2008

The development and field test of the Education Technology Leadership Assessment survey

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The development and field test of the
Education Technology Leadership Assessment survey

by

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A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Educational Leadership and Policy Studies (Educational Leadership)

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Iowa State University
Ames, Iowa
2008

DEDICATION

To education leaders who work to anticipate the challenges and opportunities posed by a technology rich future.

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ABSTRACT

Education Technology Leadership is known to be a key element in the successful use of technology in education (CoSN K-12 CTO Council, 2006). The evaluation of education technology leadership is often aided by the use of education technology standards for administrators. While education technology leadership is often associated as primarily the role of school administrators, education technology leadership also emerges from other sources; for example, teachers, technology coordinators, parents, students, and community members. Collaborative leadership theory provides a theoretical basis for the premise that education technology leadership may be effectively distributed across an organization. There is support in the literature indicating school administrators have been successful in achieving sustainable change through the use of collaborative leadership techniques (Fullan, 2001a; Wheatley, 1999). Often education technology, under the direction of a effective education technology leadership, is used as a change agent in school improvement initiatives (Fullan, 2003; P. E. Holland, 2001).

The purpose of this study was to develop an assessment of education technology leadership. With the assistance of an expert panel, a survey titled the *Education Technology Leadership Assessment* (ETLA) was created. The ETLA was intended to be a general purpose education technology leadership assessment. It was similar to the Principal Technology Leadership Assessment (PTLA) survey (Center for the Advanced Study of Leadership in Education, 2005). Where the PTLA was based on ISTE National Education Technology Standards for Administrators (NETS-A), the ETLA was based on the ISTE Technology Leadership (TL) Standards (Twomey, Shamburg, & Zieger, 2006).

The data analysis results of this study produced evidence of ETLA item reliability and validity. In addition, the EFA process generated six factors and helped to identify inter-relationships between those factors and the TL Standards used to provide the original framework for the ETLA. These findings indicated that the ETLA had potential as a useful assessment of education technology leadership. This study's findings were limited by the use of one sample population. A recommendation for future research is to continue to evaluate ETLA reliability, validity, and data inter-relationships as additional data sets are collected.

CHAPTER 1. INTRODUCTION

Each school day in America nearly 50 million students head off to approximately 97,000 public elementary and secondary schools, and before the school year is out, an estimated $489 billion will be spent related to their education (National Center for Education Statistics, 2007). A sense of urgency underpins the daily efforts of these education institutions. Because a student's education experience contributes to their opportunities for future successes, students deserve an education experience of high quality. For a school to be a launch pad to the levels of success sought by students, it must operate effectively.

Students in effective schools as opposed to ineffective schools demonstrate a higher level of achievement (Marzano, 2003). While several factors contribute to effective schools, leadership is considered vital to the successful functioning of many aspects of effective schools (Cotton, 2003; Leithwood, Louis, Anderson, & Wahlstrom, 2004; Waters, Marzano, & McNulty, 2003). A school's use of education technology is an example of an aspect of effective schools that can be impacted by leadership (Earle, 2002; Pitler, 2005).

Education technology has often been viewed as a class of technology that must be well matched to specific content areas and learning goals (Ringstaff & Kelley, 2002). Education leadership can help the organization stay focused on specific content area and learning goals. Resources (staff, equipment, facilities, etc.) must be in place before schools can begin the process of assimilating technology into their day-to-day instruction. Education technology leadership can help establish these required resources.

Once education technology resources are established, education technology leaders can use the technology as a source of learning tools. For example, technology has served as a strong catalyst for change at the classroom, school, and district level (Means & et al., 1993). Education technology has catalyzed changes in the content, methods, and overall quality of the teaching and learning process, triggering changes away from lecture driven instruction and toward constructivist, inquiry oriented classrooms (Culp, Honey, & Mandinach, 2005). Education technology tools have offered opportunity for change in the teaching process, making it more flexible, more engaging, and more challenging for students (CEO Forum, 1997, 1999; Office of Technology and Assessment, 1989, 1995). Education technology has been shown to have a strong impact when the technology integration into education is part of a broader-based reform effort (Sandholtz, Ringstaff, & Dwyer, 1997). The relationship between technology and reform is reciprocal. Each can benefit from the other.

There is evidence that in the last decade, pre-kindergarten through twelfth grade (P-12) schools have begun to accumulate sufficient resources to enable technology-supported change. For example, in the United States, the ratio of nine students per instructional computer in P-12 schools reported in 1997 (CEO Forum, 1997) has been reduced to 4.2 students per instructional computer in 2002 (Skinner, 2002). As the public desires and supports technology instruction in schools (Starkweather, 2002), many P-12 schools are increasingly promoting the use of technology (e.g., computers, software, and peripherals) in teaching and learning. Toward achieving that goal, professional development targeting the mastery of technology, such as opportunities to learn new computer programs or technological deices, is offered to teachers and staff in schools. In addition, most schools/colleges/departments of education now offer educational technology courses within the teacher preparation program to prepare future teachers to be education technology literate (Office of Postsecondary Education, 2003).

If the measure of success, however, is usage of these technologies to facilitate student learning, American schools still have a long way to go (J. McKenzie, 1998). Many commentators have noted that the level of integration of technology into school environments remains despondently low (Cuban, Kirkpatrick, & Peck, 2001; Healy, 1998). Although nearly all public school teachers now have access to computers or the Internet somewhere in their schools, only one-third of them feel “well prepared” or “very well prepared” to integrate the use of computers and the Internet into their teaching (Rowand, 2000). This large-scale absence of effective technology integration, and the resultant lack of impact on student learning, rests squarely on the shoulders of the leaders charged with implementing and enabling effective schooling practices. If the “observable failure of schools to actually use their . . . computers to any meaningful extent” (J. McKenzie, 1998, p. 6) ever is to be remedied, school technology leaders must be “leaders of change, supporters of teacher development, and modelers of technology” (Yee, 1998).

While often focused on the leadership skills of the school administrators, the study of education technology leadership also considers sources of leadership from other education stakeholders, including teachers, technology coordinators, parents, students, and community members (Twomey et al., 2006). Effective school organizations benefit when they recognize, develop, and measure education technology leadership capacity across their organization.

Statement of Problem

Teacher professional development programs often have focused on developing skills related to teaching standards. Teacher education technology professional development programs often have focused on developing skills related to education technology standards, such as ISTE NETS-T standards (ISTE, 2002). These skills have helped educators integrate the use of technology and technology based tools into their teaching practices. This integration of education technology has offered opportunities for change in instructional practices in both the classroom and in the school. But knowledge of how to use technology effectively has been only part of the challenge of integrating technology into the curriculum. Consistent, meaningful, sustainable change requires vision and leadership.

Educational leadership preparation programs have been slow to recognize the unique leadership issues related to technology confronting their graduates (Dikkers, Hughes, & McLeod, 2005). The only current large-scale initiative in this area, the Bill and Melinda Gates Foundation State Challenge Grants for Leadership Development, is temporary and focuses on professional development of current practitioners rather than on leadership pipeline issues.

School education technology leadership often has been associated with the school administrator. There have been studies measuring the education technology leadership of school administrators (Ertmer et al., 2002; P. E. Holland, 2001; Hughes & Zachariah, 2001; Mirra, 2004; Wilsmore & Betz, 2000). But studies have also shown that schools can have education technology leadership capacity beyond the school administrator's leadership (Baylor & Ritchie, 2002; Dikkers et al., 2005; Granger, Morbey, Lotherington, Owston, & Wideman, 2002; L. Holland & Moore-Steward, 2000; Spillane, Halverson, & Diamond, 2001; Welkowitz, Cohen, & Ewen, 2006). There has been limited research looking at the education technology leadership capacity of educators in addition to school administrators.

Eight standards for education technology leadership have been developed (Twomey et al., 2006). Leaders proficient in these standards would be expected to provide leadership based on a strong education technology vision, and would facilitate systemic, whole-school change that seamlessly includes technology as an important, rather than marginalized, element of the education process. Successful and effective technology integration requires systemic change that permeates the entire school organization and structure, including vision, finances, policies, and curricula (Dede, 2000). Schools have experienced difficulty connecting technology infrastructure with effective leadership in order for students, faculty, staff, and the community to reap benefits from technology. And despite the fact that technology leadership may be "the single most important factor affecting schools' successful integration of technology" (Byrom & Bingham, 2001), surprisingly little attention has focused on the technology-related leadership skills of educators. An instrument designed to help educators assess their education technology leadership would be useful.

Purpose

This study worked within the field of education technology leadership. The purpose of this study was to develop, validate, and field test a survey instrument based on the eight ISTE TL Standards (Twomey et al., 2006). The survey instrument was designed to assess the extent of the education technology leadership of any educator or education stakeholder. The instrument was designed to be used as a web based, self-assessment survey tool (Rea & Parker, 2005).

For this study, existing technology leadership assessment tools were reviewed and potential survey items were collected. An expert judgment panel of existing education technology leaders was formed. The panel consisted of school technology coordinators with education technology leadership experience. The expert panel reviewed potential survey items and provided feedback to the researcher that allowed for the refinement and alignment of the items with the eight TL Standards. The researcher's goal was to have 4-6 valid items for each TL Standard. The completed survey had 38 items.

It was important to test the reliability and validity of the survey. A field test of the survey was conducted with a selected group of educators in the Des Moines Public School District, an urban district of 32,000 students located in Des Moines, Iowa. The information collected in the field test was used to statistically evaluate the reliability and validity of the survey. Underlying structures inherent in this data were also examined using exploratory factor analysis.

Significance of Proposed Study

Education technology leadership has been found to be an important element in the integration of technology with education. Education technology leadership standards have been developed. The development of an instrument designed to assess the extent to which an individual or group possess skills relative to these education technology leadership standards would be useful to those interested in the development and study of education technology leadership.

Research Question

Following are the research questions for this study:

(1) What are the set of items aligned with each of eight education technology leadership standards that would be part of a reliable and valid survey instrument that would assess the education technology leadership skills of an individual who completes the survey?

(2) What are the underlying structures of the data generated by these items?

(3) What are the inter-relationships between the underlying data structures and the education technology leadership standards?

Basic Assumptions

Technology has been used to refer to a broad class of tools and aids. Technology in a broad sense has been defined as the "application of modern communications and computing technologies to the creation, management, and use of knowledge" (Fitzpatrick & Pershing, 1996). For the purpose of this study, education technology referred to computer and communications technologies that are owned and operated by school employees or students.

Key assumptions of this study include:

1. The expert judgment panel members were experienced technology leaders who were knowledgeable of current and emerging practices for integrating technology into education.
2. The expert judgment panel members were able to distinguish between the eight TL Standards in a common and consistent way.

3. The practice of technology integration in education is sufficiently similar across all P-12 applications so that the alignment of survey items with education technology leadership standards will be similar independent of the membership of the expert judgment panel, as long as the membership consists of practicing education technologists.

Delimitations

The goal in developing the Educator Technology Leadership Assessment (ETLA) was to produce a short, multiple-choice assessment to assess the school technology leadership of an individual and/or group of individuals. The accuracy and usefulness of this assessment was largely dependent upon the candor and care of the participants. When assessing behaviors and performance, individuals have a tendency to make several types of errors (Grote, 1996):

1. Leniency error. This occurs when an individual gives an assessment higher than they deserve. This could occur for several reasons: the individual has relatively low performance standards; the individual assumes that other individuals also inflate their ratings; or, for social or political reasons, the individual judges that it would be better not to give a poor assessment.
2. Halo error. This occurs when an individual gives an assessment based on a general impression of their performance or behavior, and the general impression is allowed to unduly influence all the assessments given. An example of halo error would be an individual who rates highly on every single assessment item. It is rare that individuals perform at exactly the same level

on every dimension of leadership. It is more likely that an individual performs better in some areas than on others.

3. Recency error. This occurs when an individual bases an assessment on their most recent behavior, as opposed to their entire behavior over some fixed period of time (e.g., the last year). This assessment should be based on the participant's behavior over an entire year.

In addition to participant related data errors, other delimitations of the study were: (1) a limited number of professionals were invited to participate on the expert judgment panel and (2) the survey items were aligned with the TL Standards during a specific time frame.

CHAPTER 2. LITERATURE REVIEW

Chapter Two builds the contextual framework for this study by incorporating relevant research and theory that are key sources for describing education technology leadership, which is the primary topic of this study. The chapter contains three sections. The first section explores the basis for education technology leadership including education technology leadership performance standards. In the second section, three different sources of education technology leadership are described. In the third section, a review of collaborative leadership theory as it relates to education technology leadership is provided. Each section contains an introduction as an advance organizer. The chapter concludes with a summary linking the research with theory to establish this study's framework.

Education Technology Leadership

The Education Technology Leadership section provides a general background and basis for the presence of technology leadership in pre-kindergarten through twelfth grade (P-12) schools today. This section discusses the importance of education technology leadership and provides a review of various education technology leadership standards.

Importance of Education Technology Leadership

There are almost as many definitions of leadership as there are persons who have attempted to define the concept (Stogdill, 1974, p. 259). For the purpose of this study, leadership was considered as a term describing the actions of an individual in relationship to other individuals. Leadership in this context can be described as "the process of persuasion and or example by which an individual (or leadership team) induces a group to pursue objectives held by the leader or shared by the leader and his or her followers"

(Garnder, 1990). Education leadership was the “guidance and direction” of instructional improvement (Elmore, 2000). Education technology leadership has been defined by the efforts to induce the pursuit of education improvement objectives with the support of technology.

The effective integration of technology into education can be throttled by the availability of education technology leadership. Schools have faced six barriers to effectively integrating technology into their curriculum, the biggest one being lack of leadership (Barnett, 2001). The school technology leader has been noted as one of the most important factors affecting the effective integration of education technology (Byrom & Bingham, 2001; Ross, McGraw, & Burdette, 2001). For example, in a quantitative study of factors that facilitate teaching and learning with technology in P-12 classrooms, strong technology leadership was determined to be a variable with high predictive influence (Baylor & Ritchie, 2002). This study found that school leaders who actively promote the use of technology by modeling technology use, planning and articulating a vision, and rewarding teachers as they strive to incorporate technology reinforce technology’s importance, thereby influencing its use by teachers and students.

Education technology leaders have worked to create school improvement with the aid of technology (Creighton, 2003). Being an educational technology leader has required the ability to adapt to the quick changing pace of technology and also the ability to apply the technology where appropriate, not necessarily as soon as it emerges. It has required adequate training and understanding of how technology can be used to enrich the learning experience (Earl & Lampe, 2004, p. 22). It has required the technology leaders to be technologically literate (Wonacott, 2001). Standards have been developed that help describe the framework for effective education technology leadership.

Education Technology Leadership Standards

Margaret Honey from the Education Development Center testified before the U.S. Senate that one can find ample empirical evidence that technology does have a positive impact when the right conditions are in place (Culp et al., 2005). She concluded that, if technologies are to be used to support real gains in educational outcomes, six factors must be in place: leadership, solid educational objectives, professional development, adequate technology resources, time, and evaluation. Norris, Smolka, and Soloway (1999), in a convergent analysis of technology studies, identified a set of five critical conditions for technology use in education: (1) access to technology and time on task, (2) adequate teacher preparation, (3) effective curriculum, (4) supportive school/district administration, and (5) supportive family. Similarly, Eichinger and Lombardo (2006) developed a professional leadership competency wheel that is applicable to education technology leadership, and is based on six leader qualities for success: (1) individual excellence, (2) organizational skills, (3) courage, (4) results, (5) strategic skills, and (6) operating skills. The education competency wheel diagram is shown in Figure 1.

The International Society for Technology in Education (ISTE) is an organization dedicated to promoting appropriate uses of technology to support and improve learning, teaching and administration in PK-12 and teacher education. ISTE is the home for the National Educational Technology Standards (NETS) Project. The primary goal of the ISTE NETS Project was to enable technology stakeholders in P-12 education to develop

Figure 1. Education Competency Wheel

Adapted from: (Eichinger & Lombardo, 2006)

national standards for educational uses of technology that facilitate school improvement in the United States (ISTE, 2006; Twomey et al., 2006).

The NETS Project was established in order to set the standards for educational uses of technology that would facilitate school improvement. Those standards have influenced program accreditation, state curriculum, and certification requirements in the United States of America (Twomey et al., 2006). The various NETS standard sets represent a consensus view and a common sense wisdom about a variety of education technology elements, including education technology leadership. The NETS Project standards served to guide educational leaders in recognizing and addressing the essential conditions for integration of education technology in support of P-12 education. Within the body of NETS Project work are four sets of education technology standards that are related to the topic of education technology leadership: (1) National Education Technology Standards for Students (NETS-S), (2) National Education Technology Standards for Teachers (NETS-T), (3) National Education Technology Standards for Administrators (NETS-A), and (4) Technology Leader (TL) standards.

The NETS-S were published in 1998. They were developed from a synthesis of responses to proposed educational technology standards from many groups and individuals across the nation who participated in conference sessions, technology forum meetings, Internet dialogue, and surveys (ISTE, 2000). The NETS-S project established six standards. These standards provided a framework for all five of the NETS Project standard sets. The NETS-S standards are listed in Table 1.

The NETS-T were developed with a focus on pre-service teacher education. NETS-T defined the fundamental concepts, knowledge, skills, and attitudes for applying technology in educational settings (ISTE, 2002). NETS-T provided a framework for implementing technology in teaching and learning. The NETS-T work supplied teachers with strategies for integrating technology into their professional preparation and into their classroom by providing a myriad of subject related resources. The NETS-T standard framework is listed in Table 2.

The NETS-A were based on the work of the Consortium for Technology Standards for School Administrators and their Technology Standards for School Administrators (TSSA). The NETS-A standards represented a national consensus

Table 1. NETS-S standards

Standard	Description
NETS-S Standard 1	Basic operations and concepts
NETS-S Standard 2	Social, ethical, and human issues
NETS-S Standard 3	Technology productivity tools
NETS-S Standard 4	Technology communications tools
NETS-S Standard 5	Technology research tools
NETS-S Standard 6	Technology problem-solving and decision-making tools

Table 2. NETS-T standards

Standard	Description
NETS-T Standard 1	Teachers demonstrate a sound understanding of technology operations and concepts.
NETS-T Standard 2	Teachers plan and design effective learning environments and experiences supported by technology.
NETS-T Standard 3	Teachers implement curriculum plans, which include methods and strategies for applying technology to maximize student learning.
NETS-T Standard 4	Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.
NETS-T Standard 5	Teachers use technology to enhance their productivity and professional practice
NETS-T Standard 6	Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in P-12 schools and apply those principles in practice.

Table 3. NETS-A standards.

Standard	Description
NETS-A Standard 1	Educational leaders inspire a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of that vision.
NETS-A Standard 2	Educational leaders ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching.
NETS-A Standard 3	Educational leaders apply technology to enhance their professional practice and to increase their own productivity and that of others.
NETS-A Standard 4	Educational leaders ensure the integration of technology to support productive systems for learning and administration.
NETS-A Standard 5	Educational leaders use technology to plan and implement comprehensive systems of effective assessment and evaluation.
NETS-A Standard 6	Educational leaders understand the social, legal, and ethical issues related to technology and model responsible decision-making related to these issues.

among educational stakeholders of what best indicated effective school leadership for comprehensive and appropriate use of technology in schools (ISTE, 2004). The NETS-A standard framework is listed in Table 3.

The TL Standards were aligned with the six National Educational Technology Standards for Teachers (NETS-T), but extended the performance expectations of each NETS-T standard. The work was spurred by recognition that teachers and administrators have the potential and the shared responsibility to integrate technology into teaching and learning. The TL Standards addressed the need for a set of performance standards for educators responsible for supporting the integration of technology into teaching and learning. “Technology leaders work as ambassadors among policy, technology, and pedagogy” (ISTE, 2002; Twomey et al., 2006, p. 17). The TL Standards serve to guide those leaders as they coordinated efforts of technical personnel, administrators, and classroom teachers. The TL Standards are listed in Table 4.

The education technology standards developed by the NETS Project were designed to identify the essential education technology skills, including education technology leadership skills. The NETS Project also produced information in support of assessing attainment of the standard skill sets. Assessments in the form of rubrics were published in the NETS Project body of work. The rubrics served to assess the various NETS standards across a performance continuum. This approach to assessing attainment of the standards suggests that proficiency in education technology leadership exists across a range as opposed to an “exist/not exist” criteria.

Another aspect of education technology leadership supported by the rubric approach to assessment was that there was the potential for complex inter-relationships and inter-dependencies, both between the various standard sets, and also within a standard set. These inter-relationships could be considered to be common threads running through the standards and the standard indicators. These underlying features, when viewed collectively, could be used to generate themes to help create a picture of technology leadership (Twomey et al., 2006). For example, themes mentioned by Twomey for the TL Standards included Evaluation, Professional Development, Design, and Implementation (p. 69). In the NETS Project, the TL Standards represented the essential skill sets of education technology leaders, with the opportunity for correlation between various TL Standard skill set indicators. In comparison, the TL Standard themes

Table 4. Technology Leadership (TL) standards

Standard	Description
Technology Leadership Standard 1	Technology Operations and Concepts. Educational technology leaders demonstrate an in-depth understanding of technology operations and concepts.
Technology Leadership Standard 2	Planning and Designing Learning Environments and Experiences. Educational technology leaders plan, design, and model effective learning environments and multiple experiences supported by technology.
Technology Leadership Standard 3	Teaching, Learning, and Curriculum. Educational technology leaders apply and implement curriculum plans that include methods and strategies for applying technology to maximize student learning.
Technology Leadership Standard 4	Assessment and Evaluation. Educational technology leaders communicate research on the use of technology to implement effective assessment and evaluation strategies.
Technology Leadership Standard 5	Productivity and Professional Practice. Educational technology leaders design, develop, evaluate and model products created using technology resources to improve and enhance their productivity and professional practice.
Technology Leadership Standard 6	Social, Ethical, Legal, and Human Issues. Educational technology leaders understand the social, ethical, legal, and human issues surrounding the use of technology in P-12 schools and develop programs facilitating application of that understanding in practice throughout their district/region/state.
Technology Leadership Standard 7	Procedures, Policies, Planning, and Budgeting for Technology Environments. Educational technology leaders coordinate development and direct implementation of technology infrastructure procedures, policies, plans, and budget for P-12 schools.
Technology Leadership Standard 8	Leadership and Vision. Educational technology leaders will facilitate development of a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of the vision.

represented the essential skill areas, where each skill area would have limited correlation with the other skill areas. The concept of essential skill sets lends itself to initiatives designed to develop education technology leadership, where the concept of essential skill areas lends itself to the assessment of education technology leadership.

The NETS Project supported efforts related to the development of education technology leadership, including education technology leadership skills sets and skill areas. The NETS Project standards provide a framework for assessing education technology achievements of various education stakeholders. The education technology leadership standards that emerged from the NETS Project appear to be well suited to support research designed to explore the assessment of education technology leadership.

Sources of Education Technology Leadership

Included with the evidence found in the literature supporting the importance of education technology leadership related to educational objectives was evidence of multiple sources of education technology leadership. In this section, three different sources of technology leadership are described. The sources are (1) Administrator, (2) Teacher, and (3) Chief Technology Officer (CTO).

The School Administrator as Technology Leader

In the majority of the literature reviewed, the school technology leader was the assumed role of the school administrator in the form of Principal or Superintendent. There was support found that both Superintendents and Principals were effective education technology leaders (Battle, 2004; Hudanich, 2002; Mirra, 2004). These effective leaders often shared common tendencies. A supportive administrator took staff input into consideration when developing school schedules or organizing school activities; engendered a high level of communication, encouragement and support that was felt by individuals; devoted resources needed to replicate successful programs; developed and supported partnerships between school and universities and corporations to stimulate the use of technology; empowered their staff; was flexible regarding the placement of technology yet insured that technology was uniformly accessible to teachers and students; had a commitment to professional development; had a respect for students as individual learners (Demetriadis et al., 2003; P. E. Holland, 2001; Kozma, 2005). In contrast, a lack of administrative support was found to limit professional growth and reinforced a hierarchical structure (Demetriadis et al., 2003).

A survey of elementary school principals revealed that while all the Principals agreed that technology was an important aspect of learning, the schools that had the highest technology-use rating shared one characteristic: strong, enthusiastic principal technology leadership (Stegall, 1998). Principals who exhibited education technology leadership were instrumental in modeling the use of technology in classrooms. They understood how it could support best practices in instruction and assessment, and they provided teachers with guidance for its use. Principals also participated actively in professional development activities related to education technology and provided teachers with opportunities to learn how to use those resources (Culp et al., 2005; National Center for Education Statistics, 2006).

When administrators supported teachers using technology with staff development and on-going dialogue about technology integration in the context of teaching and learning, their teachers exhibited sustained technology integration in the curriculum (Sandholtz et al., 1997; Stegall, 1998). Wilsmore and Betz (2000) stated that “technology will only be successfully implemented in schools if the principal actively supports it, learns as well, provides adequate professional development and supports his/her staff in the process of change" (p. 15). Granger et al. (2002) found that "supportive relationships among teachers, a commitment to pedagogically sound implementation of new technologies, and principals who encourage teachers to engage in their own learning" (p. 2) were factors that led to innovative and effective teaching in the classroom.

While literature was found that identifies the school principal as a key factor in bringing about successful change in schools (Fullan, 2001a, 2001b; Hall & Hord, 2001), Schiller (2002) claimed there is very little research on the relationship between education leadership and technology. Additional research in the area of leadership and the implementation of instructional technology was found to be needed (Wilsmore & Betz, 2000; Yee, 1998).

The School Teacher as Technology Leader

There was information found in the literature concerning the use of education technology by teachers to support education reform and student achievement improvement. In a meta-analysis of the value and use of education technology in K–12 education (Valdez, 2000), the North Central Regional Laboratory found a very strong connection between appropriate teacher use of education technology and increased student achievement:

> Education technology offers opportunities for learner-control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systematically, enhance student

achievement as measured in a variety of ways, including but not limited to standardized achievement tests (p. iii).

Technology was reported to be increasingly available in a variety of forms for use by teachers (Culp et al., 2005). As technology became more available to teachers, the issue was not whether, but how teachers contend with it (Fullan, 2001b). As education technology became more powerful, good teachers became more indispensable. While technology could generate a glut of information it had no particular pedagogical wisdom regarding new breakthroughs in cognitive science about how learners must construct their own meaning for deep understanding to occur (Earle, 2002).

The real power of education technology lied in the way its use caused teachers to develop different perspectives through rethinking teaching and learning (Riedl, Smith, Ware, Wark, & Yount, 1998). Teaching with technology has caused teachers to confront their established beliefs about instruction and their traditional roles as classroom teachers. This has meant that teachers must become experts in pedagogical design. It also has meant that teachers must use the powers of technology, both in the classroom and in sharing with other teachers what they are learning. Working in an appropriately designed technology-rich environment had the potential of producing a variety of positive outcomes (Tiene & Luft, 2001): improved patterns of social interaction, changes in teaching styles, more effective teaching, increased student (and perhaps, teacher) motivation, and enhanced student learning. Achieving this potential, however, was the challenge, and it required the correct vision of technology and its integration. The attainment of this learning potential required the leadership of teachers.

Teachers exercise leadership in the form of guidance and direction of instructional improvement. According to Elmore (2000), most of the knowledge required for this improvement resides in teachers who deliver instruction, not in the administrators who manage them. All teachers have leadership potential (Barth, 1999). It is important for teachers to exercise this leadership potential. The key to technology integration is having teachers take hold of best practice teaching strategies and implement them in their classroom. When they do this and they have ample access to technology the technology will be integrated as a tool to create student centered, active learning environments (ACOT, 1995).

The Chief Technology Officer as Technology Leader

In school districts, the responsibilities of locating, evaluating and selecting technologies, managing networked computer systems, and facilitating their effective use in classrooms fall mainly upon the shoulders of staff members variously titled "Technology Director", "Technology Coordinator", "Chief Information Officer", or "Chief Technology Officer". This study will use the term Chief Technology Officer (CTO) as the descriptor for this type of education technology leadership source in a school organization.

Education technology has been considered a strategic resource in elementary and secondary education (CoSN, 2006). No longer restricted to a few content areas or located in certain rooms, computers and networks are part of the fabric of educational practice. In an era of rising technology expenditures and greater accountability, school districts have faced daunting challenges in their efforts to implement technology resources that provide students with the quality learning experiences they deserve. For these reasons school districts must ensure the technology support they need to succeed. It has been the CTO's role to provide the school organization this support.

The CTO technology leadership role in P-12 education required the political and interpersonal skills that supplement technical and educational skills and abilities (Rust, 2006). "Education technology is often complex, but working through the political environment and the myriad entrenched processes is equally challenging" (p. 1). The CTO may be a technology expert and have experience in the instructional area, but the CTO also needed to understand how decisions are affected by internal political forces. According to Rust, "CTOs who are unaware of such alliances will unwittingly antagonize one party or the other and find themselves on the wrong end of a well-orchestrated move to shelve the next (education technology) proposal to hit the table" (p. 2).

The school CTO must be a skilled manager, a knowledgeable educator, an effective communicator, and a technologically-savvy individual who can work with all district staff at all levels within the organization. Leadership from the CTO in education requires competencies in multiple, contrasting areas. The Consortium for School Networking (CoSN) defined ten skill sets for school CTOs (CoSN, 2006; CoSN K-12 CTO Council, 2006): (1) Leadership and Vision, (2) Planning and Budgeting, (3) Team Building and Staffing, (4) Systems Management, (5) Information Management, (6) Business Leadership, (8) Education and Training, (9) Ethics and Policies, and (10) Communication Systems.

In comparison, Hurley (2002) defined CTO skills in terms of "soft" skills and "hard" skills. Soft skills included abilities related to vision, communication, human relations, and political savvy. Hard skills encompassed business knowledge and technical proficiency. These soft and hard skill sets should be framed by an understanding of the CTO of the unique nature of an educational institution and its mission. Successful school organizations have CTO leaders who "offer visionary solutions, a passion for the educational mission, the ability to implement short and long term solutions that address the goals of the organization while pushing the envelope, and the ability to gain the support of significant educational stakeholders" (p. 2).

The CTO position holds an important role in relation to school organization governance. The CTO position will often report directly to the superintendent of schools, and when this is the case, the CTO can impart education technology leadership independently across the organization, to areas of greatest need and of greatest organizational benefit (Keller & Rust, 2001). "When the CTO is not a recognized player at the highest level of the organization, "turf wars" and political end runs of standards persist, and strong arguments for mutually beneficial policies and resources are weakened" (p. 2).

Collaborative Education Technology Leadership

This section provides a general review of collaborative leadership theory and ties education technology leadership to collaborative leadership theory. The association of collaborative leadership with education technology leadership supports this study's premise that education technology leadership can effectively exist at various levels in the school organization and come from various sources.

