ABSTRACT

COULTER, BENJAMIN MARK. Utilization of Instructional Technology: Towards a Conceptual Model for Teacher Education. (Under the direction of Bradley S. Mehlenbacher)

The intent of this study was to propose and test a conceptual model that described utilization of instructional technology by teacher education faculty in University of North Carolina teacher education programs. Focus on utilization was guided by the study's conceptual framework originally developed by Seels and Richey (1994a).

Research questions focused on factor groupings contributing to overall utilization of instructional technology; investigating sub-set variables having the most influence on use of technology; describing the nature of relationship between factor groupings and use of instructional technology; creating and testing a conceptual model that illustrates factor groupings and their relation to the use of instructional technology; and identification of specific factors and barriers most frequently cited by faculty as influencing their use of instructional technology.

Development of the study included the creation of a 43 question instrument. Structural Equation Modeling employing Exploratory Factor Analysis, Principal Components Analysis, and Confirmatory Factor Analysis was used to identify and refine factor groups and test the conceptual model for goodness-of-fit.

Study results confirmed goodness-of-fit for the proposed conceptual model of technology use. Five factor groups, identified as primary components of the conceptual model, had varying degrees of relation to the use of technology, with institutional infrastructure holding the highest degree of relation.

Faculty participating in the study indicated major influencing factors for their use of technology as:

1. support structures within their teacher education program;
2. classroom availability of technology equipment for instructional use;
3. awareness of benefits that technology offers to teacher education candidates;
4. personal technology literacy.

Additionally, faculty indicated that few significant barriers exist that prevent them from using technology in teacher education courses. The most significant barrier reported was lack of time to research and develop technology-enhanced instruction.

Qualitative comments suggested that the majority of faculty had very positive attitudes towards technology use. Given increased emphasis on identified factors, UNC teacher education programs have the potential to improve technology integration throughout their preparation program.

Utilization of Instructional Technology:

Towards a Conceptual Model for Teacher Education

by

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APPROVED BY:

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Chair of Advisory Committee

BIOGRAPHY

Benjamin Mark Coulter was born in Danville, Pennsylvania in December, 1961. He earned his Bachelor of Science degree in 1985 from Idaho State University and a Masters degree in Human Resource Development from Western Carolina University in 1994.

Upon graduation from Idaho State University, Coulter entered active duty in the United States Army, serving first in Air Defense Artillery and for the remainder of his career in Military Intelligence, specializing in Counterintelligence. He retired at the rank of Major in October, 2000. His military career highlights include duty as a Company Commander in the XVIII Airborne Corps (Company A, 319th Military Intelligence Battalion), Fort Bragg, NC; HAWK Air Defense Artillery Platoon Leader and Assistant Operations Officer; Corps Human Intelligence Office; Intelligence Case Officer and Brigade Operations Officer in Munich, Germany, and Task Force Intelligence Officer while assigned to Joint Task Force Middle East, Persian Gulf. Coulter worked with many intelligence agencies and organizations, both domestically and internationally, and served as a Jumpmaster and senior parachutist while assigned to Fort Bragg.

After leaving military service, Coulter entered graduate school at Western Carolina University. Upon completing his degree in Human Resource Development, he began work as a seminar coordinator at the North Carolina Center for the Advancement of Teaching, Cullowhee, NC. In 1996, Coulter accepted the position of Director of Instructional Technology and Assistant Professor, Department of

Educational Leadership and Foundations, in the College of Education and Allied Professions at Western Carolina University.

Dr. Coulter currently resides in Canton, NC and is married to Dr. Elizabeth R. Coulter. Together they have five children, Robbie, Elizabeth, Maggie, Mary, and Abby.

ACKNOWLEDGEMENTS

The journey through a doctoral program could be described as a fantastic voyage. Certainly, it has all the elements and experiences: hope, wonder, discovery, challenge, surprise, desperation, humility, self-discovery, conquest, and always ever present, a glimmer of light at the end of the tunnel that sometimes looked like the end and other times simply whistled. This journey, a six-year endeavor, saw many transitions in my life, academically, professionally and personally. In many ways, this experience has been the most maturing and formative of my 42 years.

I have many to graciously thank and acknowledge. First, my colleagues in the Asheville Cohort were always there to support me, and continue to be there, physically and spiritually. Thank you one and all. Second, to Dr. Robbie Pittman and Dr. Harrison Kane at Western Carolina University, I marvel and salute your wisdom, patience, and expertise that guided me through the statistical challenges of this study. Third, my thanks extend to UNC instructional technology colleagues across North Carolina. Each was enthusiastic and instrumental in disseminating and collecting the data collection surveys, true colleagues in every sense of the word.

Fourth, to Dr. Brad Mehlenbacher, who in mid-stream accepted the role as Chair of my committee. His encouragement and kind words taught a valuable and memorable lesson on how to be a dissertation chair.

Fifth, my colleagues as Western Carolina University, specifically in the College of Education and Allied Professions, many of whom supported my efforts in earning this degree and were kind enough to share their knowledge, experiences, and help.

Finally, the love and support of my family made this doctoral program a personal success and a professional reality. My father, a University President and Chancellor, who went down this same road many, many years ago, was the first to encourage me. My mother and my sister believed in me. All our children: Robbie, Elizabeth, Maggie, Mary, and Abby were thoughtful, considerate, humorous, and respectful of the time and energy I needed to see this program through.

Last, my loving wife Beth, who having completed her doctoral program in 2000, still had the energy to hold my hand; say: “I do”; spend countless hours across from me reading edits; showing me the way; reminding me I could do it; always there with a smile, a laugh, and a hug; and who loves me unconditionally … my admiration will endure a lifetime.

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CHAPTER I

INTRODUCTION

Using instructional technology to enhance teaching and learning is a topic of wide emphasis and debate. While some stipulate that instructional technology offers significant challenges to cognitive development and learning (Bernauer, 1995; Dede, 1997; Fullan, 2000), others suggest that curriculum integrated with appropriate and applicable technology stimulates student interest, involvement, learning and retention (NCES, 2000; OSTP, 1997; OTA, 1995; Roblyer & Edwards, 2000; Ropp, 1999; Tomei, 1997).

Likewise, educating pre-service teachers (teacher education candidates) to utilize instructional technology is currently receiving significant attention and emphasis by national educational associations including the National Council for Accreditation of Teacher Education (NCATE) and the American Association of Colleges for Teacher Education (AACTE), national technology organizations and international societies (e.g. The Milken Exchange on Educational Technology; The International Society for Technology in Education [ISTE]; the Association for Educational Communications and Technology), and from national and regional reports (e.g. President's Information Technology Advisory Committee Report to the President (1999) (ITRC & SEIR*TEC, 1998).

NCATE, the dominant accrediting agency in teacher education, has emphasized the important role of teacher education faculty in the preparation of new teachers to utilize technology in their future classrooms. As an indicator of NCATE accreditation standards with expectations for knowledge and use of technology, Standard III.A, *Professional Education Faculty Qualifications* suggests that teacher education faculty should be knowledgeable about current practices regarding the utilization of educational technology and integrate them into their teacher education courses (NCATE, 2001).

Others relate the importance of faculty use of instructional technology by suggesting that national technology standards and practices be embedded into all teacher education courses and modeled for candidates by teacher education faculty (NCATE, 1997).

In preparing the future teaching force to use technology in educational sectors, teacher education institutions, and in particular many teacher education faculty, employ a continuum of strategies and curriculum structures that, to varying degrees, prepare the pre-service candidate to practice instructional technology in school settings (IRTC & SEIR*TEC, 1998). Interestingly, some teacher education institutions strongly encourage or require instructional technology coursework within their own programs, predominantly determined by grade level of preparation, while others do not (Association for Supervision and Curriculum Development [ASCD] report on integrating technology into teaching, 1997). Similarly, ASCD and others suggest that instructional technology integrated throughout the teacher education program is superior to a one-course educational technology approach (ASCD, 1997; NCATE, 2001; OTA, 1995).

These variations in faculty approaches to teaching and modeling instructional technology use may influence the mastery of instructional technology by newly licensed teachers and more importantly, how they themselves might utilize instructional technology in their future classrooms (NCATE, 2001). Beyond delivery methods, the significance of instructional technology being recognized as a core component in teacher education (NCATE, 2001) suggests that institutions are well served to become aware not only of the most effective and innovate approaches to integrating technology in teacher education, but also realize factors that promote or inhibit technology use by teacher education faculty.

Introduction to the study

The intent of this study is to propose and test a conceptual model that describes factors that may potentially influence or inhibit the utilization of instructional technology by teacher education faculty in University of North Carolina teacher education programs. Outcomes from the data analysis may produce information that could be used by teacher education institutions to develop or modify technology professional development for faculty; assist in the strategic development and planning of teacher education programs, and identify specific barriers and enablers that instructional technology specialists could use in focusing their instructional support efforts.

Proposed Conceptual Model:

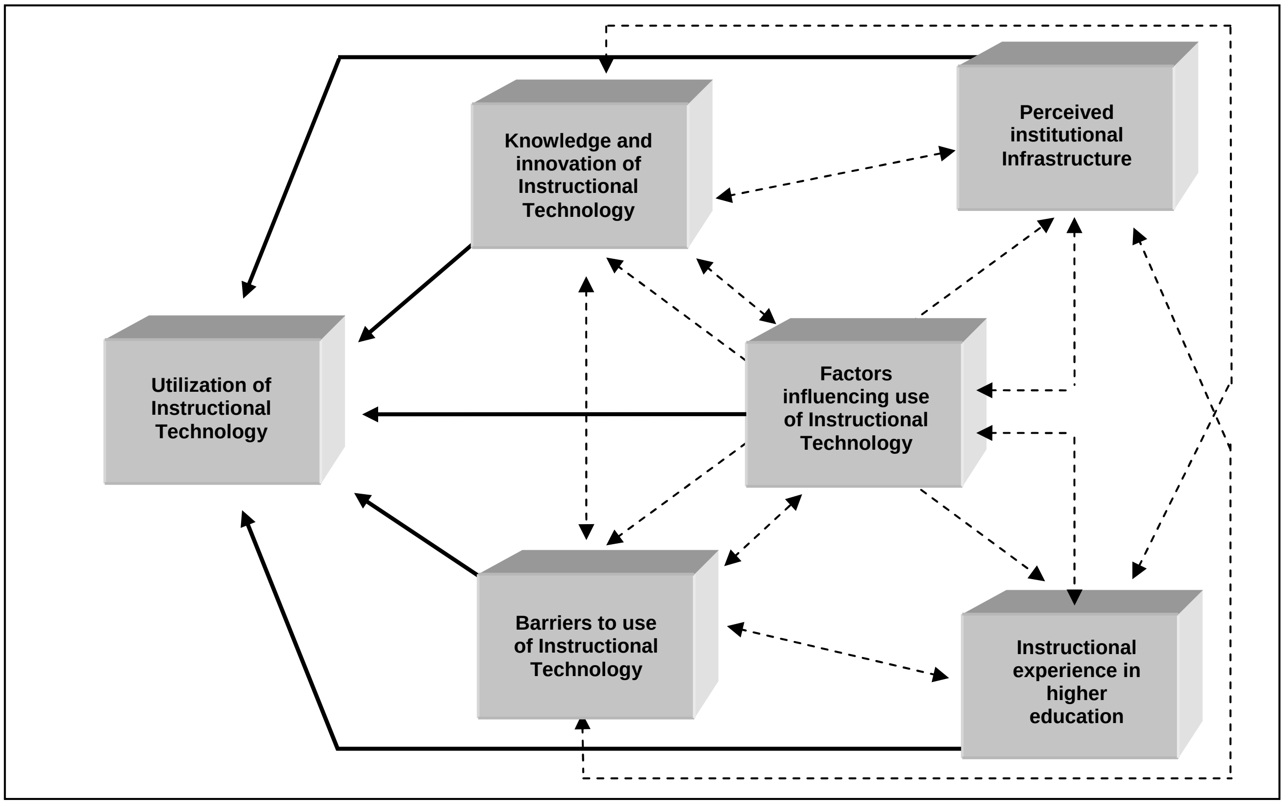


Figure 1.1. Factors contributing to the utilization of instructional technology

In figure 1.1, the conceptual model identifies 'Utilization of Technology' as the latent variable. The foundation for this variable is identified by Seels' & Richeys' Domains of Instructional Technology (1994a), recognized as a well known and used model in the field of instructional technology (AECT, 2000; Burnham, 2000; OTA, 1995). The model proposes a taxonomy of factors, titled 'domains' that have influence on the overall process of instructional technology. While the model does not define the degree of relationship an individual domain has on the overall practice of instructional technology, it identifies and defends factors that do contribute to the process of instructional technology (Seels & Richey, 1994a). Utilization focuses on the employment of specific instructional technologies through innovation, implementation and institutionalization to encourage and support its applicable use in educational settings.

Component variables are organized into five major groupings: knowledge, and innovation of instructional technology; institutional infrastructure; factors influencing the use of instructional technology; barriers to the use of instructional technology; and professional experience in education. Each major component has a sub-set of variables that define the construct. These variables align with research that suggests their inclusion in contributing to the concept of technology utilization (Beggs, 2000; Spotts & Bowman, 1995; Bitter & Pierson, 2002; Bussey, Dormody, & VanLeeuwen, 2000; Gao, 2000; Groves & Zemel, 2000).

Quantitative and qualitative data will be collected using a newly created instrument (Appendix A) founded on a review of relevant literature cited throughout the study. The instrument will be administered to all teacher education faculty in the University of North Carolina system who are teaching during the 2002-2003 academic year.

The study specifically focuses on teacher education faculty in schools/colleges/departments of arts and sciences and schools/colleges/departments of education. Hard copy surveys will be sent to all UNC instructional technology specialists in the 15 UNC teacher education institutions for dissemination to their respective teacher education faculty in throughout the institution. A follow-up online survey will be forwarded to UNC instructional technology specialists and they in turn will notify their respective teacher education faculty with an electronic request to participate with the online survey in the event they did not do so already with the hard copy instrument.

Theoretical Framework for the Study

Seels and Richey (1994a) proposed an interpretation that describes instructional technology as a systematic process of curriculum design and delivery rather than simply the individual employment of a given technology in a teaching environment. The model (Figure 1.2) identifies five domains of instructional technology all equally contributing to the overall practice of instructional technology. The schema is known and frequently used in the field to represent a systems approach to the design, delivery and assessment of instructional (Burnham, 2000).

Unlike solitary, and often linear, instructional design processes, this model embeds instructional systems design as one of many contributing elements in shaping an overall instructional development process. This supports Gagne, Briggs and Wager's (1992) description of instructional technology as an overall conceptual framework for the systematic design of instruction as well as the utilization of specific educational technologies for the betterment of teaching and learning.

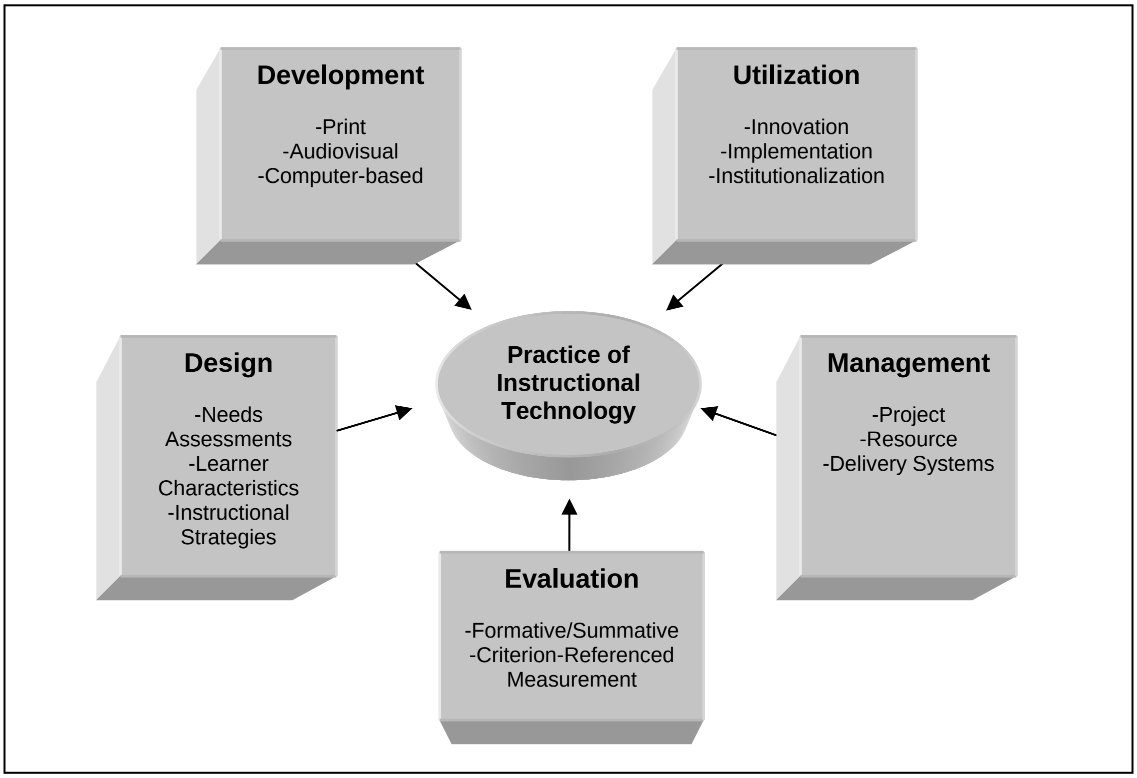


Figure 1.2. Domains of Instructional Technology. Adapted from Seels, B. B. & Richey, R. C. (1994a). Instructional technology: The definitions and domains of the field. Washington, DC: Association for Educational Communications and Technology.

Figure 1.2 illustrates five domains of instructional technology that form a framework to support the general practice of instructional technology in educational settings. This schema depicts each domain equally contributing to the overall practice of instructional technology.

The **design domain** ensures that instructional system design elements including needs assessments, learner characteristics and instructional strategies are incorporated and applied to the overall practice of instructional technology. The **development domain** considers selecting and modifying specific delivery systems and technologies to relate content to learners in a meaningful and appropriate format such as print, audiovisual, and computer-based. The **utilization domain** focuses on the employment of specific instructional technologies through innovation, implementation and institutionalization to encourage and support its applicable use in educational settings. The **management domain** centers on the project, resources, and delivery systems of the instructional technology process. The **evaluation domain** describes the importance of structured measurement to ensure that the practice of instruction, I this case an educational technology, is appropriate, accurate, and has the ability to be refined or periodically modified to optimize its impact on learning. Evaluation can be formative, summative, or criterion-referenced (Seels & Richey, 1994a).

According to this model, the practice of instructional technology should involve all five domains (Seels & Richey, 1994a). Since the employment of specific instructional technologies realized in classrooms by teachers and students lies within the utilization domain, this study will investigate those factors that teacher education faculty identify as being influential in their decision and ability to use instructional technology.

Statement of the Problem

National and statewide teacher education curriculum structures vary according to institutional standards, accreditation requirements, and program emphasis (Dolance & Norris, 1995; Ehrmann, 1995; Green & Gilbert, 1995; Massy & Zemsky, 1995). This variation is also found among individual teacher education preparation programs within the University of North Carolina system (NCDPI, 1999).

Typical teacher education programs have curricula designed for elementary, middle-grades, and secondary education as well as special preparation programs. In most cases, these curricula have both common instructional experiences for all grade-level areas of preparation and specialized curricula based on discipline content, according to grade level (elementary and middle grades, secondary, and specialized areas).

Formal technology preparation within teacher education, defined for the purposes of this study as a course in instructional technology, can be found in few, but not all teacher education programs. Therefore, while some pre-service students in the University of North Carolina system may have either a required or guided elective instructional technology course within their curriculum, others may not. The presence or lack of a formal instructional technology course may influence the practice of instructional technology in public school classrooms.

Today, more than ever, emphasis on using instructional technology to enhance learning is a predominant theme with both accreditation agencies and in classrooms at the K-16 level (Roblyer & Edwards, 2000; Ropp, 1999; Tomei, 1997). Preparing pre-service teachers to use instructional technology has gained statewide, national and international attention (NCATE, 2001).

In addressing the relevance of instructional technology and its use in teacher education programs, in 1996 the North Carolina Department of Public Instruction (NCDPI) adopted a set of basic and advanced technology competencies for educators that were originally established by a 1995 collaborative statewide task force. In 1999, the task force was reconvened and endorsed the basic and advanced competencies as still being pertinent and relevant to pre-service education and use in public school settings (University of North Carolina General Administration, 1999).

The School Technology Users Task Force (STUTF), drawing membership from the University of North Carolina, the North Carolina Community College System, and NCDPI, identified technology competencies for pre-service educators at two distinct levels that defined knowledge and use of instructional technology to enhance learning (University of North Carolina General Administration, 1999).

The first set of standards, classified as basic technology competencies, had nine defined skill categories. They were:

1. computer operation skills;
2. setup, maintenance and troubleshooting;
3. word processing/introductory desktop publishing;
4. spreadsheet/graphing;
5. database;
6. networking;
7. telecommunications;
8. media communications;
9. multimedia integration.

The task force designated these skill areas as essential foundation technology skills that each public school educator (pre-service and in-service) should demonstrate proficiency in order to develop and implement instructional technology strategies (University of North Carolina General Administration, 1999).

The second set of standards, classified as advanced technology competencies, identified knowledge, skills and strategies necessary to integrate and use instructional technology practices to enhance student learning and teacher proficiency using technology (University of North Carolina General Administration, 1999).

The advanced competencies were established in five categories as follows (these are an extension of the basic competencies and follow numerically as listed):

10. curriculum;
11. subject-specific knowledge;
12. design and management of learning environments/resources;
13. child development, learning and diversity;
14. social, legal and ethical issues.

In fall of 2003, the state of North Carolina transitioned from the basic and advanced competencies and adopted the ISTE NETS-T standards. These national standards are organized into six broad categories that provide guidelines for applying instructional technology in educational settings and serve as a framework for technology preparation of teacher candidates (Bitter & Pierson, 2002). These six standards areas include:

1. Technology Operations and Concepts;
2. Planning and Designing Learning Environments and Experiences;
3. Teaching, Learning and the Curriculum;
4. Assessment and Evaluation;
5. Productivity and Professional Practice;

6. Social, Ethical, Legal and Human Issues (ISTE, 2002).

Research Questions

1. What factors and sub-components contribute the most to the overall utilization of instructional technology by teacher education faculty?
2. What are the interrelationships between these factors and how do they relate to the use of instructional technology by teacher education faculty?
3. How well can a model be constructed that illustrates these factors and their relation to the use of instructional technology?
4. What specific components are most frequently cited that positively influence the utilization of instructional technology by teacher education faculty?
5. What specific components are most frequently identified by teacher education faculty as barriers to the utilization of instructional technology?

Purpose of the Study

Propose and test a conceptual model that describes factors and the relationships of those factors which influence the utilization of instructional technology by teacher education faculty in University of North Carolina System's teacher education programs.

Significance of the Study

Institutions of teacher preparation face ever-changing challenges to maintain currency and relevancy in preparing future teachers. Most teacher education organizations, societies, accreditation agencies, and educational and political leaders submit as a predominant theme that the use of technology to enhance learning is a critical component of all 21st century classrooms, regardless of grade or content level (NCATE, 2001; 1997).

Given the nature of this emphasis, determining components that either influence or inhibit the utilization of educational technology can greatly aid program developers, instructional support staff and agencies, and institutional planners in developing plans and professional development programs to foster increased mastery and utilization of educational technologies by teacher education faculty.

This study will specifically:

1. propose a conceptual model that describes technology utilization in consideration of the factors related to instructional technology;
2. provide insight into the scope of employment of instructional technology by full-time teacher education faculty;
3. identify influencing factors as well as barriers for using instructional technology in the preparation and delivery of teacher education courses;
4. move towards providing a conceptual model, through data analysis, to support the design and delivery of instructional technology-related professional development and strategic planning at the college, school or department level within teacher education programs. The analysis of data will enable teacher education programs to better support and promote the efforts of faculty using instructional technology and support state and national instructional technology standards.

Limitations of the Study

The following limitations apply to the study:

1. Survey will be administered only to current teacher education faculty teaching in a University of North Carolina teacher education institution. Faculty members either teaching in North Carolina private or community college teacher education programs will not be included in the data analysis.
2. Given that the survey instrument has been newly created, no previous measures of validity and reliability associated with the survey instrument exist. Only selected items that relate to the “Utilization Domain” (Seels & Richey, 1994a) and testing the proposed conceptual model will be used in the statistical treatment of data collected. Demographic questions will be used to describe a cross-section of the population, but will not be used in the factor analysis applied when testing the conceptual model.
3. While the survey collects data from a defined survey sample, findings may not be applicable or generalizible to other instructional populations including teacher education faculty in private teacher education institutions; faculty in community college teacher preparation programs; and K-12 public and private school teachers.
4. The study investigates only self-reported and perceived use of instructional technology practices, overall attitude, influential and inhibiting factors, frequency of use, and instructional technology preferences as identified by the survey instrument. Specific technology-related faculty development training; detailed data on faculty attitudes toward the use of instructional

technology in teacher preparation; attitudes toward the use of instructional technology by teacher education candidates, interns and newly licensed teachers, and technology support and funding are not the focus of this investigation. Faculty rank, academic department/school/college affiliation, full-or-part time teaching status; years teaching in teacher education and years using technology in teacher education will be identified in the demographic and profiling information.

5. Since the preparation program structures of instructional technology varies to some degree among University of North Carolina teacher education programs, consistency of pre-service preparation in instructional technology cannot be controlled.
6. Survey participants may or may not have had professional development in the area of instructional technology, may have differing experiences using instructional technology, may have attained a level of proficiency in the use of instructional technology by other means; and may have differing levels of access to technology at their teacher education institution.
7. The conceptual model of instructional technology identifies five domains influencing the overall process of instructional technology. This research focuses one of the five, utilization domain.

Assumptions of the Study

1. All initially licensed North Carolina teachers must demonstrate the ability to use and integrate instructional technologies as a condition of initial North Carolina state licensure. This requirement has been in place beginning in

1998 (University of North Carolina-General Administration, 1999). Since all UNC system teacher education faculty members are required to hold state teaching certification and are held accountable for the preparation of North Carolina initially licensed teachers, they have awareness of these licensure requirements.

2. Since all UNC teacher education programs are currently accredited by the National Council for the Accreditation of Teacher Education (NCATE, 2004a), and since NCATE has endorsed the International Society of Technology in Education (ISTE) National Educational Technology Standards for Teachers, it is assumed that all UNC teacher preparation programs place emphasis on the integration of instructional technology in their preparation coursework and recognize faculty responsibility for integrating instructional technology into their courses.
3. Since all UNC teacher education programs have recurring program reviews by the North Carolina State Department of Public Instruction and since instructional technology is an area of emphasis (NCDPI, 2000), it is assumed that teacher education faculty have awareness of the accountability to utilize instructional technology in their courses as well as state of North Carolina licensure requirements related to technology.
4. Since all respondents self-report their utilization of instructional technology as defined by the survey instrument, it is assumed that this self-disclosure is representative of their actual technology teaching practices and utilization of instructional technology within their classrooms.

5. Since each initially licensed North Carolina teacher must produce an advanced technology portfolio as a condition of licensure, it is assumed that each survey participant had some degree of familiarity with regards to the advanced technology competencies, and may also have experienced other methods of informal pre-service technology instruction that emphasized the advanced technology competencies, such as instructor modeling or advanced technology competency integration in part or throughout their teacher education program.
6. Since all teacher education institutions in the UNC system have been recipients of at least one United States Department of Education Preparing Tomorrow's Teachers to Use Technology (PT3) grant (University of North Carolina Office of the President, 2004), it is assumed that each teacher preparation program sponsored technology-related professional development opportunities for their teacher education faculty.
7. Since all UNC teacher preparation institutions have employed an instructional technology specialist, it is assumed that this person has worked with the majority of their respective faculty members in promoting, supporting and facilitating the utilization of instructional technology into teacher education courses at their institution.

