THE GLOBAL eLEARNING JOURNAL
VOLUME 2, NUMBER 4, 2013

The 21st Century Principal: A Study of Technology Leadership and Technology Integration in Texas K-12 Schools

Donna Marie Fisher, EdD
Director of Instructional Technology
Rockwall Independent School District
Rockwall, TX

L. Rusty Waller, PhD
Associate Professor
Department of Educational Leadership
College of Education and Human Services
Texas A&M University-Commerce
Commerce, TX

Abstract

The purpose of this study was twofold. First, the study examined whether differences existed between K-12 principal and teacher perceptions of teachers' abilities to effectively integrate technology in the classroom. Secondly, the study sought to determine whether a relationship existed between principals' instructional-technology leadership and the effective use of technology in their instruction.

To achieve the aim of this study, a quantitative method was used with archival data received from the Texas Education Agency (TEA) through an open records request. A total of 328 principals and 303,950 teachers participated in the study. A repeated measures MANOVA was conducted to examine differences between teachers' and principals' perceptions of teachers' abilities to integrate technology and access to professional development.

The results of this study indicated that a difference exists between principals' and teachers' perceptions of teachers' abilities to integrate technology and their access to technology-related professional development. Additionally, principal technology-leadership proficiencies yielded significant positive correlations with teachers' abilities to integrate technology and their access to technology-related professional development.

Key Words: instructional technology, principals', technology, K-12 classrooms

Introduction

The traditional model of education, where teachers serve as the source of knowledge, students passively receive information, and the textbook serves as the basic unit of instruction, no longer adequately prepares students to be productive citizens in the Digital Age (Pacific Policy Research Center [PPRC], 2010; Prensky, 2013). Technology facilitates easy access to a wealth of information and makes collaboration and global connectedness easier and quicker than has ever been possible. The expansion of these technologies into the global workplace has produced a demand for individuals who possess advanced analytical and complex communication skills (Organisation for Economic Cooperation and Development [OECD], 2012). Furthermore, research organizations concur that "new technology-based learning is consistent with the thrust toward multi-sensory, interactive, and experiential learning, all of which are important elements in deeper-order learning, understanding, and knowledge" (Gonick, 2002, p. 8). The schools of today should be "more than information factories; they must be incubators of exploration and invention" (U.S. Department of Education [DOE], 2010a, p. 1). Therefore, students need to develop skills that allow them to communicate, collaborate, think critically, and solve the types of problems that impact them directly and globally (Bevins, Carter, Jones, Moye, & Ritz, 2012; Hodge & Lear, 2011; Larson & Miller, 2011; Luterbach & Brown, 2011; Prensky, 2013; Saavedra & Opfer, 2012; Starr, 2011). Studies show that when technology is effectively deployed, it can improve the quality of teaching and positively impact student learning (Greaves, Hayes, Wilson, Gielniak, & Peterson, 2012; DOE, 2010b).

Just 30 years ago, Cuban (1983) reported that teaching practices had remained largely unchanged for over 100 years; instruction was geared primarily toward the acquisition of facts related to discrete subject areas while teacher-centered pedagogical practices focused on large-group instruction, recitation, and independent seatwork. Although large school districts used computers for business functions in the mid to late 1950s, schools were considered cutting-edge if they had a mainframe computer that was used for administrative tasks or a few computers in a shared computer lab for student instruction. In 1984, the student to computer ratio in U.S. public schools was 92 to 1 (Cuban, Kirkpatrick, & Peck, 2001).

Infusing technology into the classroom has been touted as a catalyst for changing the traditional teacher-student paradigm, allowing students to become active participants in their learning, and preparing them for the technology-driven workplace (Belland, 2009; Cuban et al., 2001; Daggett, 2010; Dwyer, Ringstaff, & Sandholtz, 1991). With the call for increased technology that began in the early 1990s, "increasing student access to high-end technology has become a national priority" (Peck, Cuban, & Kirkpatrick, 2002, p. 473). In an effort to transform K-12 classrooms into 21st century learning spaces, the U.S. federal government has played an important role by providing millions of dollars to K-12 schools to increase their technology infrastructures with new hardware, software, and Internet access. To improve student achievement and promote learning through the use of technology, Title II, Part D of the No Child Left Behind (NCLB) Act, allows the DOE to provide formula grants to state education agencies through the Enhancing Education Through Technology (EETT) program (Bakia, Mitchell, & Yang, 2007). Jones, Fox, and Levin (2011) reported that EETT funds would "provide all students, especially those who lack access to technology at home, with opportunities to gain the critical technology skills and real-world knowledge that are fundamental for obtaining jobs in this global, information-technology-rich marketplace" (p. 19).

Although K-12 schools lag behind the business world in the acquisition of technology, computers have become ubiquitous in the classroom over the last 30 years. Today, all public schools in the United States have Internet connected computers for instruction. Additionally, 97% of teachers have one or more computers located in their classrooms and, of those classroom computers, 93% have Internet access (Gray, Thomas, & Lewis, 2010; Nagel, 2010). Since 2000, the ratio of Internet-connected computers to students has steadily increased; as of 2012, the ratio of students to Internet-connected computers was 3 to 1 (Snyder & Dillow, 2012). In a recent study, 2% of schools in the United States had a 1-to-1 student-computer ratio (Greaves et al., 2012). In addition to computers in the classroom, there has also been an increase in technologies that educators use as tools to present information to students. For example, 84% of all teachers have a digital projector in their classrooms or have access to one for everyday use (Gray et al., 2010). Additionally, 28% of teachers have interactive whiteboards, and 64% have digital cameras to support instruction.

Although there is widespread agreement from K-12 and higher education stakeholders concerning a focus on digital media literacy and instructional-technology strategies to integrate technology in the classroom, these critical components of effective instruction are uncommon (Fletcher, 2009; Johnson, Adams, & Cummins, 2012a). Rather, the focus for many educator preparation programs has been on the use of the tools, not on strategies to integrate these tools (Schaffhauser, 2009). This disparity in focus may be because only 20% of states currently require technology testing for educator certification or recertification (Hightower, 2009). After 30 years of concerted efforts to increase access to technology in the K-12 classroom with the aim of transforming educational practice, many classrooms continue to function in a very traditional manner (Zhao & Frank, 2003). Even with a new generation of teachers entering the classroom, this tech-savvy generation is comfortable with the use of technology in their personal lives; however, studies have shown that these new teachers are not using these very tools to support instruction. Therefore, researchers have proposed that technology expertise alone is no substitute for pedagogical skills (Mueller, Wood, Willoughby, Ross, & Specht, 2008; Schaffhauser, 2009).

Simply placing technology in a K-12 classroom does not cause dramatic changes in learning, and a significant number of educators has not truly embraced the use of technology, if they have even used it at all in the classroom (Bailey, Henry, McBride, & Puckett, 2011; Cuban et al., 2001; Fletcher, 2009; Johnson et al., 2012a; Leonard & Leonard, 2006; Sandholtz, Ringstaff, & Dwyer, 1997). The International Association for the Evaluation of Educational Achievement (IEA, 2009) conducted a study that involved 29,000 teachers from 8,000 schools in 23 countries. Their findings revealed that many teachers reported having computers and Internet access in their classrooms for pedagogical use; however, the percentage of teachers who reported actually integrating technology was comparatively low. Additionally, the study found no correlation between the level of access in a classroom and the percentage of teachers who reported using technology (IEA, 2009). More significantly, studies have shown that physical access to technology, without instructional changes, does not significantly change learning outcomes (Alsafran & Brown, 2012; Mouza, 2008).