Collaborative Leadership Theory

Increased school reform and accountability demands, coupled with a shift away from the Industrial Age to a technological and global economy, have fostered calls for a move away from a hierarchical model of leadership to a collaborative one (Pounder, 1998). Although Principal leadership is an essential element in school success, research indicated that the complexities of schools required a new focus on collaborative leadership and the creation of a sense of community in which leadership is shared (Retallick & Fink, 2002). While there was no consensus on the precise definition of collaborative leadership (Fishbaugh, 1997), Elmore (2000) laid out specific principles that, for the purposes of this study, provided the foundation for a model of collaborative leadership:

> The purpose of leadership is the improvement of instructional practice and performance, regardless of the role. Leaders must ensure the creation of settings for learning focused on clear expectations for instruction (p. 20).

According to Elmore, instructional improvement required continuous learning as both an individual and social activity. The roles and activities of collaborative leadership flowed from the expertise required for learning and improvement, not from the formal dictates of the institution. Leaders must understand that learning grew out of differences in expertise rather than differences in formal authority. Leaders must create environments in which individuals expected to have their practice and ideas scrutinized by colleagues. Leaders must model the values and behavior that represented the common good.

In collaborative leadership settings, schools were viewed not as an organization or institution but as a community of individuals who work together for the good of the whole (Barth, 1999). Leadership that was collaborative was potentially more than the sum of the involved individuals' practice (Spillane et al., 2001). Collaborative leadership relied on multiple sources of guidance and direction. The role of the administrative leader in a collaborative leadership system was primarily to "enhance the skills and knowledge of the people in the organization, create a common culture of expectations around the use of the skills and knowledge, hold the various pieces of the organization together in a productive relationship with each other, and hold individuals accountable for their contributions to the collective result" (Elmore, 2000, p. 15).

Barth (1999) reported that the exercise of authority required reciprocity of accountability and capacity. Leaders derived their authority from their ability to create the environment necessary to carry out the requirement. Principals who were most successful as leaders in a collaborative leadership environment were able to enlist teachers in providing leadership for the entire school. This concept of collaborative practice considered school leadership as being "stretched over" the school's social and situational contexts (Spillane et al., 2001, p. 1).

In considering the availability of leadership to school improvement situations, including those with elements of education technology, it is useful to consider the leadership capacity of the organization. Leadership capacity is "an organizational concept meaning broad-based, skillful participation in the work of leadership that leads to lasting school improvement" (Lambert, 1998, 2003). High leadership capacity schools are learning communities that amplify leadership. These schools have developed a fabric of structures (e.g. teams, communities, study groups) and processes (reflection, inquiry, dialogue) that form a more lasting and buoyant web of interrelated actions. The Principal is only one of the leaders in the school community and models collaboration, listening, and engagement. Each participant shares the vision, understands how the school is moving toward the vision, and understands how he or she contributes to that journey.

The development of collaborative leadership was often used as a strategy to help organizations build leadership capacity in support of adaption to change. In theory, for a school to sustain any improvement or innovation the school's leadership must move away from role-based conceptions and be distributed across roles in the organization (Elmore, 2000). A system building leadership capacity via collaborative leadership saw the creation, sorting, and sharing of knowledge throughout the system. Knowledge flowed freely through the system at all levels (Fullan, 2001a; Wheatley, 1999).

This knowledge flow was fostered through the continual development of relationships within the system. Consider the idea of "leadership for many" (Fullan, 2001a, p. 136). Fullan's theory was that if leaders lead well then the organization will outgrow them. In this "culture of complexity", the chief role of leadership was to mobilize the collective capacity to challenge difficult circumstances. The key to success was that many individuals working in concert can become as complex as the society they live in. As Wheatley (1999, p. 36) explains, "systems influence individuals and individuals call forth systems." Organizations were living systems; possessing the same capacity to adapt and grow that is common to all life. Leading needed to be done both from the front and the back of the pack, sometimes showing the vision, sometimes pulling people along, and sometimes pushing from behind.

School improvement initiatives in schools with high leadership capacity hold great promise, but no guarantees, of sustainability (Lambert, 2005). Schools that include everyone within collaborative patterns of participation are able to develop greater levels of leadership skillfulness. This achievement can move a school closer to lasting school improvement than would otherwise be possible.

Education Technology Leadership and Collaborative Theory

There was support found in the literature that education technology leadership was well suited for consideration using a collaborative leadership theoretical viewpoint. Technology leadership was an area that administrators are often willing to share (Mehlinger & Powers, 2001; Schmeltzer, 2001). This willingness frequently was based on their own personal lack of technological expertise. For example, Ertmer et al. (2002) examined changes in administrators' ideas about technology integration and technology leadership as they participated in a semester long online professional development course. The researchers gathered quantitative and qualitative data and used the data to identify the administrators' beliefs that technology leadership is a style of leadership that is participatory and a shared responsibility. The researchers found administrators often identified the technology coordinator or technology-using teachers as the individuals with whom they shared this responsibility. One participant stated that he was not so much the leader as the "cheerleader". Administrators agreed that it was "important to hire the right people, acquire the best resources, and be able to recognize what good technology integration looked like" (p. 16).

Ian Jukes (1996) has built onto this concept of shared leadership:

> If technological initiatives are to be truly successful, responsibility for leadership must be spread around so a broad constituency of leaders develops, rather than have a single champion who must carry the entire burden of making things happen. The goal is to ensure that the plan is still viable after the leadership has moved on. The success or failure of the plan hinges on this critical step (p. 10).

Hughes and Zachariah (2001) investigated the relationship between effective administrative leadership styles and the use of technology. They surveyed public school teachers in Ohio in order to determine their attitudes and perceptions regarding leadership as it affected the school culture. They found that the facilitative leadership qualities in leaders who exhibited a collaborative leadership style proved to be more effective in the implementation of new programs or innovative instructional practices which involved technology.

There are reports that provide strong assertions that technology can catalyze school improvement (CEO Forum, 2000; U.S. Department of Commerce, 2002). Studies showed that new technologies have aided the transformation of classrooms for P–12 students and teachers (GLEF, 2001). “Around the nation teachers are using technology to create exciting and creative learning environments where students teach and learn from each other, solve problems, and collaborate on projects that put learning in a real-world context” (p. 1). Technology innovations were increasing the demand for reforms in teaching and learning approaches that, in turn, were “having a significant impact on technology use expectations” (Valdez, 2000, p. iii). Not only were technology initiatives integrating technology into teaching and learning, they were offering opportunities for organizations to build education technology leadership capacity in support of the technology initiative.

Summary

A review of the literature for this study found evidence that education technology leadership was an important element in the effort to integrate technology into learning. While many researchers examined education technology leadership by studying the education technology leadership of school administrators, there was also research that examined other sources of education technology leadership, including the leadership of teachers and of chief technology officers. Because education technology leadership was shown to effectively emerge from a variety of sources it appeared that education technology projects would lend themselves well to education leaders who were pursuing a collaborative approach to school leadership. Collaborative leadership was reported to be an effective strategy in building leadership capacity, which in turn provided support for sustained organizational change.

The nature of technology as a change agent was reported. School technology projects were often implemented in support of school change. When the leadership for these projects emerged from multiple sources in a collaborative fashion, the technology projects not only helped schools to achieve sustained improvement, but also helped the schools build leadership capacity.

CHAPTER 3. METHODS

Chapter 3 will describe the research methodology used to develop and field test a survey designed to measure education technology leadership. This chapter provides detailed information on the methodological approach of this research. The study's research design is presented, including the study's phases and the associated participants, the procedures used for data collection, and the statistical methods used to analyze the data. A research design issues section and a section discussing human subject research in relationship to this study are also included in this chapter.

Methodological Approach

This study used quantitative research methods. Quantitative research has been defined as "empirical research in which the researcher explores relationships using numeric data" (Fraenkel & Wallen, 1993, p. 5). Quantitative research methods are the process of developing systematized knowledge gained from observations that are formulated to support insights and generalizations about the phenomena under study (Lauer & Asher, 1988). Quantitative methods are an approach to research in which the investigator primarily uses post-positivist claims for developing knowledge (Creswell, 2003; Crotty, 1998).

Post-positivism followed the traditional positivist theoretical approach, but accounted for the fact that one may never know absolute truth in seeking knowledge. There are inherit assumptions in the post-positivist perspective (Phillips & Burbules, 2000), which include:

- Knowledge is seen as conjectural and supported by the strongest warrants of the Time, but can be subject to reconsideration at any time.

- Warrants for claims are made and examined; if the warrant is strong, the claim is accepted until future evidence repudiates the warrant.
- Rational thought, the evidence available, and the data collected (observed) shape knowledge at the time.
- Research is relevant and contextual. Post-positivist researchers seek statements that are relevant and true, given the context, to explain a causal relationship in the research.
- Post-positivists seek to be objective, basing research on the "best" evidence available at the time.

What one can note, under a post-positivist approach, is that the relative and contextual truth that is observed, given the nature of the research methods, may be the best knowledge at the moment. Phillips and Burbules (2000) stated, "Science does not attempt to describe the total reality (i.e., all the truths) about, say, a classroom; rather, it seeks to develop relevant true statements – ones that can serve to explain the situation that is of concern or that describe the causal relationships that are the focus of interest" (p. 38).

Often, the quantitative method uses strategies of inquiry based surveys or experiments. The instruments used in quantitative methods are designed to yield data for statistical analysis. Quantitative research also tends to be interested in whether and to what extent variance in one factor is related to variance in another factor (Creswell, 2003; Maxwell, 2005; Sansone, Morf, & Panter, 2003). Results from quantitative research can often be generalized, though this is not always the case.

Research Context

This study investigated the field of education technology leadership as it related to pre-kindergarten through twelfth grade (P-12) educators from an urban central Iowa school district. Eight Technology Leadership (TL) standards identified in the literature were used as the characteristics of education technology leadership of primary interest to the study. There was not a requirement in study for participants to have formal knowledge or training related to the TL Standards.

The primary research questions for this study were defined in Chapter 1 as:

(1) What are the set of items aligned with each of eight education technology leadership standards that would be part of a reliable and valid survey instrument that would assess the education technology leadership skills of an individual who completes the survey?

(2) What are the underlying structures of the data generated by these items?

(3) What are the inter-relationships between the underlying data structures and the education technology leadership standards?

In response to the research question of this study, a quantitative instrument in the form of a survey, the Educators Technology Leadership Assessment (ETLA), was developed. The ETLA survey was designed to assess an individual's education technology leadership abilities. The goal in developing the ETLA was to produce a short, multiple-choice assessment designed to measure the school technology leadership of a respondent across the full range of the eight TL Standards.

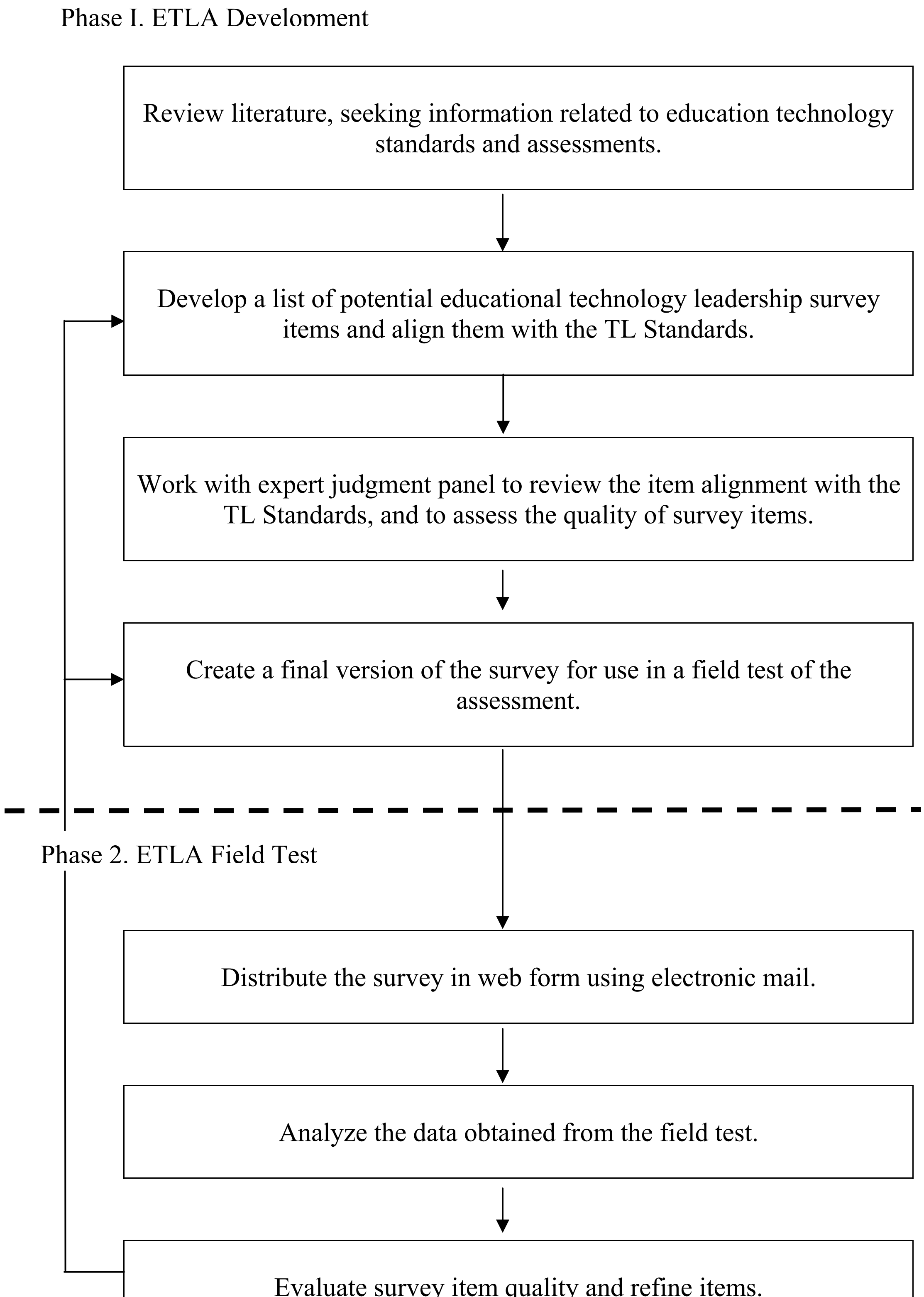
This study was conducted in two main phases: (1) the ETLA Development Phase, and (2) the ETLA Field Test Phase. In the ETLA Development Phase, the research methods were primarily designed to support the creation of valid and reliable survey items. In the ETLA Field Test Phase, the research methods were primarily designed to test the reliability and validity of the survey items. Figure 2 shows the milestone events of the study across the two study phases, in chronological order.

ETLA Development Phase

Research Design Overview

The main task in the ETLA Development Phase was the construction of the initial draft version of the ETLA survey items. The draft ETLA survey items were constructed using a process similar to the method used by the American Institutes of Research (AIR) in developing the Principal Technology Leadership Assessment (PTLA) (Center for the Advanced Study of Leadership in Education, 2005). At the time of this study, the PTLA was generally available to P-12 school organizations and educational leadership preparation programs. The survey questions used in the PTLA were based on ISTE National Educational Technology Standards for Administrators (NETS-A) (ISTE, 2004). In comparison, for the ETLA, the ISTE publication *Teachers as Technology Leaders* (Twomey et al., 2006) was used as a guide by the researcher in the construction of ETLA survey questions. The ETLA survey items were designed to align with the existing Technology Leadership (TL) Standards that were documented in the ISTE guide (p. 152-170). Development of the instrument began with a review of the TL Standards by the researcher to identify specific behaviors, activities, and practices associated with each of the standards. The information gathered in the review was used to help the researcher draft forty-four ETLA survey questions.

Figure 2. ETLA survey development process.



A goal of the researcher in the development of the draft ETLA items was to optimize items so as to elicit reliable and valid responses. The researcher was able to accomplish some item optimization directly as draft ETLA items and survey instructions were created. For example, the researcher ensured that the draft ETLA items asked respondents about past behaviors (rather than intended behaviors). And ETLA survey instructions directed respondents to develop their responses based on a discrete period of time.

To improve the likelihood for ETLA items to be reliable and valid, it was important that the ETLA survey items contained a basic level of quality. Groves (2004) suggested three quality standards that survey questions should meet: (1) content standards (i.e., are the questions asking the right things?), (2) cognitive standards (i.e., do respondents understand the questions consistently?), and (3) usability standards (i.e., can respondents complete the questionnaire easily and as they were intended to?). The development of survey questions with good quality would contribute to the goal of obtaining reliable and valid questions.

In order to provide support to the researcher in the important process of quality survey item development, the use of an expert judgment panel (Bass & Avolio, 1997) was incorporated into the study's methods. The expert judgment panel was used to help the researcher evaluate the quality of the draft ETLA survey questions. The responsibility of the expert judgment panel for this task was to review draft ETLA items and provide feedback related to the quality of each item. The data set that resulted from the collection of this expert feedback was expected to provide data useful for assessing ETLA item quality related to Groves's content, cognitive and usability standards.

In addition to the development of items with good quality, a goal in the development of the ETLA was to create a tool that would assess education technology leadership in terms of the eight TL Standards. To accomplish this, it was necessary to align the ETLA items with specific TL Standards. Each of the forty-four draft ETLA questions were initially assigned to a TL Standard area by the researcher as they were created. The result of this first alignment was that each standard area had between five and seven questions associated with the standard area. The responsibility of the expert judgment panel for this task was to review draft ETLA items and provide feedback related to the alignment of ETLA items with the TL Standards. The information obtained from the expert judgment panel was reviewed by the researcher to determine if the ETLA items had been properly aligned with the TL Standards.

Research Participants

The main participants in the ETLA Development Phase were the members of the expert judgment panel. The expert judgment panel was convened as part of one regular meeting of twenty-eight technology coordinators from central Iowa (United States of America) school districts in April of 2007. Based on their direct job responsibility as district technology coordinators to provide technology leadership to their respective school districts, these individuals were considered to have expertise in the area of education technology leadership. The technology coordinators participated as experts in this study on a volunteer basis.

Phase Data Collection

Data associated with the draft ETLA survey items were collected through the work with the expert judgment panel. An important aspect of the data collection was the use of data coding to assist in tracking data. It was anticipated by the researcher that ETLA survey items would be modified from their original draft form over the course of the study. In fact, over the course of the study, two main versions of the ETLA survey existed, the draft version and the final version. It was necessary to develop data coding methods that would assist the researcher in identifying the various versions of the ETLA items over the course of the study.

The draft ETLA version of the survey was used for work in the ETLA Development Phase of the study. In the draft ETLA item coding scheme, labels for items associated with the draft ETLA survey started with a D. The standard area that the item was aligned with was identified with a roman numeral (I-VIII). A number was used for the marker of the item within the standard area. For example, the item coded as D.V.3 identified question 3 in TL Standard area V (Productivity and Professional Practice) from the draft version of the ETLA survey.

The main data collection associated with the ETLA Development Phase was conducted with the expert judgment panel, as part of a meeting of technology coordinators. To accommodate meeting time constraints, the work of the expert judgment panel was designed to be accomplished in one two hour meeting of the panel. Given this time constraint, it was not possible for all items to be reviewed by all experts. Therefore, a process was designed to insure that each item would be reviewed by ten experts. The assignment of items to various experts for review had an element of randomness to it, in that no item was reviewed by the same ten experts.

At the meeting of the expert judgment panel, an activity designed to solicit feedback from the panel was completed. First, the researcher reviewed the TL Standards with the entire panel. This allowed the experts to become more familiar with the TL Standard areas and to seek clarification about the TL Standards.

Next each expert was provided ETLA Item Expert Feedback forms. As previously indicated, the distribution of these forms was conducted so that each ETLA item would be reviewed by ten experts. A single ETLA Item Expert Feedback form contained one ETLA item, the TL Standard that it had been associated with by the researcher, and two general purpose requests for the expert to respond to, related to the item. First, the experts were asked to self-assess themselves by responding to the item using a six point scale. Second, the experts were asked to rank the item's alignment with the TL standard area the item was assigned to using a five point scale. An area was also provided on the form for the respondent to provide additional comments related to the item.

A copy of the expert feedback form for item D.I.1 is shown in Figure 3. Copies of the entire set of ETLA Item Expert Feedback forms are contained in Appendix B.

Two data sets were generated from the work with the expert judgment panel. One data set, labeled the Expert Ranking Data Set, contained data related to the ranking of the item's strength related to the item's TL standard area. The other data set, labeled the Expert Assessment Data Set, contained data related to the item's use as a self-assessment question. The data sets collected from the expert panel along with comments submitted on the feedback forms were used by the researcher to help analyze the quality of the ETLA survey questions.

Figure 3. Example of expert panel feedback form

<u>Standard: Leadership and Vision</u>.
Educational technology leaders will facilitate development of a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of the vision. Educational technology leaders:

A. Identify and apply educational and technology-related research, the psychology of learning, and instructional design principles in guiding the use of computers and technology in education.
B. Apply strategies for and knowledge of issues related to managing the change process in schools.
C. Apply effective group process skills.
D. Lead in the development and evaluation of district technology planning and implementation.
E. Engage in supervised field-based experiences with accomplished technology facilitators and/or directors.

Question – D.I.1

To what extent did you participate in your district's or school's most recent technology planning process? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the question above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Data Analysis

To aid the evaluation of the quality of the draft ETLA items, descriptive statistics were generated using the Expert Ranking Data Set and the Expert Assessment Data Set. Included in the descriptive statistics was the number of responses (N) obtained for each item along with statistics describing the distribution of responses for the items. Item mean scores were also generated for each item for each data set. It was expected that item mean scores for the expert panel would be high. Therefore, items with low mean scores were identified as items of potentially low quality. In this way, item mean scores were an important descriptive statistic used in the analysis of draft ETLA item quality.

In the case of the item mean scores based on the Expert Ranking Data Set, the ETLA item mean score analysis was used to identify the strength of alignment of each survey item with a TL Standard area. Items with item mean scores greater than or equal to 4 were considered to be adequately aligned with the standard area. Item mean scores less than 4 indicated the items that were considered by the experts to be poorly aligned with the standard area they were associated with. These items were flagged by the researcher for modification or removal from the survey.

Related to the item mean scores based on the Expert Assessment Data Set, the data analysis was used to identify the items that generated results tied to self-perceived education technology leadership strengths of the experts. Items with low mean scores based on the Expert Assessment Data Set indicated items that may not be generating accurate results related to expert education technology leadership skills. The items with low mean scores (< 4.0) were flagged by the researcher for modification or removal from the survey.

Summary

The ETLA Development Phase of the study was designed to solicit ETLA survey item feedback from an expert judgment panel. The expert panel feedback process was designed to provide evidence of the quality of all forty–four draft ETLA survey items. The expert review also helped to confirm that ETLA survey items were aligned with TL Standards. Using feedback from the expert review, the researcher constructed the study's final version of the ETLA survey for use in the Field Test Phase of the study. There were thirty-eight items in the final version of the ETLA.

ETLA Field Test Phase

Research Design Overview

Research methods designed to produce an ETLA survey of good quality were used by the researcher in the ETLA Development Phase of the study. However, it is often necessary to evaluate the survey's quality through the use of a field test (Peterson, 2000). Rea & Parker (2005, pp. 31-32) describe a field test as a small-scale implementation of the survey that addresses critical factors such as:

> *Survey clarity.* Will respondents understand the question? Are the response choices sufficiently clear to elicit the desired information?
>
> *Survey comprehensiveness.* Are the questions and response choices sufficiently comprehensive to cover a reasonable complete range of alternatives?
>
> *Survey acceptability.* Is the survey of excessive survey length, or are survey questions perceived to invade the privacy of the respondents, or abridge ethical or moral standards?

Incorporating a field test into this study's research design provided an additional set of research methods for the researcher to use to further assess the quality of the ETLA survey. Field testing methods provided data that allowed for additional analysis of ETLA reliability and validity.

For this study, reliability was defined as the extent to which the items would yield the same results with repeated trials (Carmines & Zeller, 1979; Peterson, 2000). The reliability of an item is determined by its consistency or dependability in measuring whatever it is designed to measure. The greater the reliability of an item the smaller the likelihood of measurement errors with the item. There were statistical methods which could be applied to field test data to evaluate ETLA item reliability. The reliability statistical methods chosen for this study are described in more detail later in this chapter.

Consideration of ETLA item validity was less straightforward. There are many forms of validity defined in the literature related to survey item development, including criterion-related validity, predictive validity, content validity, convergent validity, divergent validity, and construct validity (Dillman, 2007; Fraenkel & Wallen, 1993; Groves et al., 2004; Newman & McNeil, 1998; Weiner, 2000). Across these multiple definitions, a common characteristic is that validity is concerned with the relationship between theoretical constructs and indicators. This concept of validity, which is associated with a type of validity known as construct validity, was useful to this study. Construct validity is concerned with the "extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses concerning the concepts that are being measured" (Carmines & Zeller, 1979, p. 23).

The field test of the ETLA provided data useful in the analysis of the construct validity of ETLA items. The construct hypotheses and statistical methods chosen to evaluate ETLA validity are described in more detail in the field test data analysis section found later in this chapter.

Research Participants

The population for the ETLA Field Test Phase of the study started with approximately 3,000 P-12 educators (administrators and teachers) from a single Midwest school district. Given constraints in the study's time and resources, it was not possible to survey all of these educators. Rather than use pure randomized (probabilistic) selection in the creation of the study's sample population, a purposive non-probabilistic method was used that produced a convenience sample (Hinkle, Wiersma, & Jurs, 2003; Newman & McNeil, 1998; Peterson, 2000), in the hope of achieving a high participant response rate.

To generate the convenience sample, each of the sixty Principals in the school district was asked to submit a team of five representatives from their building to complete the ETLA survey. Each team's membership was required to include the Principal and the Building Technology Specialist. The Building Technology Specialist was a teacher in each building assigned the extra job duty of on-site technology support for the school. The Building Technology Specialist served as a liaison between the school and the district Technology Department. The team's membership was rounded out with three other teachers of the Principal's choosing. The Principal was told only that their five member team would be asked to complete an education technology related survey, and that it was important to select team members that could be counted on to complete the survey.

The study's timeline coincided with a technology mini-grant program underway in the school district. In order to receive a technology mini-grant in the amount of $1,000, schools were required to complete several technology planning related tasks. The completion of the ETLA survey by the school's five member team was added to the list of tasks required in order for buildings to receive the technology funding. Incorporating the completion of the ETLA survey into the funding task list provided an incentive to each building's five member team to complete the ETLA survey exercise as directed.

The result of these convenience sample selection methods were that sixty teams, each with five members, were identified to participate in the field test. This generated a potential survey participant pool of 300 participants: 60 Principals, 60 building technology specialists, and 180 teachers. Several of the statistical analyses used in the study required 200 or more responses, so it was important to achieve a high response rate with the ETLA field test.

Data Collection

The field test of the ETLA was facilitated with the use of a web-based version of the ETLA survey. The survey was provided to participants during the 2006-2007 school year by sending survey instructions along with a link to the survey to participants via electronic mail. The survey window was open for a three week period, from May of 2007 into June of 2007. Reminder messages were sent to participants that had not responded after the first week, and again after the second week. While responses were tracked by the researcher for data grouping purposes, the researcher pledged anonymity to participants in that their individual responses would be kept confidential.

Two data sets useful for analysis were created in the field test of the ETLA. One data set, called the Field Test Data Set, was generated from the use of the ETLA as a self-assessment by the sample population. The other data set, called the Matched Data Set, was generated from the use of the ETLA as an evaluation tool by a subset of Principals that participated in the study.

In order to generate the two data sets, two sets of instructions were developed. One set was used for the general participants (N=275) who were asked to complete the survey as a self-assessment of their own education technology leadership skills. These instructions can be found in Appendix C. The other set of instructions were developed for a sub-group of Principals (N=25) who were selected to use the survey to evaluate the education technology leadership of a specific team member from their building. These instructions can be found in Appendix D.

With both data sets, basic ETLA scoring results for each question existed across of range of 0 to 5. This scale was not precise but did provide a measure for each ETLA item. For each ETLA item, a score closer to 5 represented an area of perceived strength for the respondent; a score closer to 1 represented an area of perceived need for the respondent. A score of zero in a respondent's data record indicated that the question was considered *Not Applicable* by that respondent.

The option of Not Applicable was included as a response choice for each ETLA survey item. The decision to provide a Not Applicable response choice was made by the researcher in order to help capture information related to participants' understanding (or lack of understanding) of an item (Dillman, 2007). The Not Applicable response provided participants the ability to "opt-out" of answering a question; i.e. if they didn't feel it was related to their job or if they didn't understand the question (Groves et al., 2004). Responses of Not Applicable were coded in the data set as a zero and were treated as missing data in the statistical analyses used in this study.

There were limits associated with this item scale. For example, lower scores may have represented respondent(s) personal knowledge, skill, and/or level of interest (Rea & Parker, 2005). Lower scores may also have reflected a lack of opportunity for involvement by respondents in the area of education technology leadership. A high number of Not Applicable responses may have reflected a lack of understanding by respondents of the standard area as it related to the use of education technology.

The field test data collection methods were designed to allow the data to be examined on both an individual and group basis. The data generated by the field test provided the ability to evaluate item responses, item scale responses, and the inter-relationships between items and items scales. For example, the item alignment with TL Standard areas formed item scales for the TL Standard areas. These scales were available for statistical analysis and interpretation; e.g., respondents' scores for the scale of items F.I.1, F.I.2, F.I.3, F.I.4, and F.I.5 were averaged to create a mean score for the respondents for TL standard area I (Leadership and Vision). Mean scores close to 5 represented overall strength for that standard area for the field test respondent(s). A score close to 1 represented overall an area of need for the respondent(s) for that standard.

The item mean scores also provided a basis useful in comparing different subgroups within the field test sample population. For example, the item mean scores for Principals, Building Technology Specialists, and Teachers could be averaged to form a group item mean score, and then compared. The group item mean scores close to 5 represented overall strength for that item for the group. A score close to 1 represented overall an area of need for the group for that item.

Data Analysis

This section will discuss the statistical analysis methods chosen to analyze the field test data. In addition to continuing the evaluation of ETLA survey quality that was started in the ETLA Development Phase of the study, the researcher selected methods expected to provide evidence of ETLA item reliability and validity, as defined previously in this chapter. The researcher also sought evidence of underlying data structures within the Field Test Data Set, using exploratory factor analysis research techniques.

ETLA Reliability Analysis

The Field Test Data Set was used in the evaluation of ETLA survey reliability. Evidence of survey reliability can be demonstrated using measures of internal consistency (Hinkle, Wiersma, & Jurs, 2003; Schmitt, 1996; Welkowitz et al., 2006). Cronbach's Alpha (Alpha) was used in this study as a common estimate of internal consistency of ETLA items. Alpha measured the extent to which ETLA item responses correlated highly with each other. The widely accepted social science cut-off is that Alpha should be .70 or higher for a set of items to be considered a reliable scale (Schmitt, 1996). A collection of items with a high Alpha score does not necessarily imply that the items are measuring only one construct. A set of items can have a high Alpha and still be multidimensional. This characteristic of Alpha was helpful in the analysis of ETLA field test data, as the ETLA was intended by design to have clusters of items aligned to the eight technology leadership standards.