Statistical Analysis

Structural Equation Modeling (SEM) will be the primary means of examining the proposed conceptual model and to investigate properties of the survey instrument. SEM is an extension of the general linear model (GLM) that enables a researcher to test a set of regression equations simultaneously, but differs in that it involves a latent variable instead of a dependent variable. SEM software can test traditional models, but it also permits examination of more complex relationships and models, such as confirmatory factor analysis (CFA) and time series analyses (TSA) (Stevens, 1996; Hoyle, 1995). For the purposes of this study, CFA will be used in conjunction with exploratory factor analysis to first group instrumentation items with conceptual factors, then test the factors using CFA for goodness-of-fit against the proposed conceptual model to investigate the existence of relational values between the observed variables (factors) and the latent variable (use of instructional technology).

The basic approach to performing a SEM analysis is illustrated in Figure 1.3. First, theory and related literature is researched to determine constructs that may have influence or bearing on the latent variable. Next, the researcher constructs a proposed model that illustrates hypothesized relationships between constructs, indicating a process, procedure, or schema in regard to the latent phenomenon. Following model construction, an instrument is either adopted or created to collect data on the observed variables that research and theory suggest have some relational value to the latent variable. After field testing and revision of the instrument, data is collected from the sample. EFA, by means of principal components analysis, is employed to investigate items on the instrument for correlation with identified factors, then; CFA is applied to test for goodness-of-fit and relational values between the observed variables and the latent variable. Results from EFA and CFA are interpreted by the researcher and reported.

As an outcome, since CFA tests for relations between hypothetical (nevertheless observed) constructs and latent variables, the model cannot by nature be accepted, rather, at best it can fail to be rejected based on goodness-of-fit. Finally, the researcher re-visits conceptual theories originally found to be related to the proposed model and accesses relational outcomes and modifies the proposed conceptual model as necessary with the ultimate goal of moving towards model verification and validation (Stevens, 1996; Hoyle, 1995).

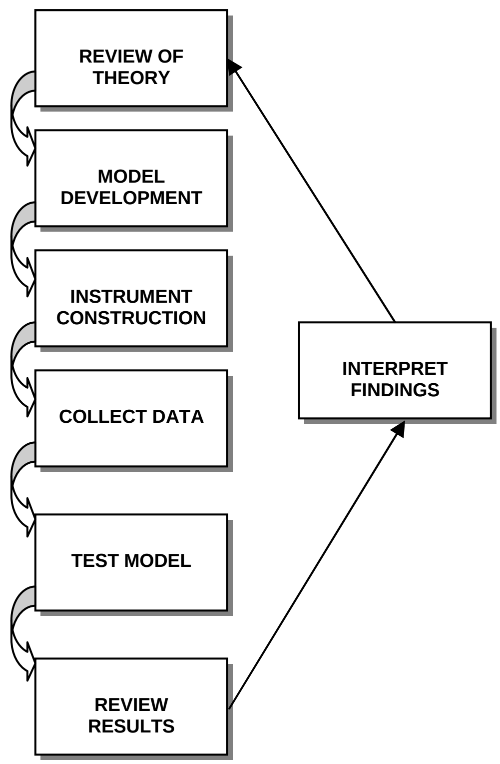


Figure 1.3. General process of structural equation modeling. Adopted from Stevens, J. (1996). Applied multivariate statistics for the social sciences*.* Mahwah, NJ: Lawrence Erlbaum Publishers

Definition of Terms

Technology portfolio - A collection of activities, evidences or reflections, correlated to state and/or national technology standards that demonstrates familiarization with and ability to use instructional technology in developing, delivering and evaluating curriculum supplemented with educational technology (Bitter & Pierson, 2002).

Barriers to the use of technology - Variables designated as negative contributors to the utilization of educational technology in the development and delivery of instruction (Beggs, 2000).

Candidates - “[i]ndividuals admitted to, or enrolled in, programs for the initial or advanced preparation of teachers, teachers continuing their professional development, or other professional school personnel. Candidates are distinguished from ‘students’ in P–12 schools” (NCATE, 2004b).

Common factor analysis – A procedure that results in factors that are derived from common variance. Common variance is the variance measured in a variable that is shared with other variables being analyzed (Child, 1990).

Computer-assisted instruction (CAI) - A common application of technology focusing on drill and practice, it is also an effective use of technology that addresses retention and remediation of information and promotes cognitive skill development (Moursund & Bielefeldt, 1999; Schacter, 1999).

Computer-assisted learning (CAL) - Software programs and associated computer hardware used to display instructions and requires learners to participate, make choices, and think critically (Kemp, Morrison & Ross, 1998).

Computer-enhanced instruction (CEI) - A way to use computers as teacher-directed content delivery tools that engage students in hands-on, student-centered learning activities (Kirkpatrick & Cuban, 1998).

Confirmatory Factor Analysis - A multivariate technique that allows for the researcher to test or confirm a hypothesis regarding which variables should be grouped together and considered a 'factor' (Child, 1990; Hair et al., 1992; Hoyle, 1995).

Delivery systems - The means by which instruction is provided to learners (including instructor-led instruction, distance education, computer-assisted learning, and self-paced instructional materials) (Dick & Carey, 1996).

Distance learning - Instruction from a remote site, using telecourse, computer, Internet, cable television, interactive television, or electronic correspondence (Beggs, 2000).

Eigenvalue - Numerical value that indicates the amount of variance accounted for by a factor and is a criterion for determining the number of factors to be extracted from the data (Cattell, 1966; Child, 1990).

Electronic technology portfolio - Digital collection of written work, scanned images, photos, video and audio that reflects a teacher candidate's educational philosophy of using technology in teaching and learning and provides evidence of the ability to incorporate technology into curriculum design, delivery and assessment (Bitter & Pierson, 2002).

Exploratory factor analysis - Provides information concerning the extent to which a varying number of factors will account for the correlations among tests. Also known as EFA, exploratory factor analysis searches for the structure or underlying dimensions among a set of variables (Child, 1990; Hair et al., 1992; Hoyle, 1995).

Factor - Combination of variables that are significantly interrelated. A factor also reflects the underlying dimension that accounts for the original set of observed variables (Child, 1990; Hoyle, 1995).

Factor analysis - General term provided for a group of multivariate statistical methods whose primary purpose is data reduction and summarization of the interrelationships between variables (Child, 1990).

Formative evaluation (as related to instructional design) - Testing a new instructional program with a sampling of learners during the developmental phase of instructional design, and using the results to improve the program in its deliverable state (Kemp, Morrison & Ross, 1998).

Hardware - Physical components that make up a computer system (Bitter & Pierson, 2002).

Influencing factors - Variables designated as positive contributors to the utilization of educational technology in the development and delivery of instruction (Beggs, 2000).

Initially licensed teachers - Newly licensed teachers who must complete a three-year induction period of service before receiving a permanent North Carolina teaching license. After the three-year induction period, certificated teachers must renew their permanent license every five years (NCDPI, 1998).

Instructional design - (1) methods used in the development of curriculum and learning activities and recognized as applicable processes for the integration of technology into education where appropriate (Lim, 2001; Parton, 2001). (2) The outcome of a design or solution to a problem involves more variables than can be represented in a solitary instructional design schema (Seels & Richey, 1994b). (3) systematic planning of instruction in which attention is given to related elements in the construction of curriculum (Kemp, Morrison & Ross, 1998).

Instructional technology - The definition of instructional technology prepared by the AECT [Association for Educational Communications and Technology] Definitions and Terminology Committee is as follows: "Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning. ... The words Instructional Technology in the definition mean a discipline devoted to techniques or ways to make learning more efficient based on theory but theory in its broadest sense, not just scientific theory. ... Theory consists of concepts, constructs, principles, and propositions that serve as the body of knowledge. Practice is the application of that knowledge to solve problems. Practice can also contribute to the knowledge base through information gained from experience. ... Of design, development, utilization, management, and evaluation ... refer to both areas of the knowledge base and to functions performed by professionals in the field. ... Processes are a series of operations or activities directed towards a particular result. ... Resources are sources of support for learning, including support systems and instructional materials and environments. ... The purpose of instructional technology is to affect and effect learning" (Seels & Richey, 1994a, pp. 1-9).

Learning styles - Preferred methods of cognitive retention by individuals or learning methods that may be more effective with different individuals (Kemp, Morrison & Ross, 1998).

Loadings - Correlation between variables or subsets and factors (Hoyle, 1995).

Model - Representation of the relationship among latent variables (factors) and observed variables (Stevens, 1996).

Multivariate data analysis - category of statistical procedures that allow for the simultaneous analysis of multiple measurements on each object under consideration (Child; 1990; Hair et al., 1992).

Oblique rotation - Rotation method in which the axes are not maintained at 90 degrees and the factors are not assumed to be uncorrelated (Hair et al., 1992; Hoyle, 1995).

Orthogonal rotation - Procedure that involves rotating the factors so the axes are maintained at 90 degrees, indicating that the factors are mathematically independent. Independent refers to a zero correlation between factors (Stevens, 1996).

Principal component analysis - An exploratory factor analytic procedure employed to determine the minimal number of factors needed to account for the maximum proportion of the variance within the original set of variables. Total variance is considered which results in factors that contain small proportions of unique variance. Unique variance is that variance which is associated to a specific variable (Child, 1990; Hair et al., 1992; Hoyle, 1995).

National Educational Technology Standards for Teachers (NETS-T) - Standards produced by the International Society for Technology in Education (ISTE). These standards are organized into six broad categories that provide guidelines for applying instructional technology in educational settings and serve as a framework for technology preparation of teacher candidates (Bitter & Pierson, 2002).

Performance indicators - Descriptors of behaviors that demonstrate attainment of desired knowledge, attitudes, or skills (ISTE, 2002).

Rotation - Procedure that involves manipulating the factor axes in order to attain a more parsimonious and more theoretical meaningful factor solution. Orthogonal and oblique rotations are two methods employed in the rotation process (Child, 1990).

Scree test - One common criterion, typically graphical, used in factor analysis to determine the ideal number of factors to be extracted based on Eigenvalues typically greater than 1.00 (Cattell, 1966; Stevens, 1996).

Self-paced learning - A learning environment that allows learners to satisfy required learning activities by accomplishing objectives at his or her own speed or convenience (Kemp, Morrison & Ross, 1998).

Summative evaluation (related to instructional design) - An evaluation designed and used after an instructional program has been implemented and completed. Information gained is used in presenting conclusions about the worth of the instructional program and to make recommendations about its adoption (Dick & Carey, 1996).

Teacher education program - A higher education program of study, typically beginning at the sophomore level, delivered by an institution of higher education, intended to graduate students with a Bachelors of Science degree in Education and concurrently receiving an initial state license to practice teaching at the Pre Kindergarten through 12th grade levels (ISTE, 2002).

Technology education - Includes the following: knowledge about and use of computers and related technologies in the delivery, development, prescription, and assessment of instruction; effective uses of computers as an aid to problem solving; school and classroom administration; educational research; electronic information access and exchange; personal productivity; and computer science education (ISTE, 2002).

Technology integration - The incorporation of electronic media into curriculum with the intent of supplementing instruction to accommodate various learning styles (ISTE, 2002).

Technology literacy - Operational knowledge of technology use in society; basic vocabulary and operation of computer/technology-based systems; and use of the computer as a vehicle for problem solving (ISTE, 2002).

Utilization domain - "The Definition and Terminology Committee [Association for Educational Communications and Technology] has provided descriptions for each of the domains: Design refers to the process of specifying conditions for learning. ... Development refers to the process of translating the design specifications into physical form. ... Utilization refers to the use of processes and resources for learning. ... Management refers to processes for controlling instructional technology. ... Evaluation is the process for determining the adequacy of instruction” (Seels & Richey, 1994a, pp. 24-43).

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Cheryl Lemke, Executive Director of the Milken Exchange on Education Technology has stated that “Today’s students live in a global, knowledge-based age and they deserve teachers whose instructional practice embraces the best that technology can bring to learning.” (Moursund & Bielefeldt, 1999, p. i). The inclusion of instructional technology as an area of focus in teacher preparation programs has evolved in significance to the point of having national and, in many cases, state-directed standards for program accreditation (Cook, 2001). However, despite the considerable integration of technology instruction into teacher training programs in the U.S., research suggests that many teacher preparation institutions fail to adequately prepare their teacher candidates to effectively use technology in teaching (Moursund & Bielefeldt, 1999).

Most technology instruction in teacher education focuses on the technology itself instead of teaching candidates how to integrate technology across a curriculum (OTA, 1995). And teacher education programs that fail to fully integrate technology themselves in their courses often do not consider preparing candidates in instructional technology critical to their overall readiness to assume instructional responsibility (NCATE, 1997; OTA, 1995). Many factors and conditions are cited as reasons that teacher education programs have been slow to prioritize instructional technology as a core component of their preparation curriculum.

Some of these contributing factors and conditions recurring throughout the research include:

1. low technology proficiency of teacher education faculty;
2. faculty failing to model instructional technology in their teaching;
3. lack of incentives for faculty effectively using technology in teaching; (d) absent, insufficient or un-enforced teacher education technology integration plans;
4. lack of emphasis from administration on the use of technology in teaching;
5. inadequate technical or instructional design support;
6. outdated or inadequate technology training facilities;
7. insufficient resources for technology acquisition (IRTC & SEIR*TEC, 1998; Moursund & Bielefeldt, 1999; OTA, 1995; USDOE, 2000).

Impact of Technology on Instruction

The impact of technology on teaching and learning is evidenced through increasing investigation and use of the term 'Instructional Technology.' Seals and Richey (1994a) state that the terms 'educational technology,' 'technology in education,' and 'instructional technology' are "used to describe applications of technology, systematic processes, and tools which can be used to solve problems of instruction and learning" (p. 4). Furthermore, when considered as a systematic process, instructional technology can be defined as "the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning" (Seals & Richey, 1994a, p. 1).

Even though there is widespread recognition of importance of instructional technology in teaching and learning and the vital role that instructors have in the effective use of instructional technology (OSTP, 1997), there have been relatively few research studies done on how and why instructors (especially in higher education) use technology (Moursund & Bielefeldt, 1999; OTA, 1995; Zhao & Cziko, 2001), and even fewer studies on why they do not use technology (Zhao & Cziko, 2001).

Much of the research in instructional technology has focused on the impact of technology on learners with limited studies conducted on instructors or teacher education faculties (OTA, 1995). Most studies investigating instructor use of technology have focused on “the successful ‘accomplished’ technology users” rather than the majority, those who do not use technology (Zhao & Cziko, 2001). Relatively few instructors use technology regularly in their teaching and the impact of computers on existing curricula is still limited primarily to the passive viewing of information, drill and practice, creating presentations and generating computer-based reports (D’Amico, 1999; Prater & MacNeil, 2001; Zhao & Cziko, 2001).

Assessment of Instructional Technology

Instruments that investigate and assess instructional technology use have been developed by individuals, educational institutions, and organizations, and can be classified in three major categories:

- Institutions of Higher Educations (IHEs) have developed instruments to assess the instructional technology integration levels in their teacher education programs,

- States and educational organizations have developed instruments to assess instructional technology integration, determine technology skill levels, collect data for federal and state educational mandates, needs assessments to plan professional development, and for gauging professional growth through individual self-assessments (CEO Forum, 2001; OTA, 1995; Moersch, 2002;). North Carolina, for example, requires teacher education programs to assess their own teacher education students for state certification by having candidates develop portfolios that demonstrate knowledge and use of technology in teaching and learning situations (NCDPI, 1999).
- Private companies have developed instruments to measure instructional technology infrastructure and proficiency in helping teachers select training appropriate for their level of need (CEO Forum, 2001).

Many instructional technology assessment instruments are standards-based instruments drawing in part upon the International Society for Technology in Education (ISTE) endorsed National Educational Technology Standards for Students, Teachers, and Administrators, state technology competencies created by many individual states over the past 10 years, and on mandates associated with recent federal legislation (Moersch, 2002).

ISTE as an organization has had a significant influence on instructional technology standards used by the National Council for Accreditation of Teacher Education (NCATE), one of the official bodies for accrediting teacher preparation programs (Moersch, 2002; NCATE, 2001). The ISTE standards serve as an outline for preparation programs to follow in preparing teacher education candidates to use technology in their teaching and contain the fundamental concepts needed by all pre-service teachers (ISTE, 2002; NCATE, 2001; USDOE, 2000).

Recent federal mandates, including the No Child Left Behind Act of 2001, the Elementary and Secondary Education Act, and reauthorization of the Higher Education Act, has also been associated with many instructional technology assessments in an effort for federally and state-funded technology programs to substantiate and provide evidence of technology benefiting the teaching and learning processes at K-12 and higher education settings (ISTE, 2002; Moersch, 2002; NCATE, 2001; NCDPI, 2001; OTA, 1995).

Most instructional technology assessment instruments evaluate pre-service, teacher education faculty, and in-service teachers' technology proficiency in one or more of the following five areas:

- Basic technology: basic computer terminology, skills and ability
- Productivity: proficiency with word processing, spreadsheets, databases, presentation software, e-mail, and Internet use
- Ethics: copyright, privacy, and fair use issues
- Basic integration: integrating instructional technology into curriculum
- Advanced integration: appropriately integrating media and technology resources into the curriculum; addressing differences in students' learning and performance; based upon principles of effective teaching and learning, align instructional technology with curriculum goals; and support active student involvement (ISTE, 2002; Moersch, 2002, USDOE, 2000).

Types of Instructional Technology Assessments

Most instructional technology assessments are survey-based and collect data quantitatively through multiple-choice questions, by categorical response, through examinations of student-generated evidence, and via performance-based examinations. Qualitatively, technology use data is assembled by means of open-ended questions, focus groups, sensing sessions, interviews and observations (ISTE, 2002; OTA, 1995).

In 2000, the United States Department of Education commissioned the Mathematica Policy Research organization, as a component of the evaluation of the Preparing Tomorrow's Teachers to use Technology (PT3) grant program, to:

1. identify instruments used to measure teacher technology proficiency;
2. examine the strengths and limitations of those instruments;
3. describe designs for a study in which those instruments could be used.

Based on this study, there were four types of instruments found that most commonly assessed instructional technology use. The following is a summary of these findings. The last two instrument types (numbers 5 and 6) are used less frequently; however, are still noteworthy.

1. Online examinations – typically multiple-choice questions that are administered and evaluated either online or by some other electronic means (USDOE, 2000). According to the U.S. DOE (2000), "The major drawback of an online examination is that the format limits the ability to measure the depth of teachers' technology integration skills" (p. 11). The online examination is also more limiting in its ability to measure even basic

technology skills because they only require a question to be answered as opposed to demonstration of skills and knowledge (USDOE, 2000).

Online examinations are recommended for use as a means of assessing technology proficiencies of students before they enter teacher education programs, during their teacher education programs, and after graduation from their teacher education programs. Because online examinations are limited in their ability to measure the depth of technology integration expected of teachers, they are not recommended for use with in-service teacher technology assessments (USDOE, 2000).

2. Portfolio assessments – usually consist of a rubric that aligns specified technology competencies with the portfolio created by the student (OTA, 1995; SIR-TEC, 2000; USDOE, 2000). Portfolio assessments, according to the U.S. DOE (2000), “provide a much better assessment of students’ technological skills and ability to apply and adapt technology to specific learning situations … [and] … allows students to demonstrate a broader range of skills than other types of assessments” (p. 21).

   Portfolio assessment is the best-suited instrument for use with measuring technology proficiency levels during teacher preparation programs because they are open-ended and they allow candidates to demonstrate knowledge and skills gained throughout their teacher preparation program (OTA, 1995; ITRC & SIR*TEC, 1998; USDOE, 2000).

   Additional resources are required of institutions using portfolio assessment methods. These include (a) trained evaluators and (b) additional time for evaluation (more than online exams). Additional concerns with using portfolio assessments are (a) tester reliability — evaluator judgment and use of multiple evaluators and (b) portfolio development time-consuming burdens placed on pre-service candidates (USDOE, 2000).

3. Performance assessments – generally contain performance evaluation means to measure technology tasks that are skill oriented. Advantages of the performance assessment include (a) generally, they are better than online exams at assessing teachers' basic technology skills instead of knowledge about technology integration (b) it requires a significantly less amount of time to complete as compared to a portfolio (USDOE, 2000).

   Disadvantages of using performance assessments include (a) time to administer and evaluate and (b) subjectivity during evaluation (USDOE, 2000).

4. Self-assessments –usually in the form of a list of skills and/or competencies administered to teacher education candidates and/or K-12 in-service teachers enabling them rate their ability in those areas. Self-assessments are usually easy to administer and are appropriate for assessing technology skill levels prior to entry or during teacher education programs. Drawbacks to using them include the potential for biased results and possible failure to address integration at an acceptable level (USDOE, 2000).

5. Interview protocol – usually in qualitative research form of questions for discussion about pre-service candidate abilities with instructional technology (USDOE, 2000).
6. Demonstration and observation methods – specifies instructional technology tasks preformed, observed, and evaluated by a trained evaluator (USDOE, 2000).

In addition to types of instruments, Moersch (2002) identified design elements common to many technology assessments. In addition to correlation between surveys and federal/state technology standards, technology assessments probe for information on technology skill level, integration of technology into instruction, attitudes affecting the use of technology in teaching, technology supporting student achievement, institutional support of technology use, experience using instructional technology, and knowledge of instructional practices using technology (Moersch, 2002; OTA, 1995; USDOE, 2000).

Teacher Education Candidates, Faculty, and In-Service Teachers

In 1998, the Milken Exchange on Instructional technology requested that ISTE survey departments/schools/colleges of education in the U.S. to ascertain information concerning the technological preparedness of pre-service candidates in terms of teaching and learning (Moursund & Bielefeldt, 1999). The survey instrument, developed by an advisory team that consisted of college deans, researchers, teacher educators, education agency officials, and ISTE personnel, evaluated:

1. course-work and faculty;
2. facilities and support;
3. field experience and practice teaching; and
4. preparedness of graduates to enter into the teaching profession.

The study concluded that in a majority of teacher education institutions surveyed, candidates were inadequately prepared to meet national technology expectations and that teacher education faculty did little to integrate standards-based instructional technologies into their teacher education courses (Moursund & Bielefeldt, 1999).

As of the year 2000, there were 15 states requiring pre-service candidates to meet some type of technology requirement prior to teaching licensure by multiple assessment methods (ISTE 2002; USDOE, 2000). Of the 26 measurement instruments identified in the United States Department of Education study, 15 were developed by institutions of higher education (USDOE, 2000). Additionally, the most frequently used types of instruments were portfolio assessments (10) and self-assessments (9) (USDOE, 2000).

Theoretical Models and Critical Factors in the Instructional Technology Process

The activity of using technology as a learning tool is recognized more as a teaching methodology than as a means for designing instruction (Williams, 2000). While the common focus of technology in education has been on activities such as doing, making, or leaning about things through the use of electronic media, this represents one component of an established conceptual framework, instructional design, and in a broader context, the instructional technology process (Seels &

Richey, 1994b). This notion supports Gagne, Briggs, and Wager (1992) who suggest that the term *instructional technology* refers to the encompassing systematic process of designing curriculum as opposed to using particular electronic hardware or computer software as a tool to enforce learning.

Knowledge and Innovation of Instructional Technology

Integrating technology into curricula with the intent of positively influencing teaching and learning has been in a state of evolution over the past 20 years (Dias & Atkinson, 2001; Dockstader, 1999). Driven primarily by hardware and software evolution, accessibility to computers in educational settings, and popular instructional technology trends, technology integration has covered the continuum from instruction on programming skills, self-directed drill and practice, interactive learning software, online training, testing, instructional delivery augmentation, and Internet-based accessibility to information, communication, and publication (Dias & Atkinson, 2001).

In all these forms of technology leveraged for instructional purposes, the concept of using technology that is context-oriented, curriculum-based and which actively involves students is recognized by many researchers as the measuring stick of successful technology innovation (Bouie, 1998; Bussey, Dormody & VanLeeuwen, 2000; Dias & Atkinson, 2001; Dockstader, 1999; OTA, 1995).

Designing Instruction

A recurring approach in illustrating the systemic, technological process of designing instruction is to map out a series of steps and procedures for instructors to follow as they develop curriculum and specific learning events and activities (Dick &

Cary, 1996; Kemp, Morrison & Ross, 1998). The systematic design process can be taught and learned by instructors who can then apply it to their own curriculum development and learning activity design. These processes are typically described in the many instructional design models, all closely associated with the larger field classified as instructional technology (Dick & Cary, 1996; Gagne, Briggs & Wager, 1992; Kemp, Morrison & Ross, 1998).

Interestingly, Williams (2000) reveals that instructional designers rarely follow each step of a specified instructional design process. Instead, they tend to adopt portions of systemic design models as they deem appropriate in proceeding towards task completion. Many known instructional design models (Dick & Cary, 1996; Kemp, Morrison & Ross, 1998) incorporate various forms of needs analysis, learner and procedure identification and implementation planning; however, teachers can engage the design process at different stages based on desired student outcomes (Williams, 2000).

Gagne, Briggs, and Wager (1992) suggest that theorists and practitioners alike develop specific interpretations of instructional design by creating a recipe that borrows ingredients from major fields of study and instructional system design models that have in some form contributed to the overarching field of instructional technology. The Kemp, Morrison, and Ross (1998) model of learner-centered instructional design actually accommodates the flexible absence of one or more design elements yet still maintains that it aids in the development of a comprehensive systematic product of learning. Supporting this position, studies suggest that developers rely on multiple models and adapt procedural components to meet specific needs, many times based on the unique needs and experiences of learners (Gagne, Briggs & Wager, 1992; Seels & Richey, 1994b).

The methods used in the development of curriculum and learning activities are also recognized as applicable processes for the integration of technology into education where appropriate (Lim, 2001; Parton, 2001). The outcome of a design or solution to a problem involves more variables than can be represented in a solitary instructional design schema (Seels & Richey, 1994b).

Instructional Systems Design Theories

Instructional systems design, according to Gagne, Briggs and Wager (1992), can be significant in the development of technology as a specific learning tool and is recognized as a suitable method for use in learning and the delivery of instruction.

Instructional design theories are generally derived from broader instructional theories (Knirk & Gustafson, 1986). While instructional theories tend to focus on individual learning styles, using an instructional systems approach establishes a set of procedures used to plan instructional content (Knirk & Gustafson, 1986). When instructional theory and instructional design theory are combined, the outcome is referred to as *instructional technology* (Gagne, Briggs & Wager, 1992).

Knirk and Gustafson (1986) focus on recognizing characteristics for learning and developed a specific set of learning conditions. When employed in an instructional design process, the yield produced optimized learning, retention and transferability. These conditions include: gaining learner attention; informing the learner of objectives; stimulating/recalling prerequisite skills; utilizing stimulus materials; providing learner guidance; eliciting desired performance; providing feedback; assessing performance; guiding transfer for retention.

Elaboration Theory, proposed by Reigeluth, contributes significantly to the instructional design process by offering macro-strategies to organize instruction through interrelation and instructional sequencing. In essence, elaboration theory describes instructional sequences in the form of task analysis that gradually exposes learners to content and at the same time relates new content or experiences to previous content or instruction, thereby reinforcing learning and stimulating cognitive growth (English & Reigeluth, 1996; Knirk & Gustafson, 1986).