While the use of technology can foster 21st century skills and provide powerful tools for learning, the value of technology in the classroom is dependent on how effectively a teacher uses it to support instruction (Eristi, Kurt, & Dindar, 2012; Wolsey & Grisham, 2011). Even though technology is more prevalent in the 21st century classroom, the extent to which educators have incorporated it into these classrooms varies dramatically and is dependent on individual educators' instructional beliefs, understanding of technology, and instructional skills (Dwyer et al., 1991). The addition of technology in classrooms, without a fundamental shift in how instruction is delivered, will not provide the desired return-on-investment. The importance of such a return-on-investment is especially significant during a time when there is a shortfall in school funding (Greaves et al., 2012).

Because the promise of technology to facilitate instructional changes—and due to teachers' lack of abilities to effectively integrate technology—extensive research has been conducted to discover best practices in the effective use of technology to support instruction. This research began almost as soon as technology began making its way into classrooms. Studies have revealed multiple barriers that inhibit technology integration, which have been divided into two groups: first-order barriers and second order barriers (Ertmer, 1999; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). First-order barriers to technology integration—barriers that are extrinsic for teachers—have been shown to affect teachers' abilities to integrate technology effectively. These first-order barriers include a lack of (a) knowledge about hardware and software (Franklin, 2007), (b) knowledge and skills from educator preparation programs (Chesley & Jordan, 2012; Franklin, 2007; Gray et al., 2010), (c) time to plan (Franklin, Turner, Kariuki, & Duran, 2001; Lim & Khine, 2006), (d) professional development from school districts (McGrail, 2005), (e) access to hardware and software (Lim & Khine, 2006), (f) technical support (Franklin et al., 2001), and (g) administrative support (Brzycki & Dudt, 2005; Demesa, 2009; Hew & Brush, 2007; Kopcha, 2012; Lim & Khine, 2006; Yang & Huang, 2007). From a technology-leadership perspective, "these school and district level factors are alterable" (O'Dwyer, Russell, & Bebell, 2004, p. 21).

Second-order barriers—barriers that are intrinsic to teachers—impede fundamental changes in teachers' uses of technology. Further, second-order barriers are more difficult to overcome because they deal with changes to teachers' belief systems. Research indicates that second-order barriers to technology integration include (a) teacher confidence in the use of technology (British Educational Communications and Technology Agency [BECTA], 2004; Dawes, 2001), (b) teacher efficacy in the use of technology (Overbaugh & Lu, 2008), (c) motivation to use technology (Wozney, Venkatesh, & Abrami, 2006), (d) teaching practices (Mouza, 2003), and, (e) the perceived value of what technology will do in the classroom (Belland, 2009; Wozney et al., 2006).

The DOE (2010b) stated, “Postsecondary institutions are key players in the transformation of teacher preparation and the national research and development efforts” (p. 7). Universities and colleges can help prepare educators to integrate technology by addressing these first- and second-order barriers that inhibit technology integration. However, new graduates report that their teacher preparation programs do not adequately prepare them to effectively integrate technology. Specifically, only 25% of educators from undergraduate programs and 33% of educators from graduate programs felt that their programs prepared them to use technology for instruction effectively (Chesley & Jordan, 2012; Gray et al., 2010). Therefore, the majority of newly graduated teachers are hired to teach in technology-rich classrooms without the necessary skills to do so.

Despite the extent of research that has been conducted on identifying barriers to technology integration, few studies have examined teachers’ abilities to integrate technology with factors that exist outside the classroom, such as with their school administrators (Hew & Brush, 2007; O’Dwyer et al., 2004). The school principal plays an important role in helping shape their teaching staff’s beliefs toward a shared vision for the use of high-quality instruction and technology integration in the classroom. In fact, lack of administrative support may be the most significant factor in a teacher choosing not to integrate technology (Bozeman & Spuck, 1991; Ritchie, 1996). Despite studies that have shown that the “quality of a principal’s leadership has a major impact on education technology usage, leading to improved student outcomes" (Greaves et al., 2012, p. 14), research on technology leadership is underrepresented in the existing literature (Albion, 2006; Davies, 2010; Kearsley & Lynch, 1994; McLeod & Richardson, 2011; Richardson, Bathon, Flora, & Lewis, 2012).

Despite the influx of technology in the K-12 classroom, the paradigm for instruction has remained largely unchanged over the past 30 years. As technology becomes ubiquitous in classrooms across the United States, educators' use and integration of technology lags behind access to technology. A recent Mid-continent Regional Educational Laboratory (McREL) study noted that during 60,000 classroom observations, only 37% of teachers used the available technology (Pitler, 2011). The researcher also noted that in 73% of observed classrooms, there was no technology use by students. Despite the promise of the potential for technology to change instruction, "traditional lectures and subsequent testing are still dominant learning vehicles in schools" (Johnson et al., 2012a, p. 9).

Recent cuts to education budgets have created a heightened sense of importance for a return-on-investment of technology expenditures (Ellerson, 2010; Ginsberg & Multon, 2011). Many researchers support the belief that school-level leadership, specifically from the campus principal, influence teachers' instructional practices positively (Leithwood & Riehl, 2003; Printy, 2010; Sebastian & Allensworth, 2012); however, there is a gap in the literature concerning technology leadership and its impact on teachers' abilities to effectively integrate technology in their classrooms (Albion, 2006; Davies, 2010; McLeod & Richardson, 2011). To be a successful principal in the 21st century, school leaders need to lead the charge to transform instructional practices on their campuses and prepare students to be productive citizens in the digital world. Research in the area of instructional-technology leadership could help principal preparation programs, state agencies, and school districts develop standards, structure coursework, and develop learning experiences that better prepare school-based administrators for the schools of today and the workplace of the future.

Purpose of the Study

The purpose of this study was twofold. First, this study examined whether differences existed between K-12 principals' and teachers' perceptions of teachers' abilities to effectively integrate technology in the classroom. Second, the study sought to determine whether a relationship existed between principals' instructional-technology leadership and the effective use of technology in their instruction.

Research Questions

The following research questions formed the basis of this study:

1. What technology leadership proficiencies do Texas K-12 school principals possess?
2. Does a difference exist between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom?
3. Does a difference exist between principals' and teachers' perceptions of access to teacher technology-related professional development?
4. Does a relationship exist between or among principal technology leadership proficiencies and teachers' abilities to integrate technology in the classroom?
5. Does a relationship exist between or among principal technology leadership proficiencies and teachers' access to technology-related professional development opportunities?

Hypotheses

The researcher proposed Hypotheses 1 and 2 in support of Research Questions 2 and 3 and Hypotheses 3 and 4 in support of Research Questions 4 and 5.

Hypothesis 1

Ho_1. No differences exist between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom.

Ha_1. A difference exists between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom.

Hypothesis 2

Ho_2. No differences exist between principals' and teachers' perceptions of access to technology-related professional development.

Ha_2. A difference exists between principals' and teachers' perceptions of access to technology-related professional development.

Hypothesis 3

Ho_3. No relationship exists between or among principals' technology-leadership proficiencies and teachers' abilities to integrate technology in the classroom.

Ha_3. A relationship exists between or among principals' technology-leadership proficiencies and teachers' abilities to integrate technology in the classroom.

Hypothesis 4

Ho_4. No relationship exists between or among principals' technology-leadership proficiencies and teachers' access to technology-related professional development opportunities.

Ha_4. A relationship exists between or among principals' technology-leadership proficiencies and teachers' access to technology-related professional development opportunities.

Significance of the Study

The infusion of technology into the K-12 classroom has changed the paradigm for effective instructional practices. Additionally, new technologies have changed the way schools function in terms of communication, organization, and management. Principals currently face issues that did not exist only a few years ago, such as cyber bullying, evaluating digital instructional materials, providing online courses, communicating via social media, hiring technology-proficient teachers, and providing high-quality technology-related professional development for existing teaching staff. These changes have impacted the roles and responsibilities of principals significantly, and they will continue to accelerate as new technologies are introduced into the classroom. Unfortunately, many principals feel they are not prepared with the knowledge and skills to take on the role of a technology leader (Brockmeier, Sermon, & Hope, 2005; Flanagan & Jacobsen, 2003; Kearsley & Lynch, 1992).