Items with good internal consistency can generate a low Alpha score if there was high random error in the item responses (Hinkle et al., 2003). The study's reliability analysis using Alpha was limited by this risk. Also, the risk of random error in this study was increased due to the availability of only one field test data set for use with Alpha analysis. Also, it is worth noting the statistical formula for Alpha took into account the number of survey items. Typically, as the number of items increase for a scale, the higher the Alpha score. It would be expected in this study's results that the Alpha for the ETLA survey overall (38 items) would be higher than the Alpha for each TL Standard aligned subgroup of items (4-5 items).

ETLA Validity Analysis

For analysis of ETLA indicators of validity, both the Field Test Data Set and the Matched Data Set were used by the researcher. The researcher was interested in finding evidence of ETLA construct validity. As mentioned previously, construct validity is concerned with the extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses concerning the concepts that are being measured. Construct validity seeks agreement between a theoretical concept and a specific measuring device or procedure. To understand whether a piece of research has construct validity, three steps should be followed (Carmines & Zeller, 1979, p. 39). First, the theoretical relationships must be specified. Second, the empirical relationships between the measures of the concepts must be examined. Third, the empirical evidence must be interpreted in terms of how it clarifies the construct validity of the particular measure being tested.

In order to examine data collected in the field test for evidence of ETLA construct validity, it was necessary to conduct experiments designed to assess construct validity. Three such assessments were developed: (1) the Job Group Assessment, (2) the Matched Data Assessment, and (3) the Not Applicable Assessment.

The Job Group Assessment was conducted by examining job groups. For the job group construct validity assessment, the hypothesized theoretical construct was: Valid ETLA items would differentiate the leadership across these job groups, and so the education technology leadership of each job group would vary compared to the others.

For this assessment, it was necessary to group the field test responses by job category. The field test sample population contained respondents from one of three job groups: (1) Principal, (2) Building Technology Specialist, and (3) Teacher. A claim for ETLA item construct validity would be supported if item mean scores for each job group varied.

The Matched Data Assessment was the second examination of ETLA construct validity. In this test, the Matched Data Set was generated by matching responses from selected principals with responses from selected teachers. To create the Matched Data Set, 25 of the 60 Principals in the field test population were selected at random to use the ETLA survey to evaluate the technology leadership of a randomly selected member of their building's team. Instead of using the ETLA survey as a self-assessment, these 25 Principals were asked to evaluate the technology leadership of a specific team member. In turn, the team member used the survey as a self-assessment of their education technology leadership skills. The 25 responses from Principals were compared with the matching (paired) 25 responses from team members.

For the matched data construct validity assessment, the hypothesized theoretical construct was: The scores of the principal would relate to the scores of the teacher. For this assessment, the indicators of primary interest to the researcher were (1) the ETLA item mean scores of principals compared to teachers, and (2) the correlation of the matched responses between principals and teachers. The a priori expectation was that a claim for ETLA item construct validity would be supported if item mean scores for Principals and Teachers were similar and if item scores were highly correlated.

The Not Applicable Assessment was performed by reviewing *Not Applicable* responses in the Field Test Data Set. All ETLA items offered study participants the opportunity to respond that the item was Not Applicable for them in their job. Because ETLA items had been aligned, with the aid of an expert judgment panel, to education technology leadership standards considered in fact to be applicable to educators, ETLA items with many Not Applicable responses indicated items with potentially low content validity. For the not applicable construct validity assessment, the hypothesized theoretical construct was: Valid ETLA items would be considered applicable by respondents. For the purpose of this study, ETLA items with a Not Applicable response rate greater than 5% of the total item responses were identified as items with potentially low construct validity.

ETLA Exploratory Factor Analysis

Factor analysis is a generic name given to a class of multivariate statistical methods whose primary purpose is data reduction and summarization (Hair, 1979). Factor analysis can be useful in supporting research methods designed to examine the relationship between variables within a data set. Tabachnick and Fidell (2001) stated:

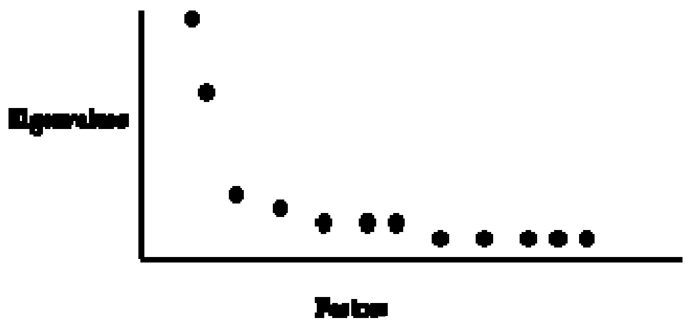
> Factor analysis is a statistical technique applied to a single set of variables when the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of one another. Variables that correlated with one another but largely independent of other subsets of variables are combined into factors. Factors are thought to represent underlying processes that have created correlations among variables. (pp. 582-583)

Exploratory factor analysis (EFA) is a form of factor analysis methodology that is generally used to discover the factor structure of a measure. EFA is used "as a means of exploring the underlying factor structure without prior specification of number of factors…" (Kim & Mueller, 1978b, p. 77). EFA is an "expedient way of asserting the minimum number of factors that can account for the observed covariation and as a means of exploring data for possible data reduction" (p. 9).

The first goal in EFA is to determine the number of factors. A common technique in EFA useful for determining the number of factors is to generate a Scree plot. The Scree plot is a two dimensional graph with factors on the x-axis and eigenvalues on the y-axis. Eigenvalues are produced by a process called principal components analysis (PCA) and represent the variance accounted for by each underlying factor. They are not represented by percentages but instead by scores that total to the number of items. For example, a 38-item scale, such as the ETLA, will theoretically have 38 possible underlying factors; each factor will have an eigenvalue that indicates the amount of variation in the items accounted for by the factor. If the first factor has an eigenvalue of 3.0, it accounts for 8% of the variance (3 ÷ 38=.08). The total of all the eigenvalues will be 38 if there are 38 items, so some factors will have smaller eigenvalues. They are typically arranged in a Scree plot. Figure 4 shows an example of a Scree plot.

As can be seen in the Scree plot example in Figure 4, the first two factors account for most of the variance and the remaining factors all have small eigenvalues. A researcher might examine the Scree plot and decide there are two underlying factors. This

Figure 4. Example of a Scree plot



approach to selecting the number of factors involves a certain amount of subjective judgment.

Another approach to deciding the number of factors is called the Kaiser-Guttman rule (Kim & Mueller, 1978a). This method simply states that the number of factors are equal to the number of factors with eigenvalues greater than 1.0. For this study, examination of a Scree plot along with the Kaiser-Guttman rule will be used to determine the number of factors found through EFA.

Once the number of factors is determined, the next goal in EFA is to describe the factors. A factor is often described in terms of the items that load high on the factor (Kim

& Mueller, 1978b). The factor loadings generated by the EFA are reported in a table called a factor matrix. The matrix can be examined to identify items that have high factor loadings on a specific factor. The grouping of items that load high on a specific factor is called the factor scale. For example, consider the sample factor matrix in Table 5. This matrix would indicate a factor structure of three factors (columns) and five items (rows). In this example, the items identified with high loadings are highlighted in bold type. Item 1 was found to load high on Factor 1 and Factor 3. Item 1 would be considered to be *multidimensional*. Item 3 loaded high on Factor 2, Item 4 loaded high on Factor 1, and Item 5 loaded high on Factor 2. These items would be considered unidimensional. Item 2 did not load high on any factor. In this example, the matrix would provide evidence indicating that Item 1 represents more than one factor, and that Item 2 should be evaluated to determine if it is contributing to the researcher's overall goals.

There are a wide number of options and settings available to researchers conducting factor analysis (Byrne, 1989; Carmines & Zeller, 1979; Kim & Mueller, 1978a, 1978b; Kline, 1994). The SPSS computer program (SPSS Version 11 for Windows) was used in this study to generate the statistics of the EFA. The SPSS software application was programmed by the researcher to use the Principal Axis Factoring option (Kim & Mueller, 1978b). The Principal Axis Factoring setting was appropriate for the factor analysis methods of this study, because this setting caused the SPSS program to perform multiple iterations using communalities estimates, until the changes in communalities from one iteration to the next satisfied the program's convergence criterion for extraction. In other words, the factors generated using Principal Axis Factoring would be expected to account for much of the variance in the data.

Table 5. Sample factor matrix.

Variable	Factor 1	Factor 2	Factor 3
Item 1	**0.723**	0.098	**-0.905**
Item 2	-0.250	-0.294	-0.314
Item 3	-0.028	**-0.879**	0.012
Item 4	**-0.952**	-0.380	-0.578
Item 5	0.297	**0.925**	-0.204

Other settings used by the researcher in this study's SPSS based factor analysis included:

- Kaiser-Meyer-Olkin measure – The Kaiser-Meyer-Olkin (KMO) setting tests whether the partial correlations among items are small. High values (close to 1.0) generally indicate that a factor analysis may be useful for the data set. If the value is less than 0.50, the results of the factor analysis would be less useful.
- Bartlett's test of sphericity – The Bartlett's Test of Sphericity tested the hypothesis that the correlation matrix is an identity matrix, which would indicate that the items are unrelated and therefore unsuitable for structure detection. Small significance level values (less than 0.05) would indicate that a factor analysis may be useful with the data set.
- Anti-image – The anti-image setting generated the anti-image correlation matrix and the anti-image covariance matrix. Small off-diagonal elements indicate a good factor model. Sampling adequacy for an item is displayed on the diagonal of the anti-image correlation matrix.

- Varimax method – This setting caused SPSS to generate a rotation component matrix using an orthogonal rotation method that minimizes the number of variables that have high loadings on each factor.

The results of the EFA provided information useful for the researcher's examination of the interrelationships in the field test data. Results of the factor analysis included a Scree plot and a rotated structure matrix which were used by the researcher to examine the relationships between ETLA items and the factors generated by the factor analysis. The Scree plot and the associated eigenvalues were useful in helping the researcher to decide on the number of factors to consider. The rotated structure matrix was used to describe the factors by identifying ETLA items that loaded high on a factor, the ETLA items that did not load high on a factor, and the ETLA items that loaded high on multiple factors. Of greatest interest to the researcher for this study were the ETLA items that did not load high on any of the factors. As these items did not contribute in a significant way to the EFA, they were flagged for future study to determine if they were contributing to the purpose of the ETLA.

In summary, exploratory factor analysis (EFA) was used in this study to explore the interrelationships of the ETLA items. By examining the factor loadings generated from the SPSS based factor analysis the researcher was able to identify underlying data structures inherent in the Field Test Data Set. It was also possible to identify ETLA items with low factor loadings. These items would then become subject to future review to determine if they were contributing in a meaningful way to the ETLA results.

Summary

The field test was conducted with a sample population of educators and was enabled with the use of a web-based survey. Two data sets were designed to be created as part of the field test, the Field Test Data Set and the Matched Data Set. The data sets were statistically analyzed by the researcher in order to produce evidence of ETLA reliability, validity, and data inter-relationships. Statistical measures used included ETLA item mean scores, ETLA item scale mean scores, Cronbach's alpha, and exploratory factor analysis (EFA).

Design Issues

Internal Validity

Measures of internal validity are often used to help a researcher ensure that the relationship between variables is unambiguous and defines the researcher's intended relationships (Fraenkel & Wallen, 1993). When a study is said to have adequate internal validity, it means that any relationship observed between two or more variables should be meaningful in its own right, rather than being due to other factors. There are a number of factors that can threaten the internal validity of a research study, and the research design should attempt to control for as many of these threats as possible.

Threats to the internal validity of this study's research design included participant characteristics, loss of participants, history, testing, and implementation. This section discusses these threats to the internal validity of this study.

Participant characteristics. Selection bias of participants is one of the most common threats to the internal validity of a study. The researcher must be aware of and control for differences in the characteristics of participants that might interfere with the variables being studied. There was selection bias associated with both of the participant groups engaged by this study. For example, in the case of the expert judgment panel the expertise of the panel member was assumed, as all participants in the expert judgment panel had professional job roles associated with education technology leadership. In the case of the field test sample population, the sample was not a true random sample but a convenience sample. All participants were employees of the same school district.

Loss of participants. One of the most difficult internal validity risks to control for is the loss of participants (Fraenkel & Wallen, 1993). This study's interaction with participants was limited to interactions at specific points in time for each group of participants, so the issue of controlling for participants over an extended period of time did not constitute a risk. What did cause a threat, in this study, was the potential failure of participants to complete all or part of the survey. Some of this risk was mitigated by using statistical methods to replace missing data. Also, an incentive in the form of the release of a technology mini-grant tied to completion of the ETLA survey task was used in the field test to help ensure a high survey return rate. The use of an online, web base survey in the field test added to the convenience for participants to complete the ETLA survey task.

History. Historical events that occur during a research project, such as an event that occurs in the middle of a data collection process, may have an impact on the participants' responses. In this study one control that was helpful in countering a potential threat in this area was that the field test data collection occurred over a short period of time; specifically, from May 2007 to June 2007. During this time period, there were no "significant" historical events identified by the researcher that may have impacted the responses given by participants who completed the survey later in the data collection window compared to participants who completed the survey early in the data collection window.

Testing. In some instances, participants may have an opportunity to practice taking a test, survey, questionnaire, or scale prior to the research or as part of the research project (e.g., pre-test, post-test design). This can result in what is known as a "practice effect." Participants who have seen or participated in preliminary or pilot tests may affect the way the participant responds in the future. For this study, participants were exposed to the associated ETLA tasks only once, which served to minimize the risk of a practice effect.

Implementation. When one group of participants receives special treatment that is not part of the research study an implementation threat has occurred. In this study, the implementation was standardized for all participants so that no one received any preferential treatment.

External Validity

The concept of external validity is synonymous with generalizing (Fraenkel & Wallen, 1993)). The external validity of a research study depends on the extent to which the results can be generalized. Creswell (2003) noted, "A threat to external validity arises when experimenters draw incorrect inferences from the sample data to other persons, other settings, and past or future situations" (p. 171). The external validity of this study was limited in that the use of only one expert judgment panel and the use of only one sample population limited the ability to generalize the results of this study.

Other Issues

Small Item Scales. Analysis of the reliability of the ETLA item scales would be bolstered by additional items aligned with each TL Standard area. Analyses and conclusions based on a scale of 4 to 6 items must be approached with caution (Avolio & Bass, 2002). Generally, a sub-scale consisting of 20 or more items is necessary to draw conclusions about a dimension's reliability (Rea & Parker, 2005). Additional trials of the ETLA would be helpful to the evaluation of ETLA reliability.

Limited number of data sets and sample populations. The use of factor analysis in this study was limited by the availability of only one data set. Kline (1994) cautions that only replicated factors should be interpreted. He also advises that the interpretation of factors from item content is not evidence of validity beyond simple face validity; i.e. claiming a test measures something from its appearance.

Small response set in Matched Data Set. The statistical tests using data matched with principals and teachers were based on a maximum sample population of N=25 matched cases. This sample size was small and findings would require verification through additional use of the ETLA. Also, the construct hypothesis used in the Matched Data Set analysis was not intended to infer that the Principal score was the "true" score; i.e., the methods were not intended to establish criterion-related validity. The intention was to evaluate ETLA item construct validity using the hypothesis that the matched scores would be similar and correlated.

Use of an incentive in the field test. In the study's field test, the completion of the ETLA survey by building teams was one of several tasks required for the building to receive a technology mini-grant. This served as an incentive for participants to complete the survey. But it also invited the potential of participant bias in the survey. For example, the Principal for each building may have selected teachers most likely to complete the survey, creating a team not necessarily representative of the building at large. There was also the potential that participants would answer in a way they thought the Technology Department would want them to.

The field test participants knew they were part of a study tied to funding for their building, which introduced a potential for a *Hawthorne effect* to the study's validity. The Hawthorne effect is a term used to describe the changes in a subject's behavior when he or she is aware that he or she is being observed. In essence, the Hawthorne effect tells us that people do not behave in the same manner when they know they are being watched as compared to when they do not know they are being watched.

Human Subjects Research

Appropriate and timely Human Subjects Research forms (Office of Research Assurances, 2006) were filed with the Iowa State University Committee on the use of Human Subjects in Research. A copy of the human subjects' approval letter can be found in Appendix E. Permission to conduct research in the Des Moines Public Schools was also obtained. A copy of the letter of approval from the district is found in Appendix F. Participation in the survey was considered implied informed consent.

Summary

The availability of a measurement tool to assess education technology leadership would be useful to both individuals seeking to become better education technology leaders, and also to individuals seeking to study and develop education technology leadership. The methods of this study were designed to develop an education technology leadership assessment (ETLA) with the aid of an expert judgment panel, and then to field test the assessment. Data generated from the field test was used to examine the ETLA for indications of reliability and validity. Interrelationships within the field test data were also examined through the use of exploratory factor analysis methods.

The methods of the study were limited in several ways, which posed risks to the study's internal and external validity. Because the study engaged human participants, Human Subjects Research guidelines were incorporated into the study's design, and the guidelines were followed by the researcher.

CHAPTER 4. FINDINGS

As stated in Chapter 1, the goal in developing the Education Technology Leadership Assessment (ETLA) was to produce a reliable and valid survey tool that can be used by individuals to self-assess their education technology leadership skills based on eight education technology leadership standards. The research questions for this study were concerned with the development of a reliable and valid survey as well as an interest in examining the underlying structures and inter-relationships of the data collected with the survey. In support of these research questions, methods were developed to assess the ETLA survey reliability and validity. Methods were also established to allow the researcher to examine the structure and inter-relationships of the data generated by the ETLA survey. The findings reported in this chapter provide evidence of the extent to which the ETLA in fact did contain reliable and valid survey items. Findings related to the observed data inter-relationships are also reported. The findings reported in this chapter will be grouped into four collections:

1. Evidence that ETLA items were aligned with the eight Technology Leadership (TL) Standards.
2. Evidence that the ETLA survey produced results that are statistically reliable.
3. Evidence that the ETLA survey produced results that are statistically valid.
4. Observations of ETLA item inter-relationships.

Results described in each of these sections were generated using descriptive statistics including measures of reliability and difference, and also from exploratory factor analysis (EFA). Data sets used in the statistical analysis were obtained from two sample populations: (1) a sample population of school technology coordinators serving as education technology experts, and (2) a sample population of educators from an urban Iowa school district.

ETLA Item Alignment with Education Technology Leadership Standards

An expert judgment panel was used to help align ETLA items with technology leadership (TL) standard areas. This section of this chapter will describe the results used in the work to guide this item alignment.

The main source of data used in the task of item alignment was descriptive statistics that were generated using the Expert Ranking Data Set. Included in the descriptive statistics were the item mean score for each item. The mean scores for the items were an important descriptive statistic used in the analysis of the Expert Ranking Data Set. An analysis of the ETLA items' mean score was used to evaluate the alignment of each survey item with a TL Standard. On the five point rating scale used by the expert panel, the score of 4 was associated with "strong" alignment between the test item and the TL Standard area. Therefore, based on the scores from the expert judgment panel, items with mean scores of 4.0 and above were considered to be strongly aligned with the standard area that it was associated with. Twenty-three items had a mean score of 4.0 or higher. Items with a mean score below 4.0 were considered to have less than strong alignment with the TL Standard. These items were flagged for modification or removal from the survey. Twenty-one items had a mean score lower than 4.0. Item D.VII.3 had a mean score lower than 3.0.

The collection of items with an item mean score less than 4.0 was considered an important finding of the study, as those items were targeted for refinement as the draft version of the ETLA was refined into the final version. Table 6 provides a summary

Table 6. Expert Ranking Data Set descriptive statistics.

ETLA Items with an Item Mean Score >= 4.0				
D.VIII.4	D.VI.2	D.VI.3	D.VII.5	D.VIII.1
D.VIII.2	D.VIII.5	D.II.5	D.VI.4	D.III.4
D.III.6	D.V.5	D.VII.4	D.I.2	D.VI.1
D.I.1	D.I.3	D.I.4	D.III.3	D.V.1
D.V.4	D.VII.1	D.VIII.3		
ETLA Items with an Item Mean Score < 4.0				
D.II.1	D.II.2	D.II.3	D.II.4	D.IV.1
D.IV.2	D.IV.3	D.IV.4	D.VI.5	D.VI.6
D.III.1	D.III.2	D.III.5	D.I.5	D.VI.7
D.I.6	D.II.6	D.V.3	D.VII.2	D.V.2
D.VII.3				

list showing the items with mean scores greater or equal to 4.0 and those less than 4.0. Appendix G contains a complete listing of the descriptive statistics generated from the Expert Ranking Data Set, including item mean score, for each draft ETLA item.

Descriptive statistics were also generated using the Expert Assessment Data Set. The descriptive statistics associated with this data set can be found in Appendix H. This data set contained the experts' self-assessment results using the draft ETLA items. Again, the item mean score was an important statistic used in the analysis of the data. But given that number of observations obtained for each item from the expert pool was low (N=10) and the assumption that the experts would tend to rate themselves high on the five point scale, there was limited ability to draw findings from analysis of the descriptive statistics generated from the Expert Assessment Data Set. Given these limits, items D.II.6 and

D.VI.6 were found to produce the lowest item mean scores of all ETLA items. Both of these items had an item mean score of 3.90. On the rating scale used by the expert panel, the score of 3 indicated the extent to which the expert respondent provided the leadership function identified in the item was "somewhat". A score of 4 indicated they supported the task "significantly". Therefore, even the lowest item mean scores found in the Expert Assessment Data Set indicated the experts believed they were performing that item's associated leadership function to a significant extent.

Table 7 provides a listing of selected summary information from the mean score statistical analysis of the Expert Ranking Data Set and the Expert Assessment Data Set. The overall mean for the Expert Assessment Data Set indicates that the experts rated themselves high (> 4), in general. This finding suggests that the ETLA assessment identified expert technology leaders, but may not differentiate the education technology skill levels within a group of education technology leaders.

The findings from analysis of the Expert Ranking Data Set and the Expert Assessment Data Set provided evidence of the ETLA's face validity. And the analysis helped to indicate the degree to which both the TL Standards and the draft items were aligned. The analysis of the Expert Ranking Data Set and the Expert Assessment Data Set also helped to identify items that needed revision. Twenty-one items were identified based on their relatively low item mean score and were reviewed. Fifteen of those items were modified with the intention of producing a stronger alignment with the standard area they represented. Seven items were removed from the survey, and one item was added. Table 8 provides an inventory of the items changed from the draft version of the

Table 7. Expert Panel descriptive statistics summary.

Expert Reviewer Feedback (n=10)	Ranking Data Set	Assessment Data Set
Lowest Mean (single item)	2.40	3.90
Highest Mean (single item)	4.80	5.00
Lowest Std. Deviation (single item)	0.00	0.00
Highest Std. Deviation (single item)	1.150	0.738
Overall Mean	3.97	4.56

Table 8. ETLA item changes between draft and final ETLA versions.

Description	Item Identifier
Items not modified from draft to final	D.I.1, D.I.2, D.I.3, D.I.4, D.II.5, D.III.3, D.III.4, D.III.6, D.V.1, D.V.4, D.V.5, D.VI.1, D.VI.2, D.VI.3, D.VI.4, D.VII.1, D.VII.5, D.VIII.1, D.VIII.2, D.VIII.3, D.VIII.4, D.VIII.5
Items modified from draft to final	D.I.6, D.II.1, D.II.2, D.II.3, D.II.4, D.III.1, D.III.2, D.IV.1, D.IV.2, D.IV.3, D.IV.4, D.V.3, D.VI.5, D.VII.2, D.VII.4
Items deleted from draft to final	D.1.5, D.II.6, D.III.5, D.V.2, D.VI.6, D.VI.7, D.VII.3
Items added from draft to final	F.IV.5

ETLA survey to the final version. The final version of the ETLA survey contained thirty-eight items. A table showing a side by side comparison of the draft ETLA items and the final ETLA items can be found in Appendix I.

ETLA Survey Reliability

In this study a field test of the ETLA was conducted. A data set, referred to as the Field Test Data Set, was created during the field test. The information for the data set was obtained using the ETLA with a sample of educators of an urban Iowa school district. To obtain this data set, the final version of the ETLA survey was distributed as a web-based survey to 275 educators. Participants included district elementary, middle school, and high school educators from the primary job groups of principals, teachers, and building technology specialists.

ETLA responses were returned from 214 participants (78% return rate). This was considered by the researcher to be a high return rate. The high return rate was attributed to the fact that the ETLA survey's field test was incorporated into the district's technology planning process and that technology funding was contingent with the completion of the survey.

Descriptive statistics were generated using the Field Test Data Set. Included in the descriptive statistics was the number of responses (N) obtained for the item along with statistics describing the distribution of responses for each item (mean, standard deviation, and variance). The correlation of the responses for each item with all other items was calculated. This statistic is known as the item-rest value. The Cronbach Alpha for the data set if the item was removed (Alpha if removed) was also included in the collection of descriptive statistics. Appendix J provides a listing of the descriptive statistics.

The framework of the ETLA was composed of item scales containing items placed by the expert review panel into eight separate sub-scales. These eight item scales were based on the eight TL Standards. Cronbach's Alpha analysis of these ETLA item scales showed high reliability for each of the eight sub-scales: Leadership & Vision (α = 0.80); Planning & Designing Learning Environments (α = 0.84), Teaching, Learning & Curriculum (α = 0.77), Assessment and Evaluation (α = 0.82), Technology Operations and Concepts ($\alpha = 0.76$), Social, Ethical, Legal and Human Issues ($\alpha = 0.84$), Procedures, Policies, Planning & Budget ($\alpha = 0.80$), Productivity and Professional Practice ($\alpha = 0.71$). All item scales had Alpha scores higher than the acceptable cutoff of 0.60, which was interpreted as an indication of internally reliable item scales. It should be noted that although the alpha coefficients for each item scale are lower than the overall reliability ($\alpha = 0.97$), this is expected and is a function of an analysis on fewer items (Welkowitz et al., 2006).

An Alpha score was also generated for each item by removing the item's responses from the Alpha calculation. Variations in the resulting "Alpha if item removed" statistic could identify items influencing the Alpha calculation. No such indication was found from the Field Test Data Set, as "Alpha if item removed" remained at $\alpha = 0.97$ for all ETLA items.

Analysis of items within each ETLA item scale was conducted. Inter-scale correlations were considered an important indicator of an ETLA item's reliability in measuring the TL Standard it was aligned with. Strong correlation scores indicated strong reliability with the items in the scale.

To help summarize the data for analysis, the mean score for the inter-scale correlations was calculated for each standard area. These inter-scale scores could exist across a range of 0 to 1.0, with 1.0 indicating an extremely strong correlation. The Procedures, Policies, Planning & Budget (0.5080) and Social, Ethical, Legal and Human Issues (0.5146) standard areas had the highest mean scores. The ETLA items aligned with these standards showed the strongest inter-scale correlations. The Productivity and

Table 9. Means of inter-scale correlations from ETLA item scales

Item Scale	Mean
Overall	0.4644
Standard 1 – Leadership	0.4513
Standard 2 – Planning	0.508
Standard 3 – Teaching	0.4053
Standard 4 – Assessment	0.4695
Standard 5 – Operations	0.4351
Standard 6 – Social	0.5146
Standard 7 – Procedures	0.4885
Standard 8 – Productivity	0.33

Professional Practice (0.3300) standard area had the lowest inter-scale mean score. Table 9 lists the means of the inter-scale correlations for each standard area.

Item-rest correlations were used similarly to item-scale correlations as an indicator of ETLA item reliability. Item-rest correlations were generated by correlating each ETLA item with the rest of the ETLA items. These item-rest correlations showed how the item is correlated with a scale computed from all other items, minus the item under consideration. Using the Field Test Data Set, the range of item-rest correlations was $r = 0.32$ to $r = 0.82$. The generally accepted cutoff item-rest score for this analysis was 0.30 and so all items showed acceptable levels of internal reliability. Five items had item-rest scores less than 0.50 (F.III.1, F.III.2, F.V.1, F.VIII.2, and F.VIII.3).

The findings of this section contributed to evidence that ETLA items were performing reliably. Analysis of the reliability of the ETLA standard scales would be bolstered by additional items in each standard area. However, any analysis and conclusions based on a scale of 4 to 6 items must be approached with caution (Avolio & Bass, 2002). Generally, a sub-scale consisting of 20 or more items is necessary to draw conclusions about a dimension's reliability (Hinkle et al., 2003; Rea & Parker, 2005). Additional trials of the ETLA would be required for a more rigorous evaluation and assessment of the ETLA's reliability.

ETLA Survey Validity

The Field Test Data Set was used in generating results designed to support the examination of the statistical validity of the ETLA survey. Three assessments designed to aid in the review of ETLA item validity were conducted: (1) a job group comparison of TL Standards item scale means, (2) a matched data set comparison, and (3) a review of Not Applicable responses for each ETLA item. Findings from these analyses are reported in this section.

Job Group Comparison Results

By the nature of their job, principals, technology specialists, and teachers would be expected to exhibit different levels of education technology leadership. If ETLA items generated responses indicating differences for these job groups a claim for construct validity of the ETLA would be supported. To explore this, an analysis was conducted using the Field Test Data Set. Respondents were classified into three job groups: teachers, technology specialists, and principals. Mean scores for each job group for each standard area were calculated. The results of the mean score calculations are listed in Table 10.

As indicated by the data in Table 10, Principals as a group had the highest overall mean scores for five of the eight TL standard areas. The Principals rated themselves the highest in the TL Standard area of teaching, which could correspond to their role as

Table 10. Field Test Data Set group means by standard area.

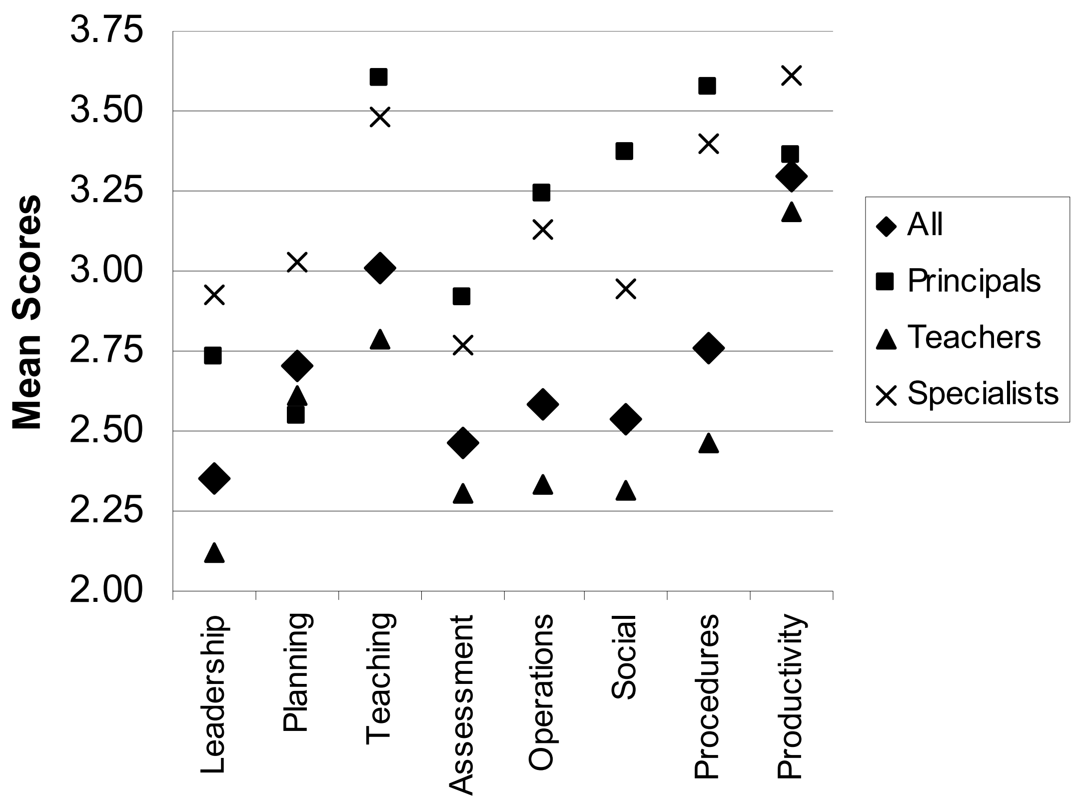
	Group			
Standard	All	Principals	Teachers	Technology Specialists
Leadership	2.35	2.74	2.12	2.93
Planning	2.70	2.54	2.61	3.03
Teaching	3.01	3.60	2.78	3.49
Assessment	2.46	2.92	2.31	2.77
Operations	2.59	3.24	2.33	3.13
Social	2.54	3.37	2.31	2.94
Procedures	2.76	3.58	2.46	3.40
Productivity	3.30	3.36	3.19	3.61

instructional leader. Building Technology Specialists as a group had the highest overall mean scores for three standard areas: Leadership, Planning, and Productivity. This could indicate the Building Technology Specialists had a relatively high sense of ownership for these technology leadership areas. Figure 5 provides a graphical representation of the job group mean score data.

Matched Data Results

Using results generated from the field test of the ETLA survey, a paired data set was generated. This data set contained matched ETLA responses from selected principals with responses from selected teachers. This data set was referred to in this study as the Matched Data Set. Twenty five Teachers from the field test population were paired with

Figure 5. Comparison of job group means by TL standard



their job supervisor; i.e. their Principal. The Teachers were asked to use the ETLA survey as a self-assessment of their education technology leadership skills. The Principals were asked to use the ETLA survey to assess the education technology leadership of the educator they were paired with. Nineteen paired samples (76% return rate) were collected and placed in the Matched Data Set.

Mean scores were calculated for each group (Principals and Teachers) for each TL Standard area. For all TL Standards, Principals had higher overall item scale mean scores. Table 11 lists the item scale mean scores for each group, and Figure 6 provides a graphical representation of the data.

The a priori hypothesis for the Matched Data Analysis was item mean scores for Principals and Teachers in the Matched Data Set would be correlated. The assumption was that, while the matched Principals and Teachers may not rate themselves identically on the six point ETLA rating scale, they would tend to consistently mark similar high and low ratings across the items, which would produce strong correlations for the items in the Matched Data Set. As can be seen in Figure 6, Principals did consistently have higher item scale mean scores for all eight TL Standard areas. However, when the correlation between each matched ETLA item was calculated, no strong ($r > .6$) correlations were found. Appendix K lists the paired item correlations.

This finding does not necessarily refute ETLA item construct validity. The results could be attributed to the small (N=19) Matched Data Set sample size, or to a lack of a common and shared understanding between the Principals and Teachers of the elements of education technology leadership. In summary, the consistency found in the item scale mean scores provided limited evidence of ETLA item validity. More analysis with additional data would be required in order to develop stronger conclusions.

Not Applicable Results

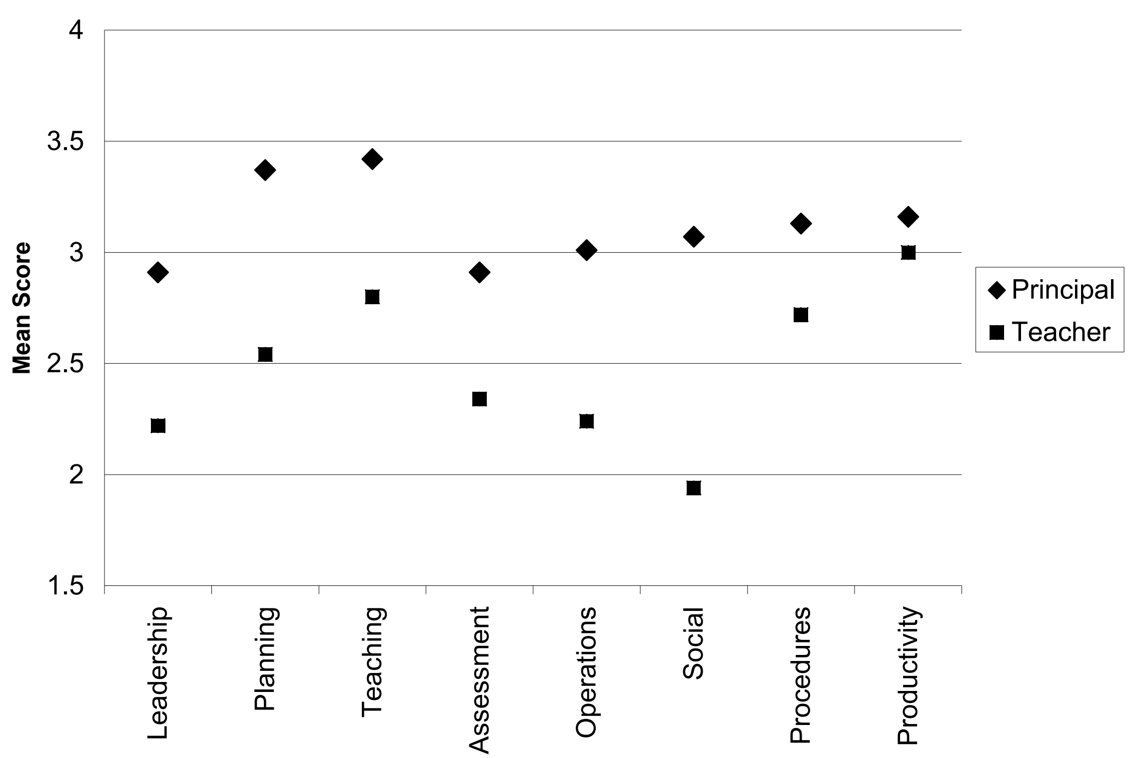
Respondents were provided the option of selecting a *Not Applicable* response on each ETLA survey item. These observations were coded as missing data in all SPSS statistical analysis used in this study. This resulted in a range of observations (N) for each item, from N=176 to N=214. This was a discrepancy of 38 (18%) of responses at the item level. The number of responses with no missing values was N=114.

The construct hypothesis for this analysis was that responses of Not Applicable for an ELTA item could indicate evidence of lower content validity for that item.

Table 11. Matched Data Set group means by standard area.

Standard	Principal	Teacher
Leadership	2.91	2.22
Planning	3.37	2.54
Teaching	3.42	2.80
Assessment	2.91	2.34
Operations	3.01	2.24
Social	3.07	1.94
Procedures	3.13	2.72
Productivity	3.16	3.00

Figure 6. Comparison of matched mean scores by TL standard



Participant demographics, such as job assignment, could also influence a respondent in marking an ETLA item Not Applicable. For example, Building Technology Specialists might be more inclined than Teachers to view the ETLA items applicable to their job responsibilities.

A threshold was set by the researcher to help establish high not-applicability. ETLA items that had five percent or more of the total Not Applicable responses for a job group (Principal, Building Technology Specialist, Teacher) were identified in this study as having high Not Applicable responses. Using this measure, seven items in the Principal job group, six items in the Building Technology Specialist job group, and four items in the Teacher job group were identified as high. ETLA items F.I.3 and F.V.3 were identified as showing high not-applicability for all three job groups. ETLA items F.V.3, F.VII.2, and F.VII.3 were identified as showing high not-applicability for two of the three job groups. Table 12 lists the items with high Not Applicable responses desegregated by job group.

Participant knowledge of the technology leadership elements measured by the ETLA survey was assumed to be inherent in the participants prior to the study. In other words, no effort was made in this study to coach or instruct participants about education technology leadership. Therefore, the results found in the Not Applicable analysis would support a claim for item construct validity. Participants' appeared to understand the items and apparently found the majority of education technology leadership indicators relevant to their job.

Table 12. ETLA items with high not applicable responses by job group.

Job Group	Item						
Principals	F.I.3	F.V.3	F.VI.1	F.VI.2	F.VI.3	F.VII.2	F.VII.3
Technology Specialists	F.I.3	F.II.1	F.V.3	F.V.4	F.VII.1	F.VII.2	
Teachers	F.I.2	F.I.3	F.V.3	F.VII.3			

Exploratory Factor Analysis

In behavioral science research factor analysis is typically used for data reduction and/or data structure detection (Kim & Mueller, 1978b). Exploratory factor analysis (EFA) is a form of factor analysis methodology that is generally used to discover the factor structure of a measure and to examine the measure's internal reliability. In this study EFA was used to help the researcher identify the inter-relationships inherent in the Field Test Data Set. EFA was also used to identify ETLA items that may not be contributing to the survey in a significant way. This section will report the findings from an analysis of EFA results.

In the EFA conducted for this study, statistics were generated to provide an indication of the suitability of the Field Test Data Set for factor analysis. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity results both provided evidence of the suitability of the data set for EFA. KMO tested whether the partial correlations among items were small. High values (close to 1.0) would generally indicate that a factor analysis may be useful for the data set (Kim & Mueller, 1978b). If the value is less than 0.50, the results of the factor analysis would be less useful. The KMO value generated for the Field Test Data Set was 0.920. This indicated the data set might be useful for factor analysis.

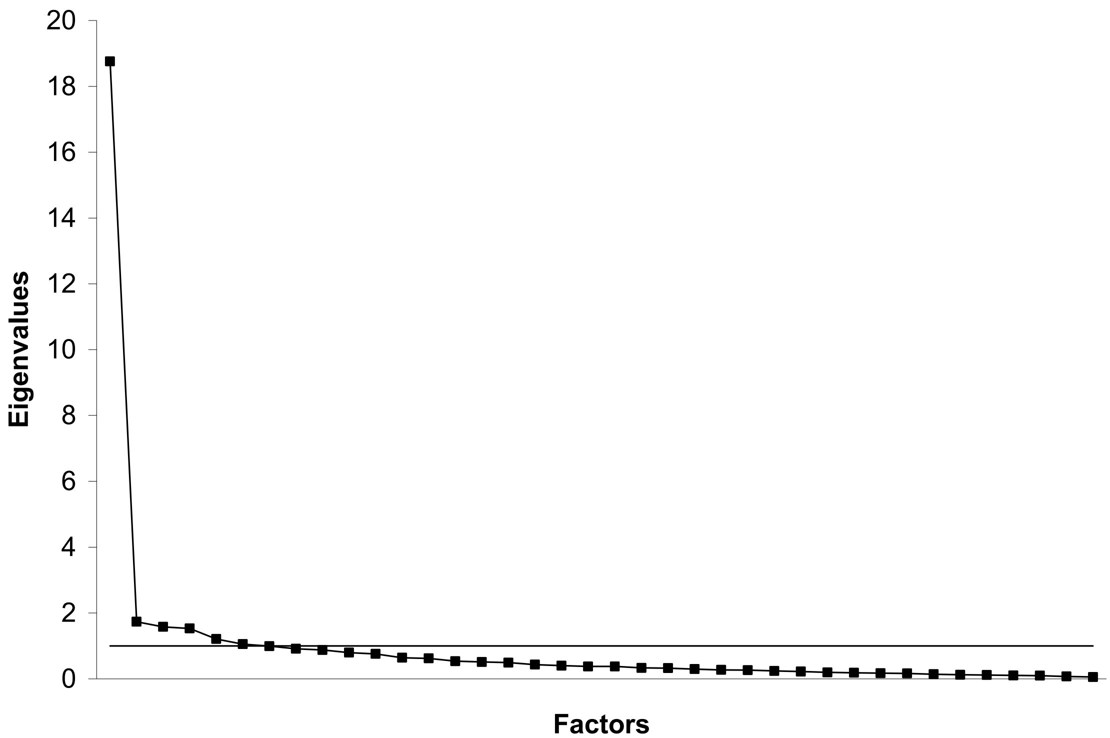
The Bartlett's Test of Sphericity tested the hypothesis that the correlation matrix was an identity matrix (Kim & Mueller, 1978b). If the correlation matrix was an identity matrix, this would have indicated that the variables are unrelated and therefore unsuitable for structure detection. Small values (less than 0.05) of significance would indicate that a factor analysis may be useful with the data set. The Bartlett's value generated for the Field Test Data Set was 0.000. This indicated the data set might be useful for factor analysis.

An a priori theory in this study related to data inter-relationships was identified in the literature review of work by the authors of the TL Standards. The authors speculated that themes coexisted within the TL Standards. EFA methods are useful in detecting structure in data, and so EFA methods lent themselves to the task of exploring the inter-relationships between the TL Standards. The factors that emerged from the EFA would represent potential education technology themes of interest.

For this study, factor analysis was performed using the SPSS program, using the SPSS Data Reduction selection with the settings of Principal Axis Factoring and Varimax rotation. These settings generated six factors with eigenvalues greater than 1, as can be seen in the Scree plot shown in Figure 7. These top six factors accounted for 68% of the variance in the Field Test Data Set. Using the Kaiser-Guttman rule described in Chapter 3, these six factors were carried forward for further EFA examination.

The next step in the EFA methodology was to label the factors. This was done by examining the factor loadings with the greatest absolute value scores for each factor. The

Figure 7. ETLA Field Test Data Set Scree plot.



items with the greatest absolute value score are said to "load high". Items that loaded high were used as indicators of the nature of the factor, and a descriptive label for the factor was created by the researcher using the high loading items as a guide.

For this study, the score of 0.40 was used as the mark for the identification of high factor loadings. The factor loadings for the factors generated with the SPSS statistical program were reported in a table called the Rotated Factor Matrix. A copy of this matrix is found in Appendix L.

Factor 1 generated by the factor analysis had 15 items that loaded with an absolute value score greater than 0.40, and 5 of these items loaded with an absolute value greater than 0.60. Table 13 lists the items, scores, and item descriptions that loaded high on Factor 1. The high loading variables seemed to share the characteristics of resource allocation and budgeting. The highest loading items on this factor were items that had been aligned with TL Standard 7 (Procedures) and TL Standard 5 (Operations). Many of the high loading items were related to resource and procurement planning, which are typically elements of the budgeting process. Factor 1 was labeled “Budgeting”.

Figure 8 is a diagram designed to depict the relative strength of the TL Standard item loadings on the Budgeting factor. The thickness of the arrowed lines connecting a TL Standard with the factor indicates the number of items that loaded on the item. The thicker lines indicate more items from that TL Standard area loading high on the factor. The identifiers for the high loading items are listed in each TL Standard oval. For example, in Figure 8, TL Standard 1 (Leadership) has two items, F.I.1 and F.I.3, which load high on the Budgeting factor.

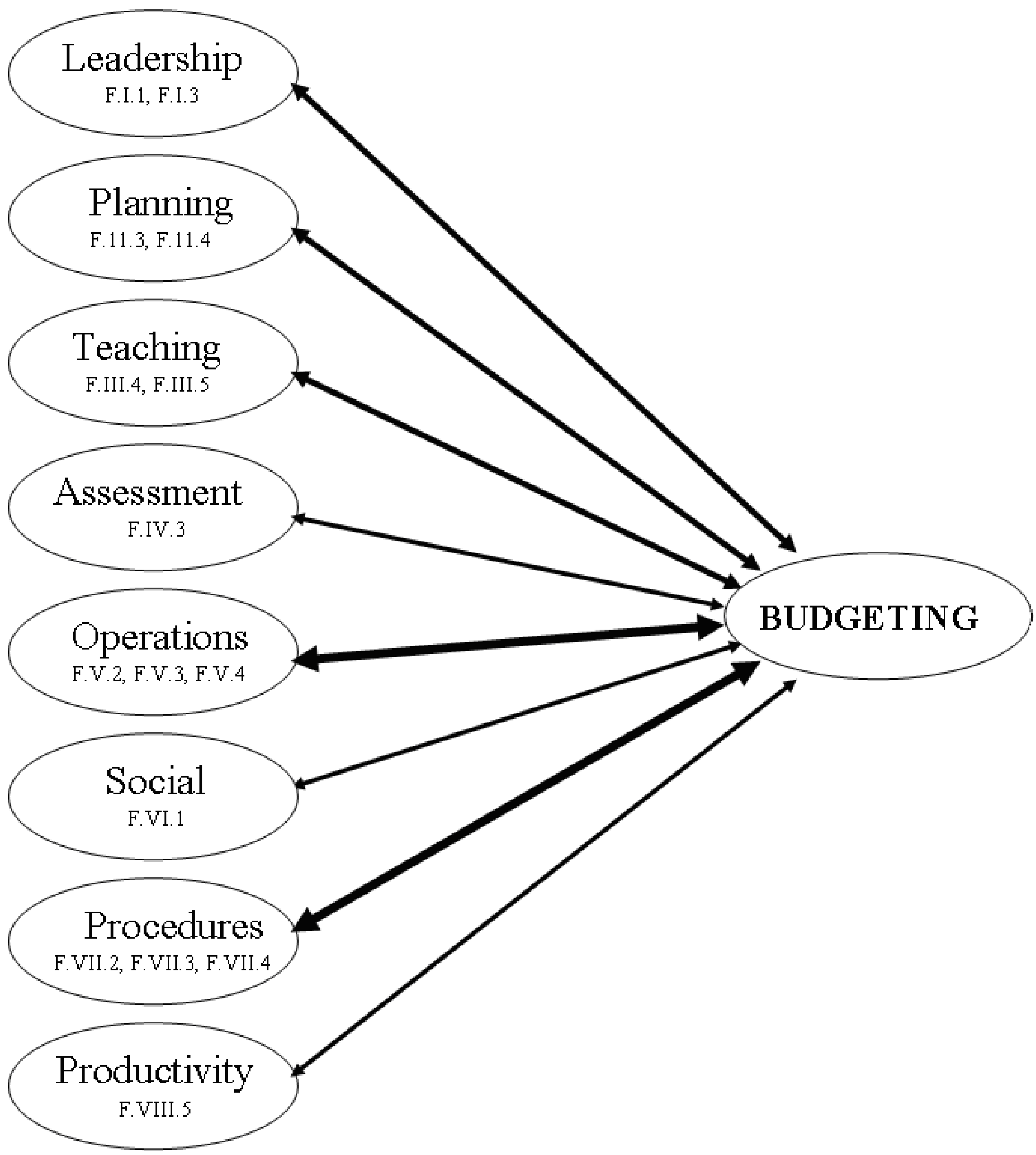
The high loading items form the item scale that represents the Budgeting factor. By definition, the responses for these items were highly correlated in the Field Test Data Set. As can be seen in Figure 8, all TL Standard areas had at least one item that loaded high on the Budgeting factor, indicating the factor is multidimensional in relation to the TL Standards. TL Standard 5 (Operations) and TL Standard 7 (Procedures) tied with the most number of items loading on the Budgeting factor, with three each.

Factor 2 generated by the factor analysis had 15 items that loaded with an absolute value score greater than 0.40, and 3 of these items loaded with an absolute value greater than 0.60. Table 14 lists the items, scores, and item descriptions that loaded high on Factor 2. The high loading items shared the characteristics of classroom instruction development and planning. The highest loading items were items that had been aligned with TL Standard 2 (Planning) and TL Standard 3 (Teaching). Because many of the high

Table 13. ETLA items with high factor loadings on Budgeting factor.

Item	Item Loading	Item Description
F.VII.2	0.748	Procedures - Contribute to technology budget plan.
F.VII.4	0.710	Procedures - Participate in building technology planning.
F.V.3	0.681	Operations - Ensure upgrade efforts.
F.VI.1	0.623	Social - Ensure equity of technology access.
F.IV.3	0.602	Assessment - Evaluate existing systems.
F.I.3	0.599	Leadership – Promote participation of others.
F.V.4	0.583	Operations - Advocate for technology support resources.
F.III.5	0.486	Teaching - Support professional development.
F.III.4	0.485	Teaching - Receive collaboration from colleagues.
F.VII.3	0.484	Procedures - Follow technology related rules.
F.VIII.5	0.457	Productivity - Evaluate technology for own job suitability.
F.II.3	0.443	Planning - Locate new technology resources.
F.II.5	0.429	Planning - Plan management of learning with technology.
F.I.1	0.424	Leadership - Participate in district technology planning.
F.V.2	0.413	Operations - Pursue added funding.

Figure 8. Diagram of TL Standards and Budgeting factor relationships.



loading items for this factor were associated with elements of instructional planning, Factor 2 was labeled "Planning".

Figure 9 depicts the relative strength of the TL Standard item loadings on the Planning factor. As can be seen in Figure 9, six TL Standard areas had at least one item that loaded high on the Planning factor. In terms of the TL Standards, this factor would be considered multidimensional. TL Standard 2 (Planning) and TL Standard 4 (Assessment) tied with the most number of items loading on the Planning factor, with four each.

Factor 3 generated by the factor analysis had 11 items that loaded with an absolute value score greater than 0.40, and 1of these items loaded with an absolute value greater than 0.60. Table 15 lists the items, scores, and item descriptions that loaded high on Factor 3. The high loading variables shared the characteristics of rulemaking and planning related to policy development. The highest loading items were items that had been aligned with TL Standard 6 (Social) and TL Standard 4 (Assessment). Many of the high loading items for this factor had ties to policy development, and so Factor 3 was labeled "Policymaking".

Figure 10 depicts the relative strength of the TL Standard item loadings on the Policymaking factor. As can be seen in Figure 10, six TL Standard areas had at least one item that loaded high on the Policymaking factor. In terms of the TL Standards, this factor would be considered multidimensional. TL Standard 6 (Social) had the most number of items loading high on the Policymaking factor, with four.

Table 14. ETLA items with high factor loadings on the Planning factor.

Item	Item Loading	Item Description
F.II.2	0.663	Planning - Apply research to tech instruction
F.III.3	0.636	Teaching - Collaboration with colleagues
F.II.4	0.609	Planning - Plan management of technology integration
F.II.5	0.560	Planning - Plan management of learning with technology
F.I.5	0.560	Leadership - Engage technology best practices
F.IV.2	0.553	Assessment - Evaluate instructional practice
F.III.4	0.553	Teaching - Receive collaboration from colleagues
F.VIII.4	0.533	Productivity - Advocate for technology in SIP
F.II.3	0.531	Planning - Locate new technology resources
F.IV.3	0.470	Assessment - Evaluate existing systems
F.IV.5	0.468	Assessment - Use measures to guide tech use
F.VII.1	0.465	Procedures - Use technology resources in instruction
F.IV.4	0.433	Assessment - Evaluate professional development
F.I.4	0.424	Leadership - Align technology plans with SIP
F.VI.5	0.403	Social - Support use of technology for all students

Figure 9. Diagram of TL Standards and Planning factor relationships.

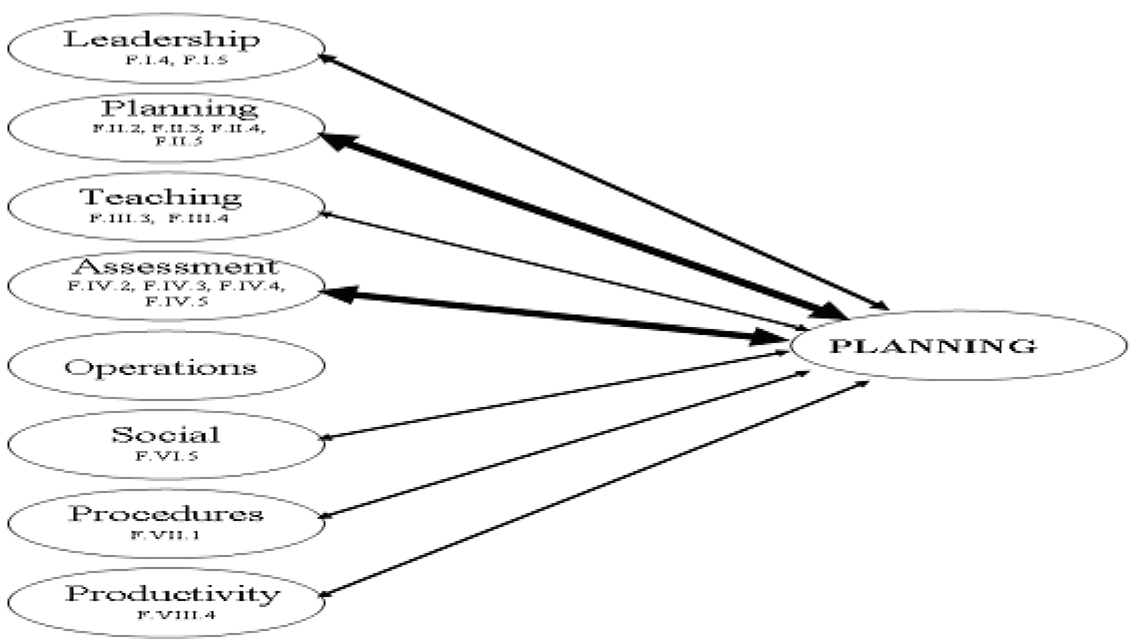
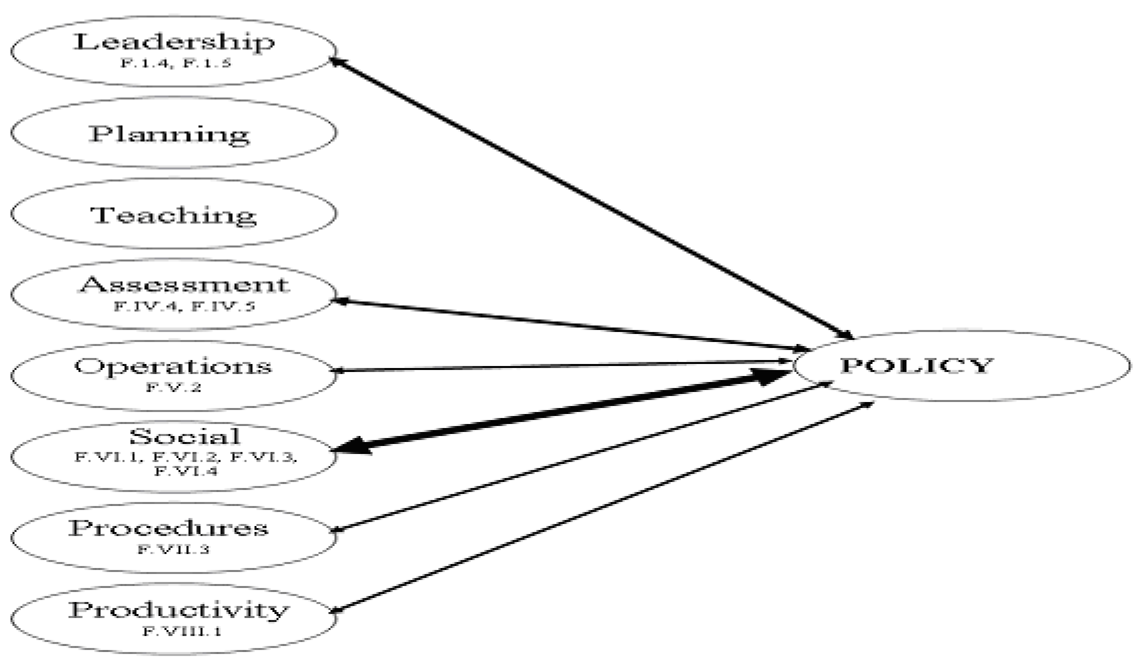


Table 15. ETLA Items with high factor loadings on Policy factor.

Item	Item Loading	Item Description
F.VI.4	0.689	Social - Involved in privacy and online safety.
F.IV.5	0.553	Assessment - Use measures to guide tech use.
F.VI.2	0.550	Social - Raise awareness of technology social issues.
F.I.4	0.506	Leadership - Align technology plans with SIP.
F.VIII.1	0.500	Productivity - Improve own technology knowledge
F.IV.4	0.468	Assessment - Evaluate professional development.
F.V.2	0.460	Operations - Pursue added funding.
F.VI.1	0.451	Social - Ensure equity of technology access in building.
F.VI.3	0.441	Social - Enforce copyright rules.
F.VII.3	0.426	Procedures - Follow rules related to tech use and procurement.
F.I.5	0.410	Leadership - Engage technology best practices.

Figure 10. Diagram of TL Standards and Policy factor relationships.



Factor 4 generated by the factor analysis had 5 items that loaded with an absolute value score greater than 0.40, and 2 of these items loaded with an absolute value greater than 0.60. Table 16 lists the items, scores, and item descriptions that loaded high on Factor 4. The high loading variables shared the characteristic of data-driven decision making to help inform instruction. The highest loading item was an item that had been aligned with TL Standard 3 (Teaching). Factor 4 was labeled “Data-driven”.

Figure 11 depicts the relative strength of the TL Standard item loadings on the Data-driven factor. As can be seen in Figure 11, four TL Standard areas had at least one item that loaded high on the Data-driven factor. TL Standard 4 (Assessment) had the most number of items loading high on the Data-driven factor, with two.

Factor 5 generated by the factor analysis had 5 items that loaded with an absolute value score greater than 0.40, and 1 of these items loaded with an absolute value greater than 0.60. Table 17 lists the items, scores, and item descriptions that loaded high on Factor 5. The high loading variables share the characteristics of classroom efficiency and productivity. The highest loading item was an item that had been aligned with TL Standard 2 (Planning). Based on the researcher’s observation that the high loading items for this factor were related to the use of technology to improve instructional efficiency, Factor 5 was labeled “Efficiency”.

Figure 12 depicts the relative strength of the TL Standard item loadings on the Efficiency factor. As can be seen in Figure 12, five TL Standard areas had one item that loaded high on the Efficiency factor.

Table 16. ETLA items with high factor loadings on Data Driven factor.

Item	Item Loading	Item Description
F.III.2	0.688	Teaching - Assist others in using data to inform instruction.
F.IV.1	0.609	Assessment - Collect student data.
F.V.1	0.520	Operations - Support connecting to technology resources.
F.IV.2	0.445	Assessment - Evaluate instructional practice.
F.I.2	0.434	Leadership - Communicate technology plan information.

Figure 11. Diagram of TL Standards and Data Driven factor relationships.