Case's instructional design sequence complements Reigeluth's Elaboration Theory by suggesting that a learner's intellectual development and working memory increases as more complex cognitive strategies are introduced and experienced (Knirk & Gustafson, 1986).

Landa's decision trees serve as effective patterns of design when mapping instruction and curriculum, especially individualized or self-paced learning. These decision trees are typically best suited for self-directed technical learning, procedural learning, and problem solving, however, critical to the success of using this model for instruction is identifying all potential activities and procedures that the learner may possibly encounter (Knirk & Gustafson, 1986).

In considering the specific use of instructional technology by teachers, some research suggests that teachers are motivated to use technology according to their perceptions and beliefs (Zhao & Cziko, 2001). Perceptual Control Theory (PCT) serves as one framework for understanding the adoption or lack of adoption of technology in teaching. In this case, PCT attempts to examine instructional technology utilization from an internalized, personal perspective instead of external conditions that may enable or inhibit teachers to use technology (Zhao & Cziko, 2001).

This theory considers teachers' use of technology by examining the internal goals of instructors and how the use of technology might help or hinder their individual objectives in teaching. Considering that teachers are goal-oriented, purposeful educators, PCT provides a model based on three perceptions of using technology in teaching:

1. Technology can most effectively meet a higher-level goal than what had been achieved in the past.
2. Using technology will not inhibit the attainment of other higher-level goals that the teacher considers more important than the one being maintained.
3. A teacher has or will have sufficient ability and resources to use technology. (Zhao & Cziko, 2001).

Central to this theory is the notion that humans control what they perceive, and in this regard, PCT theory argues that all three perceptions must be accepted and internalized as a motivating condition for technology use in instruction. If any of the three perceptions are absent, instructors may be more likely to refrain from using technology in teaching (Zhao & Cziko, 2001).

With respect to students, Williams (2000) suggests that the learner's perception of instructional technology is different than that of the instructor. From a student's standpoint, technology, when effectively utilized to support teaching and learning, is perceived as a seamless learning activity which is not separated into content and process, or theory and practice. This integrated perspective enables students to engage themselves in the practical use of technology instead of considering the pedagogical implications of how it may be influencing their learning and retention of content.

Lewis (1999) also contends that lack of sustained federal and state technology funding has resulted in limited research to develop, test, and operationalize instructional technology theory. If funding consistently becomes available, this would elevate the field of instructional technology into a specialized area that would be recognized as a true and valued educational discipline.

Theoretical models of instructional technology typically describe characteristics and styles of learning; instructional strategies and methodologies; instructional design and development models; and the relation of specific learning events and activities to learning outcomes (Knirk & Gustafson, 1986).

A broader interpretation of instructional technology has been proposed by Seels and Richey (1994a). They have developed a model which identifies domains of instructional technology all equally contributing to the overall practice of instructional technology. The schema is known and frequently used in the field to represent a systems approach to the instructional technology process (AECT, 2000; Burnham, 2000; OTA, 1995). Unlike solitary instructional design processes (Dick & Carey, 1996), this model embeds instructional systems design as one of many contributing elements in shaping an overall instructional technology process. This supports Gagne, Briggs and Wager’s (1992) description of instructional technology as an overall conceptual framework for the systematic design of instruction. Figure 2.1 illustrates the five domains of instructional technology which form a framework to support the general practice of instructional technology in educational settings. This schema depicts each domain contributing to the overall practice of instructional technology.

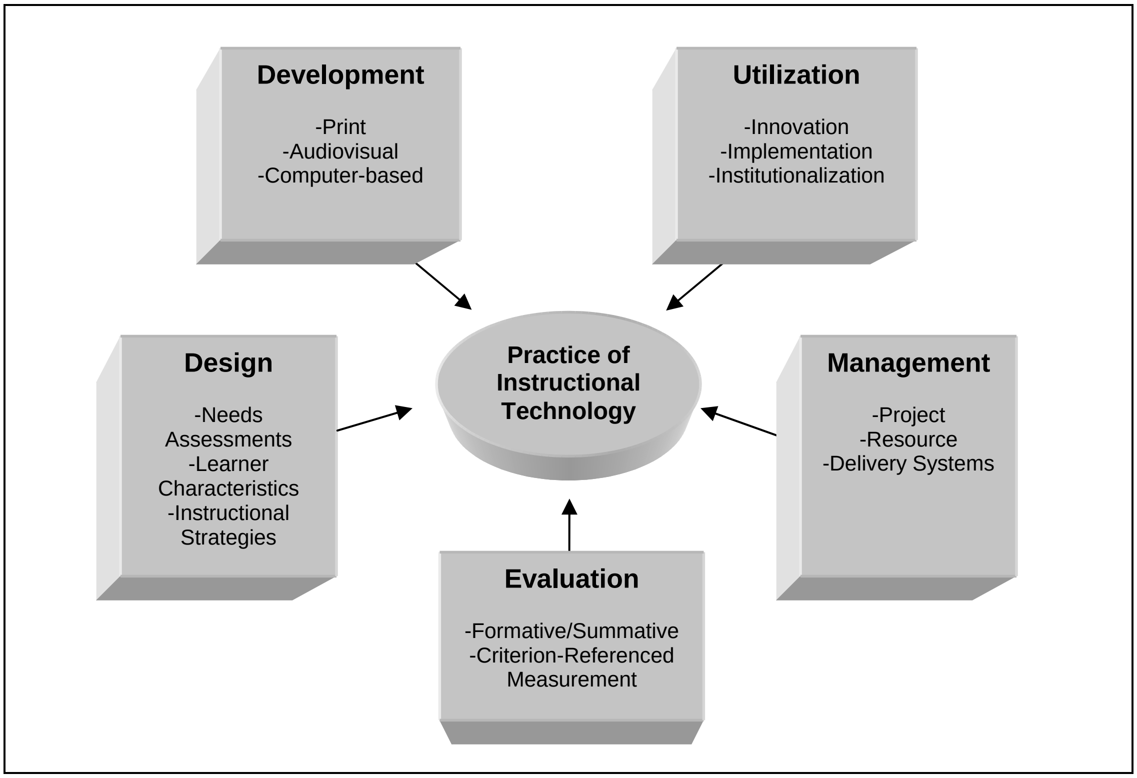


Figure 2.1 Domains of Instructional Technology. Adapted from Seels, B. B. & Richey, R. C. (1994a). Instructional technology: The definitions and domains of the field. Washington, DC: Association for Educational Communications and Technology.

The design domain ensures that instructional system design elements including needs assessments, learner characteristics and instructional strategies are incorporated and applied to the overall practice of instructional technology. The development domain considers selecting and modifying specific delivery systems and technologies to relate content to learners in a meaningful and appropriate format such as print, audiovisual, and computer-based. The utilization domain focuses on the employment of instructional technology through innovation, implementation and institutionalization to encourage and support its applicable use in educational settings. The management domain centers on the project, resources, and delivery systems of the instructional technology process. The evaluation domain describes the importance of structured measurement to ensure that the practice of instructional technology is appropriate, accurate, and has the ability to be refined or periodically modified to optimize its impact on learning. Evaluation could be formative, summative, or criterion-referenced (Seels & Richey, 1994a).

According to this theoretical model, the practice of instructional technology should involve all five domains (Seels & Richey, 1994a). Since the practice of instructional technology realized in classroom settings by instructors and students (candidates) lies within the utilization domain, this study will investigate those factors that teacher education faculty identify as being influential in their decision and ability to use instructional technology. The identification and characteristics of these elements within the utilization domain identify components that may have relational value to the use of technology in teacher education settings.

Knowledge-Based Developmental Stages

Rieber and Welliver (1989) presented five hierarchical levels of technology innovation that in turn establishes an instructor's knowledge and ability to use technology for instructional purposes. These levels, listed lower-to-higher, include:

1. familiarization with enabling instructional technologies in the discipline area; instructional use of available technology;
2. integration of available technologies into content-based, student-centered activities; reorientation of integration methods based on formative evaluation; and
3. evolution of initial integration strategies and methods into teacher-innovated applications of technology to enhance teaching and learning (Nisan-Nelson, 2001).

Nisan-Nelson (2001) and Dias and Atkinson (2001) presented evidence to support these five developmental levels by suggesting that instructors may find themselves at one of five hierarchical levels. Specifically, they associated the levels with instructors considering, planning, implementing and evaluating technology into their teaching (Dias & Atkinson, 2001; Nisan-Nelson, 2001).

The Apple Classrooms of Tomorrow (ACOT) longitudinal study conducted between 1985 through 1998 identified stages of technology integration that parallel Rieber and Welliver's hierarchical levels. The ACOT stages are:

1. entry;
2. adoption;
3. adaptation;
4. appropriation; and

5. invention (Dias & Atkinson, 2001).

Supporting the Use of Instructional Technology

Van Scoter, Ellis, and Railsback (2001) supported the view that appropriate use of technology in teaching could have positive effects on students of all ages, including higher education settings. When pedagogically combined with previous knowledge and experience, technology could improve student motivation, self-direction, sense of accomplishment, and critical thinking skills. Through the use of subject-specific curriculum software, students often times have the opportunity to explore, discover, make decisions, involve senses, and apply new information in real life situations (OTA, 1995; Van Scoter, Ellis & Railsback, 2001).

During a 1994 interview, Linda Darling-Hammond suggested that instructional technology use in classroom settings enables students to learn by providing active learning opportunities. Additionally, she stated that this allows for accommodation of individual learning styles and abilities, and prepares students to function effectively in a dynamic workplace environment that will demand persons to access and process information electronically and in new ways (Novak, 1994).

Schacter (1999) highlights five studies concerning the impact of technology on student achievement. The studies analyzed were: Kulik's Meta-Analysis Study; Sivin-Kachala's Review of the Research; The Apple Classrooms of Tomorrow (ACOT); West Virginia's Basic Skills/Computer Education (BS/CE) Statewide Initiative; and Harold Wenglinsky's National Study of Technology's Impact on Mathematics Achievement. These studies concluded that students with access to technology (CAL, integrated learning systems, higher order thinking simulations and software, collaborative systems, design and programming systems), "show positive gains in achievement on researcher constructed tests, standardized tests, and national tests" (Schacter, 1999, p.9). However, Schacter suggests that there is "evidence in some of these studies that technology use in teaching is less effective or ineffective when the learning objectives are unclear, the technology is not directly correlated to the subject matter, and the focus of the technology use is diffuse" (p. 10). Therefore, the practice and implementation of instructional technology should be systematically designed, employed, and evaluated to maximize its effectiveness on the teaching and learning process.

Utilization of Instructional Technology

Assumptions about why instructors use or do not use technology to support instruction can assist with efforts to help instructors effectively integrate technology into their teaching practice (Zhao & Cziko, 2001). These assumptions include presence or lack of appropriate training, technical support, administrative support, institutional infrastructure and emphasis, systemic incentives, and restraints due to traditional pedagogical beliefs and resistance to change (Zhao & Cziko, 2001).

Furthermore, instructors identified as being frequent, effective users of instructional technology do not necessarily have advanced technology skills or access to more resources, but instead have a high degree of innovation and are self-motivated to invest themselves in instructional technology (Zhao & Cziko, 2001). Many of these instructors, labeled as 'early adopters' of instructional technology, began integration of technology before institutional or standards-based emphasis was placed on technology use in teaching. They not only invested personal time and energy to learn technologies and their use in teaching, but also had to lobby support from administrators and other faculty for permission to access technology equipment and develop new teaching methodologies that used technology to enhance learning (OTA, 1995; Kirkpatrick & Cuban, 1998; Zhao & Cziko, 2001).

In examining foundations for the use of instructional technology, a general assumption is that universal decisions to mandate, standardize, and require the use of instructional technologies imply that it is possible for them to be applicable in all instances of education. However, many of these policies do not accommodate situational flexibility and often fail to recognize instructors as purposeful, goal-oriented individuals capable of determining whether or not to use technology in teaching (Zhao & Cziko, 2001). Therefore, some instructors petition for not using technology in instructional settings that may not conform to mandates that are strict and specify precise uses of technology (OTA, 1995). In response, emerging national instructional technology standards are more generalized than earlier mandates, allowing flexible application and adaptation depending on discipline and grade level. This new approach to standard-setting empowering educators to integrate technology they consider appropriate and applicable to teaching and learning in their classroom (Baines & Belvin, 2001) and suggests that they themselves must be knowledgeable about technology use in their discipline area (Baines & Belvin, 2001; ISTE, 2002; Zhao & Cziko, 2001).

Influences of technology on the teaching and learning process are well researched and documented (Kirkpatrick & Cuban, 1998; OTA, 1995; Van Scoter, Ellis, & Railsback, 2001). These influences can be categorized into four distinct areas whereby instructors and students can benefit from the use of technology. These areas are:

1. accommodating learning styles using new avenues of instructional methodology;
2. assisting with daily administrative tasks;
3. supplementing and enhancing professional development; and
4. assisting in the preparation of new teachers (OTA, 1995).

Kirkpatrick and Cuban (1998) expand on instructor's use of technology for teaching by suggesting that a motivational factor in using technology for teaching purposes is computer-enhanced instruction (CEI) and Computer-assisted learning (CAL). They defined CEI as a way to use computers as a teacher-directed content delivery tool that interacts with students using a variety of educational technology media, creating student-centered learning environments. Computer-assisted learning (CAL), another common application of technology focusing on drill and practice, was also identified by Kirkpatrick and Cuban an effective use of technology in addressing retention and remediation of information, ultimately promoting cognitive skill development (Kirkpatrick & Cuban, 1998; Moursund & Bielefeldt, 1999; Schacter, 1999).

Factors Influencing Use of Instructional Technology

Other research contends that instructional use of technology involves more than simply using a computer to deliver an electronic presentation or browse the Internet for technology-supported activities (Dockstader, 1999). Dockstader (1999) and Bouie (1998) suggest enabling factors which lead to effective technology integration into teaching and learning environments. These factors include: knowledge of technology-enhanced curriculum development; access to instructional technology materials, support, and training; time and interest in developing technology-enhanced curriculum; institutional support in experimenting with new technology interventions; familiarity with standards-correlated technology in the content area; awareness of successful technology use in subject areas; reward structure for developing/implementing technology-enhanced curriculum; technology literacy of the instructor (Bouie, 1998; Byrom & Bingham, 1999; Dockstader, 1999; OTA, 1995).

It is estimated that realizing these factors can consume a large amount of time and investment of effort on the part of faculty, typically three to five years. Effective use of technology integration can occur if faculty and students have access to technology, materials, professional development, encouragement, technical assistance, and instructional technology assistance (Byrom & Bingham, 1999).

Institutional Infrastructure

One major component that research suggests influences the use of instructional technology is institutional infrastructure (OTA, 1995; Seels & Richey, 1994a; University of California-Los Angles, 2003; University of Massachusetts, 1997). A report on principals of instructional technology from the University of Massachusetts in 1997 stated that: “A partnership exists between the University and its faculty to improve education. The University provides resources and administrative mechanisms; faculty contributes their knowledge, energy and inventiveness” (University of Massachusetts, 1997).

Further, a 2003 report from the University of California-Los Angles suggests that institutional support of technology can be addressed through:

1. course management systems;
2. strategic plans for technology at the university and college/school/department level;
3. a defined and functional set of instructional technology support mechanisms (technical and instructional design) at the university and department/school/college levels);
4. instructional technology infrastructure (electronic classrooms, computer labs, instructional software servers, site software licensing, digital library resources, technical help desks);
5. consultation services for curriculum re-design, alignment with technology standards, and copyright advisement;
6. a rewards structure for faculty innovation and use of technology in teaching (stipends, resources for professional development, course release time for research and development of technology-enhanced curriculum, recognition and credit for annual faculty evaluations/tenure and promotion) (University of California-Los Angles, 2003).

In an effort to standardize the collection of data regarding the posture of technology use in institutions, the CEO Forum on Education and Technology has partnered with ISTE and the American Association for Colleges of Teacher Education (AACTE) in the development and fielding of the STaR (School Technology & Readiness) chart, an online survey that analyzes responses to a series of institutional-based technology infrastructure questions (AACTE, 2004). Two variants to the STaR chart exist; one for K-12 schools and the other for colleges/schools/departments of education (AACTE, 2004; CEO Forum, 2001).

Both contain a series of questions that when answered by a person or persons knowledgeable about the technology posture of the institution, provides instantaneous feedback in the form of a profile indicating the institution's ‘level of readiness’ in using technology (CEO Forum, 2001).

The levels of readiness focus on three primary areas:

1. institutional effectiveness in leveraging technology to provide an optimal teaching and learning environment;
2. description of an institution’s current profile using technology; and
3. future areas of focus to increase its level of effectiveness in integrating technology into teaching and learning (AACTE, 2004).

The analysis reports to be an effective measure in establishing benchmarks of current technology use by faculty and students; defining the direction and scope of professional development for faculty in the effective use of instructional technology; helps policy makers determine priority of funding for technology-related expenditures; and aids in the development of assessment tools for technology use in teaching and learning (AACTE, 2004; CEO Forum, 2001).

Barriers to the Use of Instructional Technology

Similar to influencing factors, research suggests that barriers exist which impede instructional use of technology, and can be found at both the institutional and individual level (Moursund & Bielefeldt, 1999). Identification of these barriers can be beneficial in determining focus areas for institutional strategic planning, professional development offerings for faculty, targeted grant writing, review of institution and local level technology support mechanisms, and targeting instructional technology assistance for individual faculty members (Beggs, 2000; Moursund & Bielefeldt, 1999; OTA, 1995).

Common institutional barriers include lack of technical support; lack of instructional designers; lack of emphasis for instructional technology use; and lack of recognition for technology use in teaching. Common individual (faculty) barriers include: lack of experience using technology; lack of incentives for developing technology-enhanced curriculum; lack of local technical and instructional design support; lack of knowledge regarding evidence on the effectiveness of technology in content areas; and lack of awareness of technology expectations and standards for accreditation and professional practice (Beggs, 2000; Dede, 1997; Spotts & Bowman, 1995).

From a cultural context, research suggests that similar barriers to use of instructional technology by higher education faculty include 'techno-phobia' (fear of technology itself); resistance to change from traditional teaching methods; philosophical incongruity, disempowerment by the use of technology; and lack of faith when considering using new, difficult, and perceived unreliable instructional technologies. (Bollentin 1998; Green & Gilbert, 1995; Nantz & Lundgren, 1998).

Instructional Experience and Use of Technology

When investigating the use of instructional technology by higher education faculty, a recurring theme in the research is the instructional experience of a faculty member in relation to their use of technology in teaching (California State University-Center for Distributed Learning, 1998).

Some research suggests that there is a relationship between adaptation of instructional technology, motivation to use technology, and experience teaching in higher education classrooms, with motivation to integrate technology associated with experience teaching in higher education settings and having positive beliefs and practices regarding excellent teaching (Andrews, Garrison, & Magnusson, 1996).

Conversely, other research describes early adaptors of instructional technology as newer faculty with five or less years of teaching experience who are likely to have lower anxieties about using technology, have had more interaction with technology than tenured colleagues, and are motivated to use innovative technology teaching approaches by looming tenure and promotion (Roblyer & Edwards, 2000; Rueter, 1999). Likewise, the experience of teaching in distance learning settings tends to permeate the inclusion of instructional technology all courses taught by a faculty member (Schacter, 1999).

Methodologies for Teacher Preparation Candidates

More specific methods that teacher preparation institutions use to train candidates in the use of technology are reported consistently among research in the field (Amber, 2001; Gibbons & Burleson, 2001; Moursund & Bielefeldt, 1999; OTA, 1995). These methods can be divided into three areas:

1. discussion/demonstration;
2. candidate practice during preparation coursework;
3. professional practice (OTA, 1995).

Discussion/Demonstration.

Discussion/demonstration involves the teacher describing the practical use of a technology as it is applied to the enhancement of teaching and learning. Although not common, teacher education faculty may themselves demonstrate a specific technology in a preparation course setting (OTA, 1995). More often, teacher education faculty may call upon instructional technologists to visit their course and describe and demonstrate a particular technology to teacher education candidates (OTA, 1995). While exposing the candidates to an application of technology, having visiting technologists conduct the overview and demonstration reinforces the contention that teacher education faculty do not typically model technology use in pre-service education (OTA, 1995).

Candidate Technology Use During Preparation Coursework.

Engaging candidates through a practical or ‘hands-on’ activity or assignment, teacher education instructors may take candidates to a computer classroom, provide instructions, and have candidates work during class time on a specific assignment, such as a search for content-related materials on the Internet (OTA, 1995). Teacher education instructors may also require technology-related assignments that are conducted outside of class meeting times (Gibbons & Burleson, 2001). Involving candidates in this practical exposure to instructional technology is most often used in an instructional technology course, but increasingly can be found in educational methods and other foundation courses in the preparation curriculum (Moursund & Bielefeldt, 1999).

The practice of diffusing instructional technology instruction throughout the preparation curriculum supports research that suggests formative exposure and continuous development of instructional technology is more effective in teaching candidates than is a concentrated, one-time exposure found in instructional technology courses (Moursund & Bielefeldt, 1999).

Professional Practice.

Professional practice during the internship is a preferred way of demonstrating instructional technology proficiency by candidates, however, it is also the least likely to occur in a teacher education program (Moursund & Bielefeldt, 1999; OTA, 1995). While technology hardware and software is readily available in most PK-12 schools (OTA, 1995), teacher candidates often do not demonstrate their ability to use technology during their internship or student teaching, chiefly due to lack of emphasis or enforcement by teacher education supervisors (Seed, 2001).

To elevate the priority of instructional technology in teacher education programs and in turn raise the technology proficiency level of teacher candidates and teacher education faculty, Moursund and Bielefeldt (1999) offered the following recommendations:

- Instructional technology should be integrated throughout all teacher education courses and activities instead of relying on a sole comprehensive instructional technology course.
- Technology-centered professional development and consultation with instructional technologists should be offered and emphasized for teacher education faculty. The focus should be on individual technology skill

development, training on discipline-specific technology methods, understanding state and national standards, and sharing technology-integrated teaching and learning successes.

- Teacher education faculty should receive recognition for effective use of technology in their teaching. This could take the form of incentives that are outside the traditional academic rewards system and also could include recognition for research and publication efforts involving the effective use of instructional technology in their discipline.
- Technology integrated in teacher preparation courses and student technology assignments should be documented and correlated with state and national instructional technology standards.
- Strategic plans and programming efforts of teacher education institutions should strongly emphasize the integration and evaluation of instructional technology throughout the curriculum.
- Teacher education candidates need opportunities, resources, and emphasis to apply instructional technology strategies and methodologies during their internship or student teaching.
- Additional research needs to be conducted in the area of instructional technology which investigates where and how teacher candidates are prepared using technology, how initially-licensed teachers are using technology, and specific motivating factors for teachers to use technology in their teaching.

Although research agrees that most teacher preparation programs have not adequately readied future teachers to effectively use technology (Moursund & Bielefeldt, 1999; NCATE, 1997; OTA, 1995), programs have the opportunity to reform the way instructional technology is taught, modeled by faculty and practiced by interns and student teachers (Moursund & Bielefeldt, 1999).

Technology Integration Standards

Instructional technology standard setting has gained notable attention by state and national teacher education agencies, accrediting institutions and professional teaching organizations, with the majority of instructional technology standards being concentrated in one area: pre-service education (Baines & Belvin, 2001). Despite the impact these standards have had on influencing pre-service and in-service teachers in the use of technology for teaching and learning, the same standards have come under scrutiny and have been perceived as shortcomings in directing teacher preparation programs closer to technology integration (Moursund & Bielefeldt, 1999). These shortcomings are due in part to repetitive standards, outdated or obsolete standards, and standards that either are so general as to lack applicability or so specific that they only apply to specific disciplines or particular computer hardware/software platforms (Moursund & Bielefeldt, 1999; OTA, 1995).

Most organizations associated with teacher education have developed, produced and heralded their technology guidelines or standards as essential in the preparation and sustainability of teachers (Baines & Belvin, 2001) and every state in the U.S. except Iowa has developed some degree of accountability for the use of instructional technology in public school teaching (Baines & Belvin, 2001; USDOE, 2000).

In reviewing instructional technology standards, Baines and Belvin (2001) described three subsets that distinguish standard-setting agencies and their emphasis on instructional technology as follows:

1. Teacher education accrediting agencies - most prominent are the National Council for the Accreditation of Teacher Education (NCATE) and the International Society for Technology in Education (ISTE)
2. Professional subject area organizations – examples include the National Council of Teachers of English (NCTE), the National Council of Teachers of Mathematics (NCTM), the National Council on the Social Studies (NCSS), the National Association for Music Education (NAME), and the International Technology Education Association (ITEA)
3. State standards for instructional technology – Each of state has developed technology standards for K-12 students, and many of these states have developed mandated or recommended technology competencies for teacher education students and in-service teachers (Baines & Belvin, 2001; Education Commission of the States, 2000).

Teacher Education Accrediting Agencies

Accreditation in the context of teacher education is dominated by NCATE, the agency by which teacher preparation institutions are noted for quality and accountability (Baines & Belvin, 2001) and in conjunction with ISTE, the process or evaluating technology in teacher education is summarized as follows:

> The National Council for the Accreditation of Teacher Education (NCATE) is the official body for accrediting teacher preparation programs. The International Society for Technology in Education (ISTE) is the professional education organization responsible for recommending guidelines for accreditation to NCATE for programs in educational computing and technology teacher preparation. Two types of standards are applied in the accreditation process: 1) curriculum guidelines for preparation in the specialty, educational computing and related technologies; and 2) unit guidelines for infrastructure affecting all professional education programs (ITRC & SEIR*TEC, 1998, p. 6).

Between 1996 and 2000, NCATE investigated the orientation of teacher education accreditation and more specifically, how best to measure the quality of preparation institutions and their teacher candidates. The result was a new framework of teacher education accreditation standards known as NCATE 2000 (Baines & Belvin, 2001).

Departing from the former orientation of measuring a program's quality based on the process of preparation, including conceptual frameworks, curriculum structure, course sequencing and faculty qualifications, NCATE turned attention toward the teacher candidate and the candidate's performance in classrooms before and after graduation. To support this new orientation, the revised NCATE 2000 standards were structured to be performance-based instead of preparation-based (Baines & Belvin, 2001).

While the NCATE 2000 standards do not explicitly establish instructional technology standards, teacher preparation programs are expected to integrate technology throughout all six core standards as defined by guidelines established by ISTE (Baines & Belvin, 2001). Between 1999 and 2000, ISTE revised their recommended technology preparation guidelines and produced a new set of guidelines—the National Educational Technology Standards for Teachers (NETS-T)

(ISTE, 2002). The NETS-T standards cover six areas of instructional technology, designated as follows:

1. Technology Operations and Concepts
2. Planning and Designing Learning Environments and Experiences
3. Teaching, Learning and the Curriculum
4. Assessment and Evaluation
5. Productivity and Professional Practice
6. Social, Ethical, Legal and Human Issues (ISTE, 2002).

In response to these standards, Baines and Belvin (2001) criticize the guidelines suggesting that they are immeasurable, general and lack specificity. However, in the spring of 2002, ISTE released a NETS-T guidebook titled “Preparing teachers to use technology” which highlighted best practices, 32 learning activities in various content areas, chapters on model strategies, assessment, student teaching/internships, and first-year teaching with technology (ISTE, 2002). This guidebook was designed to provide concrete and realistic examples of NETS-T technology standards integrated into subject-specific curriculum areas and vowed to clarify the NETS-T standards which preparation institutions can use in the development and implementation of the standards in their teacher education programs (ISTE, 2002).