The National Education Technology Plan (NETP), released by the DOE in 2010, recognized the need to strengthen technology leadership; however, administrator preparation programs do not require principals to demonstrate the knowledge and skills to support and lead teachers in the effective use of technology or to encourage 21st century learning for students (Schrum, Galizio, & Ledesma, 2011; DOE, 2010b). In a survey of 268 principals from Florida, 59% felt that they were prepared to assume the role and make decisions as technology leaders on their campus (Albion, 2006).

Research in educational leadership helps clarify our understanding of the field by connecting principles of theory, identifying best practice, informing K-12 educational leadership preparation programs, and promoting the development of standards that improve teaching practices and student learning (The Hechinger Institute, 2008). Specifically, research in the field of technology leadership can provide direction in building capacity so principals are ready to take on the responsibilities of leading 21st century schools and help all stakeholders understand "the evolving role, competencies and dispositions towards technology and learning that principals require in order to be effective technology leaders, and how these are best developed and supported in practice" (Flanagan & Jacobsen, 2003, p. 140). While existing research shows that campus-based administrators have a positive impact on teaching practices (Alvarez, 2010), a gap in research on technology leadership exists (Albion, 2006; Davies, 2010; Kearsley & Lynch, 1992; Kowch, 2005; 2009; McLeod & Richardson, 2011; O'Dwyer et al., 2004; Richardson et al., 2012).

Method of Procedure

To determine whether a relationship exists between technology leadership and the effective integration of technology in the classroom, a quantitative study was conducted using archival data from the Texas Education Agency (TEA).

Selection of Sample

The researcher requested three sets of archival data for the 2011-12 academic school year from the TEA: (1) the Texas Campus School Technology and Readiness (STaR) Chart, (2) the Texas Teacher School Technology and Readiness (STaR) Chart, and (3) the NCLB Principal's Technology Self-Assessment (see Appendices C, D, and E, respectively). The 2011-12 academic school year is the most currently available data at the time of the study.

Collection of Data

The researcher sent the TEA an open records request for the 2011-12 NCLB Principal's Technology Self-Assessment and the 2011-12 Teacher STaR Chart (see Appendix A). This data included all Texas K-12 campuses (public, private, and charter schools) that were eligible for e-Rate funds and wished to apply for federal and state competitive grants. The TEA granted the researcher permission on October 4, 2012 to access the data via a shared and secure file sharing website, Accellion, (see Appendix B). One spreadsheet for each survey instrument requested was provided. The NCLB Principal's Technology Self-Assessment included responses from 6,414 campuses. The Teacher STaR Chart included 303,950 individual teacher responses from 7,965 campuses. Teacher STaR Chart data was averaged by campus ID number. The Campus STaR Chart data included responses from 7,760 campuses.

Additionally, Texas Campus STaR Chart results from the 2011-12 school year were downloaded from the TEA STaR chart website. Using the website's advanced search function, data were filtered so only campuses (public, private, and charter schools) that scored Target Tech in the Infrastructure domain of the Texas Campus STaR Chart were retrieved.

Treatment of Data

The researcher merged all three sets of data into a single spreadsheet. Data were paired using the Campus ID number. Campuses were excluded from the data analysis that did not include all three completed surveys—the Teacher STaR Chart; the Campus STaR Chart; and the NCLB Principal's Technology Self-Assessment. Additionally, any surveys that had incomplete data were eliminated from the spreadsheet. After merging and data clean up, the spreadsheet contained 307 campuses.

The researcher imported data into the Statistical Package for the Social Sciences (SPSS) software to obtain descriptive statistics on the research variables used in this study. Means and standard deviations were calculated for continuous data. Descriptive statistics were used to examine the self-reported technology-leadership skills that Texas K-12 principals possess.

Additionally, this study used inferential statistics to find possible correlations between the selected variables. The researcher examined outliers for values greater than 3.29 standard deviations from the mean (Stevens, 2009). Multiple MANOVAs were conducted to examine differences between the Campus STaR Charts and Teacher STaR Charts. Because multiple MANOVAs were conducted, the data were examined for multivariate outliers. Multivariate outliers were defined as observations with Mahalanobis Distances greater than $\chi^2(12) = 32.91$ at $p = .001$ (Tabachnick & Fidell, 2012).

Repeated measures MANOVAs were conducted to determine whether differences exist among multiple dependent variables. Using the Campus and Teacher STaR Charts, Teaching and Learning (TL), and Educator Preparation (EP) survey items were paired for both teachers and principals. For both the TL and EP survey items, Pearson correlation matrices assessed the absence of multicollinearity between the dependent variables. If the Pearson correlations showed coefficients greater than 0.90, then the items were averaged together.

Pearson correlations were conducted to assess the relationship between the NCLB Principal Technology Leadership survey items and total scores on the TL and EP survey items. This analysis is appropriate when the goal is to assess the relationship between two continuous variables. Normality of variables was assessed prior to the analyses.

To assess the research questions, repeated measures MANOVAs and Pearson correlations were conducted. G*Power 3.1.5 was used to assess the number of participants necessary to find significance. Using a medium effect size, an alpha of 0.05, a power of 0.80, 6 measurements, and 2 pairs of data, the required number of participants was 42 for the repeated measures MANOVA. Using a medium effect size, an alpha of 0.05, and a power of 0.80, the required number of participants was 82 for the Pearson correlation. Therefore, the researcher needed at least 82 participants to assess the research questions. Because scores were condensed to the campus level, at least 82 campuses were used.

Limitations

The following limitations were imposed upon this study:

1. All survey data used in this study were from the 2011-12 academic school year, which was the most currently available at the time of the study.
2. Self-report instruments reflect an individual's perception of his or her knowledge, skills, and ability levels; therefore, such measurements might not be an accurate perception of an individual's actual ability.
3. Only Texas K-12 public, private, and charter schools that receive Title II, D funds or wish to apply for grants are included in the TEA database.

Delimitations

The study was subject to the following delimitations:

1. A campus was excluded from the study if the results of each of the three survey instruments were not complete or missing.
2. Only campuses with a ranking of Target Tech on the Campus STaR chart were selected for the study.
3. Only campuses that had a student population of 100 or more were included in the study.

Assumptions

In pursuing this study, the research made the following assumptions:

1. It was assumed that survey participants responded accurately and honestly to questions on the self-report instruments.
2. The data were accepted as valid for use by academic researchers.

3. The data fit the assumptions of a repeated measures MANOVA; for each level of the within-subjects factor, the dependent variable had a normal distribution.
4. MANOVA assumes that independent variables are categorical and dependent variables are continuous or scale, and variance between groups is equal.
5. The data fit the assumptions of a Pearson correlation; no multicollinearity existed in the variables.

Design of the Study

This study used a quantitative design to answer research questions regarding technology leadership as it relates to principals' proficiencies, teachers' abilities to integrate technology in their classrooms, and technology-related professional development offered on K-12 campuses. To answer the research questions, repeated measures MANOVAs and Pearson correlations were conducted on three sets of archival data from the Texas Education Agency (TEA). These datasets included (a) the Texas Campus School Technology and Readiness (Campus STaR) Chart; (b) the Texas Teacher School Technology and Readiness (Teacher STaR) Chart; and, (c) the No Child Left Behind (NCLB) Principal's Technology Self-Assessment.

Instrumentation

Archival data housed in the TEA STaR Chart system were used for this study. The Texas STaR Charts—an online self-assessment administered annually to all Texas K-12 schools by the TEA—are aligned with the Texas Long-Range Plan for Technology (TLRPT) 2006-2020. Texas STaR Charts are designed to help schools gauge their progress of integrating technology into teaching and learning, assist schools in planning for technology and professional development, budget resources, and evaluate progress of local technology projects. All Texas schools and school districts that apply for state-funded technology grants require completed Texas STaR

Chart profiles as part of the application process. Texas STaR Chart data is aggregated and statewide summary data are reported to state and federal policymakers. Additionally, as of January 2002, the TEA uses data from the STaR Charts to report progress of schools districts that receive funds from NCLB Title II Part D (TEA, n.d.).

Sample Selection

The software program G*Power 3.1.5 was used to assess the number of participants necessary to find significance. Using a medium effect size, an alpha of 0.05, a power of 0.80, six measurements, and two pairs of data, the required number of participants was 42 for the repeated measures MANOVA. Using a medium effect size, an alpha of 0.05, and a power of 0.80, the required number of participants was 82 for the Pearson correlation. Therefore, at least 82 participants need to be used to assess the research questions. Being that the scores were condensed at the campus level, at least 82 campuses were used.

Data Gathering

Texas Campus STaR Chart data from the 2011-12 school year was extracted from the TEA STaR Chart website (TEA, n.d.). Using the Advanced Search function, data were filtered so only campuses (public, private, and charter schools) that scored Target Tech in the Infrastructure domain of the Texas Campus STaR Chart were retrieved. This search yielded responses from 7,760 campuses statewide. The researcher chose to limit the data in this way to control for the variable of access to technology. This was necessary as previous studies have noted that simply placing technology in a K-12 classroom does not cause dramatic changes in instructional practices (Bailey et al., 2011; Cuban et al., 2001; Fletcher, 2009; Johnson et al., 2012a; Leonard & Leonard, 2006; Sandholtz et al., 1997).

Treatment of Data

Repeated measures MANOVAs were conducted to determine whether a difference existed among multiple dependent variables. Using the Campus and Teacher STaR Charts, TL and EP survey items were paired for teachers and principals. For both the TL and EP survey items, Pearson correlation matrices were run to assess the absence of multicollinearity between the dependent variables. If the Pearson correlations showed coefficients greater than 0.90, then the items were averaged. Pearson correlations were conducted to assess the relationship between the NCLB Principal Technology Self-Assessment survey items and total scores on the TL and EP survey items. This analysis was appropriate as the goal was to assess the relationship between two continuous variables. Normality for all of the variables was assessed prior to the analyses.

Description of the Data

A total of 328 principals and 303,950 teachers participated in the study. Teachers' scores were averaged and collapsed by campus with the corresponding principal. Data were kept only if both principal and teacher data were available, which resulted in data for 317 campuses. Data were then examined for outliers. An outlier was defined as 3.29 standard deviations from the mean (Stevens, 2009). A total of 36 outlier scores were removed from the principal and collapsed teacher data. Because multivariate analyses of variance (MANOVAs) were conducted, data were also examined for multivariate outliers. Multivariate outliers were defined as participants with Mahalanobis Distances greater than χ^2 (6) = 32.91 at p = .001 (Tabachnick & Fidell, 2012). Ten multivariate outliers were removed, which resulted in data from 307 campuses.

Reliability was conducted on the NCLB, principal TL, principal EP, teacher TL, teacher EP, and principal NCLB L scores. Reliability ranged from .80 to .95, which suggests good to great reliability. Table 1 presents reliability and descriptive statistics of each scale.

Table 1
Reliability and Descriptive Statistics on Subscales

Subscale	Number of items	α	*M*	*SD*
NCLB	6	.89	3.33	0.55
Principal TL	6	.80	17.47	2.51
Principal EP	6	.80	16.75	2.75
Teacher TL	6	.94	15.67	1.86
Teacher EP	6	.95	14.74	2.00
Principal L	6	.84	19.57	3.09

Research Question 1

Research Question 1 was as follows: What technology-leadership proficiencies do Texas K-12 school principals possess? To assess Research Question 1, descriptive statistics were conducted on the six NCLB questions. Table 2 presents the means, standard deviations, medians, and modes for all six questions. The average response to the questions was between 3.07 and 3.50, which suggests that most participants ranked themselves between Advanced Tech (I practice this most of the time) and Target Tech (I practice this all of the time). The medians and modes for questions 1 through 5 were 3, while the median and mode for question 6 was 4. This finding suggests that the majority of participants selected Target Tech for question 6.

Table 2
Mean, Standard Deviation, Median and Mode for NCLB Questions

Question	*M*	*SD*	Median	Mode
1. Inspire a shared vision for comprehension integration of technology and foster an environment and culture conducive to	3.21	0.61	3	3

the realization of that vision.				
2. Ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching.	3.07	0.68	3	3
3. Apply technology to enhance my professional practice and to increase my own productivity and that of others.	3.25	0.66	3	3
4. Ensure the integration of technology to support productive systems for learning and administration.	3.22	0.64	3	3
5. Use technology to plan and implement comprehensive systems of effective assessment and evaluation.	3.18	0.70	3	3
6. Understand the social, legal, and ethical issues related to technology and model responsible decision making related to these issues.	3.50	0.64	4	4

Research Question 2

Research Question 2 stated the following: Does a difference exist between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom?

Ho_1. No differences exist between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom.

Ha_1. A difference exists between principals' and teachers' perceptions of teachers' abilities to integrate technology in the classroom.

To assess Research Question 2, a repeated measures MANOVA was conducted to determine whether differences existed in the six TL scores. Running a correlation matrix between the variables assessed the assumption of absence of multicollinearity; however, the teacher TL scores had multiple correlations that were above .80, which suggests a violation in this assumption. Because of these violations, the TL scores were collapsed into one Teacher TL score and one Principal TL score. Thus, a paired sample *t*-test was conducted. The assumption of normality was assessed using Kolmogorov Smirnov (KS) tests. The results of the tests were significant for campus scores. However, with a large sample size (> 50), the assumption could be violated with little effect on Type I error (Stevens, 2009).

The results of the paired sample *t*-test were significant, t (304) = 12.55, $p < .001$, which suggests a difference in the teacher and principal TL scores. Specifically, the principal TL scores were significantly higher than the teacher TL scores, which suggests that the principals answered the TL questions significantly higher overall. Because the paired sample *t*-test was significant, the null hypothesis was rejected in favor of the alternative hypothesis. Results of the paired sample *t*-test are presented in Table 3.

Table 3
Paired Sample t Test for Teacher vs. Principal TL Scores

	Principal		Teacher				
Variable	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*
Overall TL	17.47	2.51	15.69	1.83	12.55	304	.001

Research Question 3

Research Question 3 stated the following: Does a difference exist between principals' and teachers' perceptions of access to teacher technology-related professional development?

Ho_2. No differences exist between principals' and teachers' perceptions of access to technology-related professional development.

Ha_2. A difference exists between principals' and teachers' perceptions of access to technology-related professional development.

To assess Research Question 3, a repeated measures MANOVA was conducted to determine whether differences existed in the six EP scores. Running a correlation matrix between the variables assessed the assumption of absence of multicollinearity; however, the teacher EP scores had multiple correlations that were above .80, thus, violated this assumption. Therefore, the EP scores were collapsed into one teacher EP score and one principal EP score and a paired sample *t*-test was conducted. The assumption of normality was assessed using Kolmogorov Smirnov (KS) tests. The results of the tests were significant for campus scores. As with this data for Research Question 2, the large sample size (> 50) allows the assumption to be violated with little effect on Type I error (Stevens, 2009).

The results of the paired sample *t*-test were significant, $t(306) = 14.00$, $p < .001$, which suggests a difference in the teacher EP and principal EP scores. The principal EP scores were significantly higher than the teacher EP scores, thus, principals answered the EP questions significantly higher overall. Because the paired sample *t*-test was significant, the null hypothesis was rejected in favor of the alternative hypothesis. Results of the paired sample *t*-test are presented in Table 4.

Table 4
Paired Sample t Test for Teacher vs. Principal EP Scores

	Principal		Teacher				
Variable	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*
Overall EP	16.75	2.75	14.74	2.00	14.00	306	.001

Research Question 4

To assess Research Question 4, 49 Pearson correlations were conducted to determine the relationship between the seven NCLB L scores and the seven teacher TL scores (6 questions and total score for each measure). The results of the correlations were positively significant and ranged from $r = .20$ to $r = .43$. For the significantly positive correlation, as one score increases, the other score also increases. According to Cohen (1988), correlations range in strength from weak positive (< .30) to moderate positive (< .50). Because all correlations were significant, the null hypothesis was rejected in favor of the alternative hypothesis. Results of the correlations are presented in Table 5.

Table 5
Pearson Correlation Matrix between NCLB L Scores and Teacher TL Scores

NCLB	TL1	TL2	TL3	TL4	TL5	TL6	Overall TL
L1	.41**	.39**	.42**	.40**	.38**	.39**	.38**
L2	.36**	.36**	.36**	.36**	.31**	.40**	.35**
L3	.37**	.31**	.37**	.35**	.34**	.40**	.34**
L4	.21**	.26**	.28**	.24**	.23**	.21**	.23**
L5	.21**	.21**	.22**	.21**	.20**	.32**	.21**
L6	.32**	.34**	.34**	.33**	.34**	.32**	.30**
Average	.41**	.41**	.43**	.42**	.39**	.42**	.39**

Note. * $p < .05$. ** $p < .01$.

Research Question 5

Research Question 5 stated the following: Does a relationship exist between or among principal technology leadership proficiencies and teachers' access to technology-related professional development opportunities?

Ho_4. No relationship exists between or among principals' technology-leadership proficiencies and teachers' access to technology-related professional development opportunities.

Ha_4. A relationship exists between or among principals' technology-leadership proficiencies and teachers' access to technology-related professional development opportunities.

To assess Research Question 5, 49 Pearson correlations were conducted to assess the relationship between the seven NCLB L scores and seven teacher EP scores (6 questions and total score for each measure). The results of the correlations were positively significant for all correlations. Correlation coefficients ranged from $r = .17$ to $r = .51$. Because all correlations were significant, the null hypothesis was rejected in favor of the alternative hypothesis. Results for the correlations are presented in Table 6.

Table 6
Pearson Correlation Matrix between NCLB Scores and Teacher EP Scores

NCLB	EP1	EP2	EP3	EP4	EP5	EP6	Overall EP
L1	.46**	.46**	.39**	.35**	.41**	.35**	.44**

L2	.44**	.42**	.35**	.39**	.39**	.37**	.34**
L3	.41**	.41**	.37**	.36**	.39**	.39**	.42**
L4	.33**	.31**	.27**	.28**	.28**	.19**	.30**
L5	.29**	.28**	.17**	.21**	.22**	.22**	.25**
L6	.38**	.41**	.37**	.34**	.35**	.37**	.40**
Average	.51**	.50**	.42**	.43**	.45**	.41**	.50**

Note. * $p < .05$. ** $p < .01$.

Discussion of Findings

Findings of the study are discussed in relation to each research question.

Research Question 1

The results of this analysis indicate that principals ranked themselves highest in their abilities to understand the social, legal, and ethical issues related to technology and model responsible decision making related to these issues. This finding may be due to the influx of student-owned digital technologies (e.g., cell phones) present in schools. Today, campus administrators are faced with legal issues that force them to establish new policies and guidelines for acceptable use of these devices (Garland, 2010). Anderson and Dexter (2005) noted that social, legal, and ethical issues related to technology is a area often neglected in the research and school leaders needed to focus on these factors because of changes in society that technology cause. Based on the results of this study, principals feel that they are better prepared to face these issues today than they were 8 years ago. Principals ranked their abilities to apply technology to enhance their professional practice and increase their own productivity as the second highest item on this survey. This finding also concurs with earlier research that involved 103 elementary school principals from Miami-Dade County, Florida who also ranked themselves high on a similar survey instrument based on ISTE NETS-A (Grey-Bowen, 2010).

Of the six survey questions, the area with the lowest reported averages was question two, which relates to principals' abilities to ensure the effective integration of technology into curricular design, instructional strategies, and learning environments to maximize learning and improve teaching. These findings correspond with existing studies that have suggested that, while campus-based administrators report they have had professional development and graduate coursework in technology literacy using computer software and hardware, they are interested in learning more about technology integration in the curriculum and acquiring knowledge about strategies to assist them in becoming better technology leaders (Albion, 2006; Dawson & Rakes, 2003). In other words, effective technology integration should be measured “not by the amount or type of technology used, but by how and why it is used” (Earle, 2002, p. 7).

Research Question 2

The analyses indicate that it has become critical for individuals involved in the preparation of school administrators to provide effective technology integration methods and strategies. Principals who possess the skills to recognize and evaluate the effective integration of technology on their campuses are better equipped to lead their teaching staff on three different levels (1) they are able to guide teachers in the design and differentiation of instruction based on diverse student needs, (2) they assist teachers in providing students with skills needed for today’s workforce, and (3) they are able to lead teachers in the creation of non-traditional environments that increase accessibility for all students (TEA, n.d.). Therefore, campus-based administrators should keep in mind:

> The existence of digital learning technologies in schools does not mean that educators know how to use them. Wide variability in educators’ technology knowledge and skills exists both within and across school organizations. While some educators seem to be quickly fluent with any technology that crosses their horizons, others still are struggling to fairly master basic technologies such as email, file management systems, Internet browsers, and office productivity software. (McLeod & Richardson, 2013, p. 13)

Research Question 3

The results of the paired sample *t*-test were significant, which suggests a difference in teachers' and principals' EP scores. Principals' EP scores were significantly larger than were teacher's EP scores, which suggest that principals answered the EP questions significantly higher compared to teachers' perceptions of their access to technology-related professional development. Of 24 possible points, the teachers' average ranking was 14.75, while the principals' average ranking was 16.75.

It is important to note that the results of Research Question 2 may affect those of Research Question 3. If principals perceive their teaching staff is more proficient in the use of technology than their teachers actually are, this disparity may influence the frequency and content of technology-related professional development provided to teachers. To ensure teachers have the professional development needed to grow, "faculty development needs to be organic and continuous. Resources that have potential for improving teaching appear on a daily basis, but integrating those teaching assets into an instructional plan and implementing that is an arduous task" (Hartman, Dziuban, & Brophy-Ellison, 2007, p. 68). Ensuring that these developmental needs are met requires continual formative assessment of teachers' abilities to integrate technology and providing timely interventions, specifically in the form of effective professional development that is matched to teacher needs. Compared to teachers in the past, teachers today, report that they are fluent with digital technologies; however, "a broad continuum of faculty technology fluency persists in most schools, particularly when it comes to newer tools such as blogs, wikis, social networking, and other social media" (McLeod & Richardson, 2013, p.13).

Research Question 4

To assess Research Question 4, 49 Pearson correlations were conducted to assess the relationship between the seven NCLB L scores and the seven teacher TL scores (6 questions and a total score for each measure). The results of the correlations were positively significant and ranged from $r = .20$ to $r = .43$. The correlations ranged in strength from weak positive correlations (< .30) to moderate positive correlations (< .50) (Cohen, 1988). These findings indicate that relationships exist between and among principal technology-leadership proficiency and teachers' abilities to integrate technology in the classroom. The findings also support previous research that has indicated that a positive correlation exists between principal technology leadership and teachers' technology-related teaching practices (Alvarez, 2010; Anderson & Dexter, 2005; Chang, 2012; Cummings, 2012; Dale et al., 2007; Davies, 2010; Dawson & Rakes, 2003; Grey-Bowen, 2010; Papa, 2011; Printy, 2010; Szafranski, 2009).

