced by the National Educational Technology Standards (NETS). In addition to coursework sessions with instructors, students have been introduced to technology indicators through distance learning via the TechTrek website (a TWU-developed curriculum website incorporating elements of the *Basic Technology Competencies for Educators Inventory,* Flowers, 1997) and a Technology Competency Passport (a comprehensive evaluation tool).

The Technology Passport, based on TEA's learner-centered proficiencies, identified the skills required to produce technologically competent teachers. Preservice teachers used the Passport to acquire both *essential knowledge and skills* and *expanded knowledge and skills.* Essential knowledge and skills, which align with the state-adopted technology curriculum, includes four components or strands: (a) foundations (e.g., technology-related terms, concepts, and data-input strategies); (b) information acquisition (e.g., identification of task requirements and search strategies); (c) work in solving problems (e.g., knowledge synthesis, solution generation, results evaluation); and (d) communication (e.g., sharing results in various formats with diverse audiences). Expanded knowledge and skills addresses the competencies necessary for teachers to

effectively integrate technology into instructional design and delivery in the classroom. Competencies are categorized further as three levels of productivity, connectivity, and integration.

The LINKS project was managed by co-directors who are TWU faculty members. A training coordinator, administrative assistant, web master, and external evaluator assisted project leaders. The LINKS Center, which was established through grant resources, was housed in a multipurpose classroom building typically used for teacher education courses.

Evolution of the LINKS Project

In project years 1 and 2, each preservice teacher in professional coursework received specific, on-campus instruction over a three-semester sequence as an Intern I, Intern II, and Resident along with extensive field-based experiences. The LINKS program aligned with the three-semester sequence (Intern I to Resident). The technology curriculum delivery included large group instruction, lab instruction, and distance education support through TechTrek and by email and telephone. To monitor progress, students completed the Technology Passport, which tracked student mastery of the various technology standards required as part of the teacher education program. Each individual applying for admission to teacher education received a Passport to build early awareness of required technology proficiencies for teacher certification. The Passport also alerted professors in both the Colleges of Professional Education and Arts and Science to technology expectations and standards as they related to content areas and the state standard for technology applications.

Figure 1 illustrates the various LINKS components for year 3. As discussed previously, LINKS activities have been institutionalized as a part of the teacher education program. Students now complete two technology courses incorporating LINKS technology components (EDUC 3001, EDUC 4001) concurrently with other professional preparation courses during the first and second semesters of the undergraduate teacher education sequence. Residents in fall 2001 were the last group of students to use TechTrek and the Technology Passport. Post-baccalaureate students now complete an online course (EDUC 5131) as well.

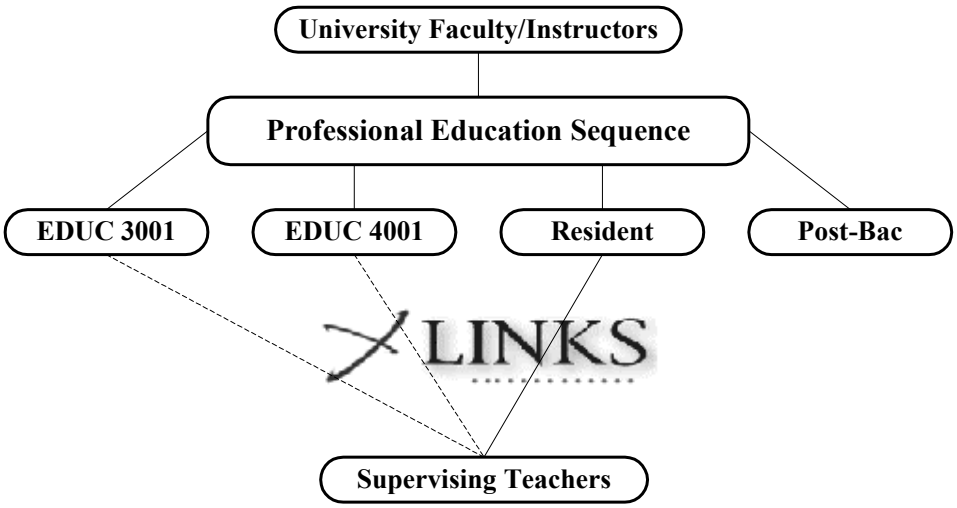

Figure 1. Texas Woman's University (TWU) Teacher Education Program

Across all project years, LINKS personnel have encouraged the awareness of mentor and supervising teachers in the field so they could be more supportive of preservice teachers' initial efforts to use technologies in instruction. LINKS has also supported university instructors in developing and implementing web-based course delivery so that instructors could model technology integration in their own curriculum design and delivery. The LINKS website and associated curriculum is now integrated within online Blackboard courses maintained by professors teaching each technology course—thus, achieving the project's three-year goal of systematic and formalized institutionalization of the integrated technology concept for preservice teacher educators. In-depth descriptions of the current preservice teacher strand, post-baccalaureate student strand, and university instructor strand are described in subsequent sections of this paper.

Approach and Method

Participants

Table 1 shows the data collection pattern for a cohort of preservice teachers who progressed through the original three project phases—Intern I, Intern II, and Residency—during their field-based placements. Students were Intern Is in fall 2000 and Residents in 2001. In fall 2001, TWU introduced the new technology course requirements for undergraduate students pursuing foundation certification. Students enrolled in two undergraduate courses, Education 3001 (EDUC 3001—Integrating Technology for Effective Learning) and Education 4001 (EDUC 4001—Integrating Technology into Instruction and Assessment), completed evaluation measures at the beginning and end of the spring 2002 semester, as did post-baccalaureate students enrolled in Education 5131 (EDUC 5131—Integrating Technology into Assessment and Instruction).

Table 1
Data Collection Patterns for Preservice and Post-Baccalaureate Teachers

Preservice		Year 2		Year 3	
Teachers	*N*	Fall 2000	Spring 2001	Fall 2001	Spring 2002
Residents	33	✓	✓	✓	
EDUC 3001	42				✓
EDUC 4001	12				✓
Post-Bacs	16				✓

Note. Data collection instruments and procedures varied for EDUC 3001 and EDUC 4001 students, post-baccalaureates, and Residents. *N* = number of students with available data.

Investigators also collected data from university instructors who volunteered to attend training sessions that supported understanding of technology integration and the delivery of web-based coursework via Blackboard. The number of instructors varied across data collection events (8 to 23 instructors), with faculty representing diverse university disciplines.

Data Collection Methods

The LINKS project measured the progress of project participants at various phases and assessed the utility and effectiveness of the LINKS training and associated technology courses. As shown in Table 2, data collection involved a variety of measures.

Table 2
LINKS Project Evaluation Measures

Measure	Acronym	Preservice Teachers & Post-Bacs	University Instructors
Self-Evaluation Rubrics			
a. Basic Computer Use	BCU	✓	
b. Internet Use	IU	✓	
c. Advanced Computer Use	ACU	✓	
CBAM: Stages of Concern Questionnaire	SoCQ	✓	✓
Level of Use Questionnaire	LoUQ		✓
Training evaluation questionnaires		✓	✓
Telephone interviews			✓

Note. CBAM=Concerns-Based Adoption Model (Hord, Austin-Huling, Rutherford, Hall, 1987).

Technology Proficiency

The primary goal of the PT^3 grant is to prepare technologically proficient teachers, so the selected instruments measured preservice and post-baccalaureate students' growth in basic and more advanced skills. Self-evaluation rubrics provided data related to individuals' technology proficiencies in basic computer use, Internet use, and advanced computer use.

Self-Evaluation Rubrics. Preservice and post-baccalaureate students completed self-evaluation rubrics measuring productivity, connectivity, and integration. Basic Computer Use and Advanced Computer Use are each measured by 7 dimensions; there are 10 dimensions for Internet Use. Each dimension includes four performance levels, with level three considered mastery. The dimensions within each instrument are listed below:

- *Basic Computer Use (BCU)*: basic computer operation, file management, word processing, spreadsheet use, database use, graphics use, hypermedia use, network use, student assessment, and ethical use understanding.
- *Internet Use (IU)*: email and electronic lists, world wide web, search tools, newsgroups and gophers, obtaining and using files, real-time and push technologies, webpage construction, learning using the internet, and netiquette (USDE, OERI, 1998).
- *Advanced Computer Use (ACU)*: instructional software use, information literacy skills, modification of instructional delivery, assessment, individualization of the educational program, professional growth and communication, and research and evaluation of technology use.

Concerns about Technology

The Stages of Concern Questionnaire (SoCQ) monitors changes in attitudes and behaviors as an innovation is implemented. The SoCQ consists of 35 items that are rated on a 7-point Likert scale with three anchors: 1 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true*

of me now). The instrument measures the intensity of concerns around three main clusters (self, task, and impact concerns). The technical qualities of the instrument are acceptable. Cronbach alpha coefficients of internal consistency range from .64 to .83, and the test-retest Pearson *r* correlations range from .65 to .86. The SoCQ was administered at the beginning and end of semester for EDUC 3001 and 4001 students and post-baccalaureates. Residents completed the SoCQ as Interns in fall 2000 and at the end of their Residency in fall 2001. Additionally, university instructors participating in training also completed the measure. When completing the electronically administered questionnaire, individuals were directed to "respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement with the use of educational technology." Educational technology was further defined for respondents according to the LINKS concepts of productivity, connectivity, and integration.

Technology Use

Level of Use Questionnaire (LoUQ). For the first project year (1999-00), data on instructors' Level of Use were collected through individual interviews. Interviews centered on instructors' use of Blackboard and followed procedures outlined in a detailed interview manual (Loucks, Newlove, & Hall, 1975). Due to excessive time requirements for individual interviews, project staff developed an objective questionnaire (LoUQ) to be administered online intermittently during the second and third year. Drawing on year-one interview responses, project staff developed items related to Blackboard use. Seven items were developed for each LoU dimension (Nonuse, Orientation, Preparation, Mechanical Use, Routine Use, Refinement, Integration, and Renewal). The final questionnaire included 56 items rated on an 8-point scale with three anchors: 0 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true of me now*). The purpose of the LoUQ was to establish instructors' level of use at various stages of the innovation adoption process.

Quality and Utility of Training

Preservice teachers, post-baccalaureates, and instructors completed session evaluation forms including both objective and open-ended items assessing the perceived quality and usefulness of various LINKS training sessions offered during the 2001-02 school year.

Faculty Perceptions

In May and June 2002, researchers conducted telephone interviews with eight TWU faculty who had participated in various LINKS activities to gauge their perceptions of LINKS and its impact on their technology proficiency and instructional use.

Findings

Preservice and Post-Baccalaureate Teachers

Preservice Teacher Strand

As stated previously, in the fall 2001 semester, TWU initiated an integrated approach to technology course requirements for all undergraduate students earning their foundation certifications. Two new undergraduate courses, Education 3001 (EDUC 3001—Integrating Technology for Effective Learning) and Education 4001 (EDUC 4001—Integrating Technology into Instruction and Assessment), are completed concurrently with other professional preparation courses during the first and second semester of the undergraduate teacher education sequence.

EDUC 3001. This undergraduate course introduces the concept of technology integration in education, including principles and strategies for using software and Internet tools for both teacher productivity and student learning. More specifically, EDUC 3001 seeks to (a) describe the evolution of educational technology and examine current issues on school and classroom implementation, (b) identify the ways in which instructional technology can enhance teaching and learning functions, (c) identify the role of Internet resources and strategies in teaching and learning, and (d) support preservice teachers' development of TExES standards and competencies related to technology. Students enrolled in EDUC 3001 complete a series of five online learning modules:

Module 1: Educational Technology: Past, Present, and Future
Module 2: Learning Theories and Technology Planning/Integration Strategies
Module 3: Examining Instructional Software
Module 4: Examining Productivity Software
Module 5: Integrating the Internet into Classroom Instruction

Each module includes a pretest, readings, activities, small- and whole-group discussions, and a posttest. In addition to the online learning modules, students must complete 10 lab modules:

Module 1: Getting Started
Module 2: Locating Resources for Unit Portfolios
Module 3: Creating Student Multimedia Presentations
Module 4: Creating Student Publications
Module 5: Creating Unit Support
Module 6: Creating Student Web Sites
Module 7: Creating Teacher Support Materials
Module 8: Developing Plans for Implementation
Module 9: Putting Unit Portfolios Together
Module 10: Showcasing Unit Portfolios

EDUC 4001. Students enrolled in EDUC 4001 learn about technology in the design and delivery of both instruction and assessment, uses for technology in the curricula, and activities successfully modeling subject-area technology integration strategies. Specific training goals for

the class include (a) identification of the unique capabilities of specific software and Internet tools to meet distinct classroom needs; (b) enhanced awareness of multimedia and hypermedia capabilities and educational applications; (c) design of lesson integration strategies for instructional software, technology tools, and multimedia and hypermedia through an integrated curriculum and specific subject area focus; and (d) continued support for preservice teachers' development of TExES standards and competencies related to technology. Similar to EDUC 3001, undergraduate students in EDUC 4001 complete five online learning modules (each including pretest, readings, activities, small- and whole-group discussions, and posttest components):

Module 1: Examining Hypermedia/Multimedia
Module 2: Exploring Curriculum Areas: Language Arts/Math/Science
Module 3: Exploring Curriculum Areas: Social Studies/Art/Music
Module 4: Exploring Curriculum Areas: Physical Education/Special Education
Module 5: Current Trends and Future Projections

EDUC 4001 students also complete the same lab modules as EDUC 3001 students.

The sections to follow present findings related to the experiences of the final cohort of Residents completing the Intern I-Intern II-Residency components of the LINKS project as well as students enrolled in EDUC 3001 and EDUC 4001. All groups of preservice teachers completed evaluation questionnaires gauging the effectiveness of associated LINKS technology activities (Residents) or the new education coursework (EDUC 3001 and EDUC 4001 students). In addition to training evaluations, Residents completed technology proficiency and attitude pretests as Intern Is in fall 2000 and posttests at the end of their Residency (fall 2001). EDUC 3001 and 4001 students completed proficiency and attitude measures at the beginning and end of the semester.

Quality and Utility of LINKS Sessions and Associated Courses

Evaluation questionnaires completed by preservice teachers at the end of each semester assessed perceptions of the quality and utility of LINKS activities (Residents) or LINKS-associated courses (EDUC 3001 and EDUC 4001 students). Residents completed a questionnaire with three objective and three open-ended items. EDUC 3001 and EDUC 4001 students responded to a slightly different evaluation questionnaire that included four objective and three open-ended questions.

All preservice teachers first rated the effects of LINKS sessions/courses on a 6-point scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*), and all students rated an item related to their motivation to use technology more in the classroom. Additionally, items on the EDUC 3001 and 4001 evaluations related to building technology proficiencies and understanding of classroom technology integration. Residents, in turn, rated effect of LINKS sessions on their ability to use technology more effectively in the classroom. On a final objective item, all preservice teachers provided an overall rating of the sessions/courses, with ratings ranging from 1 (*not at all helpful*) to 6 (*extremely helpful*). Table 3 presents preservice teachers' responses to the objective portions of the evaluation questionnaires.

Table 3
Preservice Teachers' Ratings for Training Sessions/Courses

	EDUC 3001 (S02) *N*=32	EDUC 4001 (S02) *N*=14	Resident (F01) *N*=33
Built technology proficiencies	4.7	5.1	--
Better understanding of integrating technology in the classroom	4.9	5.2	--
Motivated to use technology more in the classroom	5.0	5.0	5.4
Able to use technology more effectively in the classroom	--	--	5.5
Overall rating of sessions	4.9	4.9	5.3

Note. Items rated on a 6-point scale. F01 = fall 2001 and S02 = spring 2002.

In general, Residents provided higher ratings for evaluation items than EDUC 3001 and 4001 students. For example, in rating the sessions/courses overall, Residents provided an average rating of 5.3 (on a 6-point scale), while EDUC 3001 and 4001 students averaged a 4.9 rating. Similarly, Residents strongly agreed that, as a result of the sessions, they felt motivated to use technology more in the classroom. EDUC 3001 and 4001 students averaged lower ratings for this item, perhaps due to being in initial phases of the teacher education sequence and their relative inexperience in the classroom setting. In examining items only included on the EDUC students' evaluations, results indicate that EDUC 4001 students more often agreed that the LINKS-associated course built their technology proficiencies and gave them a better understanding of technology integration in the classroom. Overall, results suggest that as preservice teachers advance through developmental coursework, they become more technologically proficient, have a better understanding of technology integration, and are more motivated to use technology.

Important Learning, Concerns, and Suggestions

Three open-ended questions related to important learning, concerns with using the information, and suggestions for project improvement. Responses, which are summarized below, represent the opinions of the preservice teachers who responded to the questionnaire.

Important learning. The three groups of preservice teachers identified similar areas in which they feel they have improved as a result of participating in the sessions/courses. As shown in Table 4, respondents most commonly noted improvements in their technology knowledge and skills. All EDUC 3001 students mentioned gains in this area, as did the majority of EDUC 4001 students (86%) and Residents (70%). These respondents frequently identified specific technology skills or applications they had learned, such as PowerPoint, WebQuests, building file folders, or using graphics. The ability to integrate technology into the classroom was another area in which preservice teachers felt they had benefited from the sessions/courses. Between 19% and 29% of preservice teachers mentioned this as an area in which they have grown. One preservice teacher commented, "I have gained an understanding of how to integrate technology into all content areas of the teaching field." In addition to learning skills, preservice teachers also noted gains in their confidence in using technology. Not surprisingly, a higher percentage of Residents (21%), who had more exposure to LINKS-associated activities and field-based

experiences, identified this as an area of growth. Other gains mentioned by preservice teachers included an increased awareness of available technology, a greater understanding of the importance of technology in teaching, and an expansion in technology use. In general, preservice teachers' identified learning corresponds to the curricular focus of the teacher education coursework and field experiences.

Table 4
Preservice Teachers' Important Learning

Topic or Issue	EDUC 3001 (S02) *N*=32	EDUC 4001 (S02) *N*=14	Resident (F01) *N*=33
Technology knowledge and skills	32 (100%)	12 (86%)	23 (70%)
Ability to integrate technology into the classroom	6 (19%)	4 (29%)	7 (21%)
Confidence using technology	6 (19%)	2 (14%)	7 (21%)
Awareness of available technology	6 (19%)	2 (14%)	1 (3%)
Understanding of importance of technology in schools	2 (6%)	1 (7%)	1 (3%)
Use of technology	4 (13%)	3 (21%)	--

Note. F01 = fall 2001 and S02 = spring 2002

Main concerns regarding application of the information. Preservice teachers' main concerns regarding the application of technology information related to technology access, time constraints, and awareness of changes in technology. All three groups of preservice teachers mentioned concerns around adequate access to technology resources in their future positions. One preservice teacher voiced this concern commenting, "I am concerned about what to do if I am in a school district that cannot afford a lot of technology for its students." Preservice teachers also commented on concerns related to time constraints. While not frequently mentioned by EDUC 3001 and EDUC 4001 respondents (6% and 14%, respectively), this was the most frequent concern identified by Residents (45%). Thus, as preservice teachers participate in more field-based experiences, they appear to become more aware of the time constraints teachers face in incorporating technology into lessons. EDUC 3001 students, in contrast, most frequently noted concerns about keeping pace with changes in technology. Their comments reflected an awareness that technology changes quickly, and they are concerned about being "left behind." Overall, training evaluation evidence suggests that as preservice teachers move through the course sequence, their concerns reflect their experiences, with concerns maturing from wanting to know about technology (and changes therein) to actual classroom resource availability, and finally, to time constraints limiting use and integration.

Suggestions for making sessions/courses more effective. Preservice teachers' primary suggestions for improvements centered on issues related to session/course structure. More than half of EDUC 3001 students (63%) suggested including at least one face-to-face meeting during the course in addition to the online discussion. Several thought such a meeting would be beneficial to help students familiarize themselves with one another and the use of Blackboard. Many students indicated that an initial meeting at the beginning of the semester would be most helpful. All three groups of preservice teachers offered suggestions regarding session/course instruction. These suggestions varied widely but included comments such as more in-depth

online discussions, additional discussions about Intel models, and more step-by-step instructions. Some EDUC 3001 students noted it would be useful to have a specific lab time or technical assistance for education students. Notably, a large percentage of Residents (42%) were satisfied with the sessions and commented that no changes were needed.

Impact Measured by Self-Evaluation Rubrics

Basic Computer Use (BCU). BCU results, as displayed in Table 5, show that preservice teachers considered themselves more proficient technology users at the end of the semester than at the beginning of the semester.

Table 5
Basic Computer Use Rubrics for EDUC 3001 and EDUC 4001, Spring 2002

	Pretest		Posttest			Paired
EDUC 3001	Mean	SD	Mean	SD	Difference	*T*-test
Basic Computer Operation	2.74	.82	3.51	.67	0.77	**
File Management	2.63	.66	3.05	.38	0.42	**
Word Processing	2.79	.56	3.19	.45	0.40	**
Spreadsheet Use	1.95	.84	2.42	.70	0.47	**
Database Use	1.65	.70	2.48	.75	0.83	**
Graphics Use	2.23	.99	3.14	.71	0.91	**
Hypermedia Use	1.16	.49	2.19	.96	1.02	**
	Pretest		Posttest			Paired
EDUC 4001	Mean	SD	Mean	SD	Difference	*T*-test
Basic Computer Operation	3.08	.79	3.92	.29	0.83	**
File Management	3.08	.52	3.33	.49	0.25	--
Word Processing	2.92	.29	3.42	.52	0.50	**
Spreadsheet Use	2.25	.87	2.92	.79	0.67	**
Database Use	1.83	.72	2.42	.79	0.58	**
Graphics Use	2.42	.90	3.50	.52	1.08	**
Hypermedia Use	1.25	.62	2.75	.87	1.50	**

Note. Statistics based on 40-43 valid matched pairs EDUC 3001 and 12 valid matched pairs for EDUC 4001 using paired-samples *t*-tests. ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery."

Results reveal statistically significant differences ($p<.01$) in EDUC 3001 students' perceived proficiencies on all basic dimensions from pretest to posttest and on seven of eight domains for EDUC 4001 students. EDUC 3001 students ($N=48$) posted the strongest gains in hypermedia, graphics, and database use. Similarly, EDUC 4001 students ($N=12$) experienced the greatest progress in hypermedia, graphics, and basic computer operations use. By posttest, EDUC 3001 students achieved mastery (level three or higher) in basic computer management, word processing, graphics use, and file management. At posttest, EDUC 4001 students' averages on these dimensions also exceeded the mastery criterion, and their averages on all dimensions except one (database use) exceeded those of EDUC 3001 students.

Residents completed the BCU as Intern Is in fall 2000 and then at the end of their Residency in fall 2001. Results, as displayed in Table 6, illustrate the strides these preservice teachers made in their basic technology proficiencies. In total, 23 Residents had pre- and posttest data. Residents

made great progress over the course of the three semesters, with proficiencies on all domains increasing at a statistically significant level ($p<.01$ for five of six domains; $p<.05$ for one domain). Residents exhibited the greatest improvements in graphics use, database use, and basic computer operations. These preservice teachers achieved mastery level (3.00) for all domains except database and spreadsheet use, and their averages in these areas (2.91 and 2.83, respectively) neared the mastery criterion.

Table 6
Basic Computer Use Rubrics for Residents

	Intern I (F00) Pretest		Resident (F01) Posttest			
	Mean	SD	Mean	SD	Difference	Paired *T*-test
Basic Computer Operation	2.78	.85	4.00	.00	1.22	**
File Management	2.78	.42	3.22	.60	0.43	*
Word Processing	3.14	.35	3.86	.35	0.73	**
Spreadsheet Use	1.91	.67	2.83	.58	0.91	**
Database Use	1.52	.67	2.91	.60	1.39	**
Graphics Use	2.09	.85	3.61	.58	1.52	**

Note. Statistics based on 21-23 valid matched pairs using paired-samples *t*-tests. * p<.05, ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery." F00 = fall 2000 and F01 = fall 2001.

Internet Use (IU). EDUC 3001 and 4001 students generally considered themselves more proficient Internet users at the end of semester than at the beginning of semester. Results, as shown in Table 7 reveal statistically significant differences on all nine dimensions for EDUC 3001 students and eight of nine dimensions for EDUC 4001 students. Preservice teachers in EDUC 3001 showed the strongest improvements in obtaining and using files; newsgroups, gophers, and telnet; and learning opportunities using the Internet. EDUC 4001 students made the most progress in learning opportunities using the Internet, obtaining and using files, Internet basics, and real-time/push technologies. Not surprisingly, results indicate that preservice teachers more often achieved mastery criterion in EDUC 4001 than in EDUC 3001. Future teachers in EDUC 3001 reached mastery in four domains—email and mailing lists, search tools, learning opportunities using the Internet, and the World Wide Web. In addition to reaching mastery criterion in these domains, EDUC 4001 students also achieved mastery in Internet basics and obtaining and using files.

Table 7
Internet Use Rubrics for EDUC 3001 and EDUC 4001, Spring 2002

	Pretest		Posttest			Paired
EDUC 3001	Mean	SD	Mean	SD	Difference	*T*-test
Internet Basics	2.26	.62	2.95	.87	0.70	**
Email/Mailing Lists	2.72	.67	3.44	.50	0.72	**
World Wide Web	2.51	.59	3.09	.43	0.58	**
Search Tools	2.64	.53	3.29	.55	0.64	**
Newsgroups, Gophers, Telnet	1.33	.57	2.26	.76	0.93	**
Obtaining and Using Files	1.67	.61	2.65	.78	0.98	**
Real-Time/Push Technologies	1.71	.56	2.54	.87	0.83	**
Webpage Construction	1.33	.62	2.15	.99	0.82	**
Learning Opportunities Using Web	2.29	.81	3.22	.76	0.93	**
	Pretest		Posttest			Paired
EDUC 4001	Mean	SD	Mean	SD	Difference	*T*-test
Internet Basics	2.25	.75	3.33	.65	1.08	**
Email/Mailing Lists	2.58	.67	3.33	.49	0.75	**
World Wide Web	2.58	.67	3.25	.45	0.67	**
Search Tools	2.92	.52	3.25	.45	0.33	--
Newsgroups, Gophers, Telnet	1.67	.65	2.50	.91	0.83	**
Obtaining and Using Files	1.75	.75	3.00	.74	1.25	**
Real-Time/Push Technologies	1.92	.90	2.92	.90	1.00	**
Webpage Construction	1.58	.90	2.42	1.00	0.83	**
Learning Opportunities Using Web	2.27	1.00	3.64	.51	1.36	**

Note. Statistics based on 21-22 valid matched pairs for EDUC 3001 and 11-12 valid matched pairs for EDUC 4001 students using paired-samples *t*-tests. * p<.05, ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery."

Results for 22 Residents who completed the IU at the end of the fall 2000 and fall 2001 semesters are presented in Table 8.

Table 8
Internet Use Rubrics for Residents

	Intern I (F00) Pretest		Resident (F01) Posttest			Paired
Dimensions	Mean	SD	Mean	SD	Difference	*T*-test
Internet Basics	2.27	.70	3.14	.83	0.86	**
Email/Mailing Lists	2.90	.63	3.43	.51	0.52	**
World Wide Web	2.64	.73	3.09	.43	0.45	*
Search Tools	2.73	.55	3.14	.47	0.41	**
Newsgroups, Gophers, Telnet	1.59	.73	2.59	.85	1.00	**
Obtaining and Using Files	1.91	.92	2.77	.81	0.86	**
Real-Time/Push Technologies	1.95	.58	2.77	.81	0.82	**
Webpage Construction	1.23	.43	2.59	.80	1.36	**

Note. Statistics based on 21-22 valid matched pairs using paired-samples *t*-tests. * p<.05, ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery."

In general, these preservice teachers showed important gains over the three semesters, with statistically significant differences emerging in all Internet proficiency areas (p<.01 for seven of

eight domains, $p<.05$ for one domain). Residents made the greatest progress in webpage construction and newsgroups, gophers, and telnet. Moreover, these students' averages exceeded the mastery level on four domains: email and mailing lists, Internet basics, search tools, and the World Wide Web.

Advanced Computer Use (ACU). At the Resident level, preservice teachers also completed the ACU in addition to the BCU. As presented in Table 9, the 28 Residents attained higher proficiency levels at posttest, on average, for all domains except assessment of student performance. Statistically significant differences ($p<.01$) emerged in information literacy skills and instructional software use. At posttest, Residents' self-ratings met or exceeded the mastery criterion (3.00) for instructional software use, modification of instructional delivery, and professional growth.

Table 9
Advanced Computer Use Rubrics for Residents in Fall 2001

	Pretest		Posttest			Paired
Dimensions	Mean	SD	Mean	SD	Difference	*T*-test
Instructional Software Use	2.79	.74	3.25	.52	0.46	**
Information Literacy Skills	2.29	.85	2.82	.82	0.54	**
Modification of Instructional Delivery	2.89	.75	3.07	.78	0.19	--
Assessment of Student Performance	2.86	.76	2.86	.85	0.00	--
Ed. Program Individualization	2.36	.73	2.64	.68	0.29	--
Professional Growth	2.82	.55	3.00	.61	0.18	--
Research and Evaluation of Use	2.29	.90	2.43	.92	0.14	--

Note. Statistics based on 27-28 valid matched pairs using paired-samples *t*-tests. ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery."

Preservice Teachers' Concerns about Educational Technology

Stages of Concern Questionnaire (SoCQ). Research evidence indicates that change involves developmental growth, and individuals react to change in differing ways. Hord et al. (1987) identified seven types of concerns that users of an innovation may experience. These include awareness, informational needs, personal implications, time management, consequence for students, collaboration with others, and refocusing or refinement to improve the effectiveness of an innovation. Hord et al. organized these as "stages of concern," and, although the categories are not mutually exclusive, they imply a developmental progression from low-level *awareness* to high-level *refocusing and refinement*. The stages are further categorized into three primary dimensions—self, task, and impact concerns. EDUC 3001 and 4001 students completed the SoCQ at the beginning and end of the spring semester, and results are presented in Table 10.

Statistically significant differences between EDUC 3001 students' pre- and posttest results emerged along four domains ($p<.01$ for three of four), while EDUC 4001 students exhibited significant differences in three domains ($p<.05$). Outcomes also show that both preservice teacher groups initially had high informational and personal concerns (between $M=4.45$ and $M=4.95$) as well as rather strong consequence and collaboration concerns (between $M=4.23$ and $M=4.62$). This may reflect these students' early limitations in technology knowledge as well as

cognizance of their future responsibilities as teachers. At posttest, awareness and informational concerns declined, particularly for EDUC 4001 students, and consequence, collaboration, and refocusing concerns intensified. Thus, in general, preservice teachers progressed from self to impact concerns.

Table 10
Stages of Concern Rubrics for EDUC 3001 and EDUC 4001, Spring 2002

	Pretest		Posttest			Paired
EDUC 3001	Mean	SD	Mean	SD	Difference	*T*-test
Self						
Awareness	2.31	1.03	1.62	1.28	-0.69	**
Informational	4.69	1.08	4.38	1.34	-0.32	--
Personal	4.45	1.51	4.71	1.68	0.26	--
Task						
Management	3.60	1.41	3.50	1.77	-0.10	--
Impact						
Consequence	4.53	1.54	5.11	1.47	0.57	*
Collaboration	4.44	1.47	5.30	1.39	0.86	**
Refocusing	3.38	1.22	4.27	1.26	0.89	**
	Pretest		Posttest			Paired
EDUC 4001	Mean	SD	Mean	SD	Difference	*T*-test
Self						
Awareness	2.55	.86	1.50	1.01	-1.05	*
Informational	4.95	.76	4.00	1.43	-0.98	*
Personal	4.70	1.10	4.62	1.59	-0.08	--
Task						
Management	3.58	1.00	3.92	1.26	0.33	--
Impact						
Consequence	4.62	.73	4.88	1.35	0.27	--
Collaboration	4.23	1.31	4.79	1.75	0.56	--
Refocusing	2.98	1.12	4.07	1.10	1.08	*

Note. Statistics based on 41-42 valid matched pairs for EDUC 3001 and 12 valid matched pairs for EDUC 4001 students using paired-samples *t*-tests. * $p < .05$, ** $p<.01$. Ratings made on a 7-point scale with three anchors: 1 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true of me now*).

Residents completed the SoCQ as Intern Is in fall 2000 and at the end of their Residency semester. Results, as displayed in Table 11, reveal similar trends to those exhibited by EDUC 3001 and 4001 students. Overall, there were statistically significant differences in pre- and posttests across five domains for the 22 Residents with pre- and posttest data. Consistent with EDUC 3001 and 4001 students, Residents initially exhibited intense informational and personal concerns (M=5.08 and M=4.97, respectively) as well as high consequence and collaboration concerns (M=4.95 and M=4.60, respectively). Posttest results indicate declines in awareness and informational concerns (self) and subsequent statistically significant increases in personal (self) and consequence, collaboration, and refocusing (impact) concerns.

Table 11
Stages of Concern Rubrics for Residents

	Pretest (F00)		Posttest (F01)			Paired
	Mean	SD	Mean	SD	Difference	*T*-test
Self						
Awareness	2.29	.98	0.98	1.18	-1.31	**
Informational	5.08	1.09	4.69	.94	-0.39	--
Personal	4.97	1.24	5.65	.94	0.68	**
Task						
Management	3.40	1.57	3.11	1.39	-0.30	--
Impact						
Consequence	4.95	1.52	5.73	.98	0.78	**
Collaboration	4.60	1.30	5.78	.99	1.18	**
Refocusing	3.33	1.36	4.27	1.37	0.93	**

Note. Statistics based on 21-22 valid matched pairs using paired-samples *t*-tests. ** p<.01. Ratings made on a 7-point scale with three anchors: 1 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true of me now*).

Results for preservice teachers (EDUC 3001, EDUC 4001, and Residents) are consistent with the CBAM's hypothesized changes from non-user proficiencies (i.e., self concerns diminish while impact concerns intensify). Although significant changes did occur, the informational concerns remain relatively high, and these students personal concerns generally intensified, particularly for Residents. This suggests that preservice teachers are now concerned with the way using technology will affect them personally and, because many have not "mastered" some technology dimensions, they may have doubts about their own abilities and the time required to use technology effectively.

Post-Baccalaureate Teacher Strand

In addition to EDUC 3001 and 4001, LINKS activities have been incorporated into an online technology course requirement for post-baccalaureate students seeking foundation certifications. Education 5131 (Integrating Technology into Assessment and Instruction) provides post-baccalaureate students information regarding technology integration in education, principles and strategies for Internet resources and instructional software use, uses for technology in the curricula, and activities modeling subject-area technology integration. Specific course goals include (a) fostering awareness of evolving educational technology and issues in implementation; (b) identifying the unique capabilities of specific software and Internet tools to meet distinct classroom needs; (c) enhancing awareness of multimedia and hypermedia capabilities and educational applications; (d) developing integration strategies and implementation plans for using technology in the classroom environment; (e) designing lesson integration strategies for instructional software, technology tools, and multimedia and hypermedia through an integrated curriculum and specific subject area focus; and (f) supporting post-baccalaureates' development of TExES standards and competencies related to technology.