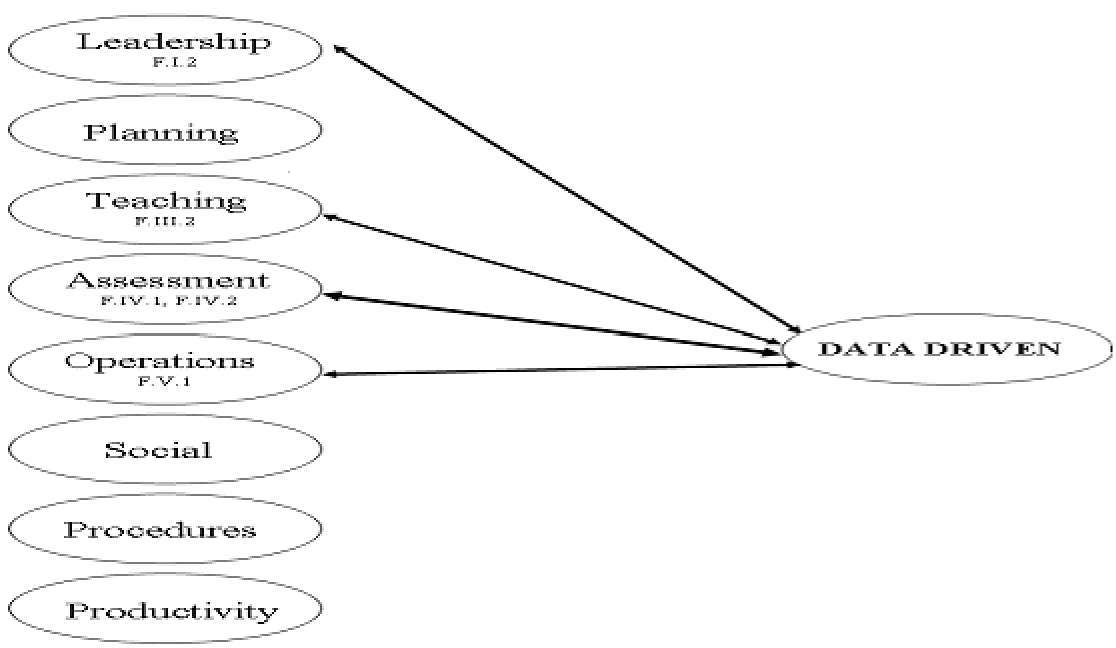
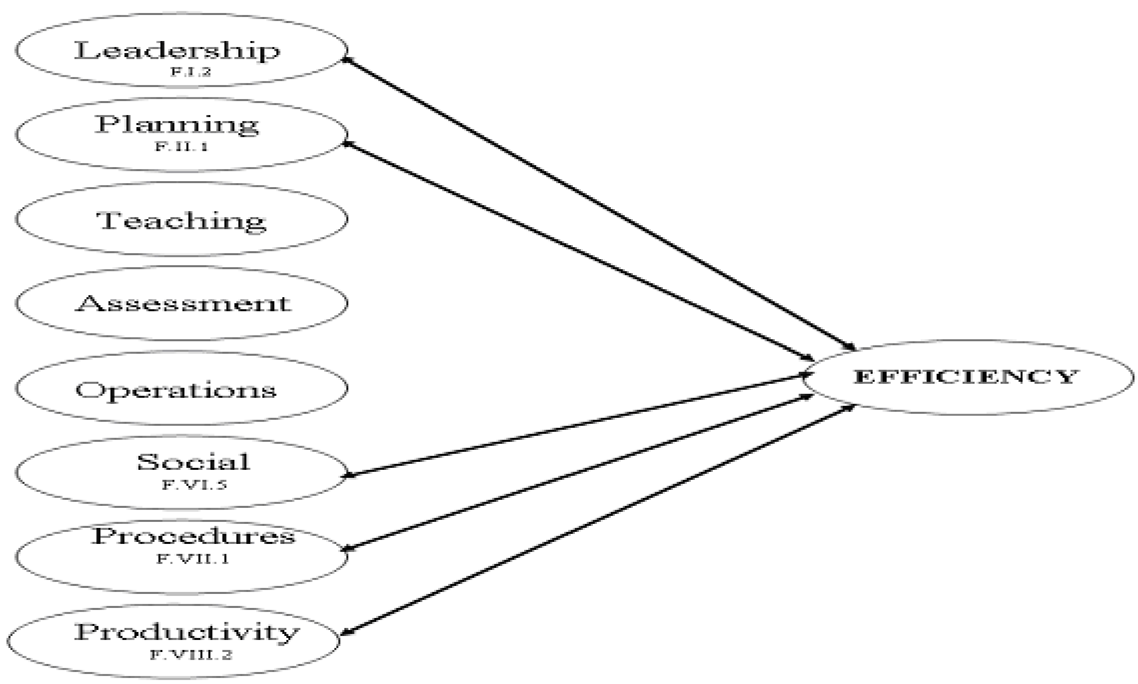


Table 17. ETLA items with high factor loadings on Efficiency factor.

Item	Item Loading	Item Description
F.II.1	0.618	Planning - Design technology integrated instruction.
F.VIII.2	0.577	Productivity - Use technology in day to day tasks.
F.I.2	0.515	Leadership - Communicate technology plan information.
F.VII.1	0.483	Procedures - Use technology resources in instruction.
F.VI.5	0.406	Social - Support use of technology for all students.

Figure 12. Diagram of TL Standards and Efficiency factor relationships.



Factor 6 generated by the factor analysis had 3 items that loaded with an absolute value score greater than 0.40. Table 18 lists the items, scores, and item descriptions that loaded high on Factor 6. The researcher's observation was that the high loading variables shared the characteristics of collaboration and communication. The highest loading items were items that had been aligned with TL Standard 8 (Productivity). Based on the observation of the common characteristics of the high loading items, Factor 6 was labeled "Communication".

Figure 13 depicts the relative strength of the TL Standard item loadings on the Communication factor. As can be seen in Figure 13, two TL Standard areas had at least one item that loaded high on the Communication factor. TL Standard 8 (Productivity) had the most number of items loading high on the Communication factor, with two.

EFA is commonly used to identify underlying structures in data based on correlations between data items. The EFA methods used in this study identified six factors, or themes. Figure 14 shows the interrelationships of TL Standards with the themes that emerged from the EFA. The figure demonstrates how multiple TL Standards contributed to multiple factors (themes).

EFA is also useful for data reduction purposes. The interest in pursuing data reduction is to determine if the assessment of education technology leadership could be done with fewer survey items with similar effectiveness. The previous observation that items associated with multiple TL Standards are loading on multiple factors would indicate the potential for education technology leadership to be assessed with similar effectiveness with fewer ETLA items. For this study, the consideration of the data reduction aspect of EFA methods relied on the examination of factor loadings to

Table 18. ETLA items with high factor loadings on Communication factor.

Item	Item Loading	Item Description
F.VIII.3	0.517	Productivity - Use technology to communicate.
F.VIII.5	0.411	Productivity - Evaluate technology for own use.
F.III.4	0.403	Teaching - Receive collaboration from colleagues.

Figure 13. Diagram of TL Standards and Communication factor relationships.

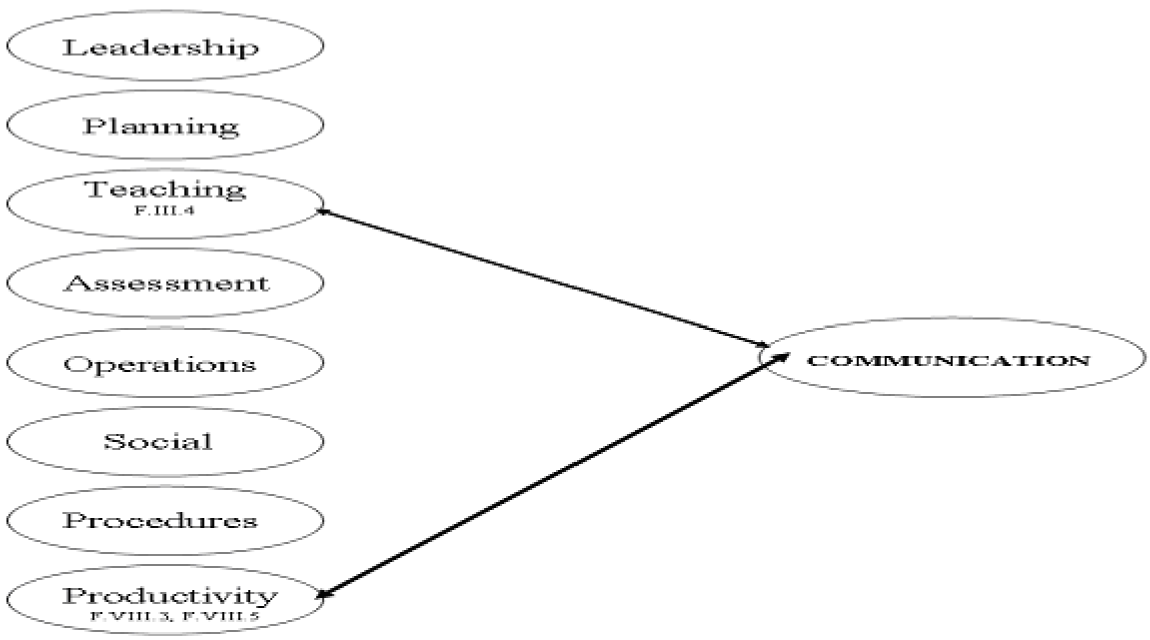


Figure 14. Diagram of TL standards and factor relationships.

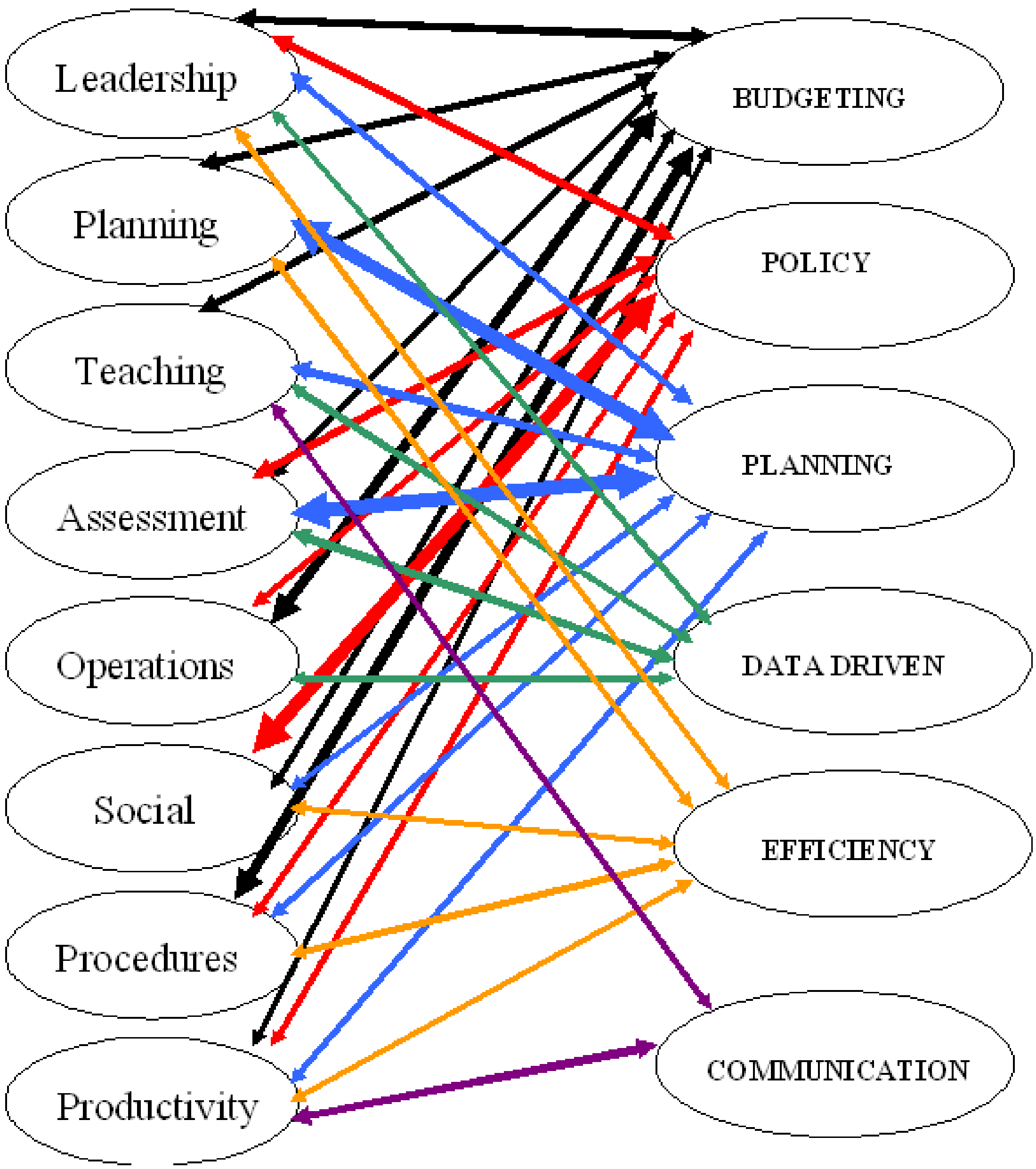


Table 19. Classification of ETLA items by their high factor loadings.

ETLA items loading high (>= 0.40) on multiple factors.					
F.I.2	F.I.4	F.I.5	F.II.3	F.II.5	F.III.4
F.IV.2	F.IV.3	F.IV.4	F.IV.5	F.V.2	F.VI.1
F.VI.5	F.VII.1	F.VII.3	F.VIII.5		
ETLA items loading high (>= 0.40) on only one factor.					
F.I.1	F.I.3	F.II.1	F.II.2	F.II.4	F.III.2
F.III.3	F.III.5	F.IV.1	F.V.1	F.V.3	F.V.4
F.VI.2	F.VI.3	F.VI.4	F.VII.2	F.VII.4	F.VIII.1
F.VIII.2	F.VIII.3	F.VIII.4			
ETLA items not loading high (< 0.40)					
F.VIII.5					

determine items that loaded high on one factor, items that loaded high on multiple factors, and items that did not load high on any factor. Table 19 provides a listing of ETLA item classification by these criteria.

As shown in Table 19, examination of the EFA results found 21 items that loaded high on only one factor. Sixteen (16) ETLA items were found with high loadings on multiple factors. One ETLA item, F.VIII.5, did not load high on any of the top six factors. This finding would indicate that this item should be reviewed for either revision or elimination in future versions of the ETLA survey. ETLA items that loaded high on only one factor were strong indicators for that particular factor. If a data reduction goal was to reduce the number of ETLA items and still measure each factor independently, the items that loaded high on only one factor would be the strongest candidates for inclusion in the reduced collection of items.

In comparison, the ETLA items that loaded high on multiple factors would be strong indicators of education technology leadership in general. If a goal was to reduce the number of ETLA items and still measure overall education technology leadership, the items that loaded high on multiple factors would be the strongest candidates for inclusion in the reduced collection of items.

In the examination of factor loadings in this study it was important to recognize the limits of conducting factor analysis based on one data set (Kline, 1994). Rigorous EFA requires the analysis of multiple data sets. While the EFA methods used in this study produced evidence of inter-relationships in the data collected in the ETLA field test, additional data sets would need to be collected and analyzed using EFA methods to confirm (or refute) these initial findings.

Summary

Results for this study were collected in support of the two main phases of the study, the expert review phase and the field test phase. The expert review phase was designed to assist the researcher with the construction of ETLA survey items that would be valid measures of specific TL Standard areas. The field test phase was designed to collect data to be used in the analyses of the reliability and the validity of the ETLA survey items. Data collected in the field test was also examined for inter-relationships, using exploratory factor analysis (EFA).

Using feedback obtained from the expert judgment panel, the 44 draft ETLA items were refined, consolidated, and aligned with one of eight TL Standards. The result at the conclusion of this editing process was the final version of the study's ETLA survey. The ETLA survey was based on a framework of eight dimensions (TL Standards). Each TL Standard area was represented by 4-5 ETLA items. There were a total of 38 items in the final ETLA survey. This version of the ETLA survey was used in a field test.

A Field Test Data Set and a Matched Data Set were created from a field test of the ETLA with a sample population of educators, and used to support quantitative statistical methods designed to study the reliability and validity of ETLA survey items. Item-scale correlation, item-rest correlation, Alpha if item removed analysis, and item mean score comparisons were the statistical methods used to generate the findings reported related to ETLA item reliability and validity. Analysis of the Field Test Data Set produced evidence that ETLA items were generating reliable and valid data.

Inter-relationships in the Field Test Data Set were explored using EFA methods. Reported EFA findings were centered on the identification of six factors. All ETLA items except item F.VIII.5 loaded high on one or more factors, indicating that most ETLA items were contributing effectively to the assessment.

Chapter 5 will contain a discussion of these findings. In Chapter 5 the findings will be connected to the review of literature. Action steps in response to the findings will also be explored.

CHAPTER 5. SUMMARY AND DISCUSSION

This chapter presents a summary of the study along with conclusions drawn from findings presented in Chapter 4. Included in this chapter is a discussion of the implications of these findings for action as well as recommendations for further research.

Summary of the study

This study worked within the field of education technology leadership. The purpose of this study was to develop and validate a survey instrument based on the International Society for Technology in Education's (ISTE) education technology leadership standards. A survey, the Education Technology Leadership Assessment (ETLA) was developed that was designed to assess the extent of the education technology leadership of the survey respondent. The instrument was designed to be used as a web based, self-assessment survey tool. The methods of the study incorporated the use of an expert judgment panel to assist in survey item creation and validation. A field test of the ETLA was conducted and the results from the field test were used to generate findings related to the reliability and validity of the ETLA instrument. Exploratory factor analysis (EFA) was also performed in order to identify underlying structures and patterns in the data gathered in the field test.

Overview of the problem

Education technology leadership has been found to be an important element in the integration of technology with education. Standards that describe the skills required by education technology leaders have been developed. The ISTE Technology Leadership (TL) Standards are an example. The development of an instrument designed to assess the extent to which an individual or group possess education technology leadership skills would be useful to those interested in the development and study of education technology leadership. The purpose of this study was to develop a reliable and valid assessment of education technology leadership as defined by the ISTE TL Standards that could be used to contribute to the study and development of education technology leadership. The ETLA was designed to address this need.

Review of the methodology

The study was organized into two phases. In Phase 1, an expert judgment panel of existing education technology leaders was formed. The panel consisted of school technology coordinators with education technology leadership credentials. The expert panel reviewed potential survey items and rated their alignment with the TL Standards using a five point scale. In addition to providing an indication of the content validity of the draft ETLA items the feedback gathered from the expert panel assisted the researcher in the refinement and alignment of the items with the eight TL Standards. At the conclusion of Phase 1, the ETLA had been narrowed from 44 draft survey items to 38 survey items. Six of the TL Standard areas were each represented by scales of 5 items, and the other two TL Standard areas were each represented by 4 item scales.

Phase 2 of the study involved a field test of the ETLA. The field test of the survey was conducted with a convenience sample of educators from the Des Moines Public School District, an urban district of approximately 32,000 students located in Des Moines, Iowa. The information collected in the field test was used to statistically evaluate the reliability and validity of the ETLA survey and to examine the underlying data structures inherent in the data set generated by the ETLA survey.

Across the two phases of this study were the following accomplishments:

1. A literature review was conducted of current and emerging education technology leadership standards and sources. This review provided information that aided the researcher in the construction of draft ETLA survey items.
2. The creation of final form survey items using the assistance of an expert panel was conducted and completed.
3. Collection of data from a convenience sample population of 300 participants through a field test of the survey was completed. The data obtained was used in analyses of the ETLA survey's reliability and validity. The structure of the data set was also examined using exploratory factor analysis methods.

Major findings

The study's primary purpose was to create a reliable and valid education technology leadership survey tool. Major findings that provided evidence of ETLA survey reliability and validity emerged from both the expert judgment panel review phase and the field test phase of this study.

Expert Panel

The main findings from the study's work with the expert judgment panel were related to the face validity of ETLA items. The expert panel's primary purpose was to review draft ETLA items and rate each item's alignment with a technology leadership standard. Results from the work of the expert panel provided evidence to support a claim of alignment of ETLA survey items with the TL Standards. For example, all 44 draft items had expert panel ratings higher than 3 on a five point scale. The score of 3 was associated with the opinion that the item was "Somewhat" aligned with the TL Standard. Twenty three items had expert panel ratings higher than 4 on the five point scale. The score of 4 was associated with the expert opinion that the item was “Strong” in it’s alignment with the TL Standard. These findings indicated to the researcher that the expert panel believed the draft ETLA items were all at least somewhat aligned with a TL Standard. Using this information, the researcher worked to strengthen ETLA item alignment with the TL Standards. Using the feedback from the expert panel, the researcher reviewed and revised 21 draft ETLA items, and in doing so created the study’s final version of the ETLA survey.

Reliability and Validity

Several major findings concerning the reliability and validity of the ETLA survey were discovered based on the results reported from the field test phase of the study. Measures of survey reliability provided an indication that the survey would produce similar results for similar sets of respondents. If the ETLA was to be used to compare groups of respondents, it’s was important that ETLA results were reliable so that the comparisons are fair and accurate. To examine ETLA survey reliability, Cronbach’s Alpha (Alpha) statistics were generated for the survey using a data obtained in a field test of the ETLA survey. For this study, Alpha scores above 0.70 were considered to provide a strong indication of reliability. Alpha scores were created for the survey overall, and for each item scale within the survey. The survey overall had an alpha score of $\alpha = 0.97$. Within the survey, seven of eight item scales had an alpha score greater than 0.75. The Alpha scores found through the analysis of the field test data provided evidence that the ETLA items were generating statistically reliable results.

The Productivity and Professional Practice item scale showed the lowest reliability compared to the other item scales. Even though this item scale’s Cronbach

Alpha score (α = 0.71) was acceptable, it was the lowest of all item scale Alpha scores. Also, all ETLA items that had been aligned to the Productivity and Professional Practice standard had item-rest correlations lower than 0.5. And the mean score for the inter-scale correlations within this standard area was the lowest of all eight of the ETLA item scales. These measures provided evidence to the researcher that the reliability measures associated with the Productivity and Professional Practice item scale were lagging behind the other seven item scales.

The ETLA was modeled after an education technology leadership survey designed for school administrators, called the Principal Technology Leadership Survey (PTLA) (Center for the Advanced Study of Leadership in Education, 2005). Where the ETLA was based on NETS TL Standards (Twomey et al., 2006), the PTLA was based on the NETS-A Standards (ISTE, 2004). Both standard sets included a Productivity and Professional Practice standard. It is interesting to note that PTLA results for Productivity and Professional Practice showed lower reliability, similar to the ETLA.

One possible explanation for the lower reliability of the Productivity and Professional Practice item scale is that the respondents may have had lower consensus as a group about the nature of the standard area. A lack of a common understanding of the standard area could have resulted in more varied responses, which would tend to generate lower reliability scores.

Even though they were lower, the reliability indicators for the Productivity and Professional Practice scale were within acceptable ranges. However, the indication of a lower reliability of the Productivity and Professional Practice scale when compared to the seven other standard areas indicate that, although the ETLA items aligned with the

Productivity and Professional Practice standard may be appropriate when considered in the context of the overall instrument, this scale of items is weaker than the other item scales as an independent measure of their specific education technology leadership skill set.

While a goal of this study was to develop a survey that was both reliable and valid, the ability to conduct rigorous analysis of survey item validity was limited. A strategy used by the researcher in the search for evidence of ETLA survey validity was to examine the Field Test Data Set through the lens of various theoretical constructs. This concept of construct validity is concerned with the extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses concerning the concepts that are being measured (Carmines & Zeller, 1979, p. 23). In this study, three separate assessments were conducted to support the researcher's analysis of construct validity: (1) the Job Group Assessment, (2) the Not Applicable Assessment, and (3) the Matched Data Assessment.

All three construct validity assessments generated findings providing evidence of ETLA item validity. For example, in the job group assessment analysis the theoretical construct that job group mean scores would vary was supported by the statistical results generated from the Field Test Data Set. Principals as a job group had the high overall mean scores for five of the eight TL Standard item scales. Building Technology Specialists as a job group had the top overall mean scores for the other three TL Standard item scales. The Principals rated themselves the highest in the TL Standard area of Teaching, which would align with the expectation that Principals are the instructional leaders of their schools. The Building Technology Specialists rated themselves highest in the TL Standard area of Productivity. This would be expected; given that the Building Technology Specialists' primary job role was helping others use technology effectively. The evidence of construct validity in the Job Group Assessment indicates that a potential future use of the ETLA could be to help explore and differentiate the nature of education technology leadership across job groups.

The hypothesized theoretical construct for the Matched Data Assessment was that the item scores of the Principal would relate to the item scores of the Teacher. For this assessment, the indicators of primary interest to the researcher were (1) the ETLA item mean scores of Principals compared to Teachers, and (2) the correlation of the matched responses between Principals and Teachers. The a priori expectation was that a claim for ETLA item construct validity would be supported if item mean scores for Principals and Teachers varied similarly and if item scores were highly correlated. While it was important to be cautious in interpreting the results of the small Matched Data Set sample, the findings did report that the item scale mean scores for the Principals were consistently higher than the item scale mean scores of the Teachers.

The ETLA item rating scale included a *Not Applicable* selection. The Not Applicable Assessment was designed by the researcher to discover if ETLA items garnered many Not Applicable responses. The hypothesized theoretical construct was that the response set for valid items would not contain more than 5% of Not Applicable responses. As reported in the study's findings, only two ETLA items exceeded this threshold. These findings provided evidence of construct validity for the ETLA survey overall.

In research associated with the use of surveys, the assessment of a survey's reliability and validity is an ongoing exercise. While the reliability and validity assessments incorporated into the methods of this study are constrained by a limited amount of data for analysis, they have provided a basis for the continued consideration of the ETLA's reliability and validity.

Factor Analysis

Major findings were reported tied to information developed through exploratory factor analysis (EFA) of the data collected in the field test of the ETLA survey. The EFA results of most interest to the researcher included the factors generated by the factor analysis and the ETLA item inter-relationships associated with those factors.

In EFA methodology, a factor is defined by the set of correlated items that are associated with the factor as part of the factor analysis process. This is the "factor" part of factor analysis methodology. Once the factors are generated, the associated item scale can be examined by the researcher and conclusions can be drawn about the nature of the factor. This is the "analysis" part of factor analysis methodology. The EFA methods used in this study generated six factors. Each factor was defined by a scale of ETLA items generated by the factor analysis. It was interesting to note the EFA result that each factor had item scales that contained ETLA items from more than one TL Standard area. This finding indicated that, based on data obtained in the field test, various ETLA items were correlated across the TL Standard areas. This inter-relationship between TL Standards and factors was depicted in Figure 14.

The TL Standard framework was used by the researcher in creating the ETLA survey. The finding of a factor structure based on groupings of correlated ETLA items provided an alternative framework from which to consider education technology leadership. The discovery of the alternative framework was not unexpected. A suggestion of this alterative framework had been found in the literature and is discussed in more detail in the next section.

Findings Related to the Literature

This section of Chapter 5 will relate the findings of this study to the education technology leadership topics found in the literature. The review of literature for this study, found in Chapter 2, presented information about various aspects of education technology leadership, including a review of standards that have been developed for education technology leadership. This review of standards helped the researcher to indentify the essential characteristics of education technology leadership.

The discussion of education technology leadership in the literature was not confined to the definition of education technology leadership standards. The various sources of education technology leadership were also described in the literature. Several sources of education technology leadership were identified by the researcher in the review of the literature, including the education technology leadership of school administrators, teachers, and technology coordinators. Included in this study's report about education technology leadership sources was the case for collaborative leadership as a form of leadership that lends itself well to organizations seeking to build education technology leadership capacity.

Education Technology Leadership Frameworks

The researcher's review of performance standards related to education technology leadership identified a set of standards developed by the ISTE organization as part of its

NETS Project work. These standards, known as the Technology Leader (TL) Standards (Twomey et al., 2006), were designed to define the framework of skills required for effective education technology leadership. This framework was considered by the researcher to be well suited for the purposes of this study, and the TL Standards framework was used to provide the underlying structure for the ETLA survey. The TL Standards were also useful to the researcher by providing a primary reference for the variety of skill sets required for effective education technology leadership. The TL Standards provided the researcher a "Standards View" framework for use in the consideration study results related to education technology leadership.

Within a framework of education technology leadership standards, the standard's indicators do not necessarily exist independent of each other. As described in the review of literature, Twomey (2006, p. 69) recognized that indicators of the TL Standards had common threads serving as "unifying features that, viewed together, create a complete and complex picture of a Technology Leader". Twomey suggested the use of technology leader themes to better understand the inter-relationships of the technology leadership standards.

The exploratory factor analysis (EFA) used in this study provided a useful method to identify education technology leadership themes. The factors generated through factor analysis methods consisted of groupings of ETLA items with high inter-item correlation. In terms of these inter-item correlations, the factors were fairly distinct from each other. The use of EFA to identify themes in the form of correlated data structures provided the researcher with a "Thematic View" framework for use in the consideration of education technology leadership.

The main components of both the Standards View and the Thematic View are represented and measured with ETLA item scales. For the Standards View, item scales aligned with the TL Standards with the assistance of an expert panel already existed. These item scales can be separated out and used to evaluate attainment of specific education technology skill sets as defined by the TL Standards. Mean scores for these item scales would be an indicator of relative strength or weakness of the respondent related to the associated TL Standard skill set.

The Thematic View framework is based on factors discovered using exploratory factor analysis. In this framework, the factors represent the education technology leadership themes. The factor loadings generated by factor analysis can be used to identify ETLA item scales associated with these education technology leadership themes. Mean scores for these item scales would be an indicator of relative strength or weakness of the respondent related to the associated theme.

The Standards View would be useful when the ETLA user's focus is on the development and assessment of skill sets aligned with each TL Standard. For example, an education technology leadership development program might choose to provide instruction related to technology planning. This instruction would be designed with a goal of developing skill related to TL Standard 2 (Planning and Designing Learning Environments). In this example, the ETLA survey would be used to measure student achievement relative to the ETLA Planning and Designing Learning Environment indicators. From the Standards View, the TL Standard 2 item scale would be the main ETLA measure for the Planning and Designing Learning Environments skill set.

By contrast, the Thematic View framework is based on collections of items that are highly correlated, but may be otherwise somewhat unrelated. Rather than representing a specific skill set, such as Planning and Designing Learning Environments, the Thematic View is based on themes that provide theoretical constructs representing areas of general purpose aptitude related to technology leadership. Continuing the example above, the use of a technology planning thematic constructs would be done in recognition that indicators of technology planning exist in TL Standards other than TL Standard 2. In the Thematic View, the ETLA item scale associated with the Planning factor would be the primary measure of technology planning.

The availability of two education technology leadership frameworks based on the same set of ETLA indicators provide users of the ETLA survey alternative views from which to consider ETLA data. The Thematic View would provide a more comprehensive measurement of technology planning compared to the Standards View. The Standards View measure would provide more information about specific skills related to technology planning.

As noted in the review of literature for this study, the work by ISTE in developing the NETS-A Standards and the TL Standards relied on forming a consensus view of what the makeup of the standards should be. The NETS-A Standard and TL Standard sets are considered to represent the common wisdom about what technology leadership means to the practitioners in the field. While there has been research exploring technology leadership based on these standards sets, there is limited research aimed a validating the standard sets themselves. Thus there is the possibility that there are gaps in the standards. The results from this study showing lower scores associated with ETLA items aligned to the Productivity and Professional Practice Standard area is an indicator that this standard area may have room for improvement. The finding in this study that the eight TL Standards could be reduced to five factors provided evidence that the standards for technology leadership could be further condensed.