From the NCLB Principal's Technology Self-Assessment, the L1 scores (proficiencies related to leadership and vision for technology) yielded the strongest correlation to all teachers' TL scores. NCLB L1 proficiencies inform administrators how to facilitate teachers' abilities to effectively integrate technology, create student-centered real-world learning experiences, and result in lessons that promote collaboration and higher-order thinking. This finding may indicate that principals with a strong vision for the use and integration of technology have the greatest potential to promote and increase the integration of technology among their teaching staff. Principals who possess L1 proficiencies cultivate a shared vision for technology use with their teaching staff by involving them in developing the vision, developing and routinely monitoring formal long-range plans to achieve that vision, fostering a culture of innovation, encouraging risk taking, and promoting research-based teaching practices (ISTE, 2009). According to McLeod and Richardson (2013), for campus based administrators,

> Facilitating organizational vision is an imperative component of any leader's role and responsibilities. When it comes to technology, any vision for powerful integration and implementation must by necessity begin with a rich understanding of the complex and

> interdependent characteristics of the new technology-infused environments in which schools are encompassed. (p. 5)

As reported in previous studies, “principals as technological leaders must develop and implement vision and technology plans for their schools, encourage the technological development and training of teachers, provide sufficient technological infrastructure support, and develop an effective school evaluation plan” (Chang, 2012, p. 328).

From the Texas Teacher STaR Chart, TL6 scores (skills that teachers possess that indicate their readiness to provide online learning experiences for their students) yielded the strongest relationship to NCLB L1 (Leadership and Vision), NCLB L2 (Learning and Teaching), and NCLB L3 (Productivity and Professional Practice) scores. Principals who possess NCLB L2 proficiencies (Learning and Teaching) promote the use of technology to enhance and support standards-based instruction, provide for learner-centered environments, facilitate the use of technology to support teaching strategies that promote higher-order thinking and problem solving, and strive to meet the diverse needs of all students (ISTE, 2009). Additionally, principals who possess NCLB L3 proficiencies (Productivity and Professional Practice) model the effective use of technology, use technology as a tool to communicate and collaborate, stay abreast of current trends in technology, and use technology for organizational improvement (ISTE, 2009). Educational paradigms shifting include online learning and collaborative models in K-12 schools (Johnson et al., 2012b); therefore, principals who maintain an awareness of emerging technologies, and model the use of those technology, may have teachers who are more likely to create web-based lessons.

Although all NCLB L scores were positively correlated to all the Texas Teacher STaR Chart TL scores, NCLB L4 and NCLB L5 scores had the weakest correlations comparatively. Principals who possess NCLB L4 proficiencies (Support, Management, and Operations) were able to develop and monitor polices and guidelines, allocate resources (financial and human) to ensure implementation of long-range technology plans, and implement procedures to drive continuous improvement of technology systems (ISTE, 2009). Principals who possess NCLB L5 proficiencies (Assessment and Management) use data to improve instructional practice and use technology to evaluate and manage administrative and operational systems in their schools (ISTE, 2009). Although these are important technology leadership proficiencies that support the infrastructure and operation of a school, they were only weakly correlated to teachers' abilities to integrate technology.

Research Question 5

To assess Research Question 5, 49 Pearson correlations were conducted to assess the relationship between the seven NCLB L scores and the seven teacher EP scores (6 questions and a total score for each measure). The results of all correlations were positively significant. Correlation coefficients ranged from $r = .17$ to $r = .51$. For Texas Teacher STaR Chart score totals, EP1 and EP2 were strongly correlated to NCLB L scores, which relates to the content and delivery model of technology-related professional development programs. EP1 scores (Professional Development Experiences) range from basic technology skills training sessions to collaborative courses on integrating technology into K-12 core subject classes and promoting higher-order thinking and problem solving with experts outside of the school (ISTE, 2009). EP2 scores (Models of Professional Development) indicate how professional development is offered. Models of professional development can range from unconnected large group sessions to frequent and ongoing opportunities that are delivered in a variety of formats to support anytime, anywhere learning, individually guided activities, and independent action research (ISTE, 2009).

Although all NCLB L scores were positively correlated to Texas Teacher STaR Chart EP scores, NCLB L5 had the weakest correlation to total EP scores. NCLB L5 scores (Principals' use of technology to Plan and Implement Assessment and Evaluation) showed a weak correlation to the capabilities of educators related to SBEC technology standards, number of professional development hours required per year, and professional development in online instruction (ISTE, 2009). Principals who understand the importance of their teaching staff to integrate technology work to include this component in classroom observations and annual evaluations, so teachers are assessed on their efforts continually to improve instruction through the use of technology (McLeod & Richardson, 2013). NCLB L4 had weak correlations to EP3 and EP4, comparatively. This finding supports previous research that has indicated that principals at schools where teachers successfully integrate technology not only ensured an adequate amount of professional development related to curricular integration of technologies in the classroom, but also "understood the complexity of change, and promoted teachers' changed practices through actions such as verbal encouragement, required participation in training, accountability for technology use, and observations of classroom practices" (Shapley et al., 2008, p. 9).

Implications for Action

The data from this study support a clearly defined need for administrators to understand the methods and strategies involved in technology integration. The savvy administrator who is well versed in strategies for technology integration will be able to evaluate new instructional methods and lead their teaching staff to employ the best instructional practices and technologies relevant to instructional objectives. Klopfer and Yoon (2005) noted, "In the current educational climate of high stakes accountability, it is critical that teachers and administrators are able to understand the uses and acquire the ability to integrate new technological innovations with existing curricula" (p. 39). However, most states do not require any technology leadership components for administrative credentials, and the absence of those requirements is mirrored in educational leadership programs (Schrum et al., 2011). Therefore, challenge for administrator preparation and staff development programs is assisting campus-based administrators in learning methods and strategies to integrate technology effectively and support student learning. The challenge posed by these transformations is more encompassing than just learning to turn on a computer or converting lectures to PowerPoint presentations; it is not about the equipment. Rather, these changes require a paradigm shift in the way educators deliver instruction lead by administrators with strong technology leadership skills. Administrator preparation programs should include experiences that provide candidates with the ability to critically evaluate the effective use of technology by students and teachers to support instruction.

Recommendations for Further Research

Findings from this study provide a general understanding of K-12 Texas principal proficiency in technology leadership as aligned with the 2011-12 NETS. The findings also provide evidence for how these proficiencies are correlated to teachers' abilities to integrate technology in the classroom. A review of the literature suggests a gap in studies related to technology leadership proficiencies for campus-based administrators (Albion, 2006; Davies, 2010; Kearsley & Lynch, 1992; Kowch, 2005, 2009; McLeod & Richardson, 2011; O'Dwyer et al., 2004; Richardson et al., 2012).

Future studies should include a longitudinal replication of this study. Data from the NCLB Principal's Technology Self Assessment is available from 2008 to the present; however, this study only examined the 2011-12 academic school year data. Descriptive statistics on NCLB L scores may show changes over time and uncover areas of strengths and weaknesses in technology-leadership proficiencies. The professional development programs of principal preparation programs, state agencies, and local school districts could address these strengths and weaknesses as these organizations design coursework and professional development opportunities for campus-based administrators. Paired sample *t*-tests could be conducted to examine whether differences exist between principals' and teachers' perceptions of Leadership, Administration, and Instructional Support and Infrastructure for Technology as measured by the Texas Teacher and Campus STaR Charts. Pearson correlations could be conducted to examine possible correlations between Texas Teacher and Campus STaR Chart domains and NCLB Principal's Technology Self Assessment domains that were not examined in this study, such as Leadership, Administration, and Instructional Support and Infrastructure for Technology.

Additionally, future studies might employ a mixed model to include qualitative data by conducting interviews with principals and teachers in addition to the archival data received from the TEA. Currently, the NCLB Principal's Technology Self Assessment is based on the ISTE NETS-A developed in 2002. In 2009, ISTE updated their standards for campus administrators. Therefore, a survey instrument could be developed based on the updated NETS-A and given to principals in lieu of using the NCLB Principal's Technology Self Assessment scores from the TEA.