NCATE has adopted these guidelines for use in their accreditation review process. Beginning in October, 2001, teacher preparation programs seeking national accreditation had to develop and implement plans that demonstrate how each standard area is integrated into their teacher education program (ISTE, 2002).

Professional Subject Area Organizations

Professional subject area organizations are another level of agencies that to varying degrees establish guidelines and expectations for technology use in teaching; however, these guidelines are directed towards in-service teachers (Baines & Belvin, 2001). Differing from teacher education accrediting agencies which establish standards for all teacher education programs, professional subject area organizations direct their technology standards towards instruction and teachers in a specific discipline. Also unlike teacher preparation technology standards, subject area organizations share little consistency among defined areas of technical competence. This is due to organizations being autonomous agencies that focus on specific teaching disciplines and also because each content area has unique opportunities to use various technologies to support teaching and learning (Baines & Belvin, 2001).

Professional subject area technology standards range from general statements supporting the use of technology in a given discipline area to specific competencies, strategies and methodologies that are suggested as appropriate and effective applications of technology for students and teachers (Baines & Belvin, 2001).

In professions other than teaching, state licensure and practice of professional standards are many times delegated to autonomous standards boards who determine specific standards and processes for measuring compliance and competence at the national level. The profession of teaching, however, is different

(OTA, 1995).

State Standards for Instructional Technology

With some variations, state standards for instructional technology have been developed for most states at the PK-12 students, in-service teachers, and initial teaching licensure levels (Baines & Belvin, 2001; Education Commission of the States, 2000; USDOE, 2000). These state/local guidelines and standards for instructional technology are established between the different levels of state-wide educational control and responsibility (OTA, 1995). While most instructional technology standards are similar, the jurisdiction or level of control is uniquely different between states (OTA, 1995). This divided responsibility for standard and guideline setting can be shared between state legislatures, state departments of public instruction, universities and colleges, district superintendents, local school boards, and principals at the school level (OTA, 1995).

Initial licensure standards that include a measure of instructional technology competence in order to receive teaching certification are gaining momentum across the country (OTA, 1995). A study conducted by the United States Department of Education revealed that, in 1999, 15 states required varying degrees of instructional technology competence for initial teacher licensure (ISTE, 2002; USDOE, 2000). States that do require technology assessments have varying ways of measuring instructional technology competence for licensure, including on-line examinations, technology portfolios, and evaluation of actual teaching using technology during student teaching/internship (Education Commission of the States, 2000; USDOE, 2000).

Other technology standards established on the state level include comprehensive PK-12 technology curriculums that focus on the skill, use and application of technology by students (Baines & Belvin, 2001). The Texas Education Agency created a technology curriculum called “Technology Applications” that specifies technology skill and competence by grade level (Baines & Belvin, 2001). This curriculum is structured to be taught in specialized computer courses and integrated across the PK-12 standard curriculum.

Other states have similar statements of technology competence and methods of instruction for PK-12 students and 19 states mandated computer competency requirements for graduating seniors in 1995 (OTA, 1995). Interestingly, many states that have technology proficiency requirements for PK-12 students do not have similar technology competency mandates for teachers (Baines & Belvin, 2001; OTA, 1995).

In North Carolina, all PK-12 students are required to be proficient in basic technology skills as a condition of graduation from high school (NCDPI, 2001). Students are taught technology skills as identified in the North Carolina Computer Skills Curriculum beginning in Kindergarten and are initially tested during grade 8 with a combination multiple choice and performance-based technology test. If students pass the examination during the 8^{th} grade, they satisfy that requirement for high school graduation. If they fail to pass at that point, local education agencies are responsible for remediation and students have until high school graduation to pass the examination (NCDPI, 2001).

In-service teachers nationwide have the least amount of guidelines or standards (OTA, 1995) and some findings suggest that most technology standards setting is aimed at pre-service candidates and PK-12 students instead of in-service teachers (Baines & Belvin, 2001). While ISTE has established NETS standards for teachers, in reality these standards are directed at the preparation of new teachers instead of holding in-service teachers accountable for their technical skill competence and ability to use technology in teaching (Moursund & Bielefeldt, 1999).

However, North Carolina has a license renewal requirement involving instructional technology. All state-licensed teachers must accrue between three to five continuing education units (CEUs) in technology during each five-year renewal cycle as a condition for continued state licensure (NCDPI, 2001). Satisfaction of this requirement, in terms of technology-granting CEUs, is determined by the local educational agency (NCDPI, 2001). School districts typically align this renewal requirement with established technology plans for professional development of their in-service teachers (NCDPI, 2001). Districts may require three, four, or five CEUs in technology (a minimum of three for state renewal) and also have authority to determine what types of professional development activities with technology will count toward the requirement (NCDPI, 2001).

Technology standard setting occurs on many different levels by many agencies, professional organizations and governing educational institutions. These standards vary according to the focus of the organization creating the standards, the population that the standards apply, and the intent of the standards in influencing technology use in educational settings (Baines & Belvin, 2001).

Research suggests that technology standards are developed along a continuum. Being more generalized at the national level, standards become increasingly specific at the professional organization level and are very specific and directive at the state and local levels (Baines & Belvin, 2001).

Regardless of this variation in specificity and purpose, technology standards are in a state of constant change and revision (Baines & Belvin, 2001; ISTE, 2002; OTA, 1995; NCDPI, 2001). As new practices and proven methods of instructional technology continue to develop and new innovations in instructional technology systems increase (Baines & Belvin, 2001), technology standards for PK-12 students, teacher candidates and in-service teachers will likewise be in a constant state of change and improvement.

Professional Development and Instructional Technology

Professional development in the area of technology for educators is critical if instructional technology is to be implemented successfully into teaching and learning processes. “It is clear that computers will not fulfill their promise, nor justify their expense, if teachers and other school staff are not comfortable using them” (Adams, 1999, p.1).

The role professional development holds in helping teachers use instructional technology is paramount to successful implementation. Atkins and Vasu (1998) indicate that learning about successful instructional technology practices during in-service training increases the likelihood that teachers will gain positive attitudes and practices using technology as an instructional resource.

As reported by the Office of Technology Assessment in 1995, “Making the connection between technology and teachers—helping the 2.8 million teachers in public and private PK-12 schools effectively incorporate technology into the teaching and learning process—is one of the most important steps the nation can take to make the most of past and continuing investments in instructional technology” (OTA, 1995, p. 8). Emphasis and methodologies that public school professional development programs place on technology education varies within the nation, states, local education agencies, and individual schools.

Technology Professional Development from a National Perspective.

Across the United States, training for teachers in the area of instructional technology has not been a high priority. Tenbusch (1998) states that “national statistics have shown that teachers receive far less on-the-job training in technology than any other professional group. The business community knows that for every dollar spent on hardware and software, another dollar must go toward staff development” (p.A16). Additionally, many federal programs allow for the introduction of technology into schools; however, they often fail to provide appropriate funding in support of teacher preparation and in-service development which, according to the OTA (1995) is “… a bad investment” (p. 42).

Federal programs that support technology professional development reach only a small percentage of teachers and much of this support is often optional and minute (OTA, 1995). “As a result, federal support for this purpose has been highly variable from year to year, piecemeal in nature, and lacking in clear strategy or consistent policy” (OTA, 1995, p. 208). Such programs include “… courses for teacher certification … summer institutes … [and] one-shot workshops on specific topics" (OTA, 1995, p. 208).

Programs sponsored by the federal government have often been established to provide professional development support for particular groups of teachers "… including mathematics, science, and special education teachers" (OTA, 1995, p. 207). Additionally, schools and districts unable to support programs on their own have benefited from federal technology-related professional development programs (OTA, 1995).

Technology Professional Development at State and Local Levels.

School systems/districts often spend the major portion of monies intended for technology implementation on software and hardware. Tenbusch (1998) states "…on average, school districts spend only about 5 percent of their technology budget on teacher training" (p. A16). According to the OTA report in 1995, "[c]urrently schools spend much more on hardware (55 percent) and software (30 percent) than they do on training (15 percent)" (p.25). "Even in schools where someone is designated to spend at least half of his or her time as a computer coordinator, very little of this time goes directly to training or helping teachers use computers" (OTA, 1995, p. 25).

For the systems making the adoption of technology in teaching a priority, important lessons are being noted and shared with the educational community. Some recommendations from these lessons include: invest heavily in human resources to support instructional technology; provide hands-on training; provide a variety of available methodologies and resources which teachers can choose to enable technology use; and support teachers by providing follow-up help and coaching (OTA, 1995).

Corporate Professional Development in Technology.

Support for technology-related professional development has also come from college, universities, and corporations. Some college/university approaches include developing master teacher/mentor programs, providing teachers with computers and training, providing administrators training, and establishing technology help centers (OTA, 1995).

Often, corporate sponsorship is relied upon for free hardware, software, and installation services. "… schools that accept offers of hardware or installation from private sector companies … could request or require that the companies also provide meaningful levels of initial training and continuing support for teachers" (OTA, 1995, p. 43).

Delivering Professional Development in Technology.

Professional development programs in instructional technology vary in purpose, strategy, and successes. Adams (1999) states "Generally, ideas about teacher training and professional development have been changing during the past 20 years. While teachers continue to thirst for innovative ideas for presenting curriculum content, administrators are finding that short-term, content-focused workshops do little to promote long-term improvement outside individual classrooms" (p. 1).

According to the Southern Technology Council, best professional development programs include stipends, in-service credits, and certificate renewal credits (Tenbusch, 1998). Other best practices recognized by the Council include: mandated use of classroom management software; mandatory in-service credits; monetary incentives for participation in training; peer-based training; teacher reward of free software/hardware; interest-free home computer financing; allow laptops to be taken home; and free home Internet service for workshop participation (Tenbusch, 1998).

Tenbusch (1998) recommends the following format for successful technology-related professional development programs: “(a) intensive training in which teachers explore new ideas and materials over several sessions; (b) follow-up consultation with mentors over an extended time period as teachers implement new practices; (c) ongoing reflective conversation with colleagues doing the same job and implementing similar technology applications; and (d) observation of other teachers using exemplary techniques for incorporating technology in the classroom” (p. A18).

In addition, time to reflect and gain the skills and techniques necessary to effectively use technology in teaching and learning is essential. “…even highly motivated teachers require substantial amounts of time—often over a three to five year period—before they feel fully versatile with a complicated new technology and are able to expand technology tools to fit their particular teaching goals. And finding time in the teaching day and year for training, collaboration, and ‘messing around with’ technology is a bane of the profession” (OTA, 1995, p. 41).

Instructional Technology Categories

Teaching instructional technology skills and methodologies is grouped into three distinct categories used by teacher education programs to emphasize the preparation of their candidates to use technology in teaching: (a) technology-assisted learning; (b) technology application tools; and (c) computer information science (Moursund & Bielefeldt, 1999).

In the category of technology-assisted learning, different instructional uses of computer-based technology define this designation. These uses are defined into three areas.

1. Computer-assisted learning describes individual interaction between student and computer as well as how that interaction assists the student in learning content. Examples include electronic-based tutorials, simulations, virtual reality environments that can be manipulated by the student and produce varying outcomes based on student input.
2. Computer-assisted research uses indicate how technology, computers in this case, help in accessing, collecting and analyzing data for empirical research. Through the Internet and World Wide Web, virtual libraries are readably accessible and offer holdings of information that grows daily.
3. Distance learning, or the use of telecommunications equipment designed to supplement student learning electronically, has evolved into several methods of content delivery. Initially using telephone and one-way closed-circuit television, distance learning currently uses e-mail, two-way teleconferencing, and specialized on-line software designed to help the instructor package electronically formatted content, exchange of materials, and administration of examinations (Moursund & Bielefeldt, 1999).

Conclusions

The literature surrounding instructional technology is wide-ranging, however, recurring themes in the research suggest a process of instructional technology does exist, albeit an emerging process in various levels of education and truly realized by none (Baines & Belvin, 2001; Bollentin 1998; Byrom & Bingham, 1999; CEO Forum, 2001; Dockstader, 1999; Dias & Atkinson, 2001; Green & Gilbert, 1995; ISTE, 2002; Kirkpatrick & Cuban, 1998; McCollum, 1998; Moursund & Bielefeldt, 1999; Nantz & Lundgren, 1998; OTA, 1995; Seels & Richey, 1994a; University of California-Los Angles, 2003; Williams; 2000; Zaho & Cziko, 2001). Most noteworthy, the review of literature suggests that certain elements may have an undetermined degree of contributive value to the overall utilization of instructional technology, but a comprehensive model that proposes and demonstrates the relationship of these elements to each other and to the utilization of instructional technology has yet to be researched.

These elements, identified through research as:

1. knowledge and innovation of technology;
2. institutional infrastructure;
3. influencing factors;
4. barriers to use;
5. instructional experience,

may or may not have varying degrees of relation to the use of instructional technology. However, in light of Seels’ and Richey’s widely-accepted Domains of Instructional Technology (1994a), the model suggests that utilization is a core component of the practice of instructional technology and a better understanding of the elements that potentially constitute this domain is a reasonable, legitimate, and needed endeavor.

CHAPTER III

METHODOLOGY

Introduction

This chapter will identify the sample being used in the study, identify the location and setting for the research, identify the research design, describe the development and implementation of instrumentation used to collect data, identify data collection procedures used in the study, and identify statistical treatments and procedures used to analyze collected data.

The purpose of this study is to propose and test a conceptual model of technology utilization by teacher education faculty (Figure1.1). Specific research questions are:

1. what factors and sub-components contribute the most to the overall utilization of instructional technology by teacher education faculty?
2. what are the interrelationships between these factors and how do they relate to the use of instructional technology by teacher education faculty?
3. how well can a model be constructed that illustrates these factors and their relation to the use of instructional technology?
4. what specific components are most frequently cited that positively influence the utilization of instructional technology by teacher education faculty?

5. what specific components are most frequently identified by teacher education faculty as barriers to the utilization of instructional technology?

The proposed conceptual model identifies ‘Utilization of Technology’ as the latent variable. The foundation for this variable is identified by Seels’ & Richeys’ Domains of Instructional Technology (1994a). Utilization focuses on the employment of specific instructional technologies through innovation, implementation and institutionalization to encourage and support its applicable use in educational settings.

Observed variables are organized into five major factors: knowledge and innovation of instructional technology; institutional infrastructure; factors influencing use of instructional technology; barriers to the use of instructional technology; and instructional experience in higher education. Each major factor has a sub-set of variables, and is listed on the instrument as sub-component questions. These components align with research that suggests their inclusion in contributing to the concept of technology utilization (Baines & Belvin, 2001; Bollentin 1998; Byrom & Bingham, 1999; CEO Forum, 2001; Dockstader, 1999; Dias & Atkinson, 2001; Green & Gilbert, 1995; ISTE, 2002; Kirkpatrick & Cuban, 1998; McCollum, 1998; Moursund & Bielefeldt, 1999; Nantz & Lundgren, 1998; OTA, 1995; Seels & Richey, 1994a; University of California-Los Angles, 2003; Williams; 2000; Zaho & Cziko, 2001).

Sample

The total number of teacher education faculty in the University of North Carolina (UNC) system was 668 (Table 3.1). To maximize generalizability of the study and to satisfy the subjects-to-variables ration necessary for confirmatory factor analysis, the researcher solicited data collection from all UNC teacher education faculty. A target return rate of 35% (n=233) was established to gather sufficient observations to conduct structural equation modeling.

Table 3.1

Sample of the Study

Institution	N	Percent of total sample
Appalachian State University	97	15%
East Carolina University	104	16%
Elizabeth City State University	18	3%
Fayetteville State University	42	6%
North Carolina A & T	41	6%
North Carolina Central University	34	5%
North Carolina State University	44	7%
UNC-Asheville	7	1%
UNC-Charlotte	57	8%
UNC-Chapel Hill	18	3%
UNC-Greensboro	43	6%
UNC-Pembroke	32	5%
UNC-Wilmington	55	8%
Western Carolina University	54	8%
Winston-Salem State University	22	3%
Total	668	100%

The study attempted to collect data from all teacher education faculty members teaching at a UNC teacher education institution. Specifically, these institutions include: Appalachian State University (ASU); East Carolina University (ECU); Elizabeth City State University (ECSU); Fayetteville State University (FSU); North Carolina Agricultural and Technical State University (NC A&T); North Carolina Central University (NCCU); North Carolina State University (NCSU); University of North Carolina at Asheville (UNC-A); University of North Carolina at Chapel Hill (UNC-CH); University of North Carolina at Charlotte (UNC-C); University of North Carolina at Greensboro (UNC-G); University of North Carolina at Pembroke (UNC-P); University of North Carolina at Wilmington (UNC-W); Western Carolina University (WCU); Winston Salem State University (WSSU).

Faculty members in these institutions represented all levels and licensure areas associated with teacher preparation (Table 3.2). The diversity of teaching certification areas provided a broad cross-section of teacher education faculty to address the research questions and contributes to the overall generalizability of the study.

Table 3.2

Discipline Areas Represented in the Sample

Content Area	N	Percentage
Gifted Education	1	0.44%
Literacy	2	0.88%
Hearning Impared/Deaf Education	2	0.88%
Art	2	0.88%
Communication Disorders	3	1.33%
Business	4	1.77%
Foreign Language	4	1.77%
Educational Psychology	4	1.77%
Physical Education	5	2.21%
Birth-Kindergarten	6	2.65%
Music	6	2.65%
Reading	7	3.10%
Social Studies	7	3.10%
Higher Education/Adult Education/Ed Leadership	8	3.54%
Language Arts/English	9	3.98%
Foundations/Methods/Generalist	9	3.98%
Science	10	4.42%
Middle Grades/Secondary	11	4.87%
Math	12	5.31%
Educational/Instructional Technology/Media	16	7.08%
Elementary	21	9.29%
Special Education	27	11.95%
TOTAL RESPONSES TO QUESTION	180	

Additionally, faculty members teaching at six different Carnegie-classified UNC institutions were represented in survey responses. These institutions (Table

3.3) include: Doctoral/research universities-extensive; Doctoral/research universities-intensive; Master's colleges and universities I/doctoral granting; Master's colleges and universities I; Baccalaureate colleges-General; and Baccalaureate colleges-liberal arts (Carnegie classification of institutions of higher education, 2002). While data analysis was not being conducted according to Carnegie classification due to anonymity, mention of the classifications represented contributes to overall generalizability of the study.

Table 3.3

Summary of UNC Institutional Carnegie-classifications

Institution	Doctoral Research-Extensive	Doctoral Research-Intensive	Master's I Doctoral Granting	Master's Granting	Baccalaureate-General	Baccalaureate- Liberal Arts
ASU			•			
ECU		•				
ECSU					•	
FSU			•			
NCA & T			•			
NCCU				•		
NCSU	•					
UNC-A						•
UNC-CH	•					
UNC-C			•			
UNC-G		•				
UNC-P				•		
UNC-W			•			
WCU			•			
WSSU					•	

Diversity of the survey sample also included faculty from:

1. urban and rural universities;
2. universities with small, medium and large teacher education enrollments;
3. teacher education programs with diverse racial, ethnic, and socio-economic candidate populations (University of North Carolina – Office of the President, 2002).

Given the encompassing application of the survey instrument to these diverse teacher education programs, it is anticipated that the study can be replicated in other states and counties to increase the generalizability of the data, analysis, and subsequent findings.

Instrumentation Background and Development

This research studies the utilization of instructional technology by teacher education faculty in the UNC System. Beggs (2000) adapted a survey instrument previously used by Groves and Zemel (2000) and originally created by Spotts and Bowman (1995). Questions were designed to determine the faculty's self-reported knowledge and use of technology, factors influencing their use of technology, and perceived barriers to the use of technology in the classroom. Additionally, faculty were asked to reflect on the importance of instructional technology to their teaching and if they would continue to adopt new technology (Groves & Zemel, 2000). They were also asked about department, home computer use, rank and years in education. While these instruments did depart from more common faculty technology surveys that focused exclusively on skills and abilities, these surveys did not incorporate national technology standards or collect data on the status of institutional infrastructure in regards to instructional technology.

Another survey instrument found to be similar in intent to collect data regarding factors of faculty technology use (Gao, 2000) did not examine as comprehensive set of components as did Groves and Zemel, Spotts and Bowman, and Beggs. In addition, Gao's study was strictly qualitative in nature and did not triangulate data with quantitative instrumentation.

The nature of this study is focused on describing the relationships, if any, of components that contribute to the overall utilization of instructional technology by teacher education faculty. In reviewing previously created faculty technology surveys, the researcher determined that no former or current instruments were acceptable or modifiable given the intent to collect data both quantitatively and qualitatively on the five component areas and their identified sub-sets in testing the proposed conceptual model. Therefore, based on the review of relevant literature and exploration of recently released national technology standards directly focused at teacher preparation (ISTE, 2002), the researcher developed a new instrument (Appendix A) to collect targeted data on the components and subsequently test the proposed conceptual model of technology use by teacher education faculty.

The survey instrument (Appendix A) used in this study is titled: *Survey of Integrating Instructional Technology into Educational Settings*, and is focused on collecting data from teacher education faculty in all 15 UNC teacher education institutions (See Table 3.1) regarding knowledge and innovation of instructional technology; institutional infrastructure; factors influencing use of instructional technology; barriers to the use of instructional technology; and instructional experience in higher education.

Field Test

To establish a level of content validity, 38 individuals participated in the field testing of the initial instrument. This group, consisting of 23 teacher education faculty and 15 instructional technology specialists throughout the UNC system, were asked to consider both the transmittal letter and the survey instrument for readability, understandability, and to objectively evaluate/comment on each item and Likert Scale categories of responses for distinction and clarity.

Outcomes from the field test revealed three classifications of comments: amount of items (length); proposed Likert scale; and timing of administration during the academic semester to teacher education faculty.

Regarding length of the survey, reviewers felt that the initial instrument was much too lengthy with upwards of 75 quantitative items and 10 qualitative items. Additionally, reviewers considered many questions to be redundant in nature. Suggestions were made to reduce the total amount of items to approximately 35-40 items that included both quantitative and qualitative questions. The desired result would be an increase in the likelihood of a faculty member taking time to complete the survey. Additionally, recommendations on revision, elimination and addition of items were made that suggested quantitative focus strictly on core constructs critical to each major grouping, elimination of items that essentially asked for the same data, and a qualitative questions to triangulate data collected and analyzed.

The initial Likert scale that was field tested offered a scale of response between 1 and 7. Reviewers felt that this added to the complexity of the instrument, creating an opportunity for respondents to be less motivated to complete the survey and be undecided between ordinal scale responses. Based on the recommendations, the Likert scale was reduced from a possible seven responses down to 4. Additionally, multiple choice responses were maintained at four possible choices with the exception of one item that had six possible responses.

Reviewers also suggested that distribution and collection of the instrument be carefully considered to increase the response rate. Recommendations were made that the survey be initially sent via inter-campus mail towards the end of academic semester, but not too late to interfere with final examinations. Additionally, suggestions were made for a follow-up identical survey transmitted via e-mail and that this instrument be an online version of the hard copy.

Scale

A four-point Likert scale collected responses regarding knowledge and innovation of technology, frequency of use, importance of instructional technology to teaching, likeliness to innovate new instructional technologies, factors influencing the use of instructional technologies, and barriers to using instructional technologies. With the exception of multiple choice responses, each classification for response to the Likert scale was coded with a numerical value as depicted in Table 3.4.

Table 3.4

Likert Scale Categories and Code Values for Responses

Survey Grouping	4	3	2	1
Knowledge and innovation of instructional technology	Almost always	Often	Some	None
Institutional infrastructure	Multiple choice	Multiple choice	Multiple choice	Multiple choice
Factors influencing use of instructional technology	Critically influential	Very influential	Somewhat influential	Not influential
Instructional experience	Multiple choice	Multiple choice	Multiple choice	Multiple choice
Barriers to the use of instructional technology	Critically important	Very important	Important	Somewhat important

The majority of data generated from the instrument was considered on an ordinal scale, however, some scales could be considered interval. The scale of measurement rank orders items according to the extent in which they possess the characteristics of interest, but the distance between the points cannot be assumed to be equal (Gall, Borg, & Gall, 1996). In considering the use of parametric or nonparametric analysis in this study, the researcher chose to employ structural equation modeling, of type of parametric statistical treatment. Gardner (1975) submits that parametric techniques, due to their robust nature, will be unlikely to lead to improper conclusions when treating ordinal data as if they were interval. Therefore, parametric analysis will be used to analyze the data.

Research Design

Exploratory Factor Analysis (EFA).

A common method of analysis employed by researchers who develop a new measure is some form of exploratory factor analysis (EFA) (Hair et al., 1992, Hoyle, 1995). The goal of EFA is to move toward a more parsimonious conceptual understanding by attempting to identify the fewest abstract constructs that explain the common variance among the measured indicators. In doing so, EFA is an invaluable aid in determining construct validity. However, EFA is a data-driven, *post hoc* approach. This is in contrast to confirmatory factor analysis (discussed below), in which a hypothesis is formed before the data are gathered, and the data are analyzed to test the hypothesis. For the purpose of this study, EFA was used to investigate the survey instrument, and CFA was used to test and determine how closely the proposed conceptual model accounted for total variance between factors and in relation to the latent variable, use of instructional technology in UNC teacher education programs.

Accordingly, EFA results are not interpreted as evidence of the unidimensionality of a measure (Hair et al., 1992; Hoyle, 1995; Stevens, 1996). Theories positing relationships between constructs “identified” by EFA alone should be regarded as highly preliminary. Therefore, CFA is a typical follow-up to EFA in further defining relational values within a hypothesized model (Stevens, 1996).

This study uses a three-step approach to EFA:

1. extract factors via principal components analysis (PCA);
2. retain factors that have an eigenvalue greater than one (E1); and

3. orthogonally rotate factors using Varimax rotation, sometimes known better as Kaiser's “Little Jiffy”, to aid in the interpretability of the extracted factors.
4. review the loadings of items on the survey instrument, and align factor components for testing the proposed conceptual model through CFA (Hoyle, 1995).

Principal Components Analysis (PCA).

PCA is a factor extraction method based on the formative model of measurement. The resultant principal components are emergent variables, dependent on the indicators (Stevens, 1996). PCA involves a mathematical procedure that partitions the total variance among the variables under study by finding successive linear combinations of the variables that account for the maximum amount of variance. This procedure is repeated with each iteration identifying a linear combination of variables, uncorrelated with each previous linear combination. Each linear combination is termed a principal component or factor. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component analysis accounts for as much of the remaining variability as possible. The procedure is repeated multiple times until all the variance between items has been accounted and identified with a component (Hair et al., 1992; Stevens, 1996).

Confirmatory Factor Analysis (CFA).

As a means of further establishing construct validity, Loehlin (1992) and others (e.g., Cronbach, 1960) recommend that EFA be followed by CFA. In contrast to EFA, CFA allows the researcher to test the a priori hypothesis that a relationship(s) exists between observed variables or factors and the latent variable (Figure 1.1). Hunter and Gerbing (1982) conceptualized confirmatory factor analysis as consisting of four basic steps:

1. hypothesize the existence of observed and latent items based on research and review of related theories;
2. build a model that defines the hypothesized structure of relationships;
3. test the measurement model for goodness-of-fit;
4. revise the model according to a solid theoretical base

In sum, once EFA established the number of constructs present, data were submitted to CFA to establish the structural fidelity of the model offered in Figure 1.1.

Data Collection

An introduction letter (Appendix B) was sent to each UNC instructional technology specialist (ITS), preceding the actual mailing of the surveys. The purpose of the letter was to inform them of the intent and scope of the research and for professional courtesy.