Post-baccalaureate students complete five online learning modules that combine topics presented in EDUC 3001 and EDUC 4001. Each module requires pretests, readings, activities, small- and

whole-group discussions, and posttests. The following comprise the EDUC 5131 learning modules:

Module 1: Education Technology: Past, Present, and Future
Module 2: Examining Instructional and Productivity Software
Module 3: Examining Hypermedia/Multimedia
Module 4: Integrating the Internet into Classroom Instruction
Module 5: Current Trends and Future Projections

In addition to the online learning modules, post-baccalaureates must also complete the following 10 lab modules (identical to those for EDUC 3001 and EDUC 4001 students):

Module 1: Getting Started
Module 2: Locating Resources for Unit Portfolios
Module 3: Creating Student Multimedia Presentations
Module 4: Creating Student Publications
Module 5: Creating Unit Support
Module 6: Creating Student Web Sites
Module 7: Creating Teacher Support Materials
Module 8: Developing Plans for Implementation
Module 9: Putting Unit Portfolios Together
Module 10: Showcasing Unit Portfolios

Quality and Utility of LINKS Course

At the end of the semester, post-baccalaureate students submitted course evaluation questionnaires. Students responded to four objective items related to the course's impact on building technology proficiencies, improving understanding of classroom technology integration, and increasing motivation to use technology in the classroom as well as providing an overall rating for the course. Post-baccalaureates rated items related to personal dimensions on a 6-point scale ranging from 1 (*strongly agree*) to 6 (*strongly disagree*). Overall session ratings ranged from 1 *(not at all helpful*) to 6 (*extremely helpful*). Findings, presented in Table 12, compare course ratings from post-baccalaureates (EDUC 5131 students) with the ratings offered by EDUC 3001 and EDUC 4001 students. Post-baccalaureates rated the course less positively than their undergraduate preservice counterparts. While EDUC 5131 students (post-baccalaureates) provided an overall rating of 3.6, EDUC 3001 and 4001 students provided a 4.9 course rating. Additionally, post-baccalaureates were less likely to agree the course had supported development along the personal dimensions assessed in the evaluation questionnaire. Their ratings averaged 4.3 for building technology proficiencies (compared to 4.7 and 5.1 for EDUC 3001 and 4001 students, respectively). Moreover, post-baccalaureate students provided even lower ratings for improving understanding and motivation to use technology in the classroom (4.0 for each) compared to undergraduate preservice teachers' averaged ratings (between 4.9 and 5.2).

Table 12
Preservice Teachers' Ratings for Courses, Spring 2002

	Post-Bacs *N*=10	EDUC 3001 *N*=32	EDUC 4001 *N*=14
Built technology proficiencies	4.3	4.7	5.1
Better understanding of integrating technology in the classroom	4.0	4.9	5.2
Motivated to use technology more in the classroom	4.0	5.0	5.0
Overall rating of sessions	3.6	4.9	4.9

Note. Items rated on a 6-point scale.

Important Learning, Concerns, and Suggestions

In addition to scaled items, post-baccalaureate students completed three open-ended items related to most important learning from the course, primary concerns, and suggestions for course improvement. Summaries of responses follow.

Important learning. Post-baccalaureates most commonly identified EDUC 5131's impact on improved technology knowledge and skills, consistent with impacts cited by undergraduate preservice teachers. As one post-baccalaureate explained, "I was basically Internet illiterate prior to this class. I have gained several skills." Skills mentioned by post-baccalaureate students included PowerPoint, webpage design, computer software, Internet search engines, and Internet etiquette. In addition to improved knowledge and skills, one EDUC 5131 student reported increased understanding of technology integration into the classroom.

Main concerns regarding application of the information. Only four post-baccalaureates expressed concerns with using technology. One expressed concerns in maintaining awareness of changes in technology, and another worried about access to technology resources in the classroom setting. Additionally, one post-baccalaureate noted concerns relating to personal technical proficiencies, and one expressed concerns with using technology in physical education classes. EDUC 3001 students raised similar issues to post-baccalaureate students.

Suggestions for making courses more effective. Post-baccalaureate students provided two primary suggestions for enhancing the effectiveness of EDUC 5131. First, similar to EDUC 3001 students, the majority of post-baccalaureates emphasized the importance of face-to-face meetings. Students desired in-person meetings so that instructors could explain course requirements and expectations, model technology integration, and provide "guided instruction" and technical assistance. Additionally, several post-baccalaureate students suggested changes in instructional related issues, including instructional pace, feedback on grades, and general guidance and instruction.

Impact Measured by Self-Evaluation Rubrics

Post-baccalaureates also completed self-evaluation rubrics measuring personal technology proficiencies at the beginning and end of the semester. Findings related the basic computer use, Internet use, and advanced computer use are presented in the following sections.

Basic Computer Use (BCU). Results for the BCU displayed in Table 13 show that post-baccalaureate students made little progress in their basic computer proficiencies. While these students made statistically significant improvements in hypermedia use, most domains showed only small increases. Additionally, post-baccalaureate students attained mastery criterion (3.00) in only two areas—basic computer operation and word processing. Moreover, these students averaged lower scores on all domains compared to EDUC 4001 students, and they scored lower than EDUC 3001 students on five of six domains (see Table 5).

Table 13
Basic Computer Use Rubrics for Post-Baccalaureates in Spring 2002

	Pretest		Posttest			Paired
	Mean	SD	Mean	SD	Difference	*T*-test
Basic Computer Operation	3.33	.62	3.27	.80	-0.07	--
File Management	2.92	.28	2.92	.86	0.00	--
Word Processing	3.00	.54	3.20	.86	0.20	--
Spreadsheet Use	2.20	.86	2.60	.99	0.40	--
Database Use	1.93	.80	2.40	.99	0.47	--
Graphics Use	2.57	.85	2.64	1.00	0.07	--
Hypermedia Use	1.40	.51	2.20	1.20	0.80	*

Note. Statistics based on 12-14 valid matched pairs using paired-samples *t*-tests. * p<.05, ** p<.01. Each domain includes 4 performance levels with level 3 considered "mastery."

Internet Use (IU) and Advanced Computer Use (ACU). Consistent with BCU results, post-baccalaureates exhibited minimal growth in their Internet use proficiencies. Overall, post-baccalaureate students, unlike their EDUC 3001 and EDUC 4001 counterparts, showed no statistically significant improvements in their Internet use, and their posttest results declined for three domains—World Wide Web, email and mailing lists, and Internet basics. In addition, these students achieved mastery level on just two domains (search tools and email/mailing lists), and their posttest results did not exceed 2.00 for webpage construction and newsgroups, gophers, and telnet. Findings related to advanced computer use also indicate that post-baccalaureates made negligible improvements in their advanced technology proficiencies. Results revealed posttest increases of less than 0.2 in only three domains, and declines in two areas, and they exhibited substantially lower scores than Residents (EDUC 3001 and 4001 students do not complete the ACU).

Overall results for post-baccalaureates suggest that these students made substantially less progress than their preservice teacher counterparts. Although post-baccalaureate students began with higher pretest scores on almost all BCU and IU domains, they exhibited minimal growth compared to substantial and often statistically significant growth for EDUC 3001 and 4001 students. Three primary factors may explain course outcomes. First, these older, second-career students may have "over-estimated" their initial technical proficiency. Second, post-

baccalaureate students may be unprepared for online learning. In making suggestions for course improvement, the majority requested face-to-face meetings. These students expressed the need for additional guidance and support from university instructors and believe they would benefit from one or more face-to-face course meetings. Additionally, combining online learning module topics from EDUC 3001 and 4001 courses into EDUC 5131 course may overwhelm some post-baccalaureate students given one post-baccalaureate's concern with "information overload."

University Instructors

In year 3, the LINKS project expanded its faculty development strand to include a number of technology-related professional development options for instructors. LINKS training in years 1 and 2 typically targeted university volunteers who were highly motivated to learn about and implement new technologies. Based on lessons learned about faculty concerns in implementing technology innovations, LINKS expanded professional development opportunities in the third year to attract "reluctant" or "late" technology adopters. By combining monies from various funding sources, LINKS enhanced the variety of professional development offerings, forged alliances with the university as a whole, and in some cases, offered monetary rewards for faculty participation. Faculty who were the "early adopters" during the first two project years frequently served as trainers or shared best practices during supplemental training events in the third year. Thus, the year 3 faculty strand, as described below, not only sustained the usual series of LINKS training sessions but also added supplemental faculty development opportunities.

LINKS Training Sessions

- LINKS faculty training and support was redesigned to encompass a series of 17 training sessions across the 2001-02 academic year. In addition to support for 23 regular participants, all faculty received technical assistance from the LINKS team either individually or online.

Supplemental Faculty Development

- *Intel Teach to the Future*. Additional funding awarded through the Intel Corporation supported faculty instruction for specific teacher education courses through participation in the Teach to the Future Program. This partnership provided valuable teaching and management materials for both faculty and preservice teachers.
- *Faculty Development Days.* Professional development sessions offered for faculty during summer 2001 included a series of sessions on distance education and guest speakers who addressed distance education instructional design and delivery issues during two Faculty Development Days at TWU.
- *Summer training institutes*. LINKS collaborated with TWU to provide summer training institutes for 12 faculty in online course development. Instructors received stipends to develop technology-integrated courses as part of a planned online curriculum for teacher education.
- *Post-baccalaureate mentoring program.* Through a unique mentoring approach, five, experienced faculty with extensive LINKS training functioned as mentors and expert facilitators for five university instructors assigned to develop post-baccalaureate online courses.

- *Faculty "Brown Bag" Workshops*. LINKS staff offered ongoing lunch-hour sessions on technology-related topics for volunteer faculty from various university disciplines between May 2001 and August 2002.

LINKS Training Sessions

LINKS recruited 23 faculty volunteers from a variety of disciplines to attend technology-training sessions beginning in September 2001 and concluding April 2002. Faculty members contributing to teacher preparation were enlisted as part of the third-year implementation of the LINKS project. The 23 volunteers registered for each LINKS training session one week before the session date. If vacancies remained, the slots were opened to interested faculty (notified by email) from the College of Professional Education and the College of Arts and Sciences**.** Attending faculty represented a variety of disciplines including Biology, Communication Sciences, Computer Science, English, Family Sciences, Foreign Languages, History, Kinesiology, Library Studies, Mathematics, Performing Arts, Philosophy, Psychology, Reading, Teacher Education, and Visual Arts.

Training goals. Two primary goals of the LINKS training sessions included (a) the introduction of LINKS standards and resources, and (b) support for instructor delivery of web-based courses as models for future teachers in their classes. In collaboration with TWU's Distance Education Learning Team, the goals were implemented through a series of technology-training sessions.

Training session overview. Training sessions served as an introduction and orientation to both LINKS and the required technology proficiencies future teachers in Texas are expected to master and demonstrate. Faculty were encouraged to serve as models for preservice teachers by integrating technology into the design and delivery of their instruction. Sessions also served as a training vehicle for the preparation of web-based course delivery via Blackboard, an integrated instructional delivery template. Altogether, LINKS delivered 17, two-hour training sessions in the center's wireless computer lab using the Blackboard integrated system. All materials were available on a "class" Blackboard site for later reference. By using Blackboard to communicate with faculty participants, meaningful learning was integrated into their own Blackboard course development.

LINKS infused advanced forms of technology throughout training sessions as transparent tools for thinking, learning, and constructing new knowledge. Integrating technology as a transparent tool includes the use of advanced forms of media such as optical technology, scanners, video and sound, digital and document cameras, and streaming video. Many sessions were designed as hands-on workshops. Instructors encouraged faculty to bring course materials, syllabi, graphics, and other materials to use in hands-on practice as they converted traditional courses and course materials to an electronic medium. Related, supplemental materials, such as printed references, webpage URLs, and digital cameras, were available to all participants. LINKS personnel also provided individual assistance at each session. LINKS personnel began each session with an overview of the session content and materials. Guest speakers from various campus departments informed participants about available TWU resources. Presenters included the University Blackboard Administrator, members from Information Technology Services, members of the Distance Education Support Team, and library personnel.

Training session topics. Faculty had opportunities to attend a total of 34 hours of instruction on the following topics:

- *Session I: Orientation and Data Collection*. This session served as an orientation to the LINKS project. In addition to detailing student and faculty benefits, the session outlined LINKS research methodology, and introduced participants to project data collection via online instruments.
- *Session II: Exploring Internet Resources*. Participants received an orientation to TWU Library resources, search engines, and other Internet tools.
- *Session III: Library Databases for Research*. Faculty learned step-by-step procedures for using TWU library resources as a basis for future research.
- *Session IV: Using End Note.* Faculty had the opportunity to gain familiarity with the use of End Note software for literature reviews and research. Using the software to tap directly into the TWU library for electronic literature searches was also discussed.
- *Session V: Intellectual Property in the Creation of Distance Learning Courseware.* Dr. Phillip Turner, chief developer of the Intellectual Property Policy at the University of North Texas, discussed issues related to intellectual property rights when creating distance-learning courseware.
- *Session VI: Distance Learning Issues.* Participants learned about issues related to distance learning, including TWU's resources and curriculum redesign, as well as distance-learning pitfalls. Successful organization of course materials prior to uploading the materials to Blackboard was also discussed.
- *Session VII: Copyright Issues in an Electronic World.* Copyright issues related to using electronic media were emphasized.
- *Session VIII: Technology Fair: Tools and Toys.* Faculty received instruction and practical advise in using a variety of devices such as camcorders, video transfer devices, MP3 players, digital voice recorders, e-books, and personal digital assistants. Data collection via online tools was also administered.
- *Session IX: Introduction to Blackboard.* Blackboard topics, including creating and exploring courses, managing and sharing information, and accessing Blackboard from home, were covered.
- *Session X: Creating and Uploading Documents to Blackboard.* This workshop session provided faculty with step-by-step instructions for uploading course materials to Blackboard.
- *Session XI: PowerPoint Presentations for the Web.* Participants received hands-on instruction in adding PowerPoint presentations and graphics to their online classes.
- *Session XII: Communication Measures.* Faculty learned how to effectively use communication measures such as discussion boards, chat rooms, and listservs. Former LINKS participants contributed to the session by demonstrating best practices.
- *Session XIII: Real World Blackboard and Pedagogy Issues.* Pedagogical issues pertaining to information dissemination via Blackboard were discussed. Speakers discussed recent findings from EduTex, a regional conference of EDUCAUSE. Best practices and TWU faculty member use of Blackboard were spotlighted.

- *Session XIV: Grades, Surveys, Pools, Tests, and Security.* In addition to learning how to navigate online gradebooks, faculty received information concerning assessments, surveys, and pool managers. Online testing security issues were also discussed.
- *Session XV: HTML and Graphics.* This session demonstrated the nature of Hypertext Markup Language and provided instruction about using HTML tags to add diversity to existing Blackboard courses.
- *Session XVI: Adobe Acrobat and PDFs.* Adobe Acrobat—software used to create Portable Document Files (PDF) that can be viewed on any computer or platform regardless of the originating software, fonts, or operating system—was reviewed.
- *Session XVII: Symposium and Data Collection.* The concluding session consisted of closure, an overview of the lessons learned from other sessions, best practices models and presentations, and online data collection.

Quality and utility of training. Faculty attending each LINKS training session completed evaluations containing scaled and open-ended items. Faculty responded to five objective items regarding program content and organization. The 6-point response scale ranged from *strongly disagree* (1) to *strongly agree* (6). Findings presented in Table 14 show the overall mean rating for all sessions was 5.5, indicating high general satisfaction with the LINKS sessions.

Table 14
University Instructors' Ratings for Training Sessions

Session	Dates	*N*	Clear/ Organized	Under-stand Concepts	Worth-while	Useful to Develop Course	Overall Rating
Orientation	9/21/01		--	--	--	--	--
Exploring Internet	9/28/01	17	5.5	5.4	5.5	5.4	5.5
Library Databases	10/05/01	12	5.8	5.7	5.8	5.3	5.7
Using End Note	10/12/01	12	4.8	4.8	5.1	4.7	4.9
Intellectual Property	10/19/01	9	5.9	5.9	6.0	5.3	5.9
Distance Learning	10/26/01	9	5.6	5.7	5.8	5.7	5.7
Copyright Issues	11/09/01	13	5.3	5.2	5.0	5.3	5.2
Technology Fair	11/16/01	11	5.9	5.6	5.7	5.4	5.8
Intro to Blackboard	2/01/02	16	5.1	5.5	5.6	5.6	5.3
Docs to Blackboard	2/08/02	11	5.5	5.3	5.4	5.3	5.6
PowerPoint	2/15/02	11	5.8	5.6	5.6	5.4	5.7
Communication	2/22/02	9	5.2	5.3	5.4	5.4	5.6
Blackboard Issues	3/01/02	13	4.8	4.5	4.7	4.5	4.5
Grades, Surveys, etc	3/08/02	11	5.8	5.5	5.6	5.6	5.6
HTML/Graphics	3/15/02	12	5.8	5.7	5.8	5.5	5.7
Adobe Acrobat/PDF	3/29/02	14	5.7	5.6	5.6	5.4	5.4
Closing Symposium	4/05/02	12	5.8	5.8	5.8	5.8	5.8
Total		**192**	**5.5**	**5.4**	**5.5**	**5.3**	**5.5**

Note. Items rated on a 6-point scale ranging from *strongly disagree* (1) to *strongly agree* (6). For total, responses varied by item.

Participants judged session activities favorably in relation to helping them understand the content presented and believed that sessions, in general, were a worthwhile investment of their time. Not

surprisingly, sessions directly related to classroom applications received the highest ratings on the usefulness of session content in developing online coursework.

Important Learning and Concerns

Faculty attending sessions in spring 2002 responded to open-ended items about their learning, concerns, and suggestions regarding the sessions.

Most important learning. When queried about learning, participants' comments were generally enthusiastic. Although several participants expressed the desire for additional training in areas such as Blackboard and PowerPoint, many indicated that the training sessions clarified their understanding of applications such as Blackboard. Participants especially appreciated the hands-on opportunities provided by LINKS in the training sessions.

Concerns regarding application of information. Faculty's primary concerns about using training information most frequently included references to time constraints ("time to learn," "time to play with Blackboard," "time to practice") and to lack of in-depth understanding. Although faculty generally viewed training as effective, many indicated concerns that they lack the expertise to implement technologies on their own. Although participants often identified their own perceived shortcomings as the hindrance, saying that the training was a little too fast-paced for their ability levels, many participants suggested that more "hands-on" practice in the training sessions might be effective, as it would give them the opportunity to gain additional familiarity with the products. Other concerns included adapting new technologies to technologies already familiar to faculty (integration of Blackboard with PowerPoint, for example), and remembering instructions and information learned in sessions when away from the training session.

University Instructor's Concerns with Blackboard and Levels of Use

Stages of Concern Questionnaire (SoCQ). Mean instructor ratings on the seven stages of concern (awareness, informational needs, personal implications, time management, consequence for students, collaboration with others, and refocusing or refinement) are presented in Table 15. While no statistically significant pre- and posttest differences emerged, outcomes suggest that as a result of training, instructors' initial awareness, informational, and personal concerns have diminished, whereas management, consequence, collaboration, and refocusing concerns intensified. Although instructors' personal concerns have declined, the high posttest rating (M=5.23) suggests that faculty remain concerned about the personal aspects of implementing BlackBoard (such as time), and individuals may be uncertain about their ability to use the application. Moreover, ratings show that faculty remain highly concerned about the consequences of online coursework on students (M=5.65) and are also concerned about collaboratively sharing their experiences with peers (M=5.02).

Table 15
Stages of Concern Rubrics For University Instructors

	Pretest (F00)		Posttest (S01)			Paired
	Mean	SD	Mean	SD	Difference	*T*-test
Self						
Awareness	2.08	1.06	1.65	1.03	-.43	--
Informational	4.95	1.71	4.61	1.28	-.34	--
Personal	5.56	1.49	5.23	1.39	-.36	--
Task						
Management	3.91	1.33	4.26	1.57	.35	--
Impact						--
Consequence	5.48	1.13	5.65	1.47	.17	--
Collaboration	4.77	1.60	5.02	1.52	.26	--
Refocusing	4.31	1.12	4.61	0.94	.30	--

Note. Statistics based on 17 valid matched pairs using paired-samples *t*-tests. Not statistically significant (--). Ratings made on a 7-point scale with three anchors: 1 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true of me now*).

Levels of Use Questionnaire (LoUQ). As shown in Table 16, eight distinct levels of use of an innovation have been identified (nonuse, orientation, preparation, mechanical use, routine use, refinement, integration, renewal). According to Hord et al. (1987), each stage encompasses a range of behaviors with distinctive actions that move the individual to the next level. CBAM's LoU interview was adapted to describe the behaviors of university instructors relative to the adoption of Blackboard. The LoUQ included 56 items, with 7 items for each of the eight stages of use.

Table 16
Levels of Use (LoU) Categories

Stage	Description
Nonuse	User has little or no knowledge of or involvement with Blackboard
Orientation	User has acquired or is acquiring information about Blackboard and/or has explored its value and what it will require
Preparation	User is preparing for first use of Blackboard
Individual Begins Blackboard Use	
Mechanical Use	User focuses most effort on the short-term, day-to-day use of Blackboard, and user attempts to master tasks required to use Blackboard
Routine Use	Use of Blackboard is stabilized
Refinement	User varies Blackboard to increase the impact on students
Integration	User is combining own efforts to use Blackboard with related activities of colleagues to achieve a collective impact on students
Renewal	User reevaluates the quality of use of Blackboard, and seeks modifications of or alterations to Blackboard to increase impact

Note. Levels of Use adapted from Measuring Levels of Use of the Innovation: A Manual for Trainers, Interviewer and Raters (Loucks, Newlove, & Hall, 1975).

Results for the LoUQ summarized in Table 17 show that, as a result of training, instructors have generally moved to higher levels of Blackboard use. Individuals are significantly less likely to now consider themselves as nonusers (*M*=1.81). In general, faculty has also been oriented to Blackboard through the informational sessions (*M*=5.55) and are preparing for first Blackboard use (*M*=5.58).

Table 17
Levels of Blackboard Use For University Instructors

	Pretest (F01)		Posttest (S02)			Paired
	Mean	SD	Mean	SD	Difference	*T*-test
Nonuse	3.02	2.4	1.81	1.8	-1.21	**
Orientation	4.19	1.6	5.55	1.2	1.36	**
Preparation	5.74	1.4	5.58	1.2	-0.16	--
Using Blackboard						
Mechanical Use	3.63	1.2	4.70	1.6	1.07	*
Routine Use	1.72	1.6	3.36	2.2	1.64	**
Refinement	3.72	1.8	4.72	2.0	1.00	*
Integration	2.55	1.8	3.81	2.1	1.26	--
Renewal	2.24	2.1	3.35	2.2	1.11	--

Note. Statistics based on 17 valid matched pairs using paired-samples *t*-tests. ** $p < .01$. * $p < .05$. Ratings made on an 8-point scale with three anchors: 0 (*not true of me now*), 4 (*somewhat true of me now*), and 7 (*very true of me now*).

Faculty ratings on the stages of Blackboard use (mechanical, routine, refinement, integration, and renewal) show that, at posttest, faculty who are using Blackboard tend to consider themselves as either mechanical users attempting to master the day-to-day tasks required to implement Blackboard (*M*=4.70) or stabilized users who are refining Blackboard to increase the impact on students (*M*=4.72). However, faculty has moved significantly toward routine Blackboard use (from *M*=1.72 to *M*=3.36). Overall, results for the LoUQ show diverse but increasingly higher levels of Blackboard use by faculty.

Supplemental Faculty Development

The LINKS project provided TWU faculty with a number of supplemental professional development options supporting the institutionalization of LINKS goals for faculty development. Through Intel training, four instructors received technology-related curricular and management materials for teacher education coursework. Altogether, nearly 170 faculty (duplicated count) benefited from Faculty Development Days on distance education instructional and design issues. Twelve instructors assigned to teach online courses in the 2001-02 academic year participated in sessions supporting course design. Through a unique mentoring relationship, five novice and five experienced faculty worked collaboratively to develop technology-infused courses at the post-baccalaureate level. Finally, faculty from a variety of disciplines participated in a series of technology-related Brown Bag workshops.

Intel Teach to the Future Program. Funding awarded through the Intel Teach to the Future Program allowed four faculty to participate in training. These funds supported key faculty

teaching preservice and post-baccalaureate courses so that strategies and materials acquired could be infused into the teacher preparation curriculum.

Faculty Development Days. In August 2001**,** LINKS collaborated with TWU to offer professional development opportunities over two days on distance education instructional design and delivery issues. In total, 76 faculty attended a session delivered by a copyright expert from The University of Texas. The speaker presented information on technology-related copyright issues, such as the basics of copyrights, how copyrights work with online materials, fair-use examples, and copyright issues arising in distance learning. Faculty completing evaluation forms (*N*=44) considered the sessions well organized, helpful in understanding the concepts, useful for online course development, and a worthwhile use of time. Participants appreciated the speaker's responses to questions and new knowledge gained about copyright law. Although faculty learned a great deal, some wanted additional information or clarification regarding laws, university policy, and protection for their own work. LINKS offered three additional technology-related training and informational sessions on the second training day. The sessions included:

- *Rewards, Benefits, and Pitfalls of Teaching Via the Internet*. A panel of speakers from the University of Texas at Arlington presented information on the importance of teaching using the Internet to 40 faculty.
- *The Importance of Effective Instructional Design in Web-based Course Development*. A speaker from the University of Texas at Arlington addressed the effective instructional design for web-based courses for approximately 30 faculty.
- *Insight from TWU Faculty with Instructional Technologies.* An experienced panel of TWU faculty members discussed instructional technologies used on the campus with approximately 20 professors.

Summer training institutes. During June 2001, LINKS supported a five-day workshop on instructional design for 12 faculty members. Instructors who were assigned to teach online courses in 2001-02 received stipends for attending. An experienced instructional designer and web developer facilitated the course. Participants were expected to complete a course framework; determine logistical, assessment, and communication mechanisms; and design at least one instructional module.

Post-baccalaureate mentoring program. During year three, the LINKS project received Department of Education approval to apply knowledge gained through work with undergraduate students to support technology integration at the post-baccalaureate level. Post-baccalaureates are students who hold a degree but are seeking teacher certification. The project goal was to integrate technology into all post-baccalaureate courses to meet students' specifically identified needs. Five faculty served as technology facilitators with responsibility for developing and implementing the technology integration courses. Facilitators received $1,500 stipends for attending 12 development sessions and conducting a product review. Additionally, five faculty (LINKS trained) who were highly skilled in technology integration and online course delivery mentored less-experienced technology facilitators in course development and conducted the product review. Mentors also received a $1,500 stipend for their oversight. Faculty developed an online technology course, EDUC 5131 (Integrating Technology into Assessment and Instruction) as well as four additional technology-infused online subject area courses.

Faculty "Brown Bag" workshops. LINKS invited faculty from a variety of disciplines within the College of Professional Education and the College of Arts and Sciences to attend a series of technology-training sessions in the LINKS Center wireless lab. Sessions, which began in May 2001 and concluded in August 2002, were delivered via lunch-hour "Brown Bag" workshops. Faculty received session notification by letter and follow-up emails. Sessions began with an overview presented by LINKS personnel, and included topics such as searching the Internet, using Internet browsers, and using email and email programs.

Faculty Perceptions of LINKS Initiatives

In May and June 2002, researchers interviewed eight TWU faculty members who had attended various LINKS training initiatives. In addition to questions about LINKS involvement and support, faculty answered questions about their perceptions of technology and the impact of technology on TWU students and the university. Faculty also used scales to rate their current technology proficiency and use as well their technology proficiency and use prior to LINKS training, and discussed these issues with researchers.

Links involvement. Faculty were involved with LINKS on several levels, ranging from quite minimal to extensive. Minimal involvement included one instructor who attended a single Blackboard session. Another individual served as a faculty mentor for a semester and spoke on one or two LINKS panel discussions. Other faculty attended a number of LINKS training sessions, including two faculty who reported attending all but one or two of the 2-hour sessions in year 3. One professor, who had attended LINKS training quite extensively in the first two years continued to attend sessions in year 3 "when interested" in topics. One instructor described a progression of involvement with LINKS, saying that he/she initially had "no concept of online teaching except that it was something you did on your computer." This instructor described year 1 as a "just learning" year but learning in year 2 was considered more sophisticated. Increasing excitement led this individual to enroll in the summer institute.

Use of LINKS support. Faculty who had used LINKS support were asked about the specifics of the support received. Many faculty made comments similar to these: "I go there to get information all the time," "LINKS is always available to help," and "They met my needs." LINKS involvement was occasionally quite brief ("quick emails" and "online info"), but often involved more extensive support ("willing to meet any time, would come by office"). In general, faculty praised LINKS for both the quality and the timeliness of their response. One faculty appreciated the "collaborative learning" environment of LINKS, saying that LINKS staff is open to learning from faculty as well. Another summarized what seems to be a general consensus about LINKS: "[The] greatest thing is the service of that group."

Technology proficiency and use. In addition to rating themselves on aspects of their technology proficiency and use before and after receiving LINKS training, faculty were asked to comment about their technology proficiency and usage levels. Faculty described their general technology proficiency and use (i.e., basic computer/technology operations and applications) before and after LINKS participation and rated themselves on a 6-point scale, with 1 indicating *little or no proficiency* and 6 indicating *advanced proficiency.* Faculty also rated the extent to which they were using technology in their teaching or coursework before and after participation in LINKS

using a 6-point scale, with 1 indicating *little or no technology use* and 6 indicating *using technology to a great extent.* Because only eight faculty were interviewed, individual results for all faculty are presented in Table 18.

Table 18
Instructor Technology Proficiency and Use Prior and Post LINKS Participation

	Technology Proficiency		Using Technology in Teaching	
	Previous	Current	Previous	Current
Instructor 1	5	5	3	5
Instructor 2	2	5	--	--
Instructor 3	4	4	2	3
Instructor 4	4	5	4	5
Instructor 5	1	5	1	5
Instructor 6	3	5	1	5
Instructor 7	2	3	1	3
Instructor 8	3	5	2	6

Note. Technology proficiency rated on a 6-point scale ranging from 1 (*little or no proficiency*) to 6 (*advanced proficiency*). Technology use rated on a 6-point scale ranging from 1 (*little or no technology use*) to 6 (*using technology to a great extent*). Technology use data unavailable for one instructor.

Results indicate that all faculty interviewed either maintained or increased their general technology proficiency levels; however, all faculty increased their technology use in teaching after LINKS participation. In describing general technology use prior to LINKS involvement, faculty mentioned using applications such as the Internet and word processing to varying degrees. Only a few faculty, typically those rating themselves a 4 or 5 on proficiency, indicated routine use of more advanced applications (i.e., PowerPoint, Blackboard). In describing their increased proficiencies after LINKS participation, faculty mentioned proficiency increases in specific applications (Blackboard, HTML) and increased comfort and confidence with technology.

As indicated in Table 18, some faculty made dramatic increases in using technology in as a result of LINKS participation. Several faculty reported that before LINKS, they used some applications, such as word processing, for classroom preparation. After LINKS participation, however, faculty were more likely to move technology use into the classroom. Many are now using Blackboard applications such as posting syllabi, course materials, pretests, or course evaluations. One faculty reported having one class completely online, while another said, "I have gone to 100% online Blackboard classes." Several faculty mentioned that they now (i.e., after LINKS participation) routinely use PowerPoint for classroom presentations. One or two faculty, however, still use technology sparingly in the classroom, citing the lack of time for technology preparation.

Impact on students. Faculty integrating technology into their teaching or coursework assessed its impact on their students. In general, faculty indicated that the impact on students has been favorable, citing increased student technology proficiency and use and increased opportunities for student interaction with course materials (via Blackboard, for example). Faculty also reported that technology has allowed students to take ownership of their education through increased

distance learning opportunities and student collaborations. Two faculty said that the immediate impact of technology has been making the attainment of a degree possible ("students who would not be able to take classes are able to take them").

Impact on TWU. Faculty was asked about the impact of LINKS on several areas of the university. According to instructors, the impact on teacher education and preservice teachers has been substantial. As they note, teacher candidates leaving TWU are now required to have a degree of technological proficiency. Faculty also report that they now see a level of technological proficiency in their students that was not there just several semesters ago, and they attribute at least part of this increased proficiency to LINKS. One of the biggest impacts has been on the increased number of students reached through technology. According to one faculty, online learning now reaches 10,000 TWU students. Preservice teachers, having been through technology training at TWU, are increasing well received in the job market. These students report back to TWU instructors that potential employers are impressed by their level of technology expertise, as well as by the quality of their technology products (e.g., presentations, portfolios). Faculty note that preservice teachers are now "more prepared to do it [technology] in the real world," and that they will be more professional in the classroom.

Many faculty also report increased collaborative relationships as a result of LINKS participation. Contacts that were made during LINKS training have evolved into full collaborations, with faculty meeting regularly (either in person or through email) to "swap ideas, share tips." Other faculty collaborate on the use of technology within their specific discipline, sharing information about, for example, course materials and evaluations. Faculty also use these established relationships to share interests and simply to get to know one another better.

Institutionalization of LINKS Initiatives

To accelerate reform efforts, the United States Department of Education awarded Preparing Tomorrow's Teachers to Use Technology (PT^3) grants promoting teaching and learning with technology. At the time of funding, the professional preparation sequence for teachers administered in the TWU College of Education did not include an education technology course or a means to assess computer literacy. The goal of the LINKS project was to build on existing technology integration efforts funded through grants from the TEA, TWU's Research Enhancement Program, and the Corporation for Public Broadcasting to establish an instructional structure and technology skills benchmarking. This goal was accomplished through systematic expansion and ultimate institutionalization of the integrated technology concept for preservice teacher educators.

To understand how colleges of education move toward technology integration, the CEO Forum on Education and Technology developed a conceptual framework (January 2000). That structure broadly guided the analysis on LINKS institutionalization. Findings to follow relate to leadership for change, the establishment of infrastructure to support technology integration, and the transformation of the teacher education curriculum. Evidence synthesized from document reviews, interviews with faculty and LINKS staff, training evaluations, and technology proficiency measures reveal how the LINKS grant influenced participants and events.

University Leaders' Commitment to Technology Integration

As stated above, LINKS was one of several initiatives influencing TWU's move toward technology integration at the institutional level and within the teacher education program. Evidence shows that effective leadership provided by LINKS project staff advanced the institutionalization of LINKS initiatives through a reliance on standards, strategic planning, ongoing communication, blended funding, and regional partnerships.