Sources of Education Technology Leadership

In the review of literature for this study several different sources of education technology leadership were identified. School administrators, school teachers, and school technology officers were indentified as sources often expected to provide education technology leadership to schools. In the field test of the ETLA survey, there were indications that the ETLA results were able to differentiate the various types of education technology leadership sources (administrator, coordinator, and teacher). For example, this study reported a finding that the mean ETLA item scale scores for Principals, Building Technology Specialists, and Teachers were different. It is important to note that this finding was limited by the availability of one data set for evaluation. Additional research would be required to determine the ability for a researcher to use ETLA results to guide categorization of education technology leadership by job role.

Regardless of the individual's job role, the ETLA would appear to be a useful tool for education leaders to use as they consider their own technology leadership strengths and weaknesses. When used as a self-assessment, the ETLA survey provides respondents with a reminder of the skills important for effective education technology leadership. The resulting ETLA data in the form of item mean scores and item scale mean scores help the respondent to identify individual areas of education technology leadership strengths and weakness. The education technology leadership information can serve to inform both respondent and also inform the broader organization that the respondent is associated with.

The concepts of leadership capacity and collaborative leadership were described in the study's review of literature. Leadership capacity was defined as "an organizational concept meaning broad-based, skillful participation in the work of leadership that leads to lasting school improvement" (Lambert, 2005, p. 38). In a school's pursuit of collaborative leadership, a desired outcome was the development of organizational leadership capacity (Elmore, 2000). While the source of leadership may come from several or many, the goal in collaborative leadership was to limit gaps in the collective essential leadership skills.

The ETLA survey would be a useful tool for those responsible for the development of collaborative education technology leadership capacity in a school. The ETLA could be used to assess the collective education technology leadership of a group of school staff, and results of the ETLA could be used to identify education technology leadership strengths and weaknesses for the group. The ETLA results could be analyzed using item scales from both the Skill and the Thematic framework views, and based on the analysis a strategic plan could be developed designed to build the education technology leadership capacity of the group across the full range of the ETLA frameworks. In this way, the ETLA could serve as an assessment tool useful for providing feedback for a school's data-driven continuous improvement process.

The study's review of literature reported that education technology leadership was considered by many experts to be an important factor in the effective technology integration with teaching and learning. Given this, the ability to measure and assess education technology leadership would be important to efforts focused on the use of technology to support teaching and learning. Based on the results and findings reported in Chapter 4, it appears that ETLA results could provide a useful measure of education technology leadership, both for specific individuals and for groups of individuals responsible for leading education technology initiatives.

Implications for Action

As discussed in Chapter 1, education technology leadership has been identified as an important factor in the integration of technology with teaching and learning. The purpose of this study was to develop a reliable and valid web-based survey tool, the ETLA, to assist in the assessment of education technology leadership. The ETLA is based on the International Society for Technology in Education's (ISTE) Technology Leadership (TL) Standards framework. The ETLA survey was designed to be used to help identify the strengths, weaknesses, and gaps associated with the TL Standards. The ETLA survey could be used across a variety of education settings as either an individual or group assessment tool. This section will provide three examples of potential ETLA use: (1) as a tool to guide professional learning community activities, (2) as an activity to incorporate into pre-service teacher preparation, and (3) as a survey to provide feedback to district technology planning efforts.

Using the ETLA with Professional Learning Communities

The term Professional Learning Community (PLC) is typically used in school settings to describe a collegial group of administrators and school staff who are united in their commitment to student learning. The ETLA survey would be a useful tool in support of PLC work related to education technology. Typically a PLC develops a shared vision, work and learn collaboratively, visit and review other classrooms, and participate in decision making (Hord, 1997). The benefits PLC related efforts provide to the staff and students include a reduced isolation of teachers, better informed and committed teachers, and academic gains for students. Hord noted, "As an organizational arrangement, the professional learning community is seen as a powerful staff-development approach and a potent strategy for school change and improvement."

The PLC experience is based on the central tenant of the PLC's collective knowledge existing in the process of "becoming". PLC learning can be viewed as an on-going "Brunerian Spiral"; i.e., a learning spiral which is constantly increasing in depth and sophistication. The basic premise of the Brunerian Spiral concept is that, the first time content is presented to a learner; it is introduced in fairly broad strokes. Later, the content will be provided again, but at a deeper level with additional detail. Over time, the content will be repeated, each time building upon what the learner already knows, so that additional layers can be provided. When viewed from above, it would appear to be a spiral, with each iteration passing over and reviewing the same content, but also providing new content to extend prior knowledge and experience (Bruner, 1966). The concept of PLC learning as a spiral that is continually expanded through study, practice, professional development and reflection, offers a powerful theoretical model of the stages that PLC members go through in becoming leaders. The development of the spiral ultimately leads to greater sophistication in the PLC members' pursuit of life-long continuing professional development.

PLCs can be formed in school settings to address any topic related to student learning, including those with elements of education technology. PLCs and education technology integration are both strategies that can be used to support school change and improvement. There is synergy inherent in combining them in the form of a PLC interested in exploring the use of education technology to impact school improvement.

Schools often choose to use PLCs as a strategy to develop their culture by deepening their collective learning related to specific topics, such as the effective integration of technology with learning. Culture refers to norms of behavior and shared values among a group of people (Kotter, 1996). Norms of behavior are common ways of acting that persist because group members teach the behavior to new members. Shared values are goals shared by most of the people in the group, and these values shape the groups behavior. For schools, culture is defined by Deal and Peterson (1999) as:

> A school's own unwritten rules and traditions, norms, and expectations that seem to permeate everything: the way people act, how they dress, what they talk about or avoid talking about, whether they seek out colleagues for help or don't, and how teachers feel about their work and their students (p. 2-3).

A school with a culture infused with PLCs would be focused on continuous learning. Therefore, self-assessment and reflection would be important elements of the PLC experience. For a PLC interested in considering education technology related topics, their understanding of education technology could be strengthened through the development of the PLC's education technology leadership capacity. As a self-assessment tool designed for use by any educator, the ETLA survey would lend itself to the assessment needs of a PLC interested in education technology. The ETLA survey could be used by a PLC to assess their collective education technology leadership strengths and weaknesses.

The ETLA could be used as a self-assessment of education technology leadership by each PLC member. The results of the ETLA could then be used to support a reflective discussion by the PLC about education technology and education technology leadership. For example, ETLA results from each TL Standard item scale could be reviewed by the PLC, and they could discuss their answers to the following questions:

- Based on ETLA results, what are the education technology leadership strengths of our PLC?
- Based on the ETLA results, what are the education technology leadership weaknesses of our PLC?
- What opportunities do our collective education technology leadership strengths provide to our PLC goals to improve student learning via the integration of education technology?
- What risks do our collective education technology leadership weaknesses present to our PLC goals to improve student learning via the integration of education technology?

The ETLA could be used just once, or multiple times over the period of PLC work. Use of the ETLA multiple times would help the PLC determine if growth related to education technology leadership was occurring, and to provide useful information to support the continued PLC reflection related to their collective education technology leadership strengths and weaknesses.

Using the ETLA with pre-service teacher preparation

The TL Standards, which served as the framework for the ETLA, emerged from work by National Council for the Accreditation of Teacher Education (NCATE). The

NCATE technology leadership program evaluation process was based on a performance-based outcomes model. Evaluation of teacher education program effectiveness required evidence of program alignment and responsiveness to NCATE standards. Teacher preparation programs interested in NCATE accreditation were required to integrate activities aligned with the TL Standards where appropriate into their curriculum. It would be possible to design such an activity based on the ETLA survey.

In this example, the ETLA survey could be introduced in the early stages of the pre-service teacher preparation program that is associated with education technology. The ETLA survey does not necessarily require development of knowledge related to education technology prior to its use as a self-assessment by an individual. Therefore, the pre-service teacher learning experience could be supported by using the ETLA survey as an education technology advanced organizer.

An advance organizer is defined as “information that is presented prior to learning and that can be used by the learner to organize and interpret new incoming information” (Mayer, 2003). Using this definition in this example, the ETLA would be used to introduce pre-service teachers to knowledge about education technology leadership. This knowledge would then serve as an umbrella framework for new material related to education technology to be taught in the pre-service program.

To be used effectively with pre-service teachers as an advanced organizer of education technology leadership knowledge, it might be best to not use the ETLA as a self-assessment. While the ETLA survey does not necessarily require knowledge of the TL Standards, it does expect real school-place experience. Pre-service teachers would have limited school experience to draw from when responding to the survey items.

Instead of using the ETLA to self-assess the extent of their technology leadership, the activity with pre-service teachers could use the ETLA to evaluate the education technology leadership of a mentor teacher. In this activity, the pre-service teacher would be asked to recall a teacher they believed used education technology effectively, and then use the ETLA to evaluate the extent that teacher exhibited the various aspects of education technology leadership. Presumably, the pre-service teachers would discover gaps in the technology leadership of the teacher they selected, which could then be used in the activity as the foundation for further reflection.

With this activity, the pre-service teacher preparation program would have an opportunity to connect learning related to education technology to the education technology leadership framework designed by NCATE. For these pre-service teachers, their deeper awareness of education technology leadership would support their efforts related to the integration of education technology with learning.

Using the ETLA to inform comprehensive technology planning

The application of education technology in a school district is complex and has the potential to overwhelm district resources. School districts that rely on a reactive, as needed approach in their adoption of education technology run the risk of making costly, personality-driven choices, rather than tactical decisions that align with their larger organizational strategy and goals. It is the education technology plan that assists and guides school districts in the application of education technology. Technology planning can assist school districts in accomplishing their education technology related goals (Fenn, Linden, & Fairchok, 2003).

School technology plans are built upon the district's education technology mission and vision. Comprehensive school technology planning efforts involve the development of both strategic and operational plan components. The ETLA survey could be a useful tool in support of district level strategic and operational technology planning.

The strategic technology plan deals with the "why" and the "when" of technology planning. Strategic planning is often approached from an administrative level and primarily focuses on the broader vision or goals of a project (C. McKenzie & Padayachee, 2001). Strategic planners work to effectively and efficiently manage, administer, and monitor the technology plan to ensure that the plan's outcomes and general direction is in accordance with organization objectives and simultaneously, the vision and mission of the organization. Strategic technology planning uses processes that are designed to determine technology needs and sets priorities for those technology needs. The strategic technology planning process works to help educators consider the connection between program activities and student outcomes. In this age of increasing accountability for schools, it is important for the school's strategic technology planning effort to not only address education technology goals, objectives, and activities, but also include indicators, benchmarks, and data sources.

As discussed in Chapter 1, education technology leadership has been shown to contribute to the effective integration of education technology with learning. Given this premise, it would be expected that the development of education technology leadership capacity would be a component of a comprehensive strategic technology plan. The ETLA survey could be used to measure organizational education technology leadership capacity by providing the survey as a self-assessment to members of the organization. If the survey was used in this way on an annual basis, the district's strategic technology planners could use the ETLA results to identify strengths and weaknesses of the organization related to education technology leadership. These results would then guide the planners in developing action steps for the operational technology plan related to the development of education technology leadership capacity in the organization.

The operational technology plan component of a school's technology plan targets the "what" and the "how" of education technology integration with learning. The operational plan is sometimes referred to as the current plan, tactical plan, or short-range plan. Contrasted with the futuristic and goal-oriented strategic technology plan, the operational technology plan is results and action oriented. The operational technology plan is designed to support day-to-day operations. The operational technology plan consists of the action steps necessary to implement the prioritized needs flowing from the strategic plan.

For an example of the use of the ETLA survey to inform strategic and operational technology planning, consider the results of this study's ETLA field test. As shown in Table 10, the field test respondents' lowest scores were in the TL Standard area of Leadership. Based on this information, a strategic technology plan goal could be developed to increase the Leadership score as measured by ETLA. In order to carry out this goal, the technology planner could develop action steps associated with the specific ETLA item indicators associated with the Leadership standard. Table 20 provides a list of these indicators and examples of action steps that might be added to the operational technology plan in support of the strategic goal to increase the organization's ETLA score for the Leadership standard.

Table 20. Examples of action steps aligned with ETLA items

Item	Item Description	Action Step
F.I.1	To what extent did you participate in your district's or school's most recent technology planning process?	Solicit feedback about technology needs, and report back out those needs will be address in the technology plan.
F.I.2	To what extent did you communicate information about your district's or school's technology planning and implementation efforts to your school's stakeholders?	Provide information about the district's technology plan in a form that can be shared with parents.
F.I.3	To what extent did you promote participation of your school's stakeholders in the technology planning process of your school or district?	In the information packet designed for parent, provide a feedback form that can be directed back to the technology planning process.
F.I.4	To what extent did you compare and align your district or school technology plan with other plans, including district strategic plans, your school improvement plan, or other instructional plans?	Encourage the inclusion of technology planning artifacts to be included in the employee job performance portfolios.
F.I.5	To what extent did you engage in activities to identify best practices in the use of technology (e.g., reviews of literature, attendance at relevant conferences, or meetings of professional organizations)?	Encourage the inclusion of best practice technology integration artifacts to be included in the employee job performance portfolios.

Progress related to the strategic technology plan goal to improve education technology leadership capacity could be tracked through the administration of the ETLA survey on a periodic basis. Results would be reviewed, and adjustments to the operational plan's action steps could be made. In this way the ETLA survey would serve as a tool to strengthen the alignment of the strategic technology plan and operational technology plan. This alignment would help ensure the strategic and operational plans are complementary, which would be an indicator of a comprehensive education technology plan.

Summary

As discussed in the examples above, the ETLA survey could generate results and information useful for a variety of education situations. When used as a self-assessment of education technology leadership, the ETLA survey would provide results that could be viewed from an intrinsic perspective; i.e., the results would provide information about the extent of education technology leadership related to the individual taking the self assessment. The ETLA results could also be viewed from an outside or extrinsic perspective; e.g., to inform education leaders about the extent of education technology leadership capacity available to a school's education technology related initiatives. The main implication for action related to the ETLA was to use the ETLA survey as a tool to inform the work of educator(s) related to education technology and education technology leadership.

Recommendation for Future Research

If the ETLA is to be used as a reliable and valid assessment of education technology leadership, more research needs to be done with collecting and analyzing ETLA data sets. While the findings reported in this study provide encouraging evidence that the ETLA is a reliable and valid education technology leadership assessment, there were limits in this study's methods associated with the limited number of ETLA data sets available for analysis. One recommendation for future research is that the methods of this study need to be replicated, and the resulting data sets need to be analyzed to determine if the ETLA survey is generating consistent results.

It would not be difficult to collect additional data for use in the continued evaluation of ETLA reliability and validity. The ETLA could be made available on the Internet as a generally available web-based assessment tool. If this ability was established, the data collected would be available for the further analysis of the ETLA and also useful as a source of immediate feedback to the survey respondent. While this method of data collection would not be random and generalized to a larger population, this strategy for data collection would provide information of similar rigor and usefulness compared to the data used in this study.

Assuming the ETLA continues to display evidence of reliability and validity in these future trials, the potential to incorporate the ETLA into education technology leadership research would emerge. Following is a list of potential research questions that could be explored in part through the use of the ETLA survey.

Future Research Question 1: How does proficiency with education technology impact education technology leadership?

Future Research Question 2: How does proficiency with education technology affect the results of factor analysis of the ETLA data set? Are ETLA responses correlated differently for education technology experts compared to education technology novices?

Future Research Question 3: Does education technology leadership vary in ways similar to education leadership?

Future Research Question 4: How does education technology leadership vary between "high tech" and "low tech" schools?

Future Research Question 5: How would ETLA results contribute to the job performance portfolio of an education leader?

Future Research Question 1 asks for the examination of the relationship between education technology proficiency and education technology leadership. This examination would be relevant in several education settings, including teacher preparation programming. The ISTE TL Standards were developed in part to help inform teacher preparation programs of the skills sets required for effective education technology leadership. It would be interesting to observe if education technology leadership varies (increases) as pre-service teachers become more adapt at the use of education technology. For example, if there was a strong correlation found between education technology knowledge and education technology leadership in pre-service teachers, then teacher preparation programs might conclude that education technology leadership in pre-service teachers was being appropriately nurtured by their education technology training. If a strong correlation was not found, then teacher preparation program might consider adding components into their training designed to develop to a greater extent education technology leadership skills in pre-service teachers.

Future Research Question 2 would be directed at a potential research interest in the nature of the inter-item correlations of the ETLA items. The factor analysis performed in this study generated six factors, based on the ETLA Field Test Data Set. However, factor analysis on additional ETLA data sets generated from different sample populations could produce different factor structures. It would be interesting to observe if the factor structures generated from ETLA data sets from accomplished education technology leaders would be different than the factors generated using data samples from novice respondents. In other words, do the ETLA item results correlate similarly for experts and novices? If similar factor structures were found, that finding would provide support for a global view of education technology leadership; i.e., all education technology leaders carry the same basic skills. If dissimilar factor structures were found then that information could help identify the "missing ingredients" between expert and novice education technology leaders; i.e., what makes the difference between good education technology leadership and great education technology leadership? In either scenario, this information would help to inform programs designed to develop education technology leadership.

Research related to Question 2 could also easily incorporate tasks designed to continue the assessment of ETLA reliability and validity. This continuing need was identified in the Major Findings section earlier in this Chapter. Data sets generated in support of research related to Question 2 could be examined for evidence of ETLA reliability and validity similar to the way this study evaluated the Field Test Data Set. This study's examination found the Productivity and Professional Practice section of the ETLA to have lower reliability compared to other ETLA section, and the recommendation of the researcher looking towards the future would be to review and improve the ETLA items associated with this section. The examination of additional ETLA data sets might help to pinpoint other ETLA items in need of improvement.

Future Research Question 3 is based on the premise that the study of education technology leadership isn't limited to education technology leadership research. Research could also be conducted in relationship to education leadership programs in general. Education leadership programs are typically focused on the development of education leaders, including Principals and Superintendents. In this context it would be interesting to search for relationships between effective education leaders and effective education technology leaders. For education leadership programs that aspire to include education technology leadership artifacts as a part of comprehensive education leadership portfolio, research efforts related to Research Question 3 would help move those program's efforts towards those ends. At a minimum, the use of the ETLA with participants in education leadership programs as an education technology leadership self-assessment would provide an artifact that would contribute to any education leader's professional portfolio.

Future Research Question 4 would contribute to research efforts in the area of leadership capacity. According to school leadership capacity theory, leadership doesn't have to come from only a school administrator, such as the Principal. It can come from multiple sources. For this potential ETLA research thread, it would be interesting to assess the sources of education technology leadership in schools considered to be effective in the use of education technology. These observations could be compared with observations of the sources of education technology leadership in buildings considered to be less effective in their education technology use. It might be unlikely that this research would discover a "silver bullet" of a certain type of education technology leadership that would be found common in all schools judged to be effective in their technology implementation. However certain patterns or trends in education technology leadership might be found in effective schools compared to less effective schools. This information, if discovered, could contribute in significant ways to school improvement efforts associated with education technology integration. A report by Anderson & Dexter (2005) outlines research methods that could be adapted to incorporate the ETLA Survey as a data source in the examination of education technology leadership and technology outcomes.

Work related to Future Research Question 5 would contribute to the study of the use of the ETLA as a job performance assessment tool. In the research design of this study, the methods associated with the Matched Data Set provided an example of how the ETLA could be used to assist with job performance evaluation. The Matched Data Set was created by having teachers use the ETLA as a self-assessment, and by having their supervisor use the ETLA to evaluate the teacher's ability related to education technology leadership. While it is beyond the scope of the ETLA survey to be used as the sole source of assessment of education technology leadership, the ETLA could be one of multiple assessments. While the ETLA scores obtained from supervisor and employee would be of interest, also of value would be the discussion between them about education technology leadership that could be facilitated by the use of the ETLA tool. Supervisor and employee could easily review, compare, and discuss ETLA results.

For example, this type of discussion could be based on a shared goal between the supervisor and employee of developing organizational education technology leadership capacity. In this example the discussion would not be "high-stakes", because the purpose would be one of mutually desired continuous improvement, not one of employee discipline or discharge. The ETLA assessment could be used multiple times by supervisor and employee, over a period of time. At first the ETLA results would help the pair to set goals related to education technology leadership capacity. Later the ETLA results would serve to inform them if progress towards their education technology leadership goals was being made.

Research related to this type of use of the ETLA would be less concerned about internal ETLA reliability and validity related to the quality of the survey items, and more concerned about the external reliability and validity of the assessment related to the responses provided by the participants. As is the case with any self-assessment, honesty from all respondents would be a key to research related to ETLA use as a job performance measurement tool. For research related to Future Research Question 5, ETLA response integrity and fidelity would be important aspects that would need to be considered and controlled for in the research design.

Future research that incorporates the ETLA could explore the questions mentioned above, or other questions related to education technology and education technology leadership. It would be important that this future research to continue to evaluate the ETLA survey's reliability and validity, and to continue to make adjustments to strengthen items when needed. As more confidence in the ETLA survey results is achieved, the more valuable the ETLA survey will become as a research tool.

Conclusions

This research study was intended to contribute to the development of a reliable and valid education technology leadership survey tool. The resulting web-enabled survey, the Educator Technology Leadership Assessment (ETLA) was based on the eight ISTE Technology Leadership (TL) Standards (Twomey et al., 2006). The survey was created with the assistance of an expert judgment panel. The survey was then field tested by asking selected individuals to self-assess their education technology leadership skills, and also by supervisors to assess the education technology leadership of a member of their staff. This study's findings were generated from the work with the expert judgment panel and from the work related to the study's field test of the ETLA survey. The reported findings in Chapter 4 provided evidence that the ETLA survey items were reliable and valid. However, the researcher's quest for indicators of ETLA survey item reliability and validity was limited by the lack of multiple data sets for analysis.

The review of literature for this study reported that the developers of the TL Standards had hypothesized the occurrence of themes underlying the TL Standards. Exploratory factor analysis (EFA) methods were used in this study to identify a set of education technology leadership themes. The themes, in the form of factors generated from the EFA, were defined by ETLA item scales produced by the EFA. The item scales contained items that were highly correlated with each other. While the results of this study's use of EFA were limited by the lack of multiple data sets for analysis, EFA methods were useful in providing a structured method for identifying and quantifying education technology leadership themes.

Based on the reported findings, the work of this study appears to offer a good start towards the development of a reliable and valid education technology leadership survey tool. For the ETLA to become a useful tool in the study of education technology leadership, further research and testing of the ETLA survey would be required. The methods designed for this study, including item mean score analysis and factor analysis, could be replicated in order to analyze data obtained from use of the ETLA survey with other sample populations. Those results, in turn, could be used to inform further refinement of the ETLA items.

APPENDIX A. TECHNOLOGY LEADERSHIP STANDARDS COMPARISON

TL	COSN	NETS-A
Leadership and Vision Educational technology leaders will facilitate development of a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of the vision. Educational technology leaders: A. Identify and apply educational and technology-related research, the psychology of learning, and instructional design principles in guiding the use of computers and technology in education. B. Apply strategies for and knowledge of issues related to managing the change process in schools. C. Apply effective group process skills. D. Lead in the development and evaluation of district technology planning and implementation. E. Engage in supervised field-based experiences with accomplished technology facilitators and/or directors.	Leadership and Vision Works closely with the executive cabinet and stakeholders to create a vision for how technology will support the district's strategic goals. Knowledge or Skills Required: A. Ability to establish and lead governance committees and facilitate the process of priority-setting and decision-making. B. Interpersonal skills and a willingness to work closely with all constituents. C. Ability to adapt known technologies to new uses and envision natural relationships between emerging technology resources and the education process. D. Big-picture understanding of school organization, of curriculum and of the issues of greatest importance to teaching and learning. E. Understanding of the change process and effective approaches to facilitating change.	Leadership and Vision Educational leaders inspire a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of that vision. Educational leaders: A. Facilitate the shared development by all stakeholders of a vision for technology use and widely communicate that vision. B. Maintain an inclusive and cohesive process to develop, implement, and monitor a dynamic, long-range, and systemic technology plan to achieve the vision. C. Foster and nurture a culture of responsible risk-taking and advocate policies promoting continuous innovation with technology. D. Use data in making leadership decisions. E. Advocate for research-based effective practices in use of technology. F. Advocate on the state and national levels for policies, programs, and funding opportunities that support implementation of the district technology plan.

TL	COSN	NETS-A
Planning and Designing Learning Environments and Experiences Educational technology leaders plan, design, and model effective learning environments and multiple experiences supported by technology. Educational technology leaders: A. Design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners. B. Apply current research on teaching and learning with technology when planning learning environments and experiences. C. Identify and locate technology resources and evaluate them for accuracy and suitability. D. Plan for the management of technology resources within the context of learning activities. E. Plan strategies to manage student learning in a technology-enhanced environment. F. Identify and apply instructional design principles associated with the development of technology resources.	Planning and Budgeting Works with the instructional and technical teams to identify the steps needed to meet strategic goals and a budget that takes into account the total cost of implementing technology solutions. Knowledge or Skills Required: A. Ability to think strategically, manage projects, and lead the district from vision to effective delivery of services. B. Ability to set practical and realistic timelines for technology implementation. C. Understanding of the steps and financial tools involved in the budgeting process. D. Strong working knowledge of the concept of total cost of ownership and the ability to translate that into realistic budgets. E. Understanding of the impact and need for technology throughout the enterprise - and the relationship between curriculum, instruction and technology in providing a teaching and learning environment.	Learning and Teaching Educational leaders ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching. Educational leaders: A. Identify, use, evaluate, and promote appropriate technologies to enhance and support instruction and standards-based curriculum leading to high levels of student achievement. B. Facilitate and support collaborative technology-enriched learning environments conducive to innovation for improved learning. C. Provide for learner-centered environments that use technology to meet the individual and diverse needs of learners. D. Facilitate the use of technologies to support and enhance instructional methods that develop higher-level thinking, decision-making, and problem-solving skills. E. Provide for and ensure that faculty and staff take advantage of quality professional learning opportunities for improved learning and teaching with technology.

TL	COSN	NETS-A
Teaching, Learning, and Curriculum Educational technology leaders apply and implement curriculum plans that include methods and strategies for applying technology to maximize student learning. Educational technology leaders: A. Facilitate technology-enhanced experiences that address content standards and student technology standards. B. Use technology to support learner-centered strategies that address the diverse needs of students. C. Apply technology to demonstrate students' higher-order skills and creativity. D. Manage student learning activities in a technology-enhanced environment. E. Use current research and district/region/state/national content and technology standards to build lessons and units of instruction.	Team Building and Staffing Creates and supports cross-functional teams for decision-making, technology support, professional development, and other aspects of the district's technology program. Knowledge or Skills Required: A. Strong leadership skills and the ability to empower others to assume leadership roles. B. Skills at facilitating team building activities, modeling examples of trust between department members, and utilizing quality improvement tools for decision-making. C. Ability to identify strengths and weaknesses and make effective hiring decisions. D. Strong communication skills and a commitment to keeping all parties informed about technology progress and choices.	Productivity and Professional Practice Educational leaders apply technology to enhance their professional practice and to increase their own productivity and that of others. Educational leaders: A. Model the routine, intentional, and effective use of technology. B. Employ technology for communication and collaboration among colleagues, staff, parents, students, and the larger community. C. Create and participate in learning communities that stimulate, nurture, and support faculty and staff in using technology for improved productivity. D. Engage in sustained, job-related professional learning using technology resources. E. Maintain awareness of emerging technologies and their potential uses in education. F. Use technology to advance organizational improvement.

TL	COSN	NETS-A
Assessment and Evaluation Educational technology leaders communicate research on the use of technology to implement effective assessment and evaluation strategies. Educational technology leaders: A. Apply technology in assessing student learning of subject matter using a variety of assessment techniques. B. Use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning. C. Apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.	Information Management Oversees the establishment and maintenance of systems and tools for gathering, mining, integrating and reporting data in usable and meaningful ways. Knowledge or Skills Required: A. Understanding of data-driven decision making and the role information needs to play in shaping and supporting a district's educational programs. B. Understanding of techniques and tools for data gathering, warehousing, and analysis - including knowledge of available applications and the options for customizing them or building new tools in-house. C. Knowledge of data-related industry standards (e.g., SIF and SCORM) and of governmental mandates (e.g. NCLB or IDEA) with information reporting requirements. D. Ability to assess and respond to the needs and concerns of a variety of knowledge workers.	Assessment and evaluation Educational leaders use technology to plan and implement comprehensive systems of effective assessment and evaluation. Educational leaders: A. Use multiple methods to assess and evaluate appropriate uses of technology resources for learning, communication, and productivity. B. Use technology to collect and analyze data, interpret results, and communicate findings to improve instructional practice and student learning. C. Assess staff knowledge, skills, and performance in using technology and use results to facilitate quality professional development and to inform personnel decisions. D. Use technology to assess, evaluate, and manage administrative and operational systems.

TL	COSN	NETS-A
Technology Operations and Concepts Educational technology leaders demonstrate an in-depth understanding of technology operations and concepts. Educational technology leaders: A. Demonstrate knowledge, skills, and understanding of concepts related to technology (as described in the ISTE National Educational Technology Standards for Teachers). B. Demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.	Systems Management Directs, coordinates, and ensures the implementation of all tasks related to: the development of technical specifications and infrastructure decisions; the selection, purchasing, installation and maintenance of IT; and the integration of technology into every facet of operations. Knowledge or Skills Required: A. Knowledge and expertise about infrastructure and performance standards for all aspects of the IT system. B. Strong technical background accompanied by a personal commitment to ongoing research and learning. C. Ability and willingness to hire skilled experts to support and oversee different aspects of the IT program. D. Ability to make purchasing and implementation decisions based on needs of the total school system - and on an understanding of the full life cycle of technology purchases.	.Support, management, and operations Educational leaders ensure the integration of technology to support productive systems for learning and administration. Educational leaders: A. Develop, implement, and monitor policies and guidelines to ensure compatibility of technologies. B. Implement and use integrated technology-based management and operations systems. C. Allocate financial and human resources to ensure complete and sustained implementation of the technology plan. D. Integrate strategic plans, technology plans, and other improvement plans and policies to align efforts and leverage resources. E. Implement procedures to drive continuous improvement of technology systems and to support technology replacement cycles.

TL	COSN	NETS-A
Social, Ethical, Legal, and Human Issues Educational technology leaders understand the social, ethical, legal, and human issues surrounding the use of technology in P-12 schools and develop programs facilitating application of that understanding in practice throughout their district/region/state. Educational technology leaders: A. Model and teach legal and ethical practice related to technology use. B. Apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.	Ethics and Policies Oversees the creation, implementation and enforcement of policies and educational programs related to the social, legal and ethical issues involved in technology use throughout the district. Knowledge or Skills Required: A. Knowledge about laws and legal issues related to copyright, privacy, filtering and other aspects of school technology use. B. Awareness of other relevant issues including safety, technology-related health concerns and guidelines for fair and ethical implementation of technology. C. Experience with AUP development and enforcement. D. Commitment to modeling responsible technology use and working closely with all constituents.	Social, legal and ethical issues Educational leaders understand the social, legal, and ethical issues related to technology and model responsible decision-making related to these issues. Educational leaders: A. Ensure equity of access to technology resources that enable and empower all learners and educators. B. Identify, communicate, model, and enforce social, legal, and ethical practices to promote responsible use of technology. C. Promote and enforce privacy, security, and online safety related to the use of technology. D. Promote and enforce environmentally safe and healthy practices in the use of technology. E. Participate in the development of policies that clearly enforce copyright law and assign ownership of intellectual property developed with district resources.