A transmittal letter introducing the study, describing the survey instrument, assuring confidentiality, and instructions for completion and submission was attached to each survey (Appendix C) along with a addressed return envelope which had the name and campus mailing address of the ITS. Sufficient copies of the survey instrument were mailed to the ITS at each of the 15 University of North Carolina teacher education programs (Figure 3.1) in one to five mailing packets, depending on the amount of instruments needed at each institution (as identified by the ITS). A separate letter of instruction for distribution and collection was enclosed with each packet (Appendix D).

All instructional technology specialists were asked to distribute the hard copy survey via campus mail to all teacher education faculty at their respective institutions, and to allow a one week for faculty to complete and return the hard copy survey.

Following the initial week of distribution and collection, the researcher contacted all ITS via electronic mail with a request to transmit an electronic mail reminder to all their respective faculty asking for their assistance in completing and returning the hard copy survey as soon as possible (Appendix E).

Four days later, the researcher again contacted each ITS, this time with a electronic transmittal letter and request for faculty who had not previously completed the hard copy survey to participate in the online survey (Appendix F). The online survey, created with software from www.freeonlinesurveys.com, was very nearly identical to the hard copy, including items, format, and opportunities for qualitative responses (Appendix G).

Various factors were applied to influence the rate of return for the survey questionnaires. These factors included:

1. limiting the length of the questionnaire to items addressing only the research questions;
2. brief, but detailed, survey instructions;
3. statement estimating time to complete the questionnaire; and

4. an alternative means to participate in the study and complete the survey instrument within the timeframe specified. (Ary, Jacobs, & Razavieh, 1996).

Mail and Internet-Based Surveys.

Of note regarding hard copy (mailed) vs. online questionnaires, Truell, Bartlett II and Alexander (2002) found that Internet-based surveys achieved a similar response rate to that of mailed (hard copy) surveys. Further, while responses tend to be expedited by electronic means, reliability between instrumentation, given consistency of items, remains at satisfactory levels (Truell, 2003).

The goal will be to receive responses from at least 35 percent of those who received either the hard copy or online survey from each UNC teacher education institution. This return rate is possible because:

1. the response rate for surveys is often higher among more highly educated people who are knowledgeable about the issues involved in the survey;
2. most faculty are aware of and engage in survey research and may have a sense of scholarly obligation to return the survey;
3. the survey will be of reasonable length and will be easy to complete within 10-15 minutes;
4. follow-up reminders from ITS who are well known to faculty will increase awareness of the survey and will appeal to their scholarly obligation to participate in the research;

5. the research results will be highly useful for the ITS in each UNC teacher education institution, therefore motivating them to participate in the distribution and collection of as many surveys as possible; and
6. the transmittal letter will explain the purpose of the survey, explain confidentiality measures, obligate the researcher to share results with interested participants as requested, and will express appreciation for cooperation.

If the response rate remains below 35 percent after three attempts to solicit surveys, the researcher will attempt to learn about the characteristics of non-respondents, determine the extent to which respondents differ from non-respondents, and use this information to consider another method to encourage participation by the survey sample (Ary, Jacobs & Razavieh, 1996; Gall, Borg & Gall, 1996).

Data Analysis

For this proposed study, the sample will include teacher education faculty in all 15 University of North Carolina teacher preparation programs (Table 3.1). These faculties teach in either schools/departments/colleges of education or schools/departments/colleges of arts and sciences, however, the intent of the research is not to compare academic affiliation with the proposed conceptual model. There were two levels of data analysis employed to test the goodness of fit and relationships of the proposed model to the utilization of instructional technology by teacher education faculty.

Latent variable structural equation modeling (SEM) was used to test if relationships exist within the proposed conceptual model. The analyses examined if relationships existed between observed variables and the latent variable, and if so, the contributing strength of each relationship to the latent variable; and if inter-relationships existed between observed variable groups represented in the proposed conceptual model.

Low levels of relationship between observed variables may suggest that each group has minimal influences on each other, but individual influences on the latent variable (Hair et al., 1992; Hoyle, 1995; Stevens, 1996). This form of analysis is superior to multiple regression since it examines relationships between observed and latent variables as opposed to relationships between independent and dependent variables (Stevens, 1996).

The SPSS program will be used to select variables, merge files, and create composites. Correlations, standard deviations, and frequency distributions will be outputted from SPSS and used as input into the structural equations program and for item response frequency analysis.

The AMOS (J. L. Arbuckle & W. Wothke, 2000 small waters corporation, Chicago, IL) software program was used to conduct the SEM analysis. Through analysis of the proposed conceptual model, and since SEM models cannot be accepted (Stevens, 1996), the researcher will either reject or fail to reject the proposed conceptual model on utilization of instructional technology in UNC teacher education programs.

Qualitative Analysis

Qualitative comments from UNC teacher education faculty concerning the factors, barriers, attitudes, and innovative uses of instructional technology will triangulate quantitative data analysis.

Results will be presented in frequency distributions, tables, figures, graphs and text. This will include demographic and profiling data relating to the respondents, data relating to the nature and scope of utilization of instructional technology by teacher education faculty, data to test the proposed conceptual model including factor and path analysis, and data relevant to the individual research questions.

Presentation of the results will be organized around the research questions and will include:

1. interpretation of findings;
2. discussion on implications or contributions of the findings to the proposal conceptual model; and
3. application of the findings to the practice of instructional technology planning and integration in teacher education programs.

Data will be sorted, classified and coded initially by a non-bias subject matter expert external to the study. This process, known as inner-rater reliability (Gall, Borg, & Gall, 1996), is to ensure accurate interpretation of qualitative data and to assist the researcher in examining the data from a non-bias point of view.

CHAPTER IV

RESULTS

Introduction

The purpose of this study is to propose and test a conceptual model that attempts to describe components and relationships of those components which may influence the use of instructional technology by teacher education faculty throughout the University of North Carolina System's teacher education programs. In reviewing the literature and research surrounding use of technology in teaching settings, five factors emerged as major groupings, which aligned with the utilization domain of a well-known and accepted instructional technology theory defined by Seels and Richey (1994a). These major components were labeled as:

1. knowledge and innovation of instructional technology;
2. institutional infrastructure;
3. factors influencing the use of instructional technology;
4. barriers to the use of instructional technology; and
5. instructional experience.

Following procedures of structure equation modeling (SEM) (Figure 1.3), the researcher developed an instrument based on theory and research, collected data, and analyzed the data using techniques consistent with SEM (Hair et al., 1992; Hoyle, 1995; Stevens, 1996).

Description of Statistical Treatments

This chapter offers results from the analysis of data collected from the study sample using four primary statistical treatments. First, descriptive statistics are presented to define the nature of the survey sample and provide item analysis of the instrument developed to collect survey data (Appendix A). Second, structural equation modeling is presented as an analysis of the survey instrument and as a test of the proposed conceptual model on technology use in UNC teacher education institutions (Figure 1.1). Specifically, exploratory factor analysis (EFA) and principal component analysis (PCA), was used to establish component and sub-set variance, eliminate abstract items, re-establish factor groupings based on PCA, and using confirmatory factor analysis (CFA), subsequently explore and describe relational paths between observed variables and the latent variable, use of instructional technology. Third, qualitative analysis will examine open-ended response questions collected by the survey instrument, and fourth, psychometric analysis of the survey instrument will assess reliability by means of Alpha correlation values.

Description of Sample

The total number of teacher education faculty in the University of North Carolina (UNC) system was 668 (Table 3.1). To maximize generalizeability of the study and to satisfy the subjects-to-variables ration necessary for confirmatory factor analysis, the researcher solicited data collection from all UNC teacher education faculty. A target return rate of 35% (n=233) was established to gather sufficient observations to conduct structural equation modeling.

The number of returned surveys, 226, represents a 33.8% response rate and thereby serves as the sample for the statistical analysis. In comparing mail (hard copy) and electronic responses, 145 responded with the hard copy survey (64.4%) and 81 responded electronically (35.6%). Cross-tab statistics was run to compare results between the two modalities, with no significant difference on item responses, consistent with findings reported by Truell (2003).

CFA analysis should be based on a minimum of 100 observations, regardless of the subjects-to-variables (STV) ratio (Gorsuch, 1983). As related to this study, the STV ratio was calculated on 40 items (variables) measured on the data collection instrument used for SEM analysis. Therefore, if a minimum of five observations are necessary for 40 items, the minimum number of observations is 200.

As can been seen in Table 3.1, faculty members in these institutions represented a broad cross-section of demographics that appears both proportional and likely to be encountered among faculty members employed in institutions associated with the UNC system (University of North Carolina-Office of the President, 2002). The diversity of teaching certification, faculty rank, teaching status, department affiliation, and teaching experience provides a broad cross-section of teacher education faculty to address the research questions. Table 3.2 likewise represents a broad cross-section of licensure areas represented by the sample.

Of interest, 96.5 percent of respondents were full-time faculty members compared to 3.5 percent who classified themselves as part-time faculty. The majority of respondents were affiliated with a department, school, or college (DSC) of education and the remainders were all affiliated with a department, school, or college of arts and sciences. Also noteworthy is the years experience of respondents teaching in teacher education, with 84.6% having four or more years experience in teacher education. This is relevant when considering that North Carolina has had licensure requirements involving technology since 1996 (NCDPI, 1999) and it is reasonable to assume that the majority of teacher education faculty are aware of licensure requirements including technology that was mandated during their tenure as teacher educators and realistically their role in the preparation process that leads to state teaching licensure.

To support this notion, 69% of respondents acknowledged that they have been using some form of technology in teacher education courses for at least four years, and overall, 99.1% of respondents indicated that they have used technology in teacher education.

Table 4.1

Characteristics of Sample

Characteristic	N	Percent
Academic Rank		
Instructor	48	21.2
Assistant Professor	66	29.2
Associate Professor	61	27.0
Full Professor	51	22.6
Teaching Status		
Full-Time	218	96.5
Part-Time	8	3.5
Academic Affiliation		
Education	188	83.2
Arts and Sciences	38	16.8
Business	--	--
Other	--	--
Years Teaching in Teacher Education		
One or less	35	15.5
Four to six	51	22.6
Seven to ten	32	14.2
Eleven or greater	108	47.8
Years using technology in teacher education		
None	2	.9
One (or less) to three	61	27
Four to six	87	38.5
Seven or greater	76	33.6

(table continues)

Table 4.1 cont.

Characteristic	N	Percent
Previously taught/are teaching a technology-focused teacher education course		
Yes	58	25.7
No	166	73.5
Experience teaching distance learning class		
No	105	46.5
Entirely web-based	47	20.8
ITV (instructional television)	12	5.3
Web-enhanced resident course	22	9.7
Other	4	1.8
No and web-based	1	.4
No and ITV	2	.9
No and web-enhanced	2	.9
Web-based and ITV	8	3.5
Web-based and web-enhanced	11	4.9
Web-based and other	1	.4
Web-based, ITV, and web-enhanced	6	2.7
ITV and web-enhanced	4	1.8
Web-enhanced and other	1	.4

Item Analysis

The survey instrument created for this study originated predominantly from the review of literature that suggested five major factors, conceptually all having some influence on the use of instructional technology in teaching environments (Baines & Belvin, 2001; Bollentin 1998; Byrom & Bingham, 1999; CEO Forum, 2001; Dockstader, 1999; Dias & Atkinson, 2001; Green & Gilbert, 1995; ISTE, 2002;

Kirkpatrick & Cuban, 1998; McCollum, 1998; Moursund & Bielefeldt, 1999; Nantz & Lundgren, 1998; OTA, 1995; Seels & Richey, 1994a; University of California-Los Angeles, 2003; Williams; 2000; Zaho & Cziko, 200). Each component group had a series of sub-sets, which in turn were transitioned into questions (items) for the survey instrument.

The survey instrument (Appendix A) consists of 43 questions. 38 questions are quantitative in nature and five questions are qualitative. The instrument has five component sections that parallel the review of literature:

1. knowledge and innovation of instructional technology;
2. institutional infrastructure;
3. factors influencing the use of instructional technology;
4. barriers to the use of instructional technology; and
5. instructional experience.

Instrument Collection Methods.

As described earlier, the response rate on the instrument was 33.8%, or 226 returned and usable surveys out of 668 distributed. The instrument was administered in two formats: hard copy and online. Both instruments were identical in composition, each consisting of five identified sections, subset quantitative questions, and qualitative questions at the end of section C – factors influencing the use of instructional technology; section D – barriers to the use of instructional technology; and section E – instructional experience.

In considering a difference in responses between the two instrument modalities, a chi-square test was performed on each response item, comparing online to hard copy responses. In only one instance, item 23 had a *p*-value of less than .05 (.001). This question, regarding personal technology literacy as a factor for influencing the use of technology, was not considered by online respondents as a significant influential factor for using technology as did hard copy respondents. One possible explanation for this response difference is that it is reasonable to assume that respondents who participated via the online survey considered their personal level of technology literacy higher than those who choose to respond by hard copy, thereby not considering it a very high factor to their use of technology.

Likewise, those who participated via hard copy reported that their personal technology literacy was an influential factor for their use of technology, and presumably, this lower level of perceived technology literacy may have resulted in their choosing to complete the hard copy survey instead of the online version. These results are consistent with other research that suggests little to no significant differences typically exist regarding return rate and more importantly, reliability estimates between mail and Internet-based surveys (Truell, 2003; Truell et al., 2002).

Section A: Knowledge and Innovation of Instructional Technology.

The National Educational Technology Standards for Teachers (NETS-T), developed by the International Society for Technology in Education (ISTE) served as the foundation for this section of questions on the survey instrument. Due to space limitations, the NETS-T standards were consolidated and are representative in section A (ISTE, 2002).

As presented in Table 4.2, many UNC teacher education faculty reported that they integrate technology to varying degrees in their teacher education courses, and often (31.9%) or almost always (33.6%) integrated concepts related to technology into teaching.

Table 4.2

Item Response Frequency Analysis – Knowledge and Innovation of Instructional Technology

Item	Response Categories			
	None	Some	Often	Almost Always
Integrate concepts related to technology into teaching	4 (1.8%)	74 (32.7%)	72 (31.9%)	76 (33.6%)
Design learning opportunities that apply technology-related teaching strategies	11 (4.9%)	83 (36.7%)	75 (33.2%)	57 (25.2%)
Instruct candidates on design of student activities using technology	25 (11.1%)	81 (35.8%)	70 (31%)	50 (22.1%)
Use technology in teaching learner-centered strategies that address student needs	19 (8.4%)	91 (40.3%)	62 (27.4%)	53 (23.5%)
Model/teach legal and ethical practices related to technology use	35 (15.5%)	81 (35.8%)	51 (22.6%)	59 (26.1%)

Section B: Institutional Infrastructure.

Items involving the organization and how it supports the use of technology were explored in section B. Subset questions were developed from sources including the CEO Forum (CEO Forum, 2001) and review of previous research

(Byrom & Bingham, 1999; Dockstader, 1999; OTA, 1995; Zaho & Cziko, 2001), all which suggest elements that are typically present and internalized in an organization to positively support the use of technology in teaching.

Table 4.3 presents response results from UNC teacher education faculty participating in the study. Faculty reported that in regards to hiring and tenure/promotion, instructional technology use is valued quite differently among UNC teacher education institutions. In respect to hiring, 31.9% survey participants reported that technology is not a consideration when hiring teacher education faculty at some institutions while conversely, 37.6% reported that it was a consideration for hiring. Similarly, 41.6% of UNC teacher education faculty reported that technology use was not recognized for tenure and promotion, however, another 27.9% indicated that technology use was recognized for tenure and promotion.

A majority of respondents indicated that they were aware of technology-related goals associated with their teacher education program's conceptual framework. Specifically, 78.3% reported that multiple goals through total integration were present in their conceptual framework, and only .2% indicated that no goals present.

The conceptual framework, a type of strategic plan in teacher preparation, provides conceptual structure regarding core components of a program, including courses, professional development, accountability, program offerings, and accountability in the preparation of P-12 educators (NCATE, 2001). Since all UNC teacher preparation programs are accredited by NCATE (NCATE, 2004a), all have a developed conceptual framework.

Throughout the literature, professional development for educators in the area of instructional technology, instructional design assistance, and availability of technical support is often mentioned as three elements crucial to the successful use of technology in teaching (Baines & Belvin, 2001; CEO Forum, 2001; Kirkpatrick & Cuban, 1998; Moursund & Bielefeldt, 1999; OTA, 1995; Seels and Richey, 1994a). As reflected as Table 4.3, 68.2% of respondents reported that they had localized instructional design support, 84.1% reported that they had moderate to multiple professional development offerings available in the area of instructional technology, and 77.9% indicated technical support was available to them on the same day as requested.

Regarding integration of technology in teacher education courses, 82.3% of UNC teacher education faculty reported that technology was integrated in greater than 50% of classes, and 73.1% indicated that instructional technology was available in greater than 50% of teacher education classrooms.

Table 4.3

Item Response Frequency Analysis – Institutional Infrastructure

Item	Response Categories			
Instructional technology goals integrated into conceptual framework	Not present 2 (.9%)	Some goals 46 (20.4%)	Multiple goals 47 (20.8%)	Total integration 130 (57.5%)
Percent of technology integrated into teacher education courses	25% 38 (16.8%)	50% 64 (28.3%)	75% 35 (15.5%)	All courses 87 (38.5%)
Percent of classroom access to technology resources	25% 61 (27%)	50% 54 (23.9%)	75% 46 (20.4%)	All classrooms 65 (28.8%)
Level of instructional technology/design support	Limited 26 (11.5%)	Centralized 53 (23.5%)	Local/Available 89 (39.4%)	Local/Immediate 58 (25.7%)
Faculty using instructional technology in regard to hiring and tenure/promotion (**continued on next page**)	Not a factor for hiring 19 (8.4%)	Not a factor for tenure and promotion 38 (16.8%)	Required for tenure and promotion 29 (12.8%)	Required for hiring 48 (21.2%)
	Not a factor for hire, but is a factor for tenure and promotion 4 (1.8%)	Not a factor for hire, but is a factor for hire 1 (.4%)	Not a factor for tenure and promotion, but is a factor for tenure and promotion 1 (.4%)	Not a factor for tenure and promotion, but is a factor for hiring 7 (3.1%)

(table continues)

Table 4.3 cont.

Item	Response Categories			
(**continued from previous page**) Faculty using instructional technology in regard to hiring and tenure/promotion	Is a factor for hire and for tenure and promotion 30 (13.3%)	Not a factor for hiring, and not a factor for tenure and promotion 49 (21.7%)		
Availability of professional development workshops and seminars for faculty regarding instructional technology	None offered 4 (1.8%)	Limited amount 31 (13.7%)	Moderate amount on certain topics 97 (42.9%)	Many offered on a variety of topics based on faculty needs 93 (41.2%)
Availability of technical support	Not present 10 (4.4%)	Available on the next business day 37 (16.4%)	Available on the same day 98 (43.4%)	Immediately available as requested 78 (34.5%)

Section C: Factors Influencing the Use of Instructional Technology.

In respect to variables that may influence the use of technology, UNC teacher education faculty were asked to respond by level of influence on a list of factors developed from multiple sources from the review of literature (Beggs, 2000; Bouie, 1998; Byrom & Bingham, 1999; Dockstader, 1999; Groves & Zemel, 2000; OTA, 1995; Spotts & Bowman, 1995). Due to space limitation on the instrument, these factors represent a broad cross-section of potential influencing factors for technology use in education.

Support of faculty in the use of technology was a major sub-set outcome of this section. UNC teacher education faculty reported (Table 4.4) that the most influential factor regarding support was technology availability in the classroom (82.7%), followed by technical support (79.6%), and instructional design support (71.7%). Interestingly, professional development support in the form of instructional technology seminars and workshops were reported as not-to-somewhat influential (46.5%).

Academic relevance, in the form of awareness of advantages that instructional technology offers and student interest generated by the use of technology, also had strong indicators of influence (Table 4.4). 78.3 of faculty responded that their awareness of advantages technology offers to instruction was very-to-critically important, and 73% of respondents likewise recognized increased student interest was very-to-critically influential in their use of technology.

Factors categorized as incentives for faculty to develop instructional technology curriculum were reported less influential than was support or academic factors (Table 4.4). In regard to release time to develop technology-integrated curriculum, teacher education faculty were somewhat divided. Overall, 58.4% reported that release time was very-to-critically influential to their use of technology; however, 41.6% reported that release time was not-to-somewhat influential. Monetary incentives to use technology in teaching were evenly divided among respondents, with half of faculty reporting not-to-somewhat influential, and the other half reporting very-to-critically influential.

Tenure and promotion and annual faculty evaluations which recognize technology use was slightly more influential than was monetary incentives, with 61.9% of faculty reporting that this form of recognition was very-to-critically influential for their use of technology in teaching (Table 4.4).

Similarly, familiarity with accreditation standards and North Carolina teacher licensing requirements involving technology had a reported moderate influence on faculty use of technology in teaching. 64.2% of responding faculty rated this factor very-to-critically influential, while 35.8% rated not-to-somewhat influential.

Not surprisingly, many faculty reported that their own level of technical competence had influence on their use of technology, with 77.9% indicating that personal technology literacy had a very-to-critically important influence on use of technology in teaching.

Table 4.4

Item Response Frequency Analysis – Factors Influencing the use of Instructional Technology

Item	Response Categories			
	Not Influential	Somewhat Influential	Very Influential	Critically Influential
Awareness of advantages that technology offers instruction	6 (2.7%)	43 (19%)	99 (43.8%)	78 (34.5%)
Technical (hardware/software) support	10 (4.4%)	35 (15.5%)	76 (33.6%)	104 (46%)
Curriculum design/ technology integration support	15 (6.6%)	49 (21.7%)	91 (40.3%)	71 (31.4%)
Seminars on technology integration in teacher education	30 (13.3%)	75 (33.2%)	77 (34.1%)	44 (19.5%)
Increased student interest	9 (4%)	51 (22.6%)	102 (45.1%)	63 (27.9%)
Familiarity with NCATE/ NCDPI technology standards/requirements for licensure/accreditation	24 (10.6%)	57 (25.2%)	80 (35.4%)	65 (28.8%)
Availability of technology in teacher education classrooms	12 (5.3%)	27 (11.9%)	60 (26.5%)	127 (56.2%)
Release time for technology-enhanced curriculum development	33 (14.6%)	61 (27%)	64 (28.3%)	68 (30.1%)
Monetary incentive for developing and using technology in teaching	46 (20.4%)	67 (29.6%)	57 (25.2%)	55 (24.3%)
Tenure and promotion/AFE recognition for using technology in teaching/ research	66 (29.2%)	74 (32.7%)	49 (21.7%)	35 (15.5%)

(table continues)

Table 4.4 cont.

Item	Response Categories			
Your personal technology literacy	9 (4%)	41 (18.1%)	89 (39.4%)	87 (38.5%)

Section D: Barriers to the Use of Instructional Technology.

Similar to influencing factors, research also suggests (Beggs, 2000; Bollentin, 1998; Green & Gilbert, 1995; Moursund & Bielefeldt, 1999; Nantz & Lundgren, 1998) that barriers which impede instructional use of technology exist, and that these barriers can be found at both the institutional and individual level (Moursund & Bielefeldt, 1999). Determining if these barriers are present can be beneficial in determining focus areas for institutional strategic planning, professional development offerings for faculty, targeted grant writing, review of institution and local level technology support mechanisms, and targeting instructional technology assistance for individual faculty members (Moursund & Bielefeldt, 1999; OTA, 1995).

Responses from UNC teacher education faculty indicated that very few considerable-to-strong barriers to the use of technology in teaching exist. The most considerable barrier reported, lack of time (different from ‘release time’ or course load reduction) to develop technology-enhanced curriculum, was identified by only 57.9% of faculty as being a considerable-to-critical barrier.

Conversely, faculty indicated that lack of pedagogical evidence that supports the use of technology in teaching (84.5% of respondents), philosophical incongruity to the use of instructional technology (81% of respondents), and lack of tenure and promotion credit for instructional technology use (79.7% of respondents) were not barriers to their use of technology (Table 4.5). Similarly, lack of instructional design support (71.2% of respondents) and lack of technical support (65.1% of respondents) did not surface as strong barriers to the use of technology.

Lack of release time to develop technology-enhanced curriculum (56.2% of respondents) and lack of accessible technology equipment (48.2%) were considered moderate barriers, but failed to emerge as true critical barriers to the use of technology in teaching.

Table 4.5

Item Response Frequency Analysis – Barriers to the Use of Instructional Technology

Item	Response Categories			
	Not a Barrier	Somewhat a Barrier	Considerable Barrier	Critical Barrier
Lack of time to develop technology-enhanced curriculum	23 (10.2%)	72 (31.9%)	67 (29.6%)	64 (28.3%)
Lack of pedagogical evidence that supports technology use	116 (51.3%)	75 (33.2%)	18 (8%)	14 (6.2%)
Lack of accessible technology equipment	63 (27.9%)	59 (26.1%)	50 (22.1%)	53 (23.5%)
Lack of release time for developing technology-enhanced curriculum	48 (21.2%)	79 (35%)	49 (21.7%)	50 (22.1%)
Lack of tenure and promotion credit for using technology	112 (49.6%)	68 (30.1%)	26 (11.5%)	17 (7.5%)
Lack of technical support	84 (37.2%)	63 (27.9%)	31 (13.7%)	47 (20.8%)
Lack of instructional design support	85 (37.6%)	76 (33.6%)	40 (17.7%)	23 (10.2%)
Philosophical incongruity to using technology in teaching	130 (57.5%)	53 (23.5%)	18 (8%)	22 (9.7%)

Factor analysis

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted on the proposed conceptual model of technology use in UNC teacher education programs. EFA was employed as a process of investigating factor structure of the measurement instrument (Appendix A) and to examine component structures for ultimate use in CFA to test the proposed conceptual model for goodness-of-fit and advancement of the model.

Exploratory Factor Analysis.

Exploratory factor analysis considers the number of constructs and the underlying factor structure for identification and clarification of components. While a necessary function of factor analysis, EFA also has limitations, including:

1. correlations describe relationships, however, causal inferences cannot be made from correlations alone;
2. sample size has influence on the accuracy of correlation;
3. variables could be specific to the sample, but not generalized to the larger population (Child, 1990; Stevens, 1996; Hoyle, 1995).

Principal component analysis (PCA), a form of EFA, was the extraction method used to define initial component groups, establish eigenvalues, and extract factors for use in confirmatory factor analysis. Varimax rotation with Kaiser Normalization was used to generate a rotated component matrix used to identify item loading and determine final component (factor) grouping for CFA analysis. Kaiser’s criterion determines the number of factors to extract based on an analytic procedure that considers factors with an eigenvalue greater than one (Bryant & Yarnold, 1998; Child, 1990; Nunnally, 1978). Additional considerations are:

1. items that have at least three significant loadings greater than .20;
2. variables loaded on a component share conceptual meaning;
3. variables that load on multiple components measure the same or different constructs;
4. the rotated component matrix demonstrates simple structure (Child, 1990; Hoyle, 1995).

The first step in data reduction/factor extraction was to distinguish the proportion of variance between items. For this investigation, principal component analysis was conducted on all 40 quantitative items on the survey instrument using the SPSS software program. As shown in Table 4.6, the difference between 1 and the uniqueness, labeled ‘extraction’, is the proportion of variance in the observed variable due to the factors. This proportion is known as the communality. Essentially, communality is the squared multiple correlation of the variable with the common factors. In principal components solutions, all initial communalities are estimated as 1, since all the variance can be accounted for as a result of the analysis.

Table 4.6

Communalities from Exploratory Factor Analysis (Principal Component Analysis)

Item	Initial	Extraction
Q1	1.000	.768
Q2	1.000	.763
Q3	1.000	.737
Q4	1.000	.706
Q5	1.000	.559
Q6	1.000	.642
Q7	1.000	.539
Q8	1.000	.647
Q9	1.000	.658
Q13	1.000	.571
Q14	1.000	.625
Q15	1.000	.566
Q16	1.000	.659
Q17	1.000	.458
Q18	1.000	.493
Q19	1.000	.500
Q20	1.000	.671
Q21	1.000	.687
Q22	1.000	.480
Q23	1.000	.577
Q25	1.000	.579
Q26	1.000	.503
Q27	1.000	.528
Q28	1.000	.718
Q29	1.000	.418
Q30	1.000	.720
Q31	1.000	.687
Q32	1.000	.588
Q37	1.000	.781
Q38	1.000	.777
Q10	1.000	.520
Q11	1.000	.633
Q12	1.000	.626
Q39	1.000	.328
Q40	1.000	.532

Extraction Method: Principal Component Analysis

Identification of Eigenvalues.

Following communalities, Eigenvalues were extracted from the 40 items on the survey instrument to determine initial component groupings (Table 4.7). Simply stated, eigenvalues represent the variance explained by each principal component. While there can be as many principal components as there are variables, actual practice and parsimony often dictate that the researcher only retain components that account for a significant amount of variance (Stevens, 1996). An eigenvalue of 1.00 (E1) is the most commonly used criterion for deciding how many factors to retain in factor reduction (Bryant & Yarnold, 1998; Cattell, 1966; Stevens, 1996). Kaiser (1960), recognized by the field as a definitive authority in factor analysis (Bryant & Yarnold, 1998; Cattell, 1966; Hoyle, 1995; Hair et al., 1992), suggested a stopping rule (i.e., retaining) only factors with an eigenvalue of at least 1, that is, the equivalent of the variance of a single standardized variable.

As Table 4.7 illustrates, nine components were identified with an initial eigenvalue of 1 or greater and 26 components were identified having an eigenvalue less than 1, therefore, nine components were retained and the remaining 26 were discarded.

Another process of identifying eigenvalues, proposed by Cattell (1966) is a graphical procedure, known as a scree test, for determining the appropriate number of eigenvalues (components) to extract. Applying the set off weights to factors creates a series of composites. In turn, each composite corresponds to a component. Each component has a variance associated with it, and that variance is called an eigenvalue. The first factor has the largest possible eigenvalue, that is, the biggest composite variance. The second factor will have the largest possible variance subject to being uncorrelated with the first one. The third will have the largest possible variance subject to being uncorrelated with the first two, and so forth. Each subsequent factor has a maximum variance subject to being uncorrelated with earlier factors. The result is a plot of the eigenvalues (variances) against their serial order (Cattell, 1966; Child, 1990; Hoyle, 1995). Graphically displayed, the scree plot depicts eigenvalues in the form of a linear slope (Figure 4.1). Eigenvalues associated in the steep slope decent are retained, however, those that are indicated in the gradual decent, correlated with values less than 1, are dropped as not significantly contributing to the variances and ultimately not being considered relevant factors in the principal component analysis (Bryant & Yarnold, 1998; Hoyle, 1995).

Table 4.7

Total Variance Explained - Initial Eigenvalues

Component	Initial Eigenvalue	% of Variance	Cumulative %
1	**6.424**	18.354	18.354
2	**3.897**	11.134	29.488
3	**2.496**	7.132	36.620
4	**1.902**	5.436	42.055
5	**1.661**	4.746	46.801
6	**1.456**	4.159	50.960
7	**1.186**	3.389	54.349
8	**1.138**	3.253	57.602
9	**1.082**	3.090	60.692
10	.997	2.849	63.541
11	.990	2.827	66.369
12	.877	2.506	68.874
13	.855	2.444	71.318
14	.834	2.383	73.701
15	.821	2.346	76.047
16	.749	2.139	78.187
17	.679	1.939	80.126
18	.634	1.812	81.938
19	.596	1.704	83.642
20	.554	1.583	85.225
21	.526	1.504	86.729
22	.497	1.420	88.149
23	.477	1.362	89.510
24	.460	1.315	90.825
25	.419	1.198	92.023
26	.398	1.137	93.161
27	.363	1.037	94.198
28	.344	.983	95.181
29	.323	.922	96.104
30	.292	.835	96.938
31	.274	.782	97.720
32	.234	.669	98.389
33	.208	.594	98.983
34	.192	.550	99.533
35	.163	.467	100.000

Extraction Method: Principal Component Analysis

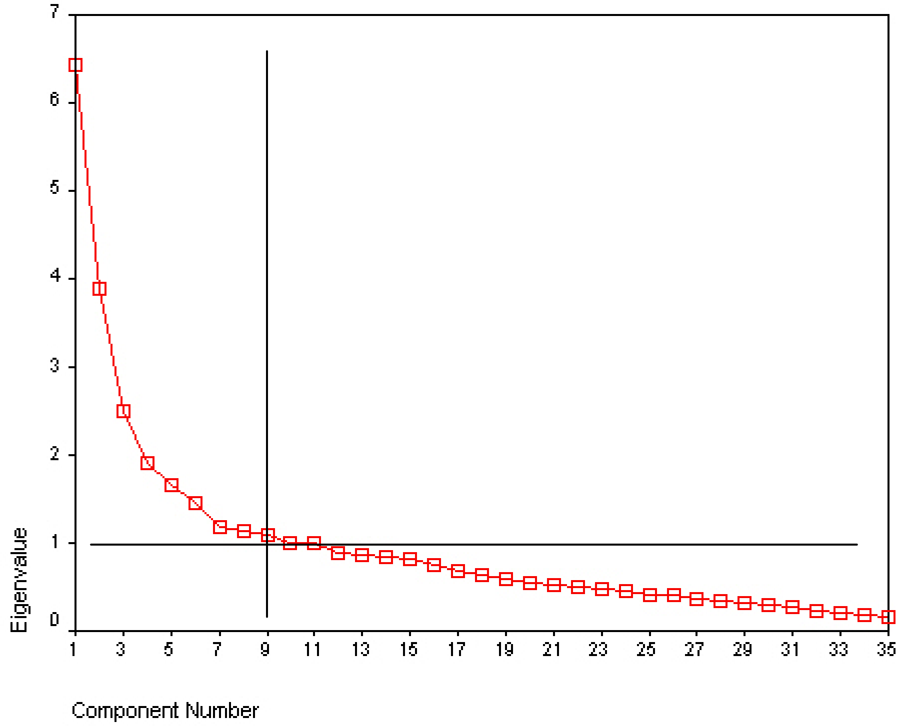


Figure 4.1. Scree Plot based on initial factor extractions.

Interpretation of Eigenvalues.

Following the identification of eigenvalues, exploratory factor analysis attempts to associate individual items eigenvalue components. With the goal of achieving simple structure, that is, identifying components with specific items (loadings) assigned to the component based on individual value, component factor analysis aids the researcher by determining the specific factor loading coefficients that can be then grouped into associated components (Bryant & Yarnold, 1998; Child, 1990). The initial components coefficients, depicted in a component matrix (Table 4.8), are unfortunately difficult to interpret due to the likelihood of redundancy of variance between component loadings (Bryant & Yarnold, 1998; Stevens, 1996).

In an attempt to achieve simple structure, it is possible and desirable to rotate the eigenvalues in an arbitrary direction to facilitate interpretation (Bryant & Yarnold, 1998; Child, 1990; Thurstone, 1947). Most commonly, this is performed using orthogonal rotation; better know as Varimax rotation (Stevens, 1996; Hoyle, 1995).

The Varimax rotation (Table 4.9) produces simple structure while retaining the independence between eigenvalues, that is, the loadings of rotated eigenvalues remain uncorrelated (Bryant & Yarnold, 1998; Thurstone, 1947) and greatly assist the researcher in identifying and labeling components (factors) according to item loadings.

Once components were rotated to achieve simple structure and to aid with interpretability, the correlations between each variable and the rotated factors were examined. Negative coefficients were discarded, being considered negatively associated with the component, and remaining items that split-loaded between two components were associated with a given component according to the higher coefficient value.

Bi-polar coefficient loadings (negative and positive on separated components) were eliminated due to conceptual ambiguity (Stevens, 1996). Associations with a specific component group were made with a minimum of three positive coefficient loadings at or above the .035 level, consistent with recognized PCA procedures (Bryant & Yarnold, 1998; Suhr, 2004; Thurstone, 1947).

Table 4.8

Initial Component Matrix

Item	Component Loadings								
	1	2	3	4	5	6	7	8	9
Q1	**.717**		**.434**						
Q2	**.735**		**.420**						
Q3	**.695**								
Q4	**.677**		**.351**						
Q5	**.639**								
Q6						**.413**	**.448**		
Q7			**-.392**					**-.377**	
Q8									
Q9	**.386**	**-.419**							
Q13	**.681**								
Q14	**.495**	**.373**							
Q15	**.574**								
Q16	**.580**		**-.360**						
Q17	**.587**								
Q18	**.615**								
Q19	**.511**								
Q20	**.420**	**.497**							
Q21	**.390**	**.472**							
Q22	**.434**	**.352**							
Q23	**.532**								
Q25		**.612**				**.350**			
Q26				**.509**					
Q27		**.592**							
Q28		**.686**							
Q29		**.442**							
Q30		**.679**							
Q31		**.697**							
Q32				**.546**					
Q37					**.706**				
Q38			**.377**	**.442**	**.621**				
Q10						**.550**		**.407**	
Q11				**.378**				**.372**	
Q12									**.617**
Q39			**-.388**						
Q40							**-.465**		

Extraction Method: Principal Component Analysis
9 components extracted

Table 4.9

Rotated Component Matrix

Item	Component								
	1	**2**	**3**	**4**	**5**	6	7	8	9
Q1	**.845**								
Q2	**.840**								
Q3	**.816**								
Q4	**.787**								
Q5	**.691**								
Q6					**.743**				
Q7					**.431**				
Q8					**.773**				
Q9					**.597**				
Q13	**.479**	.467							
Q14		**.732**							
Q15		**.712**							
Q16		**.687**				.421			
Q17		**.619**							
Q18		**.605**					-.342		
Q19		**.552**							
Q20		**.584**		.365					
Q21		**.471**		.405					
Q22		**.371**							-.429
Q23	**.404**	.401							
Q25			**.670**						
Q26			**.649**			.378			
Q27			**.540**						
Q28			**.801**						
Q29			**.588**						
Q30			**.364**						
Q31			**.725**						
Q32			**.706**						
Q37				**.869**					
Q38				**.834**					
Q10								-.690	
Q11					**.465**				
Q12									.756
Q39				**.509**					
Q40							-.410	.523	

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 9 iterations

As evidence of construct validity, the resulting structure of component-to-item alignment closely mirrored the hypothesized dimensions comprising each subscale on the data collection instrument. Table 4.10 portrays the interpreted scale, with each item assigned to its constituent factor and subscale. The result of this analysis validated five component groupings for use in CFA (Table 4.10):

1. *Factor one*: KINNOV includes seven variables related to knowledge and innovation of instructional technology in teacher education courses. This factor accounts for 5.4 percent of the total variance (Table 4.10), and it represents current integration of NETS-T national technology standards (Q1-Q5). Similarly, it suggests that a faculty member's awareness of advantages that technology offers influences their use of instructional technology (Q13); and that lack of self-defined personal technology literacy (Q23) is a critical barrier to a faculty member's use of technology in teaching.
2. *Factor two*: INSTINFRA corresponds to the institutional infrastructure that supports technology use in teacher education and explained 18.4 percent of the total variance (Table 4.10). Q6 and Q7 indicated faculty awareness and integration of technology goals stated in the conceptual framework of the teacher preparation program. Support structures for technical assistance, instructional design help, and professional development offerings (Q8; Q9; Q11) were other items associated with institutional support for technology use.
3. *Factor three*: FACTORS corresponded to items that influenced the use of

technology by teacher education faculty, including assistance with technology use (Q14; Q15; Q16; Q19), technology's ability to increase student interest (Q17), and incentives for faculty using technology (Q20; Q21). This factor accounted for 11.1 percent of the total variance.

4. *Factor four*: BARRIERS included items perceived by faculty as being obstructions in using instructional technology, and accounted for 7.1 percent of the total variance. Categories included lack of incentives (Q25; Q28; Q29), lack of equipment and support (Q27; Q30; Q31), and beliefs that technology does not support teaching and learning (Q26; Q32).
5. *Factor five*: INSTEXP correlated with instructional experience and explained 4.7 percent of the total variance. Items associated with this factor included years teaching in teacher education (Q37), Years using technology in teacher education (Q38), and experience teaching a technology-focused teacher education course (Q39).

Table 4.10

Final Coefficient Loadings and Factor Association

	Factors				
Item	KINNOV	INSTINFRA	FACTORS	BARRIERS	INSTEXP
Q1	**.845**				
Q2	**.840**				
Q3	**.816**				
Q4	**.787**				
Q5	**.691**				
Q6		**.743**			
Q7		**.431**			
Q8		**.773**			
Q9		**.597**			
Q10[3]					
Q11		**.465**			
Q12[3]					
Q13	**.479**				
Q14			**.732**		
Q15			**.712**		
Q16			**.687**		
Q17			**.619**		
Q18[3]					
Q19			**.552**		
Q20			**.584**		
Q21			**.471**		
Q22[3]					
Q23	**.404**				
Q24[2]					
Q25				**.670**	
Q26				**.649**	
Q27				**.540**	
Q28				**.801**	
Q29				**.588**	
Q30				**.364**	
Q31				**.725**	
Q32				**.706**	
Q33[2]					
Q34[1]					
Q35[1]					
Q36[1]					
Q37					**.869**
Q38					**.834**
Q39					**.509**
Q40[3]					
Q41[2]					
Q42[2]					
Q43[2]					

1 = Demographic items
2 = Qualitative items
3 = Single negative or bi-polar item loading

Confirmatory Factor Analysis

CFA was conducted using the AMOS (Analysis of Moment Structures) structural equation modeling software on the proposed conceptual model (Figure 1.1), using factors identified by exploratory factors analysis (principal component analysis).

Summary of CFA on Proposed Conceptual Model.

For the proposed model, a path diagram was constructed (Figure 4.2) using the AMOS SEM software program. A path diagram is a graphic portrayal of the model, reflecting the relationship between the latent variable and the observed variables (Hair et al., 1992; Stevens, 1996; University of Texas, 2004). The rectangles in the path diagram indicate the observed variables (component factor groupings). The oval in the diagram represents the latent variable (use of instructional technology), and the circle indicates the overall degree of explained variance. The values on the right side of the rectangles are the loadings of the variables onto the factors, and the path values, indicated with one-sided arrows, indicate direct effects (correlation paths) between each factor group and the latent variable, depicted with values indicating standard regression coefficients. The path coefficients show the direct effect the observed variable (factor) has on the latent variable in the path model (Bryant & Yarnold, 1998; Agresti & Finlay, 1997; University of Texas, 2004).

Path coefficients depict relative strength of association between variables. Directional one-headed arrows indicate the direction of influence observed (exogenous) variables in relation to the latent (endogenous) variable (Agresti &

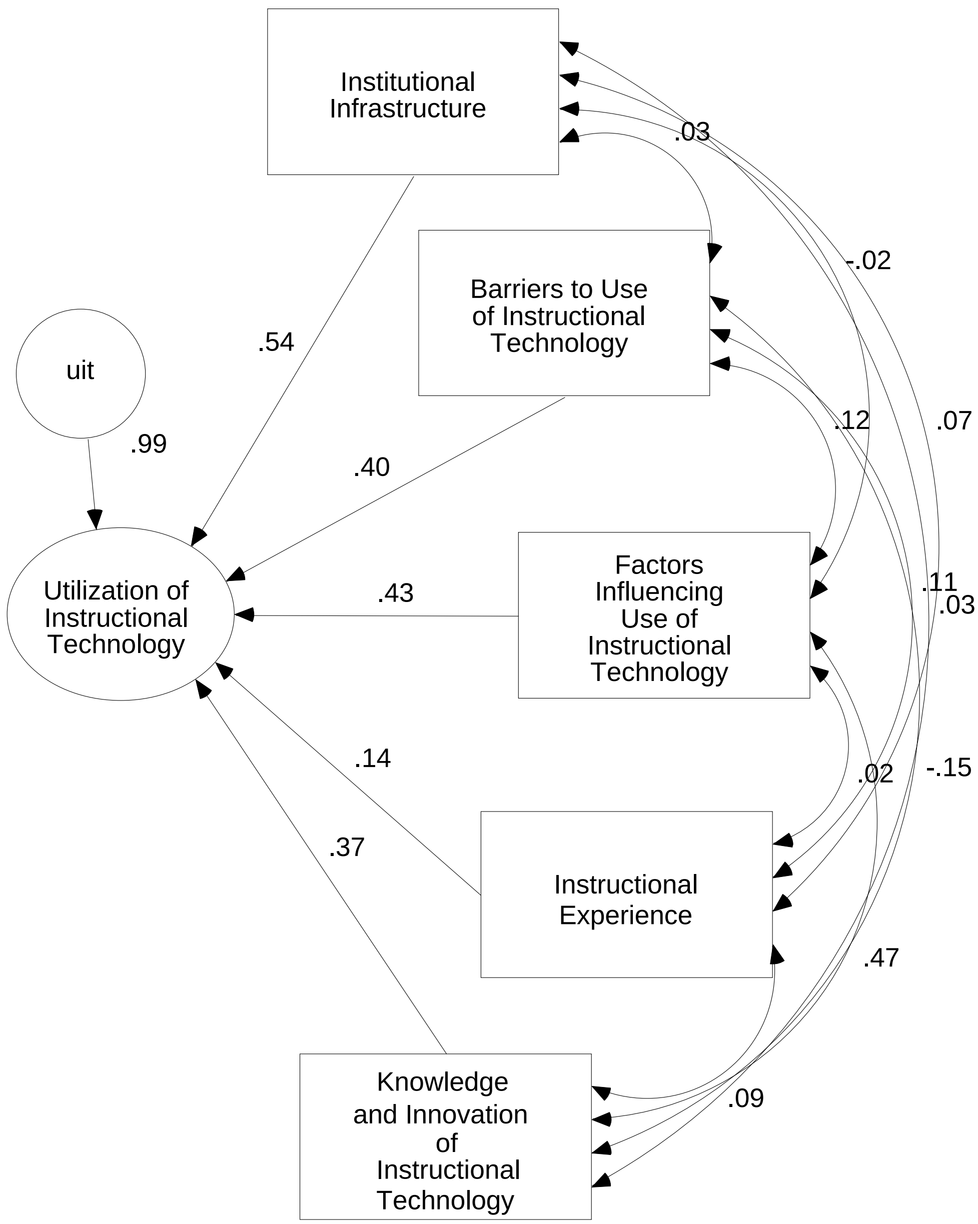
Finlay, 1997). Covariance paths between exogenous variables are indicated by two-headed arrows. Although association is one characteristic of a cause-effect relationship, it is not sufficient to imply absolute causation (Agresti & Finlay, 1997).

The AMOS output also generated model fit statistics that are designed to test or describe overall model fit. Typical fit statistics include chi-square, degrees of freedom (df), probability value (p value), comparative fit index (CFI), and root mean square error of approximation (RMSEA) (University of Texas, 2004).

Methods and Results of Model Evaluation.

Figure 4.2 illustrates results from CFA. Chi-square goodness-of-fit-test with a .05 level of significance was employed to evaluate the proposed conceptual model. The chi-square goodness-of-fit test determines the difference between the covariance structure for the sample and the covariance structure expected for the sample (Joreskog, 1993). A statistically significant difference among the sample covariance structure and the estimated population covariance structure indicates a lack-of-fit, that is, the proposed conceptual model does not fit the observed or sample covariance structure (Hoyle, 1995).

The analyzed chi-square value of 7.100 with three degrees of freedom is non-significant at the .05 level: its p-value is .069 (Table 4.11). This finding suggests that the proposed conceptual model fits the data collected from the sample.



Chi Square = 7.100 p value = .069 df = 3 TLI = .993 CFI = .999 RMSEA = .048

Figure 4.2. Confirmatory Factor Analysis Path Diagram on Proposed Conceptual Model.

Table 4.11

Chi-Square Goodness-of-Fit Test for proposed conceptual model

Chi-Square	df	probability
7.100	3	.00

Note: n = 226

The root mean square error of approximation (RMSEA) was also used to determine the fit of the proposed model. The standardized RMSEA is the square root of the mean of the squared residuals between the sample covariance structure and the estimated population covariance structure. There is no universally accepted value to evaluate the magnitude of the RMSEA generated for a proposed conceptual model, however, the smaller the RMSEA, the closer the sample covariance structure approximates the population covariance structure (Hair et al., 1992; Joreskog, 1993; Stevens, 1996). For the purposes of this study, RMSEA values below .06 were considered to provide support for model fit. Submitted as corroborating evidence, the RMSEA fit statistic of .048 was well below the .06 cutoff threshold (Table 4.12).

The comparative fit index (CFI), and the Tucker-Lewis Index (TLI) were considered when the proposed conceptual model was evaluated. The CFI is a measure of the squared differences from the predicted to the sample covariance. The TLI, also known as the non-normed fit index (NNFI) is a similar fit index used in CFA to indicate goodness-of-fit (Gorsuch, 1983; Hoyle, 1995; Joreskog, 1993). The CFI ranges from 0 to 1.0, with 0 indicating a poor fit, and 1.0 suggesting a perfect fit.

An obtained CFI above .90 is considered an acceptable level of model fit in which the model can fail to be rejected (Bryant & Yarnold, 1998; Hair et al., 1992; Hoyle, 1995; Stevens, 1996). Likewise, an obtained TLI above the recognized threshold of .095 indicates a satisfactory model fit (Bryant & Yarnold, 1998; Hoyle, 1995; Joreskog, 1993). A CFI of .999 resulted from CFA on the proposed conceptual model. Similarly, the Tucker-Lewis Index result of .993 was considerably above the .95 threshold denoting satisfactory model fit (Table 4.12).

Table 4.12

Fit Indices for Proposed Conceptual Model

Evaluation	Value
p-value	.069
Tucker-Lewis Index (TLI)	.993
Comparative Fit Index (CFI)	.999
Root Mean Square Error of Approximation	.048

Path Coefficients.

To further analyze the tested model, path coefficients should be considered as indication of relational paths between the observed variables and the latent variable (Table 4.13). Based on outcomes from CFA, the proposed conceptual model demonstrates that all observed variables having some degree of relation to the use of instructional technology, however, at .54, Institutional Infrastructure has the highest degree of relationship, followed by factors influencing use (.43) and barriers to technology use (.40).

Table 4.13

Path Coefficient Matrix (between exogenous variables and the endogenous variable)

Factor	Path Coefficient
Institutional Infrastructure	**.54**
Factors Influencing the Use of Instructional Technology	**.43**
Barriers to the Use of Instructional Technology	**.40**
Knowledge and Innovation of Instructional Technology	.37
Instructional Experience	.14

Coefficients (beta weights) between observed variables were reported at low levels (Table 4.14), with only a moderate degree of relationship suggested between knowledge/innovation and factors influencing use of technology. A low degree of relationship between observed variables is to be expected as a result of factor analysis that, if successful, differentiates component groupings into distinct factors and lends overall credibility to CFA by demonstrating relational investigation focus between observed variables and the latent variable (Bryant & Yarnold, 1998; Joreskog, 1993; Stevens, 1996).

Table 4.14

Path Coefficients (beta weights) Between Exogenous (Observed) Variables

	INSTINFRA	BARRIERS	FACTORS	INSTEXP	KINNOV
INSTINFRA	--	.03	-.02	02	.03
BARRIERS	.03	--	.12	.11	- .15
FACTORS	-.02	.12	--	.02	.47
INSTEXP	.07	.11	.02	--	.09
KINNOV	.03	-.15	.47	.09	--

Subjects-to-Variables Ratio (STV).

Regarding the sample observations necessary for SEM, researchers rely on a rule of thumb known as subjects-to-variable ratio (Joreskog, 1993). For the results of the analysis on a proposed model using CFA to be reliable, that is, for the results to be accurately replicated if the study is repeated, the minimum number of observations in the sample should be at least five times the number of items being observed (Bryant & Yarnold, 1998; Joreskog, 1993). Further, every CFA analysis should be based on a minimum of 100 observations, regardless of the STV ratio (Gorsuch, 1983). As related to this study, the STV ratio was calculated on 40 items (variables) measured on the data collection instrument used for SEM analysis.

Therefore, if a minimum of five observations are necessary for 40 items, the minimum number of observations is 200. As described earlier, the actual amount of observations for this study was (N) 226.

Generalizability.

Concerns involving the degree to which the proposed conceptual model can be generalized beyond the sample may arise (Hoyle, 1995). The difficulty with generalizability is that in using CFA, SEM models can never be accepted; rather, at best they can only fail to be rejected (Gorsuch, 1983; Joreskog, 1993; Stevens, 1996). This leads researchers to provisionally acknowledge a given model, with the understanding that other variables/factors may exist that could either confound or provide alternative explanations for observed phenomena (Joreskog, 1993). SEM researchers recognize that in most instances equivalent models that fit equally as well as their own provisionally accepted model exist. Any of these models may be “correct” because they fit the data as well as the preferred model. Researchers do their best to eliminate alternative models, but this is not always possible (Gorsuch, 1983; Joreskog, 1993; Stevens, 1996). The use of SEM thus entails some uncertainty, particularly with cross-sectional data that are not collected under controlled conditions, also true of other commonly used models such as ANOVA and multiple regression techniques (Bryant & Yarnold, 1998; Joreskog, 1993; Stevens, 1996).

Ultimately, SEM models test hypothesized factors as collected from a sample; therefore, embracing a conceptual model based on hypothetical constructs requires further validation and iterations to be considered in advancing the model for further testing (Gorsuch, 1983; Hoyle, 1995; Joreskog, 1993; Stevens, 1996).

Qualitative Analysis

In an effort to provide clarity, definition and triangulate the data, faculty were asked to respond in their own words to open-ended questions on the survey instrument regarding aspects of technology use in teacher education programs throughout the University of North Carolina system. Triangulation methods offer the researcher the advantage of overcoming the weakness of using single source data and provide a degree of validation from consideration and analysis of responses from the sample provided in their own words and from a practitioner's standpoint (Martella et al., 1999). Further, while qualitative and quantitative methods are not diametrically opposed to one another, each can complement the other method of data collection and analysis to gain better understanding of the phenomena (Agresti & Finlay, 1997).

There were five qualitative questions integrated into the survey instrument. One question focused on demographics to gather data on instructional discipline areas of responding teacher education faculty. Other questions focused on innovation of instructional technology into teaching, most significant factors and barriers to using technology, and a description of attitude in regard to their use of technology in teacher education. All responses were initially evaluated by the researcher.

To achieve inter-rater reliability, a subject matter expert with a doctorate in Educational Leadership, 25 years experience in the field of instructional technology, and well experienced in qualitative analysis, was engaged to independently evaluate all qualitative comments, and subsequently collaborate with the researcher on rating scales, scores and summarization of response categories.

Primary Teaching Content Area.

As Table 4.15 illustrates, 180 faculty (79.6%) responded to the question on instructional content area, representing a good cross-section of teacher education disciplines. Of interest, special education constituted the largest percent of respondents (15%) followed by elementary education (11.6%). Other areas represented include birth-kindergarten, middle grades and secondary education; educational technology; educational leadership; psychology; physical education; music education; social studies education; foreign language education; art education; and business education.