National and state accreditation standards guided technology infusion in teacher education. The LINKS project design relied on national and state standards to integrate technology into the teacher preparation curriculum. Technology proficiencies included those recommended by the National Council for the Accreditation of Teacher Education (NCATE), standards defined by professional associations, and proficiencies required by Texas public education. Technology competency indicators were based on the TEA's five Learner-Centered Proficiencies for Texas Schools (learner-centered knowledge, learner-centered instruction, equity in excellence for all learners, learner-centered communication, and learner-centered professional development), the Examination for the Certification of Educators in Texas (ExCET)—which has now become the TExES, the Texas Essential Knowledge and Skills (TEKS), and the Professional Development Appraisal System (PDAS). Standards provided the conceptual framework, or guiding principles, for LINKS technology initiatives.

LINKS initiatives aligned with TWU's strategic plan for technology integration. Research shows that one grant or one university entity cannot support technology integration in teacher education. Instead, integration relies on a combination of people and departments working toward elements of a strategic plan. The strategic plan at TWU, which was used as a guide for the LINKS PT^3 proposal, aims for students to be exposed to technology in all courses. Thus, LINKS staff collaborated with other university departments to deliver training for university instructors, and university participants were drawn from various disciplines contributing to teacher education. Presenters from various campus departments delivered training and informed participants on available resources. Presenters included the University Blackboard Administrator, members from Information Technology Services, members of the Distance Education Support Team, and library personnel. This approach allowed participants to explore TWU's unique distance learning issues, promoted the concept of "university without walls," and supported the transfer of information to everyday learning with students.

Lines of communication sustained by LINKS staff with university leadership supported project success. During the first implementation year of the PT^3 grant, TWU made changes in university leadership. LINKS staff met with the new president, provided an overview of project initiatives, and suggested ways to align university and grant initiatives. Staff also worked with a new Dean of Teacher Education to raise awareness of technology needs. Ongoing communication efforts between LINKS project leaders and university administrators throughout the grant resulted in increased university funding for technology, administrative support for technology integration, and the alignment of LINKS with university efforts.

LINKS resources were combined with other university initiatives. LINKS applied for and received an Intel Teach to the Future Pre-Service grant in the amount of $40,000 to support the

training of four university instructors. Each instructor received a laptop computer and a $2,000 stipend to attend technology integration workshops on the Intel curriculum. Participating faculty then redelivered training to Residents and their supervising teachers. This project enabled LINKS to systematically integrate the Intel curriculum into teacher preparation. In addition to the Intel project, LINKS collaborated with TWU to provide summer training institutes for faculty in online course development. A cost-sharing plan involving TWU ($32,000) and LINKS ($19,000) provided $4,000 stipends for instructors to develop technology-integrated courses as a part of a planned online curriculum. LINKS also teamed with the university to extend technology integration efforts to the post-baccalaureate program by supporting the development of online courses.

LINKS established partnerships with regional school districts to support preservice teachers' classroom technology integration efforts. LINKS personnel recognized that a strong, mutually beneficial relationship between the university and regional schools was needed to produce technologically proficient entry-level teachers. To forge stronger relationships, LINKS has provided training and support for mentor and supervising teachers working with preservice teachers in field-based placements. Additionally, in the third project year, LINKS extended past efforts through a collaborative effort with rural schools to encourage the integration of technology at the classroom level and to gain administrative support within a cohort of rural school districts. Selected educators received support, materials, and stipends to attend a national technology conference.

Building University Infrastructure to Support Technology Integration

Technology infusion in the teacher education program relies on an infrastructure that allows faculty and student access to technologies in university facilities, professional development for faculty, and ongoing technical support. The following sections detail TWU's progress in those areas and the grant's level of influence.

LINKS enhanced faculty access to technology by adding classroom resources for integration efforts. The LINKS implementation grant with a matching cost-share award placed permanent, multimedia workstations in large teaching classrooms in the multipurpose classroom building that is typically used for teacher education courses. The LINKS center, located in the same building, offered support for faculty and students using these stations. Additionally, LINKS invested $3,500 in the purchase and installation of multimedia software to support student-created projects in strategic locations (classrooms, labs, campus library).

The LINKS Center offered ongoing support for faculty technology integration efforts. The LINKS Center, which was established through grant resources, was a valuable resource for faculty's technology integration efforts. LINKS staff provided ongoing training sessions in the wireless lab, one-on-one assistance, web-based resources, and email and telephone support as needed. Due to the success of the center, the university will provide funds to continue center activities after the grant ends.

A growing cadre of university instructors have been oriented to the technology needs of preservice teachers and introduced to online course delivery via LINKS training and activities. Through year 3, more than 75 university instructors have either participated in LINKS training or received support from the LINKS center. Disciplines represented by participants include Biology, Communication Sciences, English, Family Sciences, Foreign Languages, History, Kinesiology, Performing Arts, Philosophy and Psychology, Reading, Teacher Education, and Visual Arts. LINKS also supported a variety of supplemental professional development opportunities in the third year beyond the proposed scope of the PT^3 grant to institutionalize LINKS activities.

Professional development efforts for faculty combined LINKS and university initiatives. The LINKS project and TWU have worked collaboratively to meet the needs of university staff. In the final project year, notable professional development achievements included these: 4 faculty participated in Intel training and redelivered training for 3 additional instructors, nearly 170 faculty (duplicated count) benefited from Faculty Development Days on distance education issues, 12 instructors participated in summer institutes supporting online course design, 5 novice and 5 experienced instructors worked collaboratively to develop technology-infused courses at the post-baccalaureate level, and an undetermined number of instructors attended faculty "Brown Bag" workshops.

LINKS training has positively impacted instructors' technology proficiency and use of technology for teaching. Data from various sources reveal a positive impact of LINKS on faculty's technology proficiency and instructional use. Instructors interviewed in year 3, had either maintained or increased their general technology proficiency levels as a result LINKS participation, and all faculty increased their technology use in teaching. In addition, findings on faculty's levels of technology use indicate that participating instructors have advanced to higher stages of Blackboard use over time.

Integration of Technology into the Teacher Education Curriculum

Stand-alone technology coursework has proved to be an ineffective approach to prepare preservice teachers to integrate technology into their teaching repertoire, so teacher preparation programs are now providing opportunities for students to see technology used and to apply it in methods and content courses. The following sections explain how LINKS project components have been incorporated into the teacher education program in anticipation of the grant's conclusion.

Curricular integration of technology and technology-based field experiences have been integrated into the teacher preparation program as a result of the LINKS project. With PT^3 support, LINKS initially refined the teacher education integrated technology component and delivered it in collaboration with the field-based teacher preparation program offered within TWU's Professional Development Center. Initially, the technology component included large group instruction, lab instruction, and distance education support through a curriculum website (TechTrek) and by email and phone. To track student progress over a three-semester sequence (Intern I, Intern II, and Resident), the Technology Passport was developed to monitor progress

toward technology standards. Over the three years of the grant, LINKS has supported nearly 400 students in preservice and post-baccalaureate programs.

LINKS preservice teacher activities have been redesigned as courses that are university teacher education requirements. Beginning in fall 2001, preservice teachers complete a sequence of courses and requirements designed to support technology integration. A two-course sequence includes EDUC 3001—Integrating Technology for Effective Learning and EDUC 4001—Integrating Technology into Instruction and Assessment. Prior to taking these courses students must (a) pass a computer literacy test, (b) pass a Computer Methods course designed for teacher educators (offered through Math and Computer Science), and (c) pass an Information Literacy Course designed for teacher educators (offered through Library Information Science). This revised format involves interdisciplinary collaboration for the education of the preservice teacher.

LINKS activities have been extended to the post-baccalaureate teacher preparation program. LINKS supported the integration of technology into the post-baccalaureate teacher preparation program (i.e., preservice teachers who have received a degree and are seeking initial teacher certification). In year 3, five university instructors designed and implemented online technology-infused methods courses for post-baccalaureate students. Through a unique mentoring approach, five experienced faculty functioned as mentors and expert facilitators of curriculum.

In sum, the LINKS website and associated curriculum is now integrated within online Blackboard courses maintained by professors teaching each technology course—thus, achieving the project's three-year goal of systematic and formalized institutionalization of the integrated technology concept for preservice teacher educators.

Summary and Conclusions

Preservice Teachers and Post-Baccalaureate Students

Findings summarized below represent the experiences and perceptions of approximately 30 Residents who progressed through LINKS experiences during the fall 2000 and fall 2001 semesters as well as approximately 60 preservice teachers enrolled in EDUC 3001 and EDUC 4001 courses. Major findings are as follows.

Preservice teachers at TWU experience a broad array of technology activities. Over three semesters, Residents progressed from initial orientation and skill building as Intern Is toward increasing emphasis on classroom integration of technology through field-based experiences as Intern IIs and Residents. Activities allowed preservice teachers to acquire competencies related to technology foundations, connectivity, productivity, and integration through coursework, desktop conferencing, lab learning opportunities, and distance learning. EDUC 3001 and 4001, which replaced the three-semester sequence, are delivered online through a series of online learning modules and labs that support increased knowledge and skills of productivity tools, instructional software, Internet use, website design, hypermedia and multimedia use, and content-specific curricular integration of technology.

Preservice teachers become increasingly positive about their technology experiences as they progress through LINKS sessions/coursework. During EDUC 3001, preservice teachers provided lower utility ratings for the course than their EDUC 4001 counterparts. Their reactions suggest that some students were initially uncertain about the value of LINKS coursework. Findings show, however, that EDUC 4001 students were more positively disposed toward building proficiencies and had a better understanding of integrating technology into instruction. Additionally, Residents expressed an even more positive opinion of their own technology abilities and the helpfulness of LINKS activities than either EDUC 3001 or 4001 students.

Preservice teachers report gains in knowledge and skills, abilities, confidence, and awareness. Regardless of level of experience, preservice teachers indicated that LINKS activities contributed to improved technology knowledge and skills, gains in ability to integrate technology in a variety of forms, increased confidence using technology, and awareness of the availability and importance of technology resources.

As preservice teachers' level of experience increased, their concerns regarding technology changed. As preservice teachers move through the course sequence, their concerns reflect their experiences. While EDUC 3001 students expressed the greatest concerns with awareness of technology resources and changes therein, EDUC 4001 students who had built technology proficiency became increasingly aware of inequalities in technology resource access in the classroom setting. Residents, relying on their field-based experiences, were more concerned about students' technology skills and the time constraints on technology use.

As a result of LINKS activities and coursework, preservice teachers became significantly more proficient technology users. On almost all Basic Computer Use (BCU) dimensions (e.g., operation, file management, word processing, and spreadsheet), statistically significant gains emerged in preservice teachers' perceived proficiency. Preservice teachers also became more proficient Internet users. EDUC 3001 students and Residents showed significant gains on all Internet Use (IU) domains over time (e.g., basics, search tools, obtaining and using files), and EDUC 4001 students experienced statistically significant growth on eight of nine domains.

Preservice teachers technology concerns, as measured by the SoCQ, progressed from self to impact concerns over time. Preservice teachers initially had high informational and personal concerns about technology as well as rather intense consequence and collaboration concerns. As students progressed over the semester (EDUC 3001 and 4001 students) or through the educational sequence (Residents), awareness and informational concerns decreased and impact concerns intensified. Concerns at all levels were higher for EDUC 3001 students than those enrolled in EDUC 4001. Residents, however, expressed greater impact concerns than EDUC 3001 or 4001 students, consistent with changes associated with growing from a novice to more proficient technology user.

Post-baccalaureate students at TWU gained a variety of technology experiences. During EDUC 5131 coursework, post-baccalaureate students build their technology knowledge and proficiencies through participation in learning modules and labs. The course exposes these students to productivity tools, instructional software, Internet use, website design, and

hypermedia and multimedia use. The majority of students (70%) cited enhanced technology knowledge and skills, consistent with findings for undergraduate preservice teachers.