TL	COSN	NETS-A
Procedures, Policies, Planning, and Budgeting for Technology Environments Educational technology leaders coordinate development and direct implementation of technology infrastructure procedures, policies, plans, and budget for P-12 schools. Educational technology leaders: A. Use the school technology facilities and resources to implement classroom instruction. B. Follow procedures and guidelines used in planning and purchasing technology resources. C. Participate in professional development opportunities related to management of school facilities, technology resources, and purchases.	Business Leadership Serves as a strong business leader who guides purchasing decisions, assists in determining the "return on investment" for all technology implementations, and fosters good relationships with vendors, potential funders, and other key groups. Knowledge or Skills Required: A. Comfort managing a budget, making purchasing decisions, and handling the financial aspects of running an IT business. B. Knowledge about market rates for technology equipment and services and the issues that determine ROI. C. Ability to direct, manage, and negotiate with vendors and business partners. D. Strong communication skills, the ability to build partnerships and articulate a vision for the district's technology program.	

TL	COSN	NETS-A
Productivity and Professional Practice Educational technology leaders design, develop, evaluate and model products created using technology resources to improve and enhance their productivity and professional practice. Educational technology leaders: A. Use technology resources to engage in ongoing professional and lifelong learning. B. Continually evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student learning. C. Apply technology to increase productivity. D. Use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning	Education and Training Budgets, plans for and coordinates on-going, purposeful professional development for all staff using new technologies. Knowledge or Skills Required: A. Current understanding of both technical and educational best practices and the appropriate uses of technology to support high-caliber, rigorous student work. B. Understanding of the key elements contributing to successful professional development. C. Awareness of technology-related professional growth needs of all staff members - including administrators and support staff - and the ability to respond to these needs, including providing "just in time" opportunities to remain current on technical content. D. Ability to plan professional development activities that help teachers meet a wide range of instructional goals for the district with help from interactive technologies.	

TL	COSN	NETS-A
	Communication Systems Directs and coordinates the use of e-mail, district web sites, voicemail systems and other forms of communication technology to facilitate decision-making, dialog and effective communication with the community and other key stakeholders. Knowledge or Skills Required: A. Working knowledge of various communication tools - including purchasing options and technical issues related to implementation. B. Understanding of web design and support issues and the staffing needed to keep district and school sites updated and operational. C. Knowledge about converging technologies and new options for enhancing communication through technology. D. Strong communication skills and the ability to provide leadership to stakeholders in the utilization of communication resources.	

APPENDIX B. EXPERT PANEL FEEDBACK FORMS

STANDARD 1

Standard: Leadership and Vision.
Educational technology leaders will facilitate development of a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of the vision. Educational technology leaders:

A. Identify and apply educational and technology-related research, the psychology of learning, and instructional design principles in guiding the use of computers and technology in education.
B. Apply strategies for and knowledge of issues related to managing the change process in schools.
C. Apply effective group process skills.
D. Lead in the development and evaluation of district technology planning and implementation.
E. Engage in supervised field-based experiences with accomplished technology facilitators and/or directors.

Question – D.I.1

To what extent did you participate in your district's or school's most recent technology planning process?

- ☐ Not applicable
- ☐ Not at all
- ☐ Minimally
- ☐ Somewhat
- ☐ Significantly
- ☐ Fully

How well do you believe this question measures this standard area?

- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 1 (cont.)

Question – D.I.2

To what extent did you communicate information about your district's or school's technology planning and implementation efforts to your school's stakeholders?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.I.3

To what extent did you promote participation of your school's stakeholders in the technology planning process of your school or district?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 1 (cont.)

Question – D.I.4

To what extent did you compare and align your district or school technology plan with other plans, including district strategic plans, your school improvement plan, or other instructional plans?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.I.5

To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 1 (cont.)

Question – D.I.6

To what extent did you engage in activities to identify best practices in the use of technology (e.g. reviews of literature, attendance at relevant conferences, or meetings of professional organizations)?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 2

Planning and Designing Learning Environments and Experiences.
Educational technology leaders plan, design, and model effective learning environments and multiple experiences supported by technology.

A. Design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners.
B. Apply current research on teaching and learning with technology when planning learning environments and experiences.
C. Identify and locate technology resources and evaluate them for accuracy and suitability.
D. Plan for the management of technology resources within the context of learning activities.
E. Plan strategies to manage student learning in a technology-enhanced environment.
F. Identify and apply instructional design principles associated with the development of technology resources.

Question – D.II.1

1. To what extent did you design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners?
   - ☐ Not applicable
   - ☐ Not at all
   - ☐ Minimally
   - ☐ Somewhat
   - ☐ Significantly
   - ☐ Fully

How well do you believe this question measures this standard area?
- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 2 (cont.)

Question – D.II.2

To what extent did you apply current research on teaching and learning with technology when planning learning environments and experiences? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.II.3

To what extent did you identify and locate technology resources and evaluate them for accuracy and suitability? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 2 (cont.)

Question – D.II.4

To what extent did you plan for the management of technology resources within the context of learning activities?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.II.5

To what extent did you plan strategies to manage student learning in a technology-enhanced environment?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 2 (cont.)

Question – D.II.6

To what extent did you identify and apply instructional design principles associated with the development of technology resources?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 3

Standard: Teaching, Learning, and Curriculum.
Educational technology leaders apply and implement curriculum plans that include methods and strategies for applying technology to maximize student learning. Educational technology leaders:

A. Facilitate technology-enhanced experiences that address content standards and student technology standards.
B. Use technology to support learner-centered strategies that address the diverse needs of students.
C. Apply technology to demonstrate students' higher-order skills and creativity.
D. Manage student learning activities in a technology-enhanced environment.
E. Use current research and district/region/state/national content and technology standards to build lessons and units of instruction.

Question – D.III.1

To what extent did you provide or make available assistance to colleagues to use technology for interpreting and analyzing student assessment data? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.III.2

To what extent did you provide or make available assistance to colleagues for using student assessment data to modify instruction? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 3 (cont.)

Question – D.III.3

To what extent did you disseminate or model best practices in learning and teaching with technology to colleagues?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.III.4

To what extent did you provide support (e.g., release time, budget allowance) to colleagues who were attempting to share information about technology practices, issues, and concerns?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 3 (cont.)

Question – D.III.5

To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong
Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.	

Question – D.III.6

To what extent did you facilitate or ensure the delivery of professional development on the use of technology to faculty and staff? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong
Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.	

STANDARD 4

Standard: Assessment and Evaluation.
Educational technology leaders communicate research on the use of technology to implement effective assessment and evaluation strategies. Educational technology leaders:

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

Question – D.IV.1

To what extent did you promote or model technology based systems to collect student assessment data?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.IV.2

To what extent did you promote the evaluation of instructional practices, including technology-based practices, to assess their effectiveness?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 4 (cont.)

Question – D.IV.3

To what extent did you assess and evaluate existing technology-based administrative and operations systems for modification or upgrade?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.IV.4

To what extent did you evaluate the effectiveness of professional development offerings in your school to meet the needs of teachers and their use of technology?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 4 (cont.)

Question – D.IV.5

To what extent did you evaluate the effectiveness of professional development offerings in your school to meet the needs of teachers and their use of technology?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 5

<u>Standard: Technology Operations and Concepts.</u>
Educational technology leaders demonstrate an in-depth understanding of technology operations and concepts. Educational technology leaders:

A. Demonstrate knowledge, skills, and understanding of concepts related to technology (as described in the ISTE National Educational Technology Standards for Teachers).
B. Demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.

Question – D.V.1

To what extent did you support colleagues in connecting to and using district- and building-level technology systems for management and operations (e.g., student information system, electronic grade book, and curriculum management system)? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.V.2

To what extent did you allocate campus discretionary funds to help meet the school's technology needs? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 5 (cont.)

Question – D.V.3

To what extent did you pursue supplemental funding to help meet the technology needs of your school? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.V.4

To what extent did you ensure that hardware and software replacement/upgrades were incorporated into school technology plans? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 5 (cont.)

Question – D.V.5

To what extent did you advocate for adequate, timely, and high-quality technology support services?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 6

Social, Ethical, Legal, and Human Issues.
Educational technology leaders understand the social, ethical, legal, and human issues surrounding the use of technology in P-12 schools and develop programs facilitating application of that understanding in practice throughout their district/region/state. Educational technology leaders:

A. Model and teach legal and ethical practice related to technology use.
B. Apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.

Question – D.VI.1

To what extent did you work to ensure equity of technology access and use in your school? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VI.2

To what extent did you implement policies and programs meant to raise awareness of technology-related social, ethical, and legal issues for staff and students? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 6 (cont.)

Question – D.VI.3

To what extent were you in involved in enforcing policies related to copyright and intellectual property?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VI.4

To what extent were you involved in addressing issues related to privacy and online safety?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 6 (cont.)

Question – D.VI.5

To what extent did you support the use of technology to help meet the needs of special education students?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VI.6

To what extent did you support the use of technology to assist in the delivery of individualized education programs for all students?	How well do you believe this question measures this standard area?
☐ Nor applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 6 (cont)

Question – D.VI.7

To what extent did you disseminate information about health concerns related to technology and computer usage in classrooms and offices?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 7

Standards: Procedures, Policies, Planning, and Budgeting for Technology Environments.
Educational technology leaders coordinate development and direct implementation of technology infrastructure procedures, policies, plans, and budget for P-12 schools. Educational technology leaders:

A. Use the school technology facilities and resources to implement classroom instruction.
B. Follow procedures and guidelines used in planning and purchasing technology resources.
C. Participate in professional development opportunities related to management of school facilities, technology resources, and purchases.

Question – D.VII.1

To what extent did you use the school technology facilities and resources to implement classroom instruction?

- ☐ Not applicable
- ☐ Not at all
- ☐ Minimally
- ☐ Somewhat
- ☐ Significantly
- ☐ Fully

How well do you believe this question measures this standard area?

- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

.

Question – D.VII.2

To what extent did you follow procedures and guidelines used in planning and purchasing technology resources?

- ☐ Not applicable
- ☐ Not at all
- ☐ Minimally
- ☐ Somewhat
- ☐ Significantly
- ☐ Fully

How well do you believe this question measures this standard area?

- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 7 (cont.)

Question – D.VII.3

To what extent did you differentiate among specifications for purchasing technology systems in school settings?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VII.4

To what extent were you participate in professional development opportunities related to management of school facilities, technology resources, and purchases?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 8

Standard: Productivity and Professional Practice.
Educational technology leaders design, develop, evaluate and model products created using technology resources to improve and enhance their productivity and professional practice.
Educational technology leaders:

A. Use technology resources to engage in ongoing professional and lifelong learning.
B. Continually evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student learning.
C. Apply technology to increase productivity.
D. Use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning

Question – D.VIII.1

To what extent did you participate in professional development activities meant to improve or expand your use of technology?

- ☐ Not applicable
- ☐ Not at all
- ☐ Minimally
- ☐ Somewhat
- ☐ Significantly
- ☐ Fully

How well do you believe this question measures this standard area?

- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VIII.2

To what extent did you use technology to help complete your day-to-day tasks (e.g., personal calendar, developing budgets, communicating with others, gathering information)?

- ☐ Not applicable
- ☐ Not at all
- ☐ Minimally
- ☐ Somewhat
- ☐ Significantly
- ☐ Fully

How well do you believe this question measures this standard area?

- ☐ Not at all
- ☐ Weak
- ☐ Somewhat
- ☐ Strong
- ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 8 (cont.)

Question – D.VIII.3

To what extent did you use technology-based management systems to access staff/faculty personnel records?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

Question – D.VIII.4

To what extent did you use technology-based management systems to access information?	How well do you believe this question measures this standard area?
☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

STANDARD 8 (cont.)

Question – D.VIII.5

To what extent did you encourage and use technology (e.g., e-mail, blogs, and videoconferences) as a means of communicating with education stakeholders, including peers, experts, students, parents/guardians, and the community? ☐ Not applicable ☐ Not at all ☐ Minimally ☐ Somewhat ☐ Significantly ☐ Fully	How well do you believe this question measures this standard area? ☐ Not at all ☐ Weak ☐ Somewhat ☐ Strong ☐ Very Strong

Please provide any suggestions or comments regarding the questions above in the space below. If you have suggestions for additional questions please write the questions in the space below.

APPENDIX C. SELF-ASSESSMENT INSTRUCTIONS FOR ETLA SURVEY

For the ETLA field test, the following instructions were provided to participants:

> You have been selected to take the Educator Technology Leadership Assessment. This assessment consists of 38 multiple choice style questions related to different aspects of education technology leadership. The results of the survey will be used to inform technology planning efforts in the Des Moines Public Schools. Thank you in advance for your survey participation. Please click the link below to begin the survey.
>
> You are being given this technology leadership assessment at the request of the technology department, which will use the results to guide its leadership training and professional development programming. Assessment items are based on the International Society for Technology in Education (ISTE) National Educational Technology Leadership Standards. The purpose of the assessment is to provide detailed and comparative feedback about education technology leadership.
>
> The individual items in the assessment ask you about the extent to which you have engaged in certain behaviors that relate to K-12 school technology leadership. Please answer all questions. If you feel a specific question is not applicable, you may mark as Not Applicable. Note that marking multiple items Not Applicable may limit the usefulness of the assessment results.
>
> There are 38 questions in the survey. It should take 15-20 minutes to complete this survey.
>
> As you answer the questions, think of your actual behavior over the course of the last school year. Do not take into account planned or intended behavior. As you select the appropriate response to each question, it may be helpful to keep in mind the performance of other educators that you know. Please note that the accuracy and usefulness of this assessment is largely dependent upon your candor. If done with care, the results can provide valuable information.
>
> Your responses to the survey will be kept confidential by the technology department researcher.

APPENDIX D. EVALUATION INSTRUCTIONS FOR ETLA SURVEY

For the ETLA field test, the following instructions were provided to Principals using the survey as a validity check:

> In order to help validate the survey, we are asking you to use the survey to assess the technology leadership of one of your staff members that is taking the survey. Specifically, we'd like you to use the survey to assess <<teacher_name>>, who was chosen at random.
>
> Again, we are asking for this to help validate the survey tool. Both your responses and <<teacher_name>> responses will be kept confidential by the researcher. This project is not in any way being used as a teacher evaluation tool.
>
> Please click the link below to begin the survey. You are being given this technology leadership assessment at the request of the Technology Department, which will use the results to guide its leadership training and professional development programming. Assessment items are based on the International Society for Technology in Education’s (ISTE) National Educational Technology Leadership Standards. The purpose of the assessment is to provide detailed and comparative feedback about education technology leadership.
>
> You are being asked to use this survey to assess the technology leadership of one of your staff members. This information will be used to help validate the survey tool.
>
> The individual items in the assessment ask you about the extent to which the selected staff member has engaged in certain behaviors that relate to K-12 school technology leadership. Please answer all questions. If you feel a specific question is Not Applicable, you may mark as not applicable. Note that marking multiple items Not Applicable may limit the usefulness of the assessment results.
>
> There are 38 questions in the survey. It should take 15-20 minutes to complete this survey.
>
> As you answer the questions, think of the staff member's actual behavior over the course of the last school year. As you select the appropriate response to each question, it may be helpful to keep in mind the performance of other staff members. Please note that the accuracy and usefulness of this assessment is largely dependent upon your candor. If done with care, the results can provide valuable information.
>
> Your responses to the survey will be kept confidential by the technology department researcher.

APPENDIX E. HUMAN SUBJECTS APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office of Research Assurances
Vice Provost for Research
1138 Pearson Hall
Ames Iowa 50011-2207
515 294-4566
FAX 515 294-4267

DATE: April 30, 2007

TO: Greg Davis
1801 W 21st St N, Newton, IA 50208

CC: Frank Hernandez
N229B Lagomarcino

FROM: Jan Canny, IRB Administrator
Office of Research Assurances

IRB ID: 07-224 **Study Review Date:** 27 April 2007

The Institutional Review Board (IRB) Chair has reviewed the project, "Mining for Gold: Finding Education Technology Leadership in the Field" (IRB ID 07-224) and has declared the study exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b), Exempt Category (2). A description of this exemption category can be found in the list on the next page. Please note that you must submit all research involving human participants for review by the IRB. Only the IRB may make the determination of exemption, even if you conduct a study in the future that is exactly like this study.

The IRB determination of exemption means that this project does not need to meet the requirements from the Department of Health and Human Service (DHHS) regulations for the protection of human subjects, unless required by the IRB. We do, however, urge you to protect the rights of your participants in the same ways that you would if the project was required to follow the regulations. This includes providing relevant information about the research to the participants.

Because your project is exempt, you do not need to submit an application for continuing review. However, you must carry out the research as proposed in the IRB application, including obtaining and documenting (signed) informed consent if you have stated in your application that you will do so or if required by the IRB.

Any modification of this research should be submitted to the IRB on a Continuation and/or Modification form, prior to making any changes, to determine if the project still meets the Federal criteria for exemption. If it is determined that exemption is no longer warranted, then an IRB proposal will need to be submitted and approved before proceeding with data collection.

APPENDIX F. DES MOINES PUBLIC SCHOOLS RESEARCH APPROVAL

DesMoines
PUBLIC SCHOOLS

Assessment Services

1915 Prospect Road, Room 210
Des Moines, Iowa 50310

May 3, 2007

Greg Davis
1801 W. 21st St. N.
Newton IA 50208

Dear Greg:

Your proposal to conduct research in the district has been reviewed. Your request is approved.

You may contact me at the address above, by phone at 242-7664, or by district E-mail if you have questions. When you have completed your study, we would appreciate receiving an abstract of your findings. We wish you success in this endeavor.

[redacted]

John F. Tompkins, Ph.D
Assessment Specialist

APPENDIX G. RANKING DATA SET DESCRIPTIVE STATISTICS

Item	N	Range	Minimum	Maximum	Mean	Std. Deviation
Leadership and Vision						
D.I.1	10	2	3	5	4.00	0.667
D.I.2	10	2	3	5	4.10	0.568
D.I.3	10	2	3	5	4.00	0.667
D.I.4	10	2	3	5	4.00	0.471
D.I.5	10	2	2	4	3.70	0.675
D.I.6	10	2	3	5	3.60	0.699
Planning & Designing Learning Environments						
D.II.1	10	2	3	5	3.90	0.738
D.II.2	10	2	3	5	3.90	0.568
D.II.3	10	2	3	5	3.90	0.568
D.II.4	10	2	3	5	3.90	0.568
D.II.5	10	2	3	5	4.30	0.675
D.II.6	10	2	3	5	3.60	0.843
Teaching, Learning & Curriculum						
D.III.1	10	1	3	4	3.80	0.422
D.III.2	10	1	3	4	3.80	0.422
D.III.3	10	2	3	5	4.00	0.471
D.III.4	10	1	4	5	4.20	0.422
D.III.5	10	3	2	5	3.80	0.789
D.III.6	10	1	4	5	4.20	0.422
Assessment and Evaluation						
D.IV.1	10	1	3	4	3.90	0.316
D.IV.2	10	1	3	4	3.90	0.316
D.IV.3	10	1	3	4	3.90	0.316
D.IV.4	10	1	3	4	3.90	0.316
Technology Operations and Concepts						
D.V.1	10	0	4	4	4.00	0.000
D.V.2	10	2	2	4	3.10	0.876
D.V.3	10	1	3	4	3.40	0.516
D.V.4	10	0	4	4	4.00	0.000
D.V.5	10	1	4	5	4.20	0.422
Social, Ethical, Legal, and Human Issues						
D.VI.1	10	2	3	5	4.10	0.738
D.VI.2	10	1	4	5	4.70	0.483
D.VI.3	10	1	4	5	4.50	0.527
D.VI.4	10	1	4	5	4.30	0.483
D.VI.5	10	1	3	4	3.90	0.316
D.VI.6	10	1	3	4	3.90	0.316
D.VI.7	10	1	3	4	3.70	0.483

Item	N	Range	Minimum	Maximum	Mean	Std. Deviation
Procedures, Policies, Planning & Budget						
D.VII.1	10	3	2	5	4.00	1.155
D.VII.2	10	2	2	4	3.20	0.789
D.VII.3	10	1	2	3	2.40	0.516
D.VII.4	10	2	3	5	4.20	0.789
D.VII.5	10	1	4	5	4.40	0.516
Productivity and Professional Practice						
D.VIII.1	10	1	4	5	4.40	0.516
D.VIII.2	10	1	4	5	4.40	0.516
D.VIII.3	10	2	3	5	4.00	0.943
D.VIII.4	10	1	4	5	4.80	0.422
D.VIII.5	10	1	4	5	4.40	0.516

APPENDIX H. ASSESSMENT DATA SET DESCRIPTIVE STATISTICS

Item	N	Range	Minimum	Maximum	Mean	Std. Deviation
Leadership and Vision						
D.I.1	10	1	4	5	4.60	0.516
D.I.2	10	2	3	5	4.00	0.667
D.I.3	10	1	4	5	4.70	0.483
D.I.4	10	1	4	5	4.60	0.516
D.I.5	10	1	4	5	4.90	0.316
D.I.6	10	2	3	5	4.10	0.568
Planning & Designing Learning Environments						
D.II.1	10	1	4	5	4.60	0.516
D.II.2	10	1	4	5	4.80	0.422
D.II.3	10	1	4	5	4.70	0.483
D.II.	10	1	4	5	4.50	0.527
D.II.5	10	1	4	5	4.60	0.516
D.II.6	10	2	3	5	3.90	0.738
Teaching, Learning & Curriculum						
D.III.1	10	2	3	5	4.10	0.568
D.III.2	10	1	4	5	4.80	0.422
D.III.3	10	1	4	5	4.70	0.483
D.III.4	10	1	4	5	4.90	0.316
D.III.5	10	2	3	5	4.00	0.471
D.III.6	10	1	4	5	4.50	0.527
Assessment and Evaluation						
D.IV.1	10	1	4	5	4.30	0.483
D.IV.2	10	1	4	5	4.50	0.527
D.IV.3	10	1	4	5	4.40	0.516
D.IV.4	10	1	4	5	4.60	0.516
Technology Operations and Concepts						
D.V.1	10	1	4	5	4.60	0.516
D.V.2	10	1	4	5	4.80	0.422
D.V.3	10	1	4	5	4.60	0.516
D.V.4	10	1	4	5	4.89	0.333
D.V.5	10	1	4	5	4.60	0.516
Social, Ethical, Legal, and Human Issues						
D.VI.1	10	1	4	5	4.90	0.316
D.VI.2	10	1	4	5	4.70	0.483
D.VI.3	10	1	4	5	4.90	0.316
D.VI.4	10	1	4	5	4.70	0.483
D.VI.5	10	1	4	5	4.60	0.516
D.VI.6	10	2	3	5	3.90	0.738
D.VI.7	10	2	3	5	4.10	0.568

Item	N	Range	Minimum	Maximum	Mean	Std. Deviation
Procedures, Policies, Planning & Budget						
D.VII.1	10	1	4	5	4.40	0.516
D.VII.2	10	1	4	5	4.50	0.527
D.VII.3	10	1	4	5	4.70	0.483
D.VII.4	10	1	4	5	4.90	0.316
D.VII.5	10	0	5	5	5.00	0.000
Productivity and Professional Practice						
D.VIII.1	10	1	4	5	4.60	0.516
D.VIII.2	10	1	4	5	4.70	0.483
D.VIII.3	10	1	4	5	4.60	0.516
D.VIII.4	10	1	4	5	4.80	0.422
D.VIII.5	10	0	5	5	5.00	0.000

APPENDIX I. COMPARISON OF DRAFT AND FINAL ETLA ITEMS

TL Standard	Final Survey Questions	Draft Survey Questions
Leadership and Vision	F.I.1. To what extent did you participate in your district's or school's most recent technology planning process?	D.I.1. To what extent did you participate in your district's or school's most recent technology planning process?
Leadership and Vision	F.I.2.To what extent did you communicate information about your district's or school's technology planning and implementation efforts to your school's stakeholders?	D.I.2. To what extent did you communicate information about your district's or school's technology planning and implementation efforts to your school's stakeholders?
Leadership and Vision	F.I.3. To what extent did you promote participation of your school's stakeholders in the technology planning process of your school or district?	D.I.3. To what extent did you promote participation of your school's stakeholders in the technology planning process of your school or district?
Leadership and Vision	F.I.4. To what extent did you compare and align your district or school technology plan with other plans, including district strategic plans, your school improvement plan, or other instructional plans?	D.I.4. To what extent did you compare and align your district or school technology plan with other plans, including district strategic plans, your school improvement plan, or other instructional plans?
Leadership and Vision	*Deleted*	D.I.5. To what extent did you advocate for inclusion of technology practices in your school?
Leadership and Vision	F.I.5. To what extent did you engage in activities to identify best practices in the use of technology (e.g., reviews of literature, attendance at relevant conferences, or meetings of professional organizations)?	D.I.6. To what extent did you engage in activities to identify best practices in the use of technology?
Planning and Designing Learning Environments	F.II.1. To what extent did you design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners?	D.II.1. To what extent did you design developmentally appropriate learning opportunities?
Planning and Designing Learning Environments	F.II.2. To what extent did you apply current research on teaching and learning with technology when planning learning environments and experiences?	D.II.2. To what extent did you apply current research on teaching and learning with technology when planning learning environments?
Planning and Designing Learning Environments	F.II.3. To what extent did you identify and locate technology resources and evaluate them for accuracy and suitability?	D.II.3. To what extent did you identify and locate technology resources and evaluate them for accuracy?
Planning and Designing Learning Environments	F.II.4. To what extent did you plan for the management of technology resources within the context of learning activities?	D.II.4. To what extent did you plan for the management of technology resources?
Planning and Designing Learning Environments	F.II.5. To what extent did you plan strategies to manage student learning in a technology-enhanced environment?	D.II.5. To what extent did you plan strategies to manage student learning in a technology-enhanced environment?

TL Standard	Final Survey Questions	Draft Survey Questions
Planning and Designing Learning Environments	*Deleted*	D.II.6. To what extent did you identify and apply instructional design principles associated with the development of technology resources?
Teaching, Learning and Curriculum	F.III.1. To what extent did you use systems like a data warehouse to access student information?	D.III.1. To what extent did you provide or make available assistance to use technology for interpreting and analyzing student assessment data?
Teaching, Learning and Curriculum	F.III.2. To what extent did you provide or make available assistance to colleagues for using student assessment data to modify instruction?	D.III.2. To what extent did you provide or make available assistance for using student assessment data to modify instruction?
Teaching, Learning and Curriculum	F.III.3. To what extent did you disseminate or model best practices in learning and teaching with technology to colleagues?	D.III.3. To what extent did you disseminate or model best practices in learning and teaching with technology to colleagues?
Teaching, Learning and Curriculum	F.III.4. To what extent did you collaborate with colleagues who were attempting to share information about technology practices, issues, and concerns?	D.III.4. To what extent did you collaborate with colleagues who were attempting to share information about technology practices, issues, and concerns?
Teaching, Learning and Curriculum	*Deleted*	D.III.5. To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan?
Teaching, Learning and Curriculum	F.III.5. To what extent did you facilitate or support the delivery of professional development on the use of technology to colleagues?	D.III.6. To what extent did you facilitate or support the delivery of professional development on the use of technology to colleagues?
Assessment and Evaluation	F.IV.1.To what extent did you promote or model technology-based systems to collect student assessment data?	D.IV.1. To what extent did you promote technology-based systems to collect student assessment data?
Assessment and Evaluation	F.IV.2. To what extent did you promote the evaluation of instructional practices, including technology-based practices, to assess their effectiveness?	D.IV.2. To what extent did you promote the evaluation of instructional practices to assess their effectiveness?
Assessment and Evaluation	F.IV.3. To what extent did you assess and evaluate existing technology-based systems in your school for modification or upgrade?	D.IV.3. To what extent did you assess existing technology-based systems in your school for modification or upgrade?
Assessment and Evaluation	F.IV.4. To what extent did you evaluate the effectiveness of technology related professional development offerings in your school?	D.IV.4. To what extent did you evaluate the effectiveness of professional development offerings in your school to meet the needs of teachers and their use of technology?
Assessment and Evaluation	F.IV.5. To what extent did you use multiple measures of evaluation to determine the appropriate use of technology-based resources?	

TL Standard	Final Survey Questions	Draft Survey Questions
Technology Operations and Concepts	F.V.1. To what extent did you support colleagues in connecting to and using district- and building-level technology?	D.V.1. To what extent did you support colleagues in connecting to and using district- and building-level technology?
Technology Operations and Concepts	*Deleted*	D.V.2. To what extent did you support colleagues in connecting to and using district- and building-level technology systems for management and operations (e.g., student information system, electronic grade book, and curriculum management system)?
Technology Operations and Concepts	F.V.2. To what extent did you pursue supplemental funding to help meet the technology needs of your school?	D.V.3. To what extent did you pursue supplemental funding to help meet the needs of your school?
Technology Operations and Concepts	F.V.3. To what extent did you ensure that hardware and software replacement/upgrades were incorporated into school technology plans?	D.V.4. To what extent did you ensure that hardware and software replacement/upgrades were incorporated into school technology plans?
Technology Operations and Concepts	F.V.4. To what extent did you advocate for adequate, timely, and high-quality technology support services?	D.V.5. To what extent did you advocate for adequate, timely, and high-quality technology support services?
Social, Ethical, Legal, and Human Issues	F.VI.1. To what extent did you work to ensure equity of technology access and use in your school?	D.VI.1. To what extent did you work to ensure equity of technology access and use in your school?
Social, Ethical, Legal, and Human Issues	F.VI.2. To what extent did you consider policies and programs meant to raise awareness of technology-related social, ethical, and legal issues?	D.VI.2. To what extent did you consider policies and programs meant to raise awareness of technology-related social, ethical, and legal issues?
Social, Ethical, Legal, and Human Issues	F.VI.3. To what extent were you involved in enforcing policies related to copyright and intellectual property?	D.VI.3. To what extent were you involved in enforcing policies related to copyright and intellectual property?
Social, Ethical, Legal, and Human Issues	F.VI.4. To what extent were you involved in addressing issues related to privacy and online safety?	D.VI.4. To what extent were you involved in addressing issues related to privacy and online safety?
Social, Ethical, Legal, and Human Issues	F.VI.5. To what extent did you support the use of technology to help meet the needs of all students, including special education students?	D.VI.5. To what extent did you support the use of technology to help meet the needs of special education students?
Social, Ethical, Legal, and Human Issues	*Deleted*	D.VI.6. To what extent did you support the use of technology to assist in the delivery of instructional education programs for all students?
Social, Ethical, Legal, and Human Issues	*Deleted*	D.VI.7. To what extent did you disseminate information about health concerns related to technology and computer usage in classrooms and offices?