Table 4.15

Primary Teaching Content Areas Reported by Respondents

Content Area	Number	Percentage
Special Education	27	15%
Elementary	21	11.6%
Educational/Instructional Technology/Media	16	8.8%
Math	12	6.6%
Middle Grades/Secondary	11	6.1%
Science	10	5.5%
Language Arts/English	9	5%
Foundations/Methods/Generalist	9	5%
Higher Education/Adult Education/Ed Leadership	8	4.4%
Reading	7	4.1%
Social Studies	7	4.1%
Birth-Kindergarten	6	3.3%
Music	6	3.3%
Physical Education	5	2.7%
Business	4	2.2%
Foreign Language	4	2.2%
Educational Psychology	4	2.2%
Counselor Education	4	2.2%
Communication Disorders	3	1.6%
Literacy	2	1.1%
Hearning Impared/Deaf Education	2	1.1%
Art	2	1.1%
Gifted Education	1	0.5%
TOTAL RESPONSES TO QUESTION	180	100%

Factors Influencing the Use of Instructional Technology.

In the section addressing factors that influence the use of instructional technology, faculty were asked to characterize the single most influential factor for themselves to use instructional technology in teacher education. A total of 173 faculty responded to this question (76.5%). As Figure 4.6 illustrates, responses were categorized into four classifications:

1. candidate needs;
2. faculty needs;
3. availability of support; and
4. incentives for using technology.

-*Candidate Needs as Influences for Using Technology*: 46 percent of responding faculty classified their responses in this classification of responses, which included:

1. increasing teacher education candidate interest;
2. candidate's need to understand and practice teaching strategies that incorporate technology to support teaching and learning;
3. assisting candidates with coursework and experiences regarding technology that would support the development of their technology portfolio for state teaching licensure;
4. ensuring state and national technology standards were addressed in teacher education courses for the preparation of candidates; and
5. as a way to engage candidates in experiential learning using technology that they in turn could model to their student in K-12 settings;
6. expectations of candidates to be taught using current methods including technology-supplemented instruction.

-*Faculty Needs as Influences for Using Technology*: 27 percent of responding faculty designated faculty needs as the single most influential factor to technology use. Responses included:

1. using technology in teacher education courses to comply with state, national and accreditation guidelines, policies and goals;
2. faculty skill level (higher skill level/proficiency equaled increased influence to use technology);
3. awareness of advantages that technology offers faculty over traditional teaching methods;
4. individualized support above faculty ability to integrate technology;
5. ease of using technology over other teaching tools;
6. appropriateness of using technology to support to curriculum development and delivery;
7. peer modeling using technology in teaching.

-*Availability of Support as an Influence for Using Technology*: 19 percent of responding faculty indicated that support in planning and delivering technology-enhanced curriculum was the most influential factor in their use of technology. Responses included:

1. localized technical support on office-based technology;
2. localized technical support of classroom-based technology;
3. availability of instructional designers to work one-on-one with faculty;
4. peer support for using technology;

5. opportunity to work with in-service teachers in developing cooperative technology experiences for candidate interns/student teachers.

-*Incentives as Influences for Using Technology*: 8 percent of responding faculty reported the following incentives as influential to their use of instructional technology:

1. release time to develop technology-integrated curriculum;
2. stipends, honorariums, grants;
3. recognition on annual faculty evaluations (AFE);
4. recognition for promotion and tenure;
5. access to use of classroom-based technology equipment;
6. availability of upgraded or new technology hardware and software for individual (professional) use.

Table 4.16

Most Significant Factor Influencing Technology Use: Qualitative Responses

Factor	N	Percent of respondents
Candidate needs	80	46%
Faculty needs	46	27%
Availability of support	33	19%
Incentives	14	8%
Total	173	100%

Barriers to the Use of Technology.

In this section, teacher education faculty was asked to identify the most significant barrier they felt restricted them from using instructional technology. Classification of responses included:

1. availability and access to technology;
2. incentives;
3. support;
4. personal disposition to using technology; and
5. candidate readiness to use technology (Table 4.17).

-*Faculty Incentives*: Interestingly, 46 percent of faculty respondents reported that incentives were the most significant *barrier* to technology use (as compared with only 8 percent reporting incentives being the factor most influential towards their use of technology. Specifically, this included:

1. lack of release time for development of technology-enhanced curriculum;

2. absence of stipends and financial supplements to encourage the use technology in teaching; and
3. lack of recognition for tenure and promotion, and for annual faculty teaching evaluations.

-*Accessibility/Access to Technology*: 25 percent of faculty indicated that lack of access to instructional technology equipment was the most significant barrier to their use of instructional technology. Faculty restricted these barriers to:

1. absence of technology hardware in classroom settings;
2. lack of discipline-specific software in classrooms;
3. lack of updated technology hardware for curriculum development and office use; and shortage of adequate shared technology resources (i.e. mobile carts; wireless laptops)

-*Personal Disposition to Using Technology*: 17 percent of faculty respondents reported that their personal disposition regarding technology was the most significant barrier towards technology in their teaching. More specifically, this included:

1. lack of skill or ability to use technology;
2. lack of knowledge about pedagogical uses of instructional technology;
3. uncertainty that technology benefits the teaching and learning process; and d) belief that technology does not support their particular discipline area.

-*Support*: 11 percent of responding faculty felt that support was a significant barrier to their use of technology. Their definition of support included:

1. lack of administrative support for technology use;
2. lack of localized technical (hardware/software) support;
3. lack of localized instructional design support; and
4. limited (or lack of abundant and diverse) professional development opportunities in the area of instructional technology.

-*Candidate Readiness to Use Technology*: Interestingly, 1 percent (2 respondents) considered that candidates were not prepared to use technology, that is, faculty felt that if candidates were not ready to use technology, this was a barrier for them to use technology in teacher preparation. Comments in this classification centered on two themes:

1. candidates lacking technology skills/abilities; and
2. candidates lacking belief that technology can positively support teaching and learning.

Table 4.17

Most Significant Barriers to Instructional Technology Use: Qualitative Responses

Perceived barrier	N	Percent of respondents
Incentives	75	46%
Availability/access	42	25%
Personal disposition	28	17%
Support	18	11%
Candidate readiness	2	1%
Total	165	100%

Innovative Uses of Instructional Technology in Teacher Education.

Following factors and barriers, faculty were asked to identify the most innovative or successful personal use of instructional technology in teacher education (Table 4.18). 148 faculty (65.4%) responded, classified in the following categories:

1. web-based activities/classes;
2. subject-specific use of technology;
3. electronic presentation;
4. course materials;
5. communication; and
6. faculty resource.

-*Web-Based Activities*: 37 percent of responding faculty designated web-based activities and classes as their most innovative use of technology. Specifically, this included:

1. demonstrating online pedagogical strategies;
2. modeling experiential activities using online resources;
3. having candidates prepare lessons, units, and materials supplemented with online materials;
4. teaching online (all online and resident-supplemented online) teacher education courses;
5. requiring candidates to review education-content web resources and
6. develop thematic web pages.

-*Subject-Specific*: Following web-based activities, 20 percent of faculty reported subject-specific uses as their most innovative or successful use of technology. These innovations included:

1. faculty use of discipline-related technologies;
2. requiring candidates to research and document content-specific uses of technology in K-12 settings; and
3. developing unit and lesson plans supplemented with subject-specific technologies.

-*Presentations/Portfolios*: 16 percent of faculty reported that presenting materials, course content, and having candidates' document/present portfolios were their most innovative uses of technology. More specifically, faculty:

1. prepared and presented course content via electronic means;
2. required the same of their candidates;
3. demonstrated the utility of technology-based portfolios (for storing portfolio entries and presenting portfolios by electronic means);
4. created course assignments for use as evidence in candidate technology portfolios.

-*Course Materials*: 14 percent of faculty described posting and transmitting course materials electronically as their most innovative use of technology. This included:

1. creating electronic reserves at a campus library;
2. transmitting/posting course syllabi via electronic means for increased candidate access;

3. disseminating course assignments and collecting candidate's course products via electronic means (i.e., drop, add, and share folders);
4. creating and disseminating course materials via electronic means (i.e., CD-ROMs; DVDs); and
5. creating and administering examinations via electronic means.

-*Communication*: 10 percent of faculty reported the facilitation of communication was their most innovative use of technology. Cases included:

1. electronic mail between instructor and candidates;
2. electronic correspondence between faculty colleagues;
3. requiring candidates to develop lesson and unit plans that included activities (as appropriate) for K-12 students to correspond in groups or individuals with geographically distant students; and
4. teaching methods and strategies of using electronic newsgroups and discussion boards.

-*Professional Resource*: A small percentage of faculty (3%) reported that their most innovative use of technology was for professional purposes, including:

1. conducting research;
2. creating, editing, and transmitting written publications;
3. publishing scholarly documents for wide-spread dissemination; and
4. participating in synchronous and asynchronous dialogue and meetings with colleagues.

Table 4.18

Most Innovative/Successful Uses of Instructional Technology: Qualitative Responses

Innovation	N	Percent of respondents
Web-based	55	37%
Subject-specific	30	20%
Presentation/portfolios	23	16%
Course materials	21	14%
Communication	15	10%
Professional resource	4	3%
Total	148	100%

Attitude Towards Use of Technology.

Faculty was requested to characterize their attitude toward technology use in teacher education. 178 (78.7%) faculty responded with written comments ranging from one word to three sentences. Responses were evaluated and screened for themes, and were subsequently coded and grouped according to the following scale:

1=Negative

2=Negative with some degree of positive

3=Neutral

4=Positive with some degree of negative

5=Positive

Descriptions of response categories and percentages of responses for each scale are presented as follows and as reflected in Table 4.19.

Table 4.19

Faculty Attitudes Toward the Use of Instructional Technology in Teacher Education: Qualitative Responses

Attitude	N	Percent of respondents
Negative	3	1.6%
Negative with some degree of positive	7	3.9%
Neutral	15	8.5%
Positive with some degree of negative	42	23.6%
Positive	111	62.4%
Total	178	100%

-*Negative Attitudes Toward Technology Use*: Three teacher education faculty members (1.6%), identified as all elementary education educators, characterized their attitude toward technology use as negative. Responses included: “scary”; “its something we have to do to survive as a teacher preparation program”, and “sadly, most students consider the calculator or computer that instrument that will aid them in avoiding learning the material!!”

-*Negative with some Degree of Positive Attitudes Toward Technology Use*: Following the small number (1.6%) of reported negative attitudes, seven teacher education faculty (3.9%) characterized their attitudes as mostly negative, but also with some positive elements. Comments included:

- “It’s a minor component, based on its relevance”
- “Frustration when equipment breaks down or I can't get it to function as it is supposed to. Sometimes it is just a button or knob that has not been pushed, but I don't know the idiosyncrasies of each equipment group. I always seem to need to go back to IT for help.”

- “Skepticism of the pedagogical value of many uses of technology.”

-*Neutral Attitudes Toward Technology Use*: 15 teacher education faculty (8.5%) reported that their attitudes toward technology use was generally neutral. Samples of comments for this classification include:

- “Not an issue in the courses I teach”
- “Lukewarm”
- “Technology is only a ‘means’ towards an ‘end.’
- “It has its place”
- “Ambivalent”
- “Technology offers some benefits, but it is currently being OVER emphasized.
- Technology should be viewed as a means to an end; however, in our institution it is viewed as and end in itself.”

-*Positive with some Degree of Negative Attitudes Toward Technology Use*: Over 23.6 percent of responding faculty (42 responses) characterized their attitude toward technology as mostly positive, but with some degree of negative. Responses representative of this classification are as follows:

- “Wish I could do more!”
- “I use it if/when it improves learning”
- “I like it, but don’t feel competent enough”
- “I would use more of it if I felt I had the support and technology available to me. Support is the key and my college provides almost none, and the university IT Services is unable to provide timely assistance. The ‘frustration factor’ is very high, but I still think it has its place.”
- “Positive-when it works. I’ve had many bad experiences where the equipment didn’t work and I had to come up with an alternative method.”
- “Love it when it is appropriate - hate contriving experiences”

- “Strong - just need time to develop tech. instruction and tech. expertise”
- “Want to make effective use of technology - not technology for the sake of technology”
- “Great as enhancement/ fear loss of interpersonal relationship between teacher & students”
- “I try to integrate what I can and learn with my students”.
- “Valuable, but cannot replace content expertise or expressive scholarship as a teacher. More support is necessary.”

-*Positive Attitudes Toward Technology Use*: By far, the largest percentage of faculty who responded (62.4%) indicated they had positive attitudes toward technology use in teacher education, as captured by a sampling of statements as follows:

- “Teachers must know how to use technology and how to teach students ever changing technology”
- “Positive…it has definitely increased active engagement/participation of all students (almost all - I still have a few who procrastinate & don't keep up - guess that's a given …)”
- “Technology is imperative to teachers of today and tomorrow”
- “I love it! I make sure that my students use it extensively in developing lesson plans, researching theories & theorists', reviewing & summarizing websites; electronic portfolios”
- “Good idea…if full integration occurs - technology should not be addition to curriculum”
- “Outstanding - I love enhancing my courses w/ technology”
- “Would not teach without technology”
- “Support appropriate use of technology in teacher education”
- “Great ... since it's good for student learning, I will continue using it”
- “Extremely favorable, bordering on fanatic.”

- “I think it's critical to both model and teach the use of technology in the classroom.”
- “Technology must be used in all aspects of teacher education”
- “I am open to using it and learning about it. I feel free to experiment and make mistakes.”
- “For teaching and learning, it is the present – it is without a doubt the future”

Factor Reliability

The reliability of an instrument can be characterized by the accuracy, consistency, and stability of the responses generated by items (questions) on the instrument. Reliability can then be defined as an estimate of the extent to which the measurement instrument is free of unsystematic error (Martella et al., 1999). Reliability, therefore, helps determine the degree to which items will generate reproducible data, and is typically represented using correlation coefficients. The correlation coefficient will range between greater than zero (0) and less than one (1). The closer to 1.0 (with 1.0 being considered a perfect correlation) that the correlation is, the higher the reliability of the instrument is considered to be (Agresti & Finlay, 1997; Martella et al., 1999).

Parameters generally accepted to established reliability include ‘satisfactory’ levels of reliability considered at the .70 coefficient level; ‘good’ levels of reliability considered at the .80 coefficient level; and ‘excellent’ levels of reliability considered at or above the .90 level (Martella et al., 1999).

Since the instrument used to collect data in this study is newly developed, initial reliability must be accessed by means of internal consistency. Cronbach’s

Coefficient Alphas will be used to measure internal consistency (Martella et al., 1999), and based on the analysis, the instrument may possibly need revision and certainly need re-administration to further evaluate its reliability. This is considered a necessity in the development and normalization of a measurement device to gain acceptance (Martella et al., 1999).

For assessment of reliability, the analysis was conducted and is presented using the five major component groups that resulted from factor analysis as previously reported in this chapter (Table 4.10). This method was chosen to better evaluate the internal consistency of subsets as they were applied to confirmatory factor analysis in the ultimate effort of testing the conceptual model of technology use in teacher education.

1. *Factor: Knowledge and Innovation of Instructional Technology.*

   This factor, consisting of items (questions) 1, 2, 3, 4, 5, 13, and 23 (Table4.20 yielded a reliability alpha coefficient of .87 (Table 4.20), indicating a high level of internal reliability.

Table 4.20

Reliability Analysis Scale – Alpha: Knowledge and Innovation of Instructional Technology

Items	N of cases	Alpha
Q1, Q2, Q3, Q4, Q5, Q13, Q23	226.0	.8746

2. *Factor: Institutional Infrastructure*

This factor, consisting of items (questions) 6, 7, 8, 9, and 11 (Table 4.21), yielded a reliability alpha coefficient of .63 (Table 4.21), indicating a marginally satisfactory level of internal reliability.

Table 4.21

Reliability Analysis Scale – Alpha: Institutional Infrastructure

Items	N of cases	Alpha
Q6, Q7, Q8, Q9, Q11	226.0	.6314

3. *Factor: Factors Influencing the Use of Instructional Technology*

This factor, consisting of items (questions) 14, 15, 16, 17, 19, 20, and 21 (Table 4.22), yielded a reliability alpha coefficient of .80 (Table 4.22), indicating good level of internal reliability.

Table 4.22

Reliability Analysis Scale – Alpha: Factors Influencing the Use of Instructional Technology

Items	N of cases	Alpha
Q14, Q15, Q16, Q17, Q19, Q20, Q21	226.0	.7977

4. *Factor: Barriers to the Use of Instructional Technology.*

   This factor, consisting of items (questions) 25, 26, 27, 28, 29, 30, 31, and 32 (Table 4.23), yielded a reliability alpha coefficient of .77 (Table 4.23), indicating a good level of internal reliability.

Table 4.23

Reliability Analysis Scale – Alpha: Barriers to the Use of Instructional Technology

Items	N of cases	Alpha
Q25, Q26, Q27, Q28, Q29, Q30, Q31, Q32	226.0	.7675

5. *Factor: Instructional Experience*

   This factor, consisting of items (questions) 37, 38, and 39 (Table 4.24), yielded a reliability alpha coefficient of .70 (Table 4.24), indicating a satisfactory level of internal reliability.

Table 4.24

Reliability Analysis Scale – Alpha: Instructional Experience

Items	N of cases	Alpha
Q37, Q38, Q39	226.0	.6986

6. *Overall Item Reliability*

In consideration of all items used in the confirmatory factor analysis of the proposed conceptual model (Table 4.25), the reliability alpha coefficient was .76, indicating a good level of internal reliability for the collective model test.

Table 4.25

Reliability Analysis Scale – Alpha: Overall Items Used in Confirmatory Factor Analysis

Items	N of cases	Alpha
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q11, Q13, Q14, Q15, Q16, Q17, Q19, Q20, Q21, Q23, Q25, Q26, Q27, Q28, Q29, Q30, Q31, Q32, Q37, Q38, Q39	226.0	.7621

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The intent of this study was to propose and test a conceptual model that described variables that may have bearing on the utilization of instructional technology by teacher education faculty in University of North Carolina teacher education programs. Focus on utilization was guided by the study's conceptual framework originally developed by Seels and Richey (1994a). Their model of instructional technology, entitled "Domains of Instructional Technology" (Figure 2.1) described a systematic process of instructional technology (Seels & Richey, 1994a) and recognized utilization as a major contributing factor to the employment of instructional technology. Within this factor, they identified core components (innovation, institutionalization, and implementation) that served as the foundation for the development of this study.

Potential outcomes from the data analysis may produce information that could be used by teacher education institutions to develop or modify technology professional development for faculty; assist in the strategic development and planning of teacher education programs, and identify specific barriers and enablers that instructional technology specialists could use in focusing their instructional support efforts.

Research questions specifically focused on: factor groupings contributing the most to the overall utilization of instructional technology by teacher education faculty; investigating sub-set variables that faculty reported having the most influence on their use of instructional technology; describing the nature of relationship between factor groupings and their relation to the use of instructional technology by teacher education faculty; creating and testing a model that illustrates factor groupings and their relation to the use of instructional technology; identification of specific factors and barriers most frequently cited by faculty as influencing their use of instructional technology.

Development of the study included reviewing related research on instructional technology, including technology’s role in the teaching and learning process, state and national policies regarding use of technology in teacher education programs, investigation of methods and instruments designed to collect date on technology use, and discovering elements that researchers agree have influence on technology use in teaching settings.

Upon the conclusion that no previously developed instrument was available to collect data from teacher education faculty on the five identified factor groups, the researcher developed his own instrument, titled: *Survey of Integrating Instructional Technology into Educational Settings* (Appendix A) and upon field testing and revision, administered the instrument to 668 teacher education faculty throughout the University of North Carolina System. Results and statistical analysis of the collected data is presented in Chapter 4.

Conclusions from the research are presented in regards to addressing the stated research questions.

1. What factors and sub-components contribute the most to the overall utilization of instructional technology by teacher education faculty?

Question 1: Findings

Factor groupings were initially created through a synthesis of research on teaching and learning with technology and in consideration of the conceptual framework set forth by Seels and Richey (1994a). As presented in Chapter 4, factor analysis was conducted to distinguish the groups through exploratory factor analysis and principal components analysis. When confirmatory factor analysis was conducted, the five factors and the latent variable (use of instructional technology) were tested to discover relational paths. Reliability coefficients (Table 4.25) suggest that the factor groups overall had satisfactory-to-good levels of internal reliability.

Results from CFA suggest that each of the five factor groups did have some degree of relation to the use of technology. Institutional infrastructure had the most relational value towards technology use, followed by factors influencing the use of instructional technology and barriers to the use of instructional technology respectively. Instructional experience was the least related factor to use of technology. Knowledge and innovation of instructional technology had a lower relational value (.37), and was not grouped with the top three factors due to weak substantiation with qualitative comments.

Quantitative and qualitative analysis of responses were consistent in indicating that teacher education faculty consider the interest of the student (candidate), the availability of support structures, and their own personal level of technology literacy as the most influencing factors for use of technology in their teaching.

Question 1: Discussion

As indicated in the results of CFA, institutional infrastructure had the highest relational (path) value towards technology use. This is supported by results from the frequency distribution of responses to questions regarding the importance of where support structures are positioned to assist faculty in designing and delivering technology enhanced curricula. Further, qualitative comments from faculty triangulate the findings and emphasize the importance faculty place on support being readily available in localized settings. More specifically, faculty reported that the most influential support elements were technology availability in the classroom (82.7%), followed by technical support (79.6%), and instructional design support (71.7%).

Professional development support in the form of instructional technology seminars and workshops reported as not-to-somewhat influential (46.5%)

Variables involving the benefits to teacher education candidates included:

1. awareness that technology offers teaching and learning,
2. increasing the interest level of students, and
3. recognition that standards and competencies must be addressed for the betterment and preparation of the candidates, as well as the continuing accreditation of the preparation program.

While this may suggest that faculty have interest in technology for the sake of retaining teaching employment, other data, including qualitative comments, imply that most faculty members are concerned about the quality preparation of new teachers and if technology is in their best interest. As research suggests, this becomes a highly influential motivation for technology integration into teacher education courses.

Support structures were also reported as being critical to the amount and degree of technology integration realized in teacher education programs. Furthermore, faculty indicate they are more likely to integrate technology into their teaching when the support structure is in place and they feel comfortable and competent about their personal technology literacy (including recognition and acceptance of technology use in discipline areas).

Support structures need to be localized and available to encourage technology use beyond the limits of an individual's literacy level. Factors that influence the use of technology also showed relationship to the latent variable. Of interest, awareness of advantages that technology provides and recognition of benefits technology offers students were reported as very-to-critically influential to faculty. This supports the idea that faculty are becoming more student-centered (Dockstader, 1999; Kirkpatrick & Cuban, 1998; OTA, 1995) and serving the educational needs of students (candidates) are guiding themes that direct the way faculty develop and deliver curricula.

Faculty also reported that their personal technology literacy was a significant influencing factor to their use of technology, and suggests that even though they may have the best interest of the candidate in mind, the degree to which they develop and deliver instruction integrated with technology is largely dependent on their self-defined level of technical competence and the level of support available that supplements their existing level of technology proficiency.

Barriers showed a similar relational value to technology use, but to a lesser degree. Consistent with the frequency of responses and qualitative comments, faculty indicated there were few considerable barriers to their using technology in teacher education, with the strongest barrier being lack of personal time to develop technology-enhanced curricula. As clarification, faculty comments suggest that while empirical evidence on technology use is important to them, they do not have the time necessary to research this on their own. Further, it suggests that efforts made to make faculty aware of research in the area of technology use and specifically in their discipline area may increase the likelihood that they consider using technology in their own teaching.

2. What is the nature of relationship between factor groupings and how do they relate to the use of instructional technology by teacher education faculty?

Question 2: Findings

Beta weights between factor subscales suggested that weak relationships exist between factors, with the exception of factors influencing the use of technology and knowledge and innovation of technology, which only showed a modest relationship.

CFA modeling suggested that relationships between factor groupings and the use of instructional technology had more meaningful bonds than between major component groups.

Question 2: Discussion

The relatively low beta weights indicate that the factor groups are mostly unique and distinct from one another. This is anticipated since the items were composed to parallel the literature, which suggests that these are independent constructs. Ultimately, the non-relational value between factor groups contributes toward the strength of the overall model by eliminating shared items (sub-set variables) between major components, thereby focusing the analysis on discovery of paths between each grouping (factor) and the latent variable.

Interestingly, CFA did report that knowledge and innovation of instructional technology and factors influencing the use of technology were somewhat inter-related. This may suggest that a faculty member who experiences a degree of positive influences may certainly have a better awareness or acknowledgement of the benefits technology offers and may also have an increased likelihood of innovating technology into his/her teaching.

3. How well can a model be constructed that illustrates these elements and their relation to the use of instructional technology?

Question 3: Findings

Overall analysis of CFA indicated an excellent goodness-of-fit between the variables and the proposed model. The result is failure to reject the proposed conceptual model.

Likewise, EFA was instrumental in refining the factor groupings and based on individual rotated item loadings, assisted the researcher in the creation of final factor groupings that were internally reliable, yet distinct and unique when testing the overall model.

Question 3: Discussion

While this does not suggest that the model be accepted in total as a tool to anticipate all factors that describe why (or why not) faculty use technology in teacher education, it does move closer to understanding elements that may contribute to the use of technology, suggests strengths of relational paths between factors and technology use, and provides supportive evidence that the model be tested further towards eventual acceptance.

Newly hypothesized models inherently are a first step toward identifying a process or theory, but cannot reasonably be expected to define themselves solely on the initial test (Joreskog, 1993; Stevens, 1996), especially in light that a newly created measurement instrument was used to collect data for model analysis.

Further, SEM models can never be accepted, they can only fail to be rejected (Gorsuch, 1983; Hoyle, 1995; Joreskog, 1993). At best, SEM may allow a researcher to have faith that the conceptual model has a degree of descriptive strength and certainly provides the foundation for further model and instrument testing in a movement toward ultimate acceptance.

As evidence that the measurement instrument needs refinement and additional testing, 13 of the 40 items were eliminated from the final CFA for rationale as follows:

Questions 34, 35, and 36 were eliminated because they were demographic in nature and were determined not to be distinct elements contributing toward the use of instructional technology. Rather, they served in describing the sample and in contributing to the generalizability of the study in teacher education settings,.

Questions 24, 33, 41, 42, and 43 were qualitative questions and served to triangulate the analysis instead of service as unique variables.

Questions 10, 12, 18, 22, and 40 were eliminated due to abnormal factor loadings. Specifically: a) question 10 had a negative loading in a dual-loaded component group. Possible explanation is confusion on multiple responses and that responding faculty outside departments/schools/colleges of education (DSCE) were unfamiliar with the construct as applied and practiced within the DSCE; b) question 12 also had a negative loading on a dual-loaded component. Possible explanation is similar to rationale offered for question 10, (lack of knowledge on practices unique to and within the DSCE); c) question 18 had a bi-polar loading, indicating confusion on interpretation of the question by respondents possibly due to recent changes in technology standards and competencies required for licensure/accreditation; d) question 22 also had a bi-polar loading. Possible rationale for abnormal loading due to multiple constructs embedded in a single question, creating confusion and lack of distinction for a single Likert Scale response; e) question 40 likewise had a bi-polar loading. Possible explanation is confusion on multiple responses and/or phrasing of responses either being confusing or not representative of distance education practices unique to DSCE/teacher education programs across the UNC system.

Given these caveats, the strength of statistical outcomes when testing the conceptual model lends evidence that utilization of instructional technology may well include the identified factors and that the factors are indeed related to technology use.

4. What specific factors are most frequently cited that positively influence the utilization of instructional technology by teacher education faculty?

Question 4: Findings

In respect to quantitative responses, support structures to encourage integration and use of technology, the quality of candidate preparation, and personal technology literacy were the highest categories of influence reported by teacher education faculty. Specifically, this included: availability of technology in instructional settings (82.7%); availability of localized technical support (79.6%); personal awareness of advantages technology offers to instruction (78.3%); technology literacy (77.9%); increased student interest (73%); and access to localized instructional design support (71.7%).