University Instructors

In year 3, the LINKS project expanded its faculty development strand to include a vast array of technology-related professional development options for instructors. By combining resources from various sources, the project not only sustained the usual series of LINKS training sessions but also added supplemental faculty development opportunities. The following are key findings.

LINKS provided ongoing training sessions across the academic year accompanied by as-needed technical support. In year 3, 23 faculty from a variety of disciplines attended technology-training sessions throughout the academic year. If vacancies occurred in each of the 17 sessions, the slots were opened to other interested TWU faculty. Attending faculty represented a variety of disciplines, such as Biology, Communication Sciences, Computer Sciences, English, Family Sciences, Foreign Languages, History, Kinesiology, Library Science, Mathematics, Performing Arts, Philosophy and Psychology, Reading, Teacher Education, and Visual Arts.

LINKS training sessions and ongoing support helped instructors bridge the gap between the technical and the pedagogical. LINKS supported instructor development through whole-group sessions geared to a broad range of topics supporting instructors' proficiency for web-based course delivery. Many sessions were designed as hands-on workshops. LINKS personnel encouraged faculty to bring course materials, syllabi, graphics, and other materials to use in hands-on practice as they converted traditional courses and course materials to an electronic medium. Guest speakers from various campus departments informed participants about available TWU resources. LINKS staff also provided one-on-one assistance on request.

Faculty viewed LINKS training as useful in developing online courses and understanding critical issues, such as intellectual property rights. University instructors participating in LINKS training provided the highest ratings for sessions that directly related to their most pressing online teaching and learning challenges: intellectual property rights, distance learning issues, and using HTML and graphics. About three-quarters of fall 2001 session participants intended to develop an online course, and the majority cited a need for assistance from the LINKS center to support course development.

Instructors' main concerns centered on time, personal skill proficiency, and resources. Although instructors enjoyed the opportunity to learn about new technologies, many training participants were concerned with time limitations, and expressed apprehension about finding time to learn about and practice using new technologies, and about time required to transfer existing course materials to new formats. Typical concerns about technology proficiency included comments about personal skill limitations, saying that training was fast-paced for their ability levels.

Suggestions for training improvement centered on the need for hands-on practice and the individualization of training to meet instructors' particular needs. Faculty most often requested more active, hands-on practice during training sessions. For sessions dealing with specific technologies, such as Blackboard and Adobe Acrobat, many participants also suggested that training sessions accommodate differing ability levels. Participants did not express this need in

more general sessions, such as Internet exploration or copyright issues. For all sessions, participants requested additional materials that would support independent learning efforts.

Instructors' concerns with Blackboard implementation, as measured by the SoCQ, progressed from self to impact concerns over time. SoCQ outcomes suggested that as a result of training, instructors' initial awareness, informational, and personal concerns had diminished, whereas management, consequence, collaboration, and refocusing concerns intensified. Even so, faculty remained concerned about the personal aspects of implementing Blackboard (such as time) and their own abilities to use the application. Moreover, faculty remain highly concerned about the consequences of online coursework on students.

Faculty results for the Levels of Use Questionnaire show diverse but increasingly higher levels of Blackboard use. Results for 17 instructors with pretests and posttests on the LoUQ show that, as a result of training, instructors have generally moved to higher levels of Blackboard use. Individuals are significantly less likely to currently consider themselves as nonusers. Faculty ratings show that, at posttest, faculty who are using Blackboard tend to consider themselves as either mechanical users attempting to master day-to-day tasks or stabilized users who are refining Blackboard to increase the impact on students. Some faculty have also moved significantly toward routine Blackboard use.

LINKS provided faculty with a wide array of professional development options. The LINKS project provided TWU faculty with a number of professional development options supporting the institutionalization of LINKS goals for faculty development. Through Intel training, four instructors received technology-related curricular and management materials for teacher education coursework. Altogether, nearly 170 faculty (duplicated count) benefited from Faculty Development Days on distance education instructional and design issues. Twelve instructors assigned to teach online courses in the current academic year participated in sessions supporting course design. Through a unique mentoring relationship, five novice instructors and five experienced faculty worked collaboratively to develop technology-infused courses at the post-baccalaureate level. Finally, faculty from a variety of disciplines participated in a series of technology-related Brown Bag workshops.

LINKS training has positively impacted instructors' proficiency and use of technology in teaching. Eight faculty members interviewed indicated they either maintained or increased their general technology proficiency levels as a result of participation in LINKS activities. In describing increased skills, faculty mentioned proficiency increases in specific applications (Blackboard, HTML) and increased comfort and confidence with technology. All faculty increased their technology use in teaching after LINKS participation. Many are now using Blackboard applications, such as posting syllabi, course materials, pretests, or course evaluations. Several faculty also mentioned that they now routinely use PowerPoint for classroom presentations. One or two faculty members, however, still use technology sparingly in the classroom, citing the lack of time for technology preparation.

Institutionalization of Technology Initiatives

Evaluation findings for years one through three as well as information collected from project staff indicate that the LINKS PT^{3}grant has moved TWU toward the infusion of technology into the teacher education program and the university as a whole. Important findings relative to institutionalization include the following.

Effective leadership provided by LINKS staff advanced institutionalization through a reliance on technology standards, strategic planning, ongoing communication, blended funding, and regional partnerships. LINKS project leaders relied on national and state standards to integrate technology into the teacher preparation curriculum. LINKS components were aligned with TWU's strategic plan, and LINKS staff collaborated with other university leaders and departments to deliver training for instructors from various departments contributing to teacher education. Lines of communication sustained by LINKS staff with university leaders and blended resources supported project success. In addition, LINKS personnel established relationships with regional school districts to enhance supervising teachers' support for entry-level teachers.

LINKS initiatives increased faculty access to technology, provided professional development opportunities, and offered ongoing technical and curricular support. LINKS enhanced faculty access to technology by adding classroom resources for university classroom integration efforts. The LINKS Center also offered a training lab and ongoing support for faculty's technology integration efforts. More than 75 university instructors have been oriented to the technology needs of preservice teachers and introduced to online course delivery via LINKS training and activities. Combining LINKS and university professional development activities enhanced overall effectiveness. Data indicate that LINKS training has positively impacted instructors' technology proficiency and use of technology for teaching.

LINKS project components have been integrated into the teacher education program—thus, achieving the three-year goal of systematic and formalized institutionalization. In project years 1 and 2, technology training for preservice teachers focused on LINKS-provided curricular integration and technology-based field experiences integrated within the teacher education program. In year 3, LINKS preservice teacher activities were redesigned as online courses that are university teacher education requirements. LINKS activities have also been extended to the post-baccalaureate teacher preparation program.

References

Blake, S., Holcombe, L., & Foster, D. (1998). Technology and teachers: An investigation of attitudes and beliefs of introductory use by preservice teachers. *Journal of Technology and Teacher Education, 6*(1), 39-49.

Brindley, R., Fleege, P. & Graves, S. (2000). A friend in need: Early childhood mentoring model. *Childhood Education*, 76(5), 312-316.

Berge, Z. L., & Muilenburg, L. (2001). Obstacles faced at various stages of capability regarding distance education in institutions of higher education: Survey results. *TechTrends, 46*(4), 40-45.

Buhendwa, F. M. (1996). Preservice teachers' computer literacy: Validation of an instrument to measure self-efficacy for computer-based technologies. (ERIC Document Reproduction Service No. ED 405 355).

Buss, A. R. (2001). A delphi study of educational telecollaborative projects: Identifying critical elements and obstacles. *Journal of Educational Computing Research, 24*(3), 235-248.

Casado, M. (2001). Delivering library services to remote students. *Computers in Libraries, 21*(4), 32-34,36-38.

CEO Forum on Education & Technology (January, 2000). Teacher preparation StaR chart: A self-assessment tool for colleges of education. Retrieved May 20, 2002, from http://www.ceoforum.org/downloads/tpreport.pdf

Cohen, L. B., & Jacobson, T. E. (2000). Helping students choose tools to search the web. *Distance Education, 4*(7), 3.

Drazdowski, T. A., Holodick, N. A., & Scappaticci, F. T. (1998). Infusing technology into a teacher education program: Three different perspectives. *Journal of Technology and Teacher Education, 6*, 141-149.

Faison, C. L. (1994). Integrating technology into teacher education: A modular approach. *Technology and teacher education annual* (pp. 169-171). Charlottesville, VA: Association for the Advancement of Computing in Education.

Groves, M. M., & Zemel, P. C. (2000). Instructional technology adoption in higher education: An action research case study. *International Journal of Instructional Media, 27*(1), 57-65.

Guha, S. (2001). An effective way of teaching early childhood education on-line. *Childhood Education*, 77(4), 226-229.

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

International Society for Technology Education (ISTE, 2002). *National educational technology standards for teachers*. Retrieved May 20, 2002, from http://cnets.iste.org/index3.html.

Judge, S. L. (2001). Computer applications in programs for young children with disabilities: Current status and future directions. *Journal of Special Education Technology*, 16(1), 29-40.

Loucks, S. F., Newlover, B. W., and Hall, G. E. (1975). *Measuring Levels of Use of the Innovation: A Manual for Trainers, Interviewers and Raters.* Austin, TX: Southwest Educational Development Laboratory

McIntyre, S. R. & Tlusty, R. H. (1995, April). *Computer-mediated discourse: Electronic dialogue journaling and reflective practice.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Medcalf-Davenport, N. A. (1999). Historical and current attitudes toward and uses of educational Technology: In J. D. Price, J., Willis, D. A. Willis, M. Jost, & S. Boger-Mehall (Eds.), *The information technology and teacher education annual* (pp. 1424-1428). Charlottesville, VA: Association for the Advancement of Computers in Education.

National Council for Education Statistics (2000). *Teacher use of computers and the Internet in public schools: Statistics in brief.* Retrieved May 20, 2002, from http://nces.ed.gov/pubs2000/quarterly/summer/3elem/q3-2.html

Office of Technology Assessment. (1995*). Teachers and technology: Making the connection.* (Report No. OTA-HER-616). Retrieved May 20, 2002, from http://www.wws.princeton.edu/~ota/disk1/1995/9541_n.html

Parker, A., & Farrelly, D. (1994). Forced to succeed: Introducing the media to preservice teachers. *International Journal of Instructional Media, 21*, 295-299.

Schrum, L., & Dehoney, J. (1998). Meeting the future: A teacher education program joins the information age. *Journal of Technology and Teacher Education, 6,* 23-37.

Simmons, J. B. & Linnell, C. C. (1998). New tech ed. teachers via the out-of-field permit approach. *The Technology Teacher, 58*(1), 27-32.

Smithey, M. W., & Hough, B. W. (1999). Creating technology advocates: Connecting preservice teachers with technology. *Technology Horizons in Education Journal, 26,* 78-79.

Strudler, N. & Wetzel, K. (1999). Lessons from exemplary colleges of education: Factors affecting technology integration in preservice programs. *Educational Technology Research and Development, 47*(4), 63-81.

Veen, W. I., Lam, I., & Taconis, R. (1998). A virtual workshop as a tool for collaboration: Towards a model of telematic learning environments. *Computers & Education, 30*(1-2), 31-39.

Way, C. E., & Northeast and Islands Regional Educational Lab. at Brown University (NEIREL) Providence RI. (2001). *Teacher Development: A Strategy for School Improvement*. Rhode Island.

Weigel, V. B. (2002). *Deep Learning for a Digital Age: Technology's Untapped Potential To Enrich Higher Education*. California.

White, J. T., & Myers, S. D. (2001). You can teach an old dog new tricks: The faculty's role in technology implementation. *Business Communication Quarterly, 64*(3), 95-101.

Wood, E.; Willoughby, T.; Specht, J.; Stern-Cavalcante, W. & Child, C. (2002). Developing a computer workshop to facilitate computer skills and minimize anxiety for early childhood educators. *Journal of educational psychology, 94*(1), 164-70.