TL Standard	Final Survey Questions	Draft Survey Questions
Procedures, Policies, Planning	F.VII.1.To what extent did you use technology resources to implement classroom instruction?	D.VII.1. To what extent did you use technology resources to implement classroom instruction?
Procedures, Policies, Planning	F.VII.2. To what extent did you contribute with planning on how to spend building discretionary technology funds.	D.VII.2. To what extent did you differentiate among specifications for purchasing technology systems in school settings?
Procedures, Policies, Planning	*Deleted*	D.VII.3. To what extent did you participate in professional development opportunities related to management of school facilities, technology resources, and purchases?
Procedures, Policies, Planning	F.VII.3. To what extent did you follow procedures and guidelines used in planning and purchasing technology resources?	D.VII.4. To what extent did you follow procedures and guidelines used in purchasing technology resources?
Procedures, Policies, Planning	F.VII.4. To what extent did you participate in technology planning for your building?	D.VII.5. To what extent did you participate in technology planning for your building?
Productivity and Professional Practice	F.VIII.1. To what extent did you participate in professional development activities meant to improve or expand your use of technology?	D.VIII.1. To what extent did you participate in professional development activities meant to improve or expand your use of technology?
Productivity and Professional Practice	F.VIII.2. To what extent did you use technology to help complete your day to day tasks? (E.g. personal calendar, developing budgets, communicating with others, gathering information)?	D.VIII.2. To what extent did you use technology to help complete your day to day tasks? (E.g. personal calendar, developing budgets, communicating with others, gathering information)?
Productivity and Professional Practice	F.VIII.3. To what extent did you encourage and use technology (e.g. e-mail, blogs, videoconferences) as a means of communicating with education stakeholders, including peers, experts, students, parents/guardians, and the community?	D.VIII.3. To what extent did you encourage and use technology (e.g. e-mail, blogs, videoconferences) as a means of communicating with education stakeholders, including peers, experts, students, parents/guardians, and the community?
Productivity and Professional Practice	F.VIII.4. To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan?	D.VIII.4. To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan?
Productivity and Professional Practice	F.VIII.5. To what extent did you evaluate and compare options for the technology you used in your job?	D.VIII.5. To what extent did you evaluate and compare options for the technology you used in your job?

APPENDIX J. FIELD TEST DESCRIPTIVE STATISTICS

Item	N	Mean	Std. Deviation	Variance	Item-Rest Correlation	Alpha if item removed
F.I.1	205	2.55	1.34	1.80	0.58	0.97
F.I.2	189	2.52	1.30	1.70	0.63	0.97
F.I.3	182	2.09	1.16	1.34	0.74	0.97
F.I.4	196	2.29	1.16	1.35	0.72	0.97
F.I.5	206	2.33	1.11	1.24	0.73	0.97
F.II.1	206	2.92	1.07	1.14	0.66	0.97
F.II.2	205	2.87	1.01	1.02	0.73	0.97
F.II.3	208	2.45	1.12	1.26	0.71	0.97
F.II.4	205	2.52	1.09	1.18	0.77	0.97
F.II.5	210	2.75	1.11	1.24	0.77	0.97
F.III.1	208	3.09	1.19	1.41	0.32	0.97
F.III.2	208	3.01	1.14	1.29	0.48	0.97
F.III.3	206	2.93	1.09	1.19	0.79	0.97
F.III.4	212	3.04	1.02	1.04	0.76	0.97
F.III.5	207	2.96	1.29	1.67	0.80	0.97
F.IV.1	207	2.76	1.07	1.14	0.55	0.97
F.IV.2	198	2.51	1.11	1.23	0.70	0.97
F.IV.3	206	2.28	1.20	1.44	0.78	0.97
F.IV.4	203	2.61	1.14	1.30	0.76	0.97
F.IV.5	201	2.15	1.04	1.09	0.73	0.97
F.V.1	206	3.40	1.14	1.30	0.47	0.97
F.V.2	201	2.06	1.26	1.59	0.65	0.97
F.V.3	181	2.13	1.24	1.53	0.76	0.97
F.V.4	202	2.76	1.28	1.63	0.73	0.97
F.VI.1	195	2.58	1.28	1.65	0.82	0.97
F.VI.2	201	2.19	1.15	1.32	0.72	0.97
F.VI.3	191	2.19	1.30	1.69	0.64	0.97
F.VI.4	203	2.37	1.27	1.61	0.74	0.97
F.VI.5	203	3.36	1.17	1.37	0.65	0.97
F.VII.1	198	3.29	1.06	1.12	0.61	0.97
F.VII.2	196	2.22	1.36	1.85	0.71	0.97
F.VII.3	176	2.80	1.52	2.32	0.70	0.97
F.VII.4	210	2.73	1.42	2.03	0.74	0.97
F.VIII.1	213	3.14	1.24	1.54	0.69	0.97
F.VIII.2	214	4.29	0.83	0.70	0.45	0.97
F.VIII.3	214	3.93	0.92	0.85	0.27	0.97
F.VIII.4	194	2.29	1.17	1.36	0.71	0.97
F.VIII.5	206	2.61	1.19	1.42	0.74	0.97

APPENDIX K. MATCHED PAIRED ITEM CORRELATIONS

Paired Item	N	Correlation	Sig.
ETLA Item 1	17	0.086	0.743
ETLA Item 2	13	0.199	0.514
ETLA Item 3	14	0.392	0.166
ETLA Item 4	15	-0.106	0.707
ETLA Item 5	15	-0.523	0.045
ETLA Item 6	19	0.172	0.481
ETLA Item 7	19	-0.011	0.963
ETLA Item 8	17	-0.278	0.280
ETLA Item 9	17	0.239	0.356
ETLA Item 10	18	-0.238	0.341
ETLA Item 11	18	0.192	0.444
ETLA Item 12	18	0.387	0.112
ETLA Item 13	18	0.005	0.984
ETLA Item 14	19	0.546	0.016
ETLA Item 15	16	0.443	0.086
ETLA Item 16	17	-0.258	0.318
ETLA Item 17	18	-0.548	0.018
ETLA Item 18	15	-0.376	0.167
ETLA Item 19	16	-0.257	0.336
ETLA Item 20	15	-0.333	0.226
ETLA Item 21	18	0.369	0.132
ETLA Item 22	14	0.224	0.441
ETLA Item 23	13	-0.071	0.818
ETLA Item 24	16	-0.303	0.255
ETLA Item 25	16	-0.263	0.324
ETLA Item 26	15	-0.170	0.545
ETLA Item 27	14	-0.477	0.084
ETLA Item 28	15	0.168	0.549
ETLA Item 29	17	0.073	0.781
ETLA Item 30	18	-0.121	0.632
ETLA Item 31	14	0.312	0.278
ETLA Item 32	10	0.320	0.367
ETLA Item 33	16	0.213	0.429
ETLA Item 34	19	0.251	0.299
ETLA Item 35	19	-0.118	0.630
ETLA Item 36	19	-0.125	0.610
ETLA Item 37	15	-0.151	0.591
ETLA Item 38	13	-0.298	0.323

APPENDIX L. EFA ROTATED FACTOR MATRIX

Item	Factor					
	1	2	3	4	5	6
F.I.1	0.424					
F.I.2				0.434	0.515	
F.I.3	0.599					
F.I.4		0.424	0.506			
F.I.5		0.560	0.410			
F.II.1					0.618	
F.II.2		0.663				
F.II.3	0.443	0.531				
F.II.4		0.609				
F.II.5	0.429	0.560				
F.III.1						
F.III.2				0.688		
F.III.3		0.636				
F.III.4	0.485	0.553				0.403
F.III.5	0.486					
F.IV.1				0.609		
F.IV.2		0.553		0.445		
F.IV.3	0.602	0.470				
F.IV.4		0.433	0.468			
F.IV.5		0.468	0.553			
F.V.1				0.520		
F.V.2	0.413		0.460			
F.V.3	0.681					
F.V.4	0.583					
F.VI.1	0.623		0.451			
F.VI.2			0.550			
F.VI.3			0.441			
F.VI.4			0.689			
F.VI.5		0.403			0.406	
F.VII.1		0.465			0.483	
F.VII.2	0.748					
F.VII.3	0.484		0.426			
F.VII.4	0.710					
F.VIII.1			0.500			
F.VIII.2					0.577	
F.VIII.3						0.517
F.VIII.4		0.533				
F.VIII.5	0.457					0.411

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX M. ETLA SURVEY (PRINTED VERSION)

Instructions: You are being given this technology leadership assessment at the request of the technology department, which will use the results to guide its leadership training and professional development programming. Assessment items are based on the International Society for Technology in Education's (ISTE) National Educational Technology Leadership Standards. The purpose of the assessment is to provide detailed and comparative feedback about education technology leadership. The individual items in the assessment ask you about the extent to which you have engaged in certain behaviors that relate to K-12 school technology leadership. Please answer all questions. If you feel a specific question is not applicable, you may mark as not applicable.

There are 38 questions in the survey. It should take 15-20 minutes to complete this survey. As you answer the questions, think of your actual behavior over the course of the last school year. Do not take into account planned or intended behavior. As you select the appropriate response to each question, it may be helpful to keep in mind the performance of other educators that you know. Please note that the accuracy and usefulness of this assessment is largely dependent upon your candor. If done with care, the results can provide valuable information. Your responses to the survey will be kept confidential by the technology department researcher.

To what extent did you participate in your district's or school's most recent technology planning process?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you communicate information about your district's or school's technology planning and implementation efforts to your school's stakeholders?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you promote participation of your school's stakeholders in the technology planning process of your school or district?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you compare and align your district or school technology plan with other plans, including district strategic plans, your school improvement plan, or other instructional plans?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you engage in activities to identify best practices in the use of technology (e.g., reviews of literature, attendance at relevant conferences, or meetings of professional organizations)?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you apply current research on teaching and learning with technology when planning learning environments and experiences?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you identify and locate technology resources and evaluate them for accuracy and suitability?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you plan for the management of technology resources within the context of learning activities?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you plan strategies to manage student learning in a technology-enhanced environment?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you use systems like a data warehouse to access student information?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you provide or make available assistance to colleagues for using student assessment data to modify instruction?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you disseminate or model best practices in learning and teaching with technology to colleagues?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you collaborate with colleagues who were attempting to share information about technology practices, issues, and concerns?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you facilitate or support the delivery of professional development on the use of technology to colleagues?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you promote or model technology-based systems to collect student assessment data?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you promote the evaluation of instructional practices, including technology-based practices, to assess their effectiveness?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you assess and evaluate existing technology-based systems in your school for modification or upgrade?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you evaluate the effectiveness of technology related professional development offerings in your school?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you use multiple measures of evaluation to determine the appropriate use of technology-based resources?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you support colleagues in connecting to and using district- and building-level technology?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you pursue supplemental funding to help meet the technology needs of your school?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you ensure that hardware and software replacement/upgrades were incorporated into school technology plans?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you advocate for adequate, timely, and high-quality technology support services?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you work to ensure equity of technology access and use in your school?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you consider policies and programs meant to raise awareness of technology-related social, ethical, and legal issues?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent were you involved in enforcing policies related to copyright and intellectual property?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent were you involved in addressing issues related to privacy and online safety?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you support the use of technology to help meet the needs of all students, including special education students?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you use technology resources to implement classroom instruction?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you contribute with planning on how to spend building discretionary technology funds?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you follow procedures and guidelines used in planning and purchasing technology resources?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you participate in technology planning for your building?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you participate in professional development activities meant to improve or expand your use of technology?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you use technology to help complete your day to day tasks? (E.g. personal calendar, developing budgets, communicating with others, gathering information)?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you encourage and use technology (e.g. e-mail, blogs, and video-conferences) as a means of communicating with education stakeholders, including peers, experts, students, parents/guardians, and the community?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you advocate for inclusion of research-based technology practices in your school improvement plan?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

To what extent did you evaluate and compare options for the technology you used in your job?

- ❑ Not applicable
- ❑ Not at all
- ❑ Minimally
- ❑ Somewhat
- ❑ Significantly
- ❑ Fully

APPENDIX N. DEFINITIONS

Assessment. A method of measurement used to evaluate progress. Student assessment typically refers to a method of evaluating student performance and attainment to determine whether or not a student is achieving the expected outcome(s).

Halo error. This occurs when an individual assesses themselves based on a general impression of their performance or behavior, and the general impression is allowed to unduly influence all the assessments given. An example of halo error would be an individual who rates highly on every single assessment item. It is rare that individuals perform at exactly the same level on every dimension of leadership. It is more likely that an individual performs better in some areas than on others.

Leniency error. This occurs when an individual gives themselves an assessment higher than they deserves. This could occur for several reasons: the individual has relatively low performance standards; the individual assumes that other individuals also inflate their ratings; or, for social or political reasons, the individual judges that it would be better not to give a poor assessment.

Recency error. This occurs when an individual bases an assessment on their most recent behavior, as opposed to their entire behavior over some fixed period of time (e.g., the last year).

Research-based. A practice that employs systematic, empirical methods that draws on observation or experiment to provide reliable data. Research-based work uses research designs and methods appropriate to the research question posed and are presented in sufficient detail for replication. The strongest research-based practices typically obtain acceptance through peer-reviewed journals or expert panels.

Technology. Generally refers to personal computers, networking devices and other computing devices (e.g., electronic whiteboards and personal digital assistants (PDAs)); also includes software, digital media, and communications tools such as the Internet, e-mail, CD-ROMs, and video conferencing.

Technology planning. Any process by which multiple stakeholder groups (e.g., district administration, school administration, faculty, and parents) convene to develop a strategy for the use or expanded use of technology in instruction and operations. Technology planning need not be separate from other planning efforts, but should be a recurring theme if integrated within a more comprehensive planning process.

REFERENCES

ACOT. (1995). A report on 10 years of ACOT research. Retrieved September 1, 2006, from http://images.apple.com/education/k12/leadership/acot/pdf/10yr.pdf

Anderson, R. E., & Dexter, S. (2005). School technology leadership: An empirical investigation of prevalence and effect. *Educational Administration Quarterly, 41*(1), 49-82.

Avolio, B. J., & Bass, B. M. (2002). *Developing potential across a full range of leadership: cases on transactional and transformational leadership*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Barnett, H. (2001). *Successful K-12 technology planning: Ten essential elements* (No. EDO-IR-2001-06). Syracuse, N.Y.: ERIC Clearinghouse on Information and Technology.

Barth, R. S. (1999). *The teacher leader*. Providence, R.I.: Rhode Island Foundation.

Bass, B. M., & Avolio, B. J. (1997). *Full range leadership development: Manual for the multifactor leadership questionnaire*. Redwood City, CA: Mind Garden, Inc.

Battle, M. C. (2004). *Superintendents' perceptions of educational technology leadership.* Unpublished Ph.D., The University of Southern Mississippi, United States -- Mississippi.

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers & Education, 39*(4), 395-414.

Bruner, J. S. (1966). *Toward a theory of instruction*. Cambridge, Mass.,: Belknap Press of Harvard University Press.

Byrne, B. M. (1989). *A primer of LISREL: Basic applications and programming for confirmatory factor analytic models*. New York: Springer-Verlag.

Byrom, E., & Bingham, M. (2001). *Factors influencing the effective use of technology for teaching and learning: Lessons learned from the SEIR-TEC Intensive Site Schools. 2nd Edition*. Greensboro, NC: SouthEastern Regional Vision for Education.

Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment*. Beverly Hills, CA: Sage Publications.

Center for the Advanced Study of Leadership in Education. (2005). Principals Technology Leadership Assessment. Retrieved September 1, 2006, from http://www.schooltechleadership.org/uploaded/PTLA_Info_Packet.pdf

CEO Forum. (1997). School technology and readiness report: From pillars to progress. Retrieved September 1, 2006, from http://www.ccoforum.org/downloads/

CEO Forum. (1999). School technology and readiness report: Professional development - A link to better learning. Retrieved September 1, 2006, from http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED428747&site=ehost-live

CEO Forum. (2000). School technology and readiness report: The powers of digital learning. Retrieved September 1, 2006, from http://ccoforum.org/downloads/report3.pdf

CoSN. (2006). CoSN's school district Chief Technology Officers' (CTO) Council. Retrieved September 1, 2006, from http://www.cosn.org/resources/cto_council/index.cfm

CoSN K-12 CTO Council. (2006). What it takes: Essential skills of the K-12 CTO. Retrieved September 1, 2006, from http://www.cosn.org/resources/cto_council/skills.cfm

Cotton, K. (2003). *Principals and student achievement: What the research says*. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Creighton, T. B. (2003). *The principal as technology leader*. Thousand Oaks, CA: Corwin Press.

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

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage Publications.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813-834.

Culp, K. M., Honey, M., & Mandinach, E. (2005). A retrospective on twenty years of education technology policy. *Journal of Educational Computing Research, 32*(3), 279-307.

Deal, T. E., & Peterson, K. D. (1999). *Shaping school culture: The heart of leadership*. San Francisco: Jossey Bass Inc.

Dede, C. (2000). Emerging influences of information technology on school curriculum. *Journal of Curriculum Studies, 32*(2), 281-303.

Demetriadis, S., Barbas, A., Molohides, A., Palaigeorgiou, G., Psillos, D., Vlahavas, I., et al. (2003). Cultures in negotiation: Teachers' acceptance/resistance attitudes considering the infusion of technology into schools. *Computers & Education, 41*(1), 19-37.

Dikkers, A. G., Hughes, J. E., & McLeod, S. (2005). A bridge to success: STLI - In that no man's land between school technology and effective leadership, the University of Minnesota's School Technology Leadership Initiative is a welcoming bridge. *T.H.E. Journal, 32*(11), 20.

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method* (2nd ed.). Hoboken, N.J.: Wiley.

Earl, J., & Lampe, M. D. (2004). *Toward a new golden age in American education - How the Internet, the law and today's students are revolutionizing expectations*. Retrieved September 3, 2006. from http://www.ed.gov/about/offices/list/os/technology/plan/2004/index.html.

Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology, 42*(1), 5-13.

Eichinger, R. W., & Lombardo, M. M. (2006). Education competency wheel. Retrieved September 3, 2006, 2006, from https://www.microsoft.com/education/competencies/default.mspx

Elmore, R. F. (2000). *Building a new structure for school leadership*. Washington, DC: The Albert Shanker Institute.

Ertmer, P. A., Bai, H., Dong, C., Khalil, M., Park, S. H., & Wang, L. (2002). Online professional development: Building administrators' capacity for technology leadership. *Journal of Computing in Teacher Education, 19*(1), 5-11.

Fenn, J., Linden, A., & Fairchok, S. (2003). *Strategic technology planning: Picking the winners* (No. R-20-3354): Gartner, Inc.

Fishbaugh, M. S. (1997). *Models of collaboration*. Boston: Allyn and Bacon.

Fitzpatrick, K. A., & Pershing, J. A. (1996). *Technology: Indicators of quality information technology systems in K-12 schools*. Schaumburg, IL: National Study of School Evaluation.

Fraenkel, J. R., & Wallen, N. E. (1993). *How to design and evaluate research in education* (2nd ed.). New York: McGraw-Hill.

Fullan, M. (2001a). *Leading in a culture of change*. San Fransico: Jossey Bass.

Fullan, M. (2001b). *The new meaning of educational change* (3rd ed.). New York: Teachers College Press.

Fullan, M. (2003). *Change forces with a vengeance*. New York: RoutledgeFalmer.

Garnder, J. W. (1990). *On leadership*. New York: Free Press.

GLEF. (2001). GLEF Blast Newsletter. Retrieved September, 2006, from http://www.edutopia.org/EdutopiaPDF/Fall01.pdf

Granger, C. A., Morbey, M. L., Lotherington, H., Owston, R. D., & Wideman, H. H. (2002). Factors contributing to teachers' successful implementation of IT. *Journal of Computer Assisted Learning, 18*(4), 480-488.

Grote, R. C. (1996). *The complete guide to performance appraisal*. New York: AMACOM.

Groves, R. M., Fowler, F. J., Couper, M. P., Lepkowski, J. M., Singer, E., & Tourangeau, R. (2004). *Survey methodology*. Hoboken, NJ: J. Wiley.

Hair, J. F. (1979). *Multivariate data analysis: With readings*. Tulsa, Ok.: PPC Books.

Hall, G., & Hord, S. (2001). *Implementing change: Patterns, principles, and potholes*. Boston: Allyn & Bacon.

Healy, J. M. (1998). *Failure to connect: How computers affect our children's minds - for better and worse*. New York: Simon and Schuster.

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences* (5th ed.). Boston: Houghton Mifflin.

Holland, L., & Moore-Steward, T. (2000). A different divide: Preparing tech-savvy leaders. *Leadership, 30*(1), 8-10,37-38.

Holland, P. E. (2001). Professional development in technology: Catalyst for school reform. *Journal of Technology and Teacher Education, 9*(2), 245-267.

Hord, S. M. (1997). Professional learning communities: What are they and why are they important? Retrieved November 1, 2007, from http://www.sedl.org/change/issues/issues61.html

Hudanich, N. V. (2002). *Identifying educational technology leadership competencies for New Jersey's school superintendents.* Unpublished Ed.D., Seton Hall University.

Hughes, M., & Zachariah, S. (2001). An investigation into the relationship between effective administrative leadership styles and the use of technology. *International Electronic Journal For Leadership in Learning, 5*(5).

Hurley, D. (2002). *The yin and yang of technology leadership in education* (No. COM-16-1192): Gartner, Inc.

ISTE. (2000). *National educational technology standards for students*. Eugene, OR: International Society for Technology in Education.

ISTE. (2002). *National educational technology standards for teachers*. Eugene, OR: International Society for Technology in Education.

ISTE. (2004). *National educational technology standards for administrators*. Eugene, OR: International Society for Technology in Education.

ISTE. (2006). National educational technology standards. Retrieved September 1, 2006, from http://osx.latech.edu/

Jukes, I. (1996). The essential steps of technology planning. *School Administrator, 53*(4), 8-14.

Keller, B., & Rust, B. (2001). *K-12 E-education: Governance* (No. SPA-14-4362): Gartner, Inc.

Kim, J., & Mueller, C. W. (1978a). *Factor analysis: Statistical methods and practical issues*. Beverly Hills, CA: Sage Publications.

Kim, J., & Mueller, C. W. (1978b). *Introduction to factor analysis: What it is and how to do it*. Beverly Hills, CA: Sage Publications.

Kline, P. (1994). *An easy guide to factor analysis*. New York: Routledge.

Kotter, J. P. (1996). Transforming organizations: Why firms fail. In *Leading Change*. Boston: Harvard Business School Press.

Kozma, R. B. (2005). National policies that connect ICT-based education reform to economic and social development. *Human Technology, 1*, 117-156.

Lambert, L. (1998). *Building leadership capacity in schools*: Association for Supervision & Curriculum Development.

Lambert, L. (2003). *Leadership capacity for lasting school improvement*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Lambert, L. (2005). What does leadership capacity really mean? *Journal of Staff Development, 26*(2), 38-40.

Lauer, J. M., & Asher, J. W. (1988). *Composition research: Empirical designs*. New York: Oxford University Press.

Leithwood, K., Louis, K. S., Anderson, S., & Wahlstrom, K. (2004). *How leadership influences student learning*. New York, NY: The Walace Foundation.

Marzano, R. J. (2003). *What works in schools: Translating research into action*. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage.

Mayer, R. E. (2003). *Learning and instruction*. New Jersey: Pearson Education, Inc.

McKenzie, C., & Padayachee, G. (2001). *Technology II: Implementation planning guide*. Sacromento, CA: California Community Colleges.

McKenzie, J. (1998). Technology's webs. *School Administrator, 55*(4), 6-10.

Means, B., & et al. (1993). *Using technology to support education reform* (No. 0160420482). District of Columbia: U.S. Government Printing Office.

Mirra, D. R. (2004). *The role of the school superintendent as a technology leader: A Delphi study.* Unpublished Ed.D., Virginia Polytechnic Institute and State University.

National Center for Education Statistics. (2006). *Digest of education statistics, 2005* (No. NCES 2006-030): U.S. Department of Education.

National Center for Education Statistics. (2007). *Digest of education statistics, 2006* (No. NCES 2007-017): U.S. Department of Education.

Newman, I., & McNeil, K. A. (1998). *Conducting survey research in the social sciences*. Lanham, Md.: University Press of America.

Norris, C., Smolka, J., & Soloway, E. (1999). *Convergent analysis: A method for extracting the value from research studies on technology in education.* Paper presented at the The Secretary's Conference on Educational Technology, Washington, DC.

Office of Postsecondary Education. (2003). *Application for grants under the preparing tomorrow's teachers to use technology (PT3)*. Washington, DC: U.S. Dept. of Education, Office of Postsecondary Education, Higher Education Programs,.

Office of Research Assurances. (2006). Human subjects. Retrieved September 1, 2006, from http://www.compliance.iastate.edu/ComplianceWeb/irbForms.aspx

Office of Technology and Assessment. (1989). *Linking for learning: A new course for education*. Washington, DC: U.S. Government Printing Office.

Office of Technology and Assessment. (1995). *Teachers & technology: Making the connection*. Washington, DC: U.S. Government Printing Office.

Peterson, R. A. (2000). *Constructing effective questionnaires*. Thousand Oaks, CA: Sage Publications.

Phillips, D. C., & Burbules, N. C. (2000). *Postpositivism and educational research*. Lanham, Md.: Rowman & Littlefield Publishers.

Pitler, H. (2005). *McREL technology initiative: The development of technology intervention program. Final report*. Aurora, CO: Mid-Continent Research for Education and Learning (McREL).

Pounder, D. G. (1998). *Restructuring schools for collaboration promises and pitfalls*. Albany, NY: State University of New York Press.

Rea, L. M., & Parker, R. A. (2005). *Designing and conducting survey research: A comprehensive guide* (3rd ed.). San Francisco: Jossey-Bass.

Retallick, J., & Fink, D. (2002). Framing leadership: Contributions and impediments to educational change. *International Journal of Leadership in Education, 5*(2), 91-104.

Riedl, R., Smith, T., Ware, A., Wark, A., & Yount, P. (1998). *Leadership for a technology-rich educational environment.* Paper presented at the SITE 98: Society for Information Technology & Teacher Education International Conference, Washington, DC.

Ringstaff, C., & Kelley, L. (2002). *The learning return on our educational technology investment: A review of findings from research*. San Francisco, CA: WestEd.

Ross, J. D., McGraw, T. M., & Burdette, K. J. (2001). *Toward an effective use of technology in education: A summary of research*. Charleston, WV: AEL, Inc.

Rowand, C. (2000). Teacher use of computers and the internet in public schools. *Education Statistics Quarterly, 2*(2), 72-75.

Rust, B. (2006). *CIOs in K-12 education must demonstrate political and interpersonal skills* (No. G00139095): Gartner, Inc.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York: Teachers College Press.

Sansone, C., Morf, C. C., & Panter, A. T. (2003). *The Sage handbook of methods in social psychology*. Thousand Oaks, CA: Sage Publications.

Schiller, J. (2002). Interventions by school leaders in effective implementation of information and communications technology: Perceptions of Australian principals. *Technology, Pedagogy and Education 11*(3), 289-301.

Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment, 8*(4), 350.

Skinner, R. A. (2002). Tracking tech trends. *Education Week, 21*(35), 53.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2001). Investigating school leadership practice: A distributed perspective [Electronic Version]. *Educational Researcher*. Retrieved September 2006 from www.soemadison.wisc.edu/elpa/people/faculty/halverson/JamesSpillaneDistributedLeadership.pdf.

Starkweather, K. N. (2002). ITEA/Gallup Poll: Interpreting what others think of technology teaching. *Technology Teacher, 61*(8), 31-33.

Stegall, P. (1998). *The Principal: Key to technology implementation*. Paper presented at the Annual Meeting of the National Catholic Education Association.

Stogdill, R. M. (1974). *Handbook of leadership: A survey of theory and research*. New York: Free Press.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Boston: Allyn and Bacon.

Tiene, D., & Luft, P. (2001). Teaching in a technology-rich classroom. *Educational Technology, 41*(4), 23-31.

Twomey, C. R., Shamburg, C., & Zieger, L. B. (2006). *Teachers as technology leaders*. Eugene, OR: ISTE Publications.

U.S. Department of Commerce. (2002). A nation online. How Americans are expanding their use of the Internet. Retrieved September 1, 2006, from http://www.ntia.doc.gov/ntiahome.dn

Valdez, G. (2000). *Computer-based technology and learning evolving uses and expectations*. Oak Brook, IL: North Central Regional Educational Laboratory.

Waters, T., Marzano, R. J., & McNulty, B. (2003). *Balanced Leadership: What 30 years of research tells us about the effect of leadership on student achievement*. Denver, CO: McRel.

Weiner, L. (2000). Research in the 90s: Implications for urban teacher preparation. *Review of Educational Research, 70*(3), 369-406.

Welkowitz, J., Cohen, B. H., & Ewen, R. B. (2006). *Introductory statistics for the behavioral sciences* (6th ed.). Hoboken, N.J.: Wiley.

Wheatley, M. J. (1999). *Leadership and the new science: Discovering order in a chaotic world* (2nd ed.). San Francisco: Berrett-Koehler Publishers.

Wilsmore, D., & Betz, M. (2000). Information technology and schools: The Principal's role [Electronic Version]. *Educational Technology & Society*. Retrieved September 1, 2006 from http://ifets.ieee.org/periodical/vol_4_2000/discuss_october2000.pdf.

Wonacott, M. E. (2001). Technological literacy. ERIC Digest. Washington, DC: Office of Educational Research and Improvement.

Yee, D. L. (1998). Chalk, chips, and children. *Educational Leadership, 55*(7), 57-59.

ACKNOWLEDGMENTS

I'd like to acknowledge the support of my major professors during my PhD program of study at Iowa State University. Dr. Tom Alsbury, who helped me develop my program of study and get me started. Dr. Frank Hernandez, who helped me through the middle stages of my program, including my Capstone work. Dr. Scott Mcleod, who served as a mentor and a guide for my work related to education technology leadership.

In addition to the leadership of my major professors, I had great support from a number of Iowa State University faculty and staff, including Dr. Gary Phye, Dr. Ann Thompson, Dr. Denise Schmidt, Dr. Troyce Fisher, and Dr. Joanne Marshall. I offer a special thank you to Judy Weiland in the Department of Education Leadership and Policy Studies for helping me to navigate through the University procedures and various requirements.

Thank you to my colleagues in the Des Moines Schools who encouraged me in the pursuit of my degree. Dr. Linda Lane especially served to inspire and motivate me in my PhD efforts. And thank you to the members of my PhD cohort, especially Dr. Elizbeth Cox, for making the effort to stay in touch and make sure we all supported each other even after the coursework was finished.

My wife Amy, my son Calvin, and my daughter Haley provided great love and support throughout my pursuit of the PhD degree. As a family we share in each other's accomplishments, and I know they were a big part of this one.