Qualitative comments (presented in Chapter 4) substantiated and reinforced high frequency responses involving influencing factors, with comments on positive attitudes elaborating on the importance of support structures, student (candidate) benefits and personal technology competence.

Question 4: Discussion

Similar to the discussion of findings for research question 2, faculty felt that institutional support systems had the greatest influence on their use of technology in teacher preparation. Faculty defined this support as local technical and instructional design assistance and institutionally-provided technology available for use in teacher education classrooms.

Faculty equally acknowledged that realization and understanding of direct benefits to candidates had a very high degree of influence on their efforts to use technology in teacher education, and their personal technology literacy had a direct effect on the amount and scope of technology integrated in their teacher education courses.

5. What specific factors are most frequently identified by teacher education faculty as barriers to their utilization of instructional technology?

Question 5: Findings

A review of related research suggested that in educational settings, several common barriers to the use of technology in teaching exist; however, faculty in this study indicated that there were very few significant barriers to their use of technology in teacher education, with the strongest barrier (57.9%) being identified as lack of time to develop technology-enhanced curriculum.

Question 5: Discussion

This finding is substantiated by consideration of qualitative comments regarding characterization of attitudes towards technology use. Of the 178 faculty responding to characterization of attitude towards technology use, only 14% indicated that they had a negative or neutral attitude regarding technology use.

This suggests that UNC teacher education faculty predominantly have positive attitudes towards technology use and that teacher preparation programs do a fair job of addressing, eliminating or minimizing common barriers to technology use.

Conclusions

Results from the present investigation of technology use in UNC teacher education programs indicate the following conclusions:

1. A conceptual model of technology use has been developed that suggests a high degree of goodness-of-fit. Based on the statistical analysis using EFA and CFA, the researcher failed to reject the proposed conceptual model.
2. Five factor groups as primary components of the conceptual model have varying degrees of relation to the use of technology in UNC teacher education programs, with institutional infrastructure holding the highest degree of relation.
3. While the model suggests a relational structure is present, acceptance of the conceptual model is not reasonable because a newly created measurement instrument was developed to collect data. Since the measurement instrument has been administered only once, it is in need of further validation and retesting to establish significant measurements of validity and reliability before acceptance as an accurate instrument to collect data on use of instructional technology.
4. As an acknowledged rule using Structural Equation Modeling, the first iteration of model testing at best forms the foundation for future model and theory investigation and testing (Joreskog, 1993). While this is true for this study, results from the initial test suggest that the model is worthy of advancement for further investigation, analysis and testing moving towards ultimate acceptance as a model to describe factors that influence technology use in teacher education programs.

5. Teacher education faculty participating in the study indicated major influencing factors for their use of technology: a) support structures within the teacher education program (localized hardware/software/instructional design assistance); b) classroom availability of technology equipment for instructional use; c) awareness of benefits that technology offers to teacher education candidates; and d) personal technology literacy.
6. Faculty indicated that few significant barriers exist that prevent them from using technology in teacher education courses, however, the most significant barrier reported was lack of time to research and develop technology-enhanced instruction.
7. Qualitative comments from UNC teacher education faculty suggest that the majority have very positive attitudes towards technology use, and given increased emphasis on influencing factors, UNC teacher education programs have the potential to increase technology integration and throughout their preparation program.

Recommendations

Research.

1. The results from the current investigation might be specific and unique to the sample of this study, and limits generalizability of findings to participating faculty from UNC teacher education institutions. As such, it follows that this study should be replicated with another sample from a similar collection of teacher education programs to increase understanding and applicability to the broader base of teacher education.

2. The newly developed measurement instrument is in need of additional refinement, retesting and analysis as a natural part of its development into an accepted device to collect accurate information on technology use in teacher education settings.
3. While the analysis and outcomes from SEM testing are very positive, the initial test of a model using EFA and CFA at best establishes a foundation for future analysis and testing for advancement towards model acceptance (Joreskog, 1993).
4. Continued research should be conducted to further explore and expand the list and description of variables that have potential influence on technology use in teacher education settings.

Application for Practitioners.

Based on outcomes from the present study and in light of technology use, teacher education programs in the University of North Carolina System may elect to consider the following recommendations:

1. Focus professional development offerings to highlight empirical evidence that demonstrates the utility and benefits associated with technology integration.
2. Contemplate existing support structures created to aid faculty in the development and delivery of technology-supplemented curricula.
3. Research and submit technology grant applications that focus on increasing the technology literacy of faculty members, and expand the scope of literacy to include methodology, strategies, and innovative uses of technology in unique discipline areas.

4. Monitor technology integration as measured by national and state technology standards to ensure that candidates are adequately prepared to integrate technology to support teaching and learning when they become licensed teachers.
5. Highlight and share the findings of this study beyond the DSCE to cooperating teachers, school administrators, and other educators who may benefit from understanding influencing factors and potential barriers to technology use in education settings.

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Appendices

Appendix A
(Survey Instrument)

Survey of Integrating Instructional Technology into Educational Settings

Section A: <u>Knowledge and innovation of instructional technology</u>

Please indicate (circle number) the <u>frequency</u> you as a teacher-education instructor:

	None	**Some**	**Often**	**Almost Always**
Integrate concepts related to technology into your teaching	**1**	**2**	**3**	**4**
Design learning opportunities that teach technology-enhanced instructional strategies/methodologies to teacher-education candidates	**1**	**2**	**3**	**4**
Instruct teacher-education candidates in the design of student learning activities in a technology-enhanced environment	**1**	**2**	**3**	**4**
Use technology to teach learner-centered strategies that address the diverse needs of students	**1**	**2**	**3**	**4**
Model and teach legal and ethical practice related to technology use	**1**	**2**	**3**	**4**

Section B: <u>Institutional infrastructure</u>

Please respond (circle number) to the best of your knowledge regarding institutional infrastructure and instructional technology (<u>Note</u>: Department/School/College of Education is abbreviated D/S/C-E):

With regards to your conceptual framework <u>within your Department/School/College of Education (D/S/C-E),</u> instructional technology goals are:
(1) Not present
(2) Some goals
(3) Multiple goals
(4) Integrated throughout the conceptual framework

Instructional technology is integrated into courses throughout <u>your D/S/C-E</u> in:
(1) 25% of the courses
(2) 50% of the courses
(3) 75% of the courses
(4) In all courses where appropriate

Access to instructional technology resources at the <u>D/S/C-E-level</u> is available in:
(1) 25% of classrooms
(2) 50% of classrooms
(3) 75% of classrooms
(4) All classrooms

Instructional technology/instructional design assistance <u>within the D/S/C-E</u> is:
(1) Limited
(2) Some available, but centralized
(3) Available and locally accessible
(4) Readily available and accessible for just-in-time needs

Faculty using instructional technology in teaching <u>within the D/S/C-E</u> is: *(circle all that apply)*
(1) Not considered a qualification for hiring
(2) Not considered a factor for tenure and promotion
(3) Recognized as part of the tenure and promotion process
(4) Recognized as a qualification for hiring

Professional development regarding instructional technology for faculty <u>within in the D/S/C-E</u> consists of:
(1) None offered
(2) Limited technology workshops/seminars
(3) Moderate offering of technology workshops/seminars on certain topics
(4) Many workshops/technology seminars on a variety of topics based on faculty needs

Technical support <u>within (internal) the D/S/C-E</u> is:
(1) Not present
(2) Available immediately as requested
(3) Available at some point on the day requested
(4) Typically available on the next business day or longer

Section C: <u>Factors *influencing* the use of instructional technology</u>

Please indicate (circle number) the degree of importance you place on the following factors that may influence your use of instructional technology in teacher-education:

Factor:	**Not Influential**	**Somewhat Influential**	**Very Influential**	**Critically Influential**
Awareness of advantages that technology offers instruction	**1**	**2**	**3**	**4**
Technical (hardware/software) support	**1**	**2**	**3**	**4**
Curriculum design/technology integration support	**1**	**2**	**3**	**4**
Seminars on technology integration in teacher education	**1**	**2**	**3**	**4**
Increased student interest	**1**	**2**	**3**	**4**
Familiarity with NCATE &	**1**	**2**	**3**	**4**

NCDPI technology standards/ requirements for licensure/accreditation				
Availability of technology in teacher education classrooms	**1**	**2**	**3**	**4**
Release time for technology-enhanced curriculum development	**1**	**2**	**3**	**4**
Monetary incentive for developing and using technology in teaching	**1**	**2**	**3**	**4**
Tenure and promotion/AFE recognition for using technology in teaching/research	**1**	**2**	**3**	**4**
Your personal technology literacy	**1**	**2**	**3**	**4**

What is the single most influential factor for you to use instructional technology in your teacher education courses?

Section D: *Barriers* to the use of instructional technology

Please indicate (circle number) the degree of importance you place on the following barriers that may influence your non-use of instructional technology:

Factor:	**Not a barrier**	**Somewhat a barrier**	**Considerable barrier**	**Critical barrier**
Lack of time to develop technology-enhanced curriculum	**1**	**2**	**3**	**4**
Lack of pedagogical evidence that supports technology use	**1**	**2**	**3**	**4**
Lack of accessible technology equipment	**1**	**2**	**3**	**4**
Lack of release time for developing technology-enhanced curriculum	**1**	**2**	**3**	**4**
Lack of tenure & promotion credit for using technology	**1**	**2**	**3**	**4**
Lack of technical support	**1**	**2**	**3**	**4**
Lack of instructional design support	**1**	**2**	**3**	**4**

Philosophical incongruity to using technology in teaching	**1**	**2**	**3**	**4**

What is the most significant barrier for you to not use instructional technology in your teacher education courses?

Section E: Instructional Experience *(circle number)*

Please indicate your faculty rank:
(1) Instructor
(2) Assistant Professor
(3) Associate Professor
(4) Full Professor

Teaching status:
(1) Full-time
(2) Part-time

Affiliation:
(1) Department/School/College of Education
(2) Department/School/College of Arts and Sciences
(3) Department/School/College of Business
(4) Other (please specify):____

Years teaching in teacher-education:
(1) One (or less) to three
(2) Four to six
(3) Seven to ten
(4) Eleven or greater (please specify: _______________)

Years using technology in teacher-education
(1) None
(2) One (or less) to three
(3) Four to six
(4) Seven or greater (please specify: _______________)

Have you ever taught a technology-focused teacher-education course? (i.e. Computers in Education; Educational Technology)
(1) Yes
(2) No

Have you ever taught a distance-education course? (circle all that apply)
(1) No
(2) Yes, entirely web based
(3) Yes, ITV (instructional television based)
(4) Yes, residential web enhanced
(5) Other (please specify: ________________________)

Please describe your most innovative (or most successful) use of instructional technology in a teacher-education course:

Please characterize your attitude towards your use of technology in teacher-education:

Please list your primary teaching content area within teacher-education *(i.e. BK; Elementary Education; Social Studies; Language Arts)****:***

Thank you for your participation!
Please return this survey in the provided envelope to your
Instructional Technology Specialist

Appendix B

(Introductory letter to Instructional Technology Specialists)

Dear colleagues,

As I have been mentioning at our previous UNC TETC meetings, I am finishing my doctorate at NCSU in Adult and Community College Education, and I am now prepared to send out my dissertation survey that is targeted toward all teacher education faculty in the UNC system. I am asking for your kind help in the distribution and collection of these surveys from your teacher education faculty.

I have attached a copy of the instrument as a "read-ahead" for you and invite any comments before I make the final copies for distribution. I plan on making the copies on November 19th.

NOTE: In order to send you sufficient copies to distribute to your faculty, will you please e-mail me your best estimate on the final number of surveys I should send to you? If you can send me this estimate by **Thursday, November 20**, that would very be helpful.

Many thanks for your help in disseminating and collecting these surveys for the study. I trust that the results will provide relevant information for all our teacher education technology programs and will assist in the production of a model that describes instructional technology use throughout our system.

Incidentally, the data will be aggregate to the UNC system, so no individual responses or responses from individual institutions will be reported.

Please give me a call or email if you have any immediate questions and I will follow-up with a phone call in a few days.

With thanks,

Ben

Appendix C
(Transmittal letter)

Survey of Integrating Instructional Technology into Educational Settings: Towards a Conceptual Model for Teacher Education

To: UNC System Teacher-Education Faculty Members
From: Ben Coulter, Director of Instructional Technology, Western Carolina University and Doctoral Candidate, NC State University
Subject: Internet Use and Scholarship
Date: November 21, 2003

As our fall academic semester draws to a close, I am asking for your help with research on instructional technology integration in teacher-education. The purpose of this study is to propose and test a conceptual model that describes conditions and relationships of those conditions which influence the use of instructional technology by teacher-education faculty throughout the University of North Carolina System's teacher-education programs.

The enclosed questionnaire collects data to be analyzed as part of my doctoral dissertation research at North Carolina State University. Your cooperation and involvement with this study is greatly appreciated. Please complete the attached questionnaire and return it in your campus' mail (in the attached, pre-addressed envelope) to your Department/School/College of Education Instructional Technology Specialist (ITS) by **Friday, December 5, 2003**. All responses from your university will be collected by your ITS and bulk mailed to me. It should take ten to fifteen minutes of your time to complete this instrument.

The significance of the study is to:
- propose a conceptual model that describes technology utilization in consideration of the factors related to instructional technology,
- provide insight into the scope of employment of instructional technology by teacher-education faculty,
- identify relationships and degrees of influence that research-based variables have on the utilization of instructional technology, and
- provide a conceptual model and data analysis to support the design and delivery of instructional technology-related professional development and strategic planning at the college, school or department level within teacher-education programs.

Your participation in this survey is voluntary and all data will be aggregated. There will be no comparisons, analysis, or reporting by university, program, or by individual faculty member. This is an anonymous survey, so please do not include your name. If you would like a copy of the results of this study, please feel free to contact me or your Instructional Technology Specialist.

Dr. Brad Mehlenbacher is chair of my dissertation committee and would be glad to answer any questions you may wish to ask him. To contact Dr. Mehlenbacher please e-mail: brad_m@unity.ncsu.edu or call (919) 515-6242.

I would appreciate any comments or questions you may have on the research or survey instrument. Please feel free to communicate them to me by phone or e-mail: (828) 227-3299 bcoulter@email.wcu.edu

Thank you for your cooperation.

Appendix D
(Distribution letter)

TO: UNC Instructional Technology Specialists
FROM: Ben Coulter
DATE: Monday, November 24, 2003
SUBJ: Assistance with Instructional Technology Survey…

Hello again to everyone.

Thank you so much for your willingness to assist me in the dissemination and collection of the enclosed instructional technology survey.

As you know, this survey will hope to serve two purposes…first, gather data for use in my dissertation, but second, and more importantly for our group, collect and analyze information that we may be able to use in our efforts to target professional development towards teacher-education faculty and better understand some factors and barriers to use of instructional technology in teacher preparation programs.

I've enclosed the following in this packet:

-Surveys for your full-time teacher-education faculty members (based on the number you sent me via e-mail)

-Cover letter (attached to the survey)

-Self-addressed return envelopes that should help completed surveys find their way back to you.

If you will, please distribute these items to each of your full-time teacher-education faculty members in your department/school/college of education AND to any teacher-education faculty members who work outside the department/school/college of ed but who are still considered teacher-education faculty (typically these folks teach in Arts & Sciences).

My hope is that you can distribute these surveys/envelopes just as soon as possible…and my target date for faculty to get them back to you is **Friday, December 5**. I know this is aggressive, but given the upcoming holidays and final exams, I hope we can find a small window to get these out and back with some reasonable response rates.

Once you have them collected, I'll really only need the survey less the cover letter. If it is convenient for you to return them to me via inter-campus mail, that would be great. If not, I'll be happy to provide postage for a return mailing. My address here in Cullowhee is:

270 Killian Building
College of Education and Allied Professions
Western Carolina University
Cullowhee, NC 28723

As follow-up, I'm creating an online version of the same instrument and I'd ask that on Monday, December 8 you could send along an e-mail request to your same teacher-education faculty and include the URL for the online survey. I'll of course e-mail you the text copy of the follow-up message and URL for this reminder next week, and again appreciate your help in sending this out to your faculty.

Many thanks again and please give me a ring or e-mail if you have any questions of concerns (828-227-3299; bcoulter@email.wcu.edu).

Appendix E

(E-mail reminder letter to Instructional Technology Specialists)

First, thank you so much for helping in the distribution and collection of the hard copy surveys I sent to you last week. I know it was a short turn-around time, but I hope you have received some back from your faculty.

As a follow-up and in an attempt to boost participation to the hard copy surveys I sent last week, I'd like to ask you to please copy and paste the message below (the message is between the dotted lines) into an e-mail from you to all your teacher education faculty and send it out as soon as possible (tomorrow would be wonderful). PLEASE FEEL FREE TO EDIT THE MESSAGE AS NECESSARY FOR YOUR FACULTY. (FYI...the online survey has an introductory section that describes the instrument, survey and time to complete information).

I'll be attending NCETC this week beginning Wednesday, so if it is easier for you to bring your hard copy responses to Greensboro, I'd be happy to receive them there at the Four Seasons (I think our reservation is under Beth Coulter).

Many thanks again for your help in this effort and in my study. If you have any questions, please give me a call at 828-227-7111 or drop me an e-mail.

Best regards for a happy holiday season! Ben

Follow-up request for survey participation:

Integrating Instructional Technology into Educational Settings: Towards a Conceptual Model for Teacher Education

For those who have completed and returned the hard copy survey sent out last week, thank you!

In the event you did not receive a hard copy (or have not had the chance yet to fill it out), you are invited to participate in the online version of the paper copy. This survey was sent to all UNC teacher education faculty.

To participate, simply click on the web address below. The online survey takes about **10-15 minutes to complete.** I appreciate your willingness to share your experiences and thoughts on instructional technology in teacher education. This survey is completely **anonymous**, so please do not include your name when responding.

If you can, I would greatly appreciate your response (either hard copy or online) by **Friday, December 12, 2003**.

Many thanks in advance and best wishes for a happy holiday season!

Online survey link: http://freeonlinesurveys.com/rendersurvey.asp?id=48487

Appendix F

(Online survey letter – Email)

Follow-up request for survey participation:

Integrating Instructional Technology into Educational Settings: Towards a Conceptual Model for Teacher Education

For those who have completed and returned the hard copy survey sent out last week, thank you!

In the event you did not receive a hard copy (or have not had the chance yet to fill it out), you are invited to participate in the online version of the paper copy. This survey was sent to all UNC teacher education faculty.

To participate, simply click on the web address below. The online survey takes about **10-15 minutes to complete**. I appreciate your willingness to share your experiences and thoughts on instructional technology in teacher education. This survey is completely **anonymous**, so please do not include your name when responding.

If you can, I would greatly appreciate your response (either hard copy or online) by **Friday, December 12, 2003**.

Many thanks in advance and best wishes for a happy holiday season!

Online survey link: http://freeonlinesurveys.com/rendersurvey.asp?id=48487

Appendix G
(Online survey instrument)

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Survey of Integrating Instructional Technology into Educational Settings

Thank you for participating in this survey. This data is being collected from all teacher-education faculty in the UNC system as part of a doctoral dissertation from North Carolina State University. **Participation in this survey should take 10-15 minutes**.

The purpose of this study is to propose and test a conceptual model that describes conditions and relationships of those conditions which influence the use of instructional technology by teacher-education faculty throughout the University of North Carolina System's teacher-education programs.

Your participation in this survey is voluntary and all data will be aggregated. There will be no comparisons, analysis, or reporting by university, program, or by individual faculty member. Responses to this online survey cannot and will not be traced by electronic means, including IP number identification. Please do not include your name or institutional name in any part of this survey.

For questions concerning this study, please contact the dissertation chair, Dr. Brad Mehlenbacher, via e-mail (brad_m@unity.ncsu.edu) or by telephone (919) 515-6242.

For a summary of the study results, please contact the researcher:

Benjamin M. Coulter
Director of Instructional Technology
Assistant Professor, Department of Educational Leadership and Foundations
College of Education and Allied Professions
Western Carolina University
Cullowhee, NC 28723
bcoulter@email.wcu.edu
(828) 227-7111

* *Please indicate the frequency you as a teacher-education instructor:*

Integrate concepts related to technology into your teaching:

- None
- Some
- Often
- Almost Always

* *Please indicate the frequency you as a teacher-education instructor:*

Design learning opportunities that apply technology-enhanced instructional strategies for teacher-education candidates

- None
- Some
- Often
- Almost Always

* *Please indicate the frequency you as a teacher-education instructor:*

Instruct teacher-education candidates in the design of student learning activities in a technology-enhanced environment:

- None
- Some
- Often
- Almost Always

* *Please indicate the frequency you as a teacher-education instructor:*

Use technology to teach learner-centered strategies that address the diverse needs of students

- None
- Some
- Often
- Almost Always

* *Please indicate the frequency you as a teacher-education instructor:*

Model and teach legal and ethical practice related to technology use

- ○ None
- ○ Some
- ○ Often
- ○ Almost Always

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Page 2 of 5

Survey of Integrating Instructional Technology into Educational Settings

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

With regards to the conceptual framework within your Department/School/College of Education (D/S/C-E), instructional technology goals are:

- ○ Not present
- ○ Some goals
- ○ Multiple goals
- ○ Integrated throughout the conceptual framework

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

Instructional technology is integrated into courses throughout your D/S/C-E in:

- ○ 25% of the courses
- ○ 50% of the courses
- ○ 75% of the courses
- ○ In all courses where appropriate

* *Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-*

Access to instructional technology resources at the D/S/C-E level is available in:

- ○ 25% of classrooms
- ○ 50% of classrooms
- ○ 75% of classrooms
- ○ All classrooms

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

Instructional technology/instructional design assistance within the D / S/ C-E is:

- ◯ Limited
- ◯ Some available, but centralized
- ◯ Available and locally accessible
- ◯ Readily available and accessible for just-in-time needs

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

Faculty using instructional technology in teaching within the D / S / C-E is: (select all that apply)

- ☐ Not considered a qualification for hiring
- ☐ Not considered a factor for tenure and promotion
- ☐ Recognized as part of the tenure and promotion process
- ☐ Recognized as a qualification for hiring

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

Professional development regarding instructional technology for faculty within in the D / S / C-E consists of:

- ◯ None offered
- ◯ Limited technology workshops/seminars
- ◯ Moderate offering of technology workshops/seminars on certain topics
- ◯ Many workshops/technology seminars on a variety of topics based on faculty needs

*

Please respond to the best of your knowledge regarding institutional infrastructure and instructional technology-

Technical support within (internal) the D / S / C-E is:

- ◯ Not present
- ◯ Available immediately as requested
- ◯ Available at some point on the day requested
- ◯ Typically available on the next business day or longer

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Survey of Integrating Instructional Technology into Educational Settings

*

Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:

Awareness of advantages that technology offers instruction

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

*

Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:

Technical (hardware/software) support

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Curriculum design/technology integration support

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

*
Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:

Seminars on technology integration in teacher education

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Increased student interest

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Familiarity with NCATE & NCDPI technology standards/requirements for licensure/accreditation

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Availability of technology in teacher education classrooms

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

*
Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:

Release time for technology-enhanced curriculum development

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

*
Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:

Monetary incentive for developing and using technology in teaching

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Tenure and promotion/AFE recognition for using technology in teaching/research

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* *Please indicate the degree of importance you place on the following factor that may influence your use of instructional technology in teacher-education:*

Your personal technology literacy

- Not Influential
- Somewhat Influential
- Very Influential
- Critically Influential

* **What is the single most influential factor for you to use instructional technology in teacher education courses?**

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Survey of Integrating Instructional Technology into Educational Settings

* *Please indicate the degree of importance you place on the following* ***barriers*** *that may influence your non-use of instructional technology:*

Lack of time to develop technology-enhanced curriculum

- ○ Not a barrier
- ○ Somewhat a barrier
- ○ Considerable barrier
- ○ Critical barrier

*
Please indicate the degree of importance you place on the following ***barriers*** *that may influence your non-use of instructional technology:*

Lack of pedagogical evidence that supports technology use

- ○ Not a barrier
- ○ Somewhat a barrier
- ○ Considerable barrier
- ○ Critical barrier

*
Please indicate the degree of importance you place on the following ***barriers*** *that may influence your non-use of instructional technology:*

Lack of accessible technology equipment

- ○ Not a barrier
- ○ Somewhat a barrier
- ○ Considerable barrier
- ○ Critical barrier

*
Please indicate the degree of importance you place on the following ***barriers*** *that may influence your non-use of instructional technology:*

Lack of release time for developing technology-enhanced curriculum

- ○ Not a barrier
- ○ Somewhat a barrier
- ○ Considerable barrier
- ○ Critical barrier

*
*Please indicate the degree of importance you place on the following **barriers** that may influence your non-use of instructional technology:*

Lack of tenure & promotion credit for using technology

- ◯ Not a barrier
- ◯ Somewhat a barrier
- ◯ Considerable barrier
- ◯ Critical barrier

* *Please indicate the degree of importance you place on the following **barriers** that may influence your non-use of instructional technology:*

Lack of technical support

- ◯ Not a barrier
- ◯ Somewhat a barrier
- ◯ Considerable barrier
- ◯ Critical barrier

*
*Please indicate the degree of importance you place on the following **barriers** that may influence your non-use of instructional technology:*

Lack of instructional design support

- ◯ Not a barrier
- ◯ Somewhat a barrier
- ◯ Considerable barrier
- ◯ Critical barrier

* *Please indicate the degree of importance you place on the following **barriers** that may influence your non-use of instructional technology:*

Philosophical incongruity to using technology in teaching

- ◯ Not a barrier
- ◯ Somewhat a barrier
- ◯ Considerable barrier
- ◯ Critical barrier

* ***What is the most significant barrier for you to not use instructional technology in your teacher education courses?***

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Survey of Integrating Instructional Technology into Educational Settings

*** Please indicate your faculty rank:**

- Instructor
- Assistant Professor
- Associate Professor
- Full Professor

*** Teaching status:**

- Full-time
- Part-time

*** Affiliation:**

- Department/School/College of Education
- Department/School/College of Arts and Sciences
- Department/School/College of Business
- Other (Please Specify):

*** Years teaching in teacher-education:**

- One (or less) to three
- Four to six
- Seven to ten
- Eleven or greater (specify below)
- Other (Please Specify):

*** Years using technology in teacher-education:**

- ○ None
- ○ One (or less) to three
- ○ Four to six
- ○ Seven or greater (specify below)
- ○ Other (Please Specify):

*** Have you ever taught a technology-focused teacher-education course?** (i.e. Computers in Education; Educational Technology)

- ○ Yes
- ○ No

*** Have you ever taught a distance-education course?** (please select all that apply)

- ☐ No
- ☐ Yes, entirely web based
- ☐ Yes, ITV (instructional television)
- ☐ Yes, residential web enhanced

Other (Please Specify):

Please describe your most innovative (or most successful) use of instructional technology in a teacher-education course:

Please characterize your attitude towards your use of technology in teacher-education:

Please list your primary teaching content area within teacher-education: (i.e. B-K; Elementary Education; Social Studies; Language Arts, etc...)

Submit Survey

Thank you again for your time and response to this survey. As a reminder, your responses will not be attributable to yourself, your teacher-education program, or your institution. For questions or a summary of the survey results, please contact: Benjamin M. Coulter, Director of Instructional Technology; Assistant Professor, Department of Educational Leadership and Foundations; College of Education and Allied Professions; Western Carolina University; Cullowhee, NC 28723 (828) 227-7111 bcoulter@email.wcu.edu