Conclusions

This study was intended to contribute to the body of research on technology leadership. In classrooms today, "the abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators" (Johnson et al., 2012b, p. 4). Studies show that principals' technology-leadership proficiencies are a critically important factor in the effective use and integration of technology by teachers and students to support learning (Anderson & Dexter, 2005). Instructional technology is not a new concept; rather the idea of infusing technology into the curriculum has been around for the last century. The call for teachers to integrate technology into the curriculum, provide necessary skills for the 21st century workplace, and support best teaching practices has increased over the last 30 years; however, simply adding technology to a classroom does not make it a better learning environment. To ensure this integration occurs in the classroom, "principals/superintendents must walk the talk and play a pivotal role in providing leadership in the use of technology" (Papa, 2011, p. 38). The findings of this study indicate that strong technology leadership by campus administrators is positively correlated to teachers' abilities to integrate technology in the classroom effectively. Ultimately, the responsibility to increase teachers' use and integration of technology,

> Does not reside solely on the shoulders of teachers. Instead, through strategic decisions regarding the focus and range of professional development opportunities, the ease with which technology is made available within schools, and the outward expression of the importance of technology use by principals, superintendents, and other school leaders, these analyses suggest that technology use by teachers will increase. (O'Dwyer et al., 2004, p. 24)

References

Albion, P. (2006). *Technology leadership*. Paper presented at the 17th international Conference of the Society for Information Technology & Teacher Education, Orlando, FL.

Alsafran, E., & Brown, D. S. (2012). The relationship between classroom computer technology and students' academic achievement [Online]. *Research in Higher Education Journal*, 1-19. Retrieved from http://www.aabri.com/manuscripts/111021.pdf

Alvarez, C. C. (2010). *Principal leadership: Factors sustaining successful school innovation* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3438316)

Anderson, R. E., & Dexter, S. (2005). School technology leadership: an empirical investigation of prevalence and effect. *Educational Administration Quarterly*, *41*, 49-82. doi:10.1177/0013161X04269517

Bailey, A., Henry, T., McBride, L., & Puckett, J. (2011, August). *Unleashing the potential of technology in education* [Report]. Retrieved from The Boston Consulting Group: http://www.bcg.com/documents/file82603.pdf

Bakia, M., Mitchell, K., & Yang, E. (2007). *State strategies and practices for educational technology: Volume I—Examining the enhancing education through technology program* [Annual report]. Retrieved from U.S. Department of Education website: http://www2.ed.gov/rschstat/eval/tech/netts/netts-vol1.pdf

Belland, B. R. (2009). Using the theory of habitus to move beyond the study of barriers to technology integration. *Computers & Education*, *52*(2), 353-364. doi:10.1016/j.compedu.2008.09.004

Bevins, P., Carter, K., Jones, V. R., Moye, J., & Ritz, J. M. (2012). The technology and engineering educator's role in producing a 21st century workforce. *Technology & Engineering Teacher*, *72*(3), 8-12.

Bozeman, W. C., & Spuck, D. W. (1991). Technological competence: Training educational leaders. *Journal of Research on Computing in Education*, *23*(4), 514-529.

British Educational Communications and Technology Agency. (2004, June). *A review of the research literature on barriers to the uptake of ICT by teachers* (Version 1). Retrieved from http://dera.ioe.ac.uk/1603/1/becta_2004_barrierstouptake_litrev.pdf

Brockmeier, L. L., Sermon, J. M., & Hope, W. C. (2005). Principals' relationship with computer technology. *National Association of Secondary School Principals Bulletin*, *89*(643), 45-63. doi:10.1177/019263650508964305

Brzycki, D., & Dudt, K. (2005). Overcoming barriers to technology use in teacher preparation programs. *Journal of Technology and Teacher Education*, *13*(4), 619-641.

Chesley, G. M., & Jordan, J. (2012). What's missing from teacher prep. *Educational Leadership*, *69*(8), 41-45.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Cuban, L. (1983). How did teachers teach, 1890-1980. *Theory Into Practice*, *22*(3), 159-165. doi:10.1080/00405848309543056

Cuban, L. (2006). Getting past futile pedagogical wars. *Phi Delta Kappan*, *87*(10), 793-795.

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. doi:10.3102/00028312038004813

Cummings, C. D. (2012). *A study of technology leadership among elementary principals in a suburban Texas independent school district* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3510141)

Daggett, W. R. (2010). *Preparing students for their technological future*. Unpublished manuscript. Retrieved from http://www.leadered.com/pdf/ Preparing%20Students%20for%20Tech%20Future%20white%20paper.pdf

Davies, P. M. (2010). On school educational technology leadership. *Management in Education*, *24*(2), 55-61. doi:10.1177/0892020610363089

Dawes, L. (2001). What stops teachers using new technology? In M. Leask (Ed.), *Issues in Teaching using ICT* (pp. 61-79). London, UK: Routledge.

Dawson, C., & Rakes, G. C. (2003). The influence of principals' technology training on the integration of technology in schools. *Journal of Research on Technology in Education*, *36*, 29-49.

Demesa, A. L. (2009). *Technology skills sparks success: A study of best practices for teacher and the effective integration of technology in the K-12 classroom environment* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3372235)

Dexter, S. (2011). School technology leadership: Artifacts in systems of practice. *Journal of School Leadership*, *21*(2), 166-189.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership, 48*(8), 45-52.

Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges [Online]. *ET Magazine 42,* 5-13 Retrieved from http://www.bookstoread.com/etp/earle.pdf

Ellerson, N. M. (2010). *A cliff hanger: How America's public schools continue to feel the impact of the economic downturn* [Report]. Retrieved from http://www.aasa.org/uploadedFiles/Policy_and_Advocacy/files/CliffHangerFINAL(1).pdf

Eristi, S. D., Kurt, A. A., & Dindar, M. (2012). Teachers' views about effective use of technology in classrooms. *Turkish Online Journal of Qualitative Inquiry*, *3*(2), 30-41.

Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, *47(4*). 47-61. doi:10.1007/BF02299597

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*(2), 423-435. doi:10.1016/j.compedu.2012.02.001

Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration*, *41*(2), 124-142. doi:10.1108/09578230310464648

Fletcher, G. H. (2009, May 9). A matter of principals. *T. H. E. Journal*, *36*(5), 22-27.

Franklin, C. (2007). Factors that influence elementary teachers use of computers. *Journal of Technology and Teacher Education*, *15*(2), 267-293.

Franklin, T., Turner, S., Kariuki, M., & Duran, M. (2001). Mentoring overcomes barriers to technology integration. *Journal of Computing in Teacher Education*, *18*(1), 26-31.

Garland, V. E. (2010). Emerging technology trends and ethical practices for the school principal. *Journal of Educational Technology Systems*, *38*, 39-50. doi:10.2190/ET.38.1.e

Ginsberg, R., & Multon, K. D. (2011, May 10). Leading through a fiscal nightmare: The impact on principals and superintendents. *Phi Delta Kappan*, *92*(8), 42-47.

Gonick, L. (2002). Leadership: A new role. *Educause Review*, *37*(4), 8-9.

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in U.S. public schools: 2009* (NCES 2010-040). Washington, DC: National Center for Education Statistics.

Greaves, T. W., Hayes, J., Wilson, L., Gielniak, M., & Peterson, E. L. (2012). *Revolutionizing education through technology: The project RED roadmap for transformation* [e-Book]. Eugene, OR: International Society for Technology in Education.

Grey-Bowen, J. E. (2010). *A study of technology leadership among elementary public school principals in Miami-Dade County* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3427096)

Hartman, J. L., Dziuban, C., & Brophy-Ellison, J. (2007, September/October). Faculty 2.0. *Educause Review*, *42*(5), 62-76.

Hew, K. F., & Brush, T. (2007). Integrating technology into k-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Education Technology Research and Development*, *55*, 223-252. doi:10.1007/s11423-006-9022-5

Hightower, A. M. (2009). Tracking U.S. trends: States earn B average for policies supporting educational technology use. *Education Week: Technology Counts*, *28*(6), 30-33.

Hodge, K. A., & Lear, J. L. (2011). Employment skills for 21st century workplace: The gap between faculty and student perceptions. *Journal of Career & Technical Education*, *26*(2), 28-41.

Johnson, L., Adams, S., & Cummins, M. (2012a). *The NMC horizon report: 2012 k-12 edition* [Annual report]. Austin, TX: The New Media Consortium.

Johnson, L., Adams, S., & Cummins, M. (2012b). *The NMC horizon report: 2012 higher education edition* [Annual report]. Austin, TX: The New Media Consortium.

Johnson, L., Lamb, A., & Teclehaimanot, B. (2003). Academic technology: The convergence of diverse disciplines. *College & University Media Review*, *9*(2), 91-106.

Jones, R., Fox, C., & Levin, D. (2011). *State technology leadership essential for 21st century learning* [Annual report]. Retrieved from SETDA website: http://www.setda.org/c/document_library/get_file?folderId=6&name=DLFE-1302.pdf

Kearsley, G., & Lynch, W. (1992). Educational leadership in the age of technology: The new skills. *Journal of Research on Computing in Education*, *25*, 50-60.

Kearsley, G., & Lynch, W. (1994). *Educational technology leadership perspectives*. Englewood Cliffs, N. J.: Educational Technology.

Klopfer, E., & Yoon, S. (2005). Developing games and simulations for today and tomorrow's tech savvy youth. *Techtrends: Linking Research & Practice to Improve Learning*, *49*(3), 33-41. doi:10.1007/BF02763645

Kopcha, T. J. (2012). Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development. *Computers & Education*, *59*(4), 1109-1121. doi:10.1016/j.compedu.2012.05.014

Larson, L. C., & Miller, T. N. (2011, March 1). 21st century skills: Prepare students for the future. *Kappa Delta Pi*, *47*(3), 121-123.

Leithwood, K. A., & Riehl, C. (2003). *What we know about successful school leadership*. Philadelphia, PA: Laboratory for Student Success.

Leonard, L. J., & Leonard, P. E. (2006). Leadership for technology integration: Computing the reality. *Alberta Journal of Educational Research*, *52*(4), 212-224.

Lim, C. P., & Khine, M. S. (2006). Managing teachers' barriers to ICT integration in Singapore schools. *Journal of Technology and Teacher Education*, *14*, 97-125.

Luterbach, K. J., & Brown, C. (2011). Education for the 21st century. *International Journal of Applied Educational Studies*, *10*(2), 14-32.

McGrail, E. (2005). Teachers, technology, and change: English teachers' perspectives. *Journal of Technology and Teacher Education*, *13*, 5-24.

McLeod, S., Bathon, J. M., & Richardson, J. W. (2011). Studies of technology tool usage are not enough. *Journal of Research in Leadership Education*, *6*(5), 288-297.

McLeod, S., & Richardson, J. W. (2013). Supporting effective technology integration and implementation. In M. Militello and J. I. Friend (Eds.), *Principal 2.0: Technology and educational leadership*. Charlotte, NC: Information Age Publishing.

Mouza, C. (2003). Learning to teach with new technology: Implications for professional development. *Journal of Research on Technology in Education*, *35*(2), 272-289.

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, underprivileged school. *Journal of Research on Technology in Education, 40*(4), 447-472.

Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers and Education*, *51*(4), 1523-1537. doi:10.1016/j.compedu.2008.02.003

O'Dwyer, L. M., Russell, M., & Bebell, D. J. (2004). Identifying teacher, school, and district characteristics associated with elementary teachers' use of technology: A multilevel perspective. *Education Policy Analysis Archives*, *12*(48), 1-33.

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, *55*(3), 1321-1335. doi:10.1016/j.compedu.2010.06.002

Organisation for Economic Co-operation and Development. (2012). *Education at a glance 2012: OECD indicators*. Retrieved from http://www.oecd.org/edu/eag2012.htm

Overbaugh, R., & Lu, R. (2008). The impact of a NCLB-EETT funded professional development program on teacher self-efficacy and resultant implementation. *Journal of Research on Technology in Education*, *41*, 43-61.

Pacific Policy Research Center. (2010). *21st century skills for students and teachers* [Literature Review]. Retrieved from Kamehameha Schools: http://www.ksbe.edu/spi/PDFS/21%20century%20skills%20full.pdf

Pitler, H. (2011, Jun/Jul). So many devices, so little use. *T H E Journal*, *38*(6), 42-44.

Prensky, M. (2013). Our brains extended. *Educational Leadership*, *70*(6), 22-27.

Printy, S. (2010). Principals' influence on instructional quality: Insights from US schools. *School Leadership & Management*, *30*(2). doi:10.1080/13632431003688005

Richardson, J. W., Bathon, J., Flora, K. L., & Lewis, W. D. (2012). NET-A scholarship: A review of published literature. *Journal of Research on Technology in Education*, *45*(2), 131-151.

Ritchie, D. (1996). The administrative role in the integration of technology. *National Association of Secondary School Principals. NASSP Bulletin*, 80(582), 42-52. doi:10.1177/019263659608058208

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan*, *94*(2), 8-13.

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

Schaffhauser, D. (2009). Which came first—the technology or the pedagogy? *T.H.E. Journal*, *36*(8), 27-32.

Schrum, L., Galizio, L. M., & Ledesma, P. (2011, March). Educational leadership and technology integration: An investigation into preparation, experiences, and roles. *Journal of School Leadership*, *21*(2), 241-261.

Sebastian, J., & Allensworth, E. (2012, October). The influence of principal leadership on classroom instruction and student learning: A study of mediated pathways to learning. *Educational Administration Quarterly*, *48*(4), 626-663. doi:10.1177/0013161X11436273

Shapley, K., Maloney, C., Caranikas-Walker, F., & Sheehan, D. (2008, July). *Evaluation of the Texas Technology Immersion Pilot: Third-year (2006-07) traits of higher technology immersion schools and teachers* [Annual report]. Retrieved from Texas Center for Educational Research website: http://www.tcer.org/research/etxtip/documents/y3_etxtip_qual.pdf

Snyder, T. D., & Dillow, S. A. (2012). *Digest of education statistics 2011* (NCES 2012-001). Washington, DC: Government Printing Office.

Starr, K. J. (2011). President's message: 21st century skills, 21st century infrastructure. *Information Technology & Libraries*, *30*(2), 54. doi:10.6017/ital.v30i2.3002

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). Mahwah, NJ: Routledge.

Szafranski, S. L. (2009). *The relationship between technology use of administrators and technology use of teachers: A quantitative study* (Doctoral dissertation). Available from ProQuest Dissertation and Theses database. (UMI No. 393490)

Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics* (6th ed.). Boston, MA: Pearson.

Texas Education Agency (n.d.). *Texas STaR chart history*. Retrieved from http://starchart.epsilen.com/history.html

The Hechinger Institute. (2008). *The Hechinger Institute guide to educational research for journalists*. Retrieved from http://hechinger.tc.columbia.edu/primers/ Guide%20to%20Education%20Research%207-2008.pdf

Wolsey, T., & Grisham, D. L. (2011). A nation of digital immigrants: Four principles. *California Reader*, *44*(2), 1-9.

Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, *14*, 173-207.

Yang, S. C., & Huang, Y. (2007). A study of high school English teachers' behavior, concerns and beliefs in integrating information technology into English instruction. *Computers in Human Behavior*, *24*, 1085-1103. doi:10.1016/j.chb.2007.03.009

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology use in school: An ecological perspective. *American Educational Research Journal*, *40*(4), 807-840.