

DEVELOPING AND SUSTAINING SCHOOLS AS TECHNOLOGY-ENRICHED LEARNING ORGANIZATIONS

By

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ABSTRACT

During the last two decades, an assumption was advanced by policy makers that making technology available would result in effective technology transfer and integration in the teaching and learning process (Cuban, 2001); however, reality has been less kind with research presenting a pessimistic picture regarding the impact of technology in the classroom and on teachers' instructional strategies (Becker, 2001). The purpose of this study was to examine how technology-enriched learning environments can be developed and sustained through Professional Learning Community (PLC) paradigms that make meaningful differences in teacher and student learning.

Key words: schools as sustainable learning organizations, leadership, professional learning communities, technology integration, change in educational practice.

INTRODUCTION

Technology plays an integral role in the United States economic, social, and political presence where the importance of a technologically literate workforce is emphasized (Culp, Honey, & Mandinach, 2003). The significance of this role is illustrated by the U.S. Department of Labor's (2006) estimate that the occupations of computer specialists will increase faster than others through the year 2014. Are our students prepared to enter this workforce? A report by business and higher education leaders indicates that students are falling short of scientific and technological literacy and are ill-prepared to leverage scientific and technological skills as participants in a democratic society (Business & Higher Education Forum, 2005). Skills that are necessary in the workforce, such as adapting to change, decision-making, and problem solving strategies, are developed by managing content within word processing, spreadsheets, and drawing programs (Cradler, McNabb, Freeman, & Burchett, 2002). To have the greatest impact on student learning, students must utilize technology as a workplace tool and the content must be an integral part of an articulated curriculum and assessment program (CEO Forum, 2001; Cradler et al., 2002; TSSA Collaborative, 2001; Wengliinsky, 2006). Research studies have provided evidence that when technology is utilized as a tool for application of content in problem-solving

situations and as students transfer their learning to contexts in the real world, higher-order thinking and workforce skills are developed and student achievement also increases (Cradler et al, 2002; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Schacter, 1999; Wengliinsky, 2006).

By 1999, National Center for Educational Statistics [NCES] (2000) reported 99 percent of teachers had access to computers somewhere in the school and 84 percent had computers in the classroom. Computer use increased if the teachers had access to the computers in their classroom (Becker, 2001; NCES, 2000). Unfortunately, the digital divide seeks out all contexts. The distribution of computers and access to the Internet were not equitable among schools (NCES, 2000). Schools with lower minority enrollments were more likely to have Internet access and a greater distribution of computers. By 2003, most schools were bridging the great divide by providing students who did not have the resources available in their homes with access to the Internet and computers (DeBell & Chapman, 2006).

Teacher preparation for technology diffusion was another story altogether. In 1999, only one-third of teachers reported feeling adequately prepared to use computers for classroom instruction while the less experienced teachers feel more confident than their well experienced

peers (NCES, 2000). Becker (2001) found that professional development increased teachers' feeling of preparedness to use computers and Internet, and during this time, three-fourths of the teachers reported using technology for planning, teaching, or for e-mail (Technology Counts, 2001), while only a few teachers reported utilizing technology for word processing, providing lower-ability students content-related drills, or assigning constructivist type projects for students (Becker, 2001).

Many have questioned whether if the investment of \$40 billion in federal funds and the money from the state and local agencies have created rich learning environments for students. Cuban (2001) reports that technology in schools had a minimal impact on teachers' classroom instruction. *Edtech* (2003), a Benton Foundation report, identified that districts that are successful in their implementation of technology have established a clear vision of the role of technology and provided professional development that transcends basic technology skills. The present study responds to these challenges and investigated how technology diffusion can be coupled with professional development to enrich staff development and technology integration toward the greater goal of improved student achievement.

Conceptualizing the Problem

The theoretical perspectives of the study were drawn from learning organizations and change theories as well as research-based practices that support these theories in schools. Schools as learning organizations were discussed in relation to change dynamics, leadership, and professional development. The study's conceptual framework was focused on building and sustaining organizations "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (Senge, 2000, p. 3). Senge (2000) builds on Weick's (1979) premise that the process of organizing involves the interlocked behaviors of at least two people and develops a framework for learning that is based on the way people

interact. Managing the complex social dynamics of learning organizations involves processes and influences of change in individuals that transform the organization into a learning community.

The learning of individuals, teams, and the organization are influenced by the capacity of the whole. An individual's learning capacity increases as personal mastery is achieved and one's mental models change. A shared vision capitalizes on the individuals' mastery and capacity. Senge (1990) states "when more people come to share a common vision, the vision may not change fundamentally. But it becomes more alive, more real in the sense of a mental reality that people can truly imagine achieving" (p. 212). Developing a shared vision involves inquiry and dialogue into complex issues. Through these social processes, such as discourse and reflection, individual or collective beliefs and assumptions may be challenged resulting in generative learning that develops new understanding and capacities (Senge, 1990; Sun & Scott, 2003). The learning resources are provided by the social groups (Brown & Duguid, 2000), and as an organization works toward achieving the shared vision, the vision becomes "a vehicle for advancing the larger story" (Senge, 1990, p. 351) through the inter-relationships of the organization as a whole.

Schools As Learning Organizations

In this age of accountability at the state and national level, many schools feel compelled to test the latest innovation or program, often dividing the efforts of the staff and fostering an atmosphere of fragmentation. This predicament suggests the need for building coherence in the organization as a dynamic system rather than approaching the challenge from linear thinking (Fullan, 2001; Newmann, King, & Youngs, 2000). System thinking builds coherence through a focus on the whole rather than the distractive lure of isolated parts, development of overall goals rather than stand alone events, consideration of the organization at different levels and between levels, and the context of its history and environmental relationships (Fullan, 2003). Systemic structures and the resulting inter-relationships are the key

variables that influence behaviors in organizations (Senge, 1990). Feedback: a concept of systems thinking, refers to “the process of actions reinforcing actions repeatedly, resulting in patterns that provide meaning in the language of the organization”. Feedback provides opportunities to be involved in problem-solving, to reflect about other approaches, and to collectively share the resulting actions (Brown & Duguid, 2000). Through the processes of reinforcing feedback, even small changes can produce significant effects towards a shared vision. Seeing the organization as a whole and considering change processes are ideas from system thinking that have profound implications for professional development and influencing behaviors in schools (Senge, 1990).

Systemic Change in Learning Organizations

Change in learning organizations:

For schools to be learning organizations, school leaders need to focus on the system and understand change processes and school cultures as complex, living organizations. “To understand things systematically literally means to put them into a context, to establish the nature of their relationships” (Capra, 1996, p. 27). Fullan (2003) stresses the importance of addressing the context or the conditions under which we operate, rather than accepting it. To change the context refers to our understanding of words, environment, or circumstances that affect or influence the meaning of ideas or concepts, for example, identifying what is important to the organization, such as collaborative goal setting, and develop structures that facilitate these processes (Fullan, 2003).

Leadership for change:

A new type of leadership is required in schools that function as learning organizations. These leaders are “designers, stewards, and teachers. They are responsible for *building and sustaining organizations* where people continually expand their capabilities to understand complexity, clarify vision, and improve shared mental models - that, they are responsible for learning” (Senge, 1990, p. 340, emphasis in original). Research by Waters,

Marzano, and McNulty (2003) stresses the importance of the principal who leads educational reform and understands the changes that impact student achievement and what these changes require for the faculty. The principal, as the formal leader, utilizes the concept of distributed leadership and establishes collaborative processes and structures for sharing decision-making with teachers on substantive issues which build the leadership capacity of individuals and the organization forming a school culture that supports the development of learning communities (Elmore, 2000; Spillane, Halverson & Diamond, 1999)

Professional development for change.

When schools emerge as learning organizations, their culture has a significant impact on the professional growth of individuals as well as the learning communities of the organization. Professional development based on systems thinking promotes change in these schools and through processes and structures that involves the interconnections and relationships of all levels of the organization contribute to the development of the shared vision for teaching and learning. Loucks-Horsley et al. (2003) recommended that when there is a strong collaborative environment and schools exhibit the characteristics of learning communities, professional development can have an impact on school improvement. The structures and processes of the learning community provide the supportive conditions for the collaborative and collective knowledge building of individuals and the collective faculty that enhances the capacity of the school (Brown & Duguid, 2000, Newmann et al., 2000).

For teachers to shift their instructional practices, professional development must provide constructive learning experiences (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, et al., 2003; Sparks & Hirsh, 1997). Teachers more readily understand and practice constructivist methodologies when “they have classroom support for altering their practices, such as peer coaching, scripting of lessons, and team teaching” (Brooks & Brooks, 1993, p. 121). Collaborative processes that provide teachers opportunities of sharing knowledge and analysis of ideas

or strategies contribute to a collective wisdom impacting teachers' practice (Brown & Duguid, 2000). This idea is supported by Becker and Riel's (2000) findings that there is a similarity in the way teachers' conduct themselves as teachers and the manner in which they organize their classrooms. For example, teachers who focus on traditional teaching strategies and have students working alone on externally driven curricula do not participate with peers in professional activities. In contrast, teachers who are engaged in the larger professional community and participate in collaborative exchanges provide the same type of interactions for students in the classroom.

Professional Development and Technology Integration

Professional development for integrating technology in teaching and learning involves the same processes of change as any innovation (Hall & Hord, 1987). Dwyer, Ringstaff, and Sandholtz (1991) found that learning to use technology is an evolving process and teachers' exhibit attitudes and practices involving technology in distinct stages of use. Other researchers have identified that teachers go through similar processes as they begin using technology (Riel & Fulton, 2001; Ross, McGraw, & Burdette, 2003). Teachers' use of technology begins by trying to replicate existing strategies and is more likely to use word-processing programs or drill and practice applications. As teachers become more familiar with the technology, they move to more learner-centered, project based activities (Ross et al., 2003). In a study of technology integration and the professional development, Burns (2002) identified technology as a catalyst for a community of practice, which "served as a vehicle for 'learning about learning,' a mirror in which teachers could see their best practices reflected for learning and teaching" (p. 302). Integrating technology impacts teachers' instructional strategies and influences the way they relate to the content of courses, to colleagues, with students, and in the school community (Burns, 2002).

Understanding the environment that promotes learning provides guidelines for effective technology use. Using technology as a tool can enhance learning by bringing real-world problems into the classroom by including

activities that are learner- centered and involve critical thinking, feedback, reflection, revision, and provide connections to the community, scientists and other experts (Bransford, Brown, & Cocking, 2000; Burns, 2005). Roschelle et al. (2000) analyzed major studies of computers as learning tools and found that the achievement level of students is enhanced through computer-based applications that involve the students in these fundamental characteristics of learning. In general, the studies (Cradler et al., 2002; Roschelle et al., 2000) reveal that technology applications provide opportunities for students to construct their own knowledge by interacting with the content and by asking questions, manipulating the data, or taking intellectual risks. Students can participate as individuals or work in small collaborative groups, which provide the social context for learning. In a meta-analysis investigation of the effect of technology on student outcomes, Waxman, Lin and Michko (2003) found modest, positive effects of instructional technology on teaching and learning. "The results can be generalized across a wide variety of conditions that have been investigated as well as across student, school and study characteristics" (Waxman et al., 2003, p. 13). A key factor in implementing these ideas is providing professional development to build a collaborative learning environment that integrates technology into the curriculum and teaching strategies as in the Grants-to-Schools project.

Context

This study involved the Grants-to-Schools project funded by the Oklahoma Educational Technology Trust (OETT) with the mission of equipping public schools and CareerTech students with the technology and technological skills necessary to compete in the global marketplace. OETT established a partnership with Oklahoma - Achievement through Collaboration and Technology Support (OK-ACTS) to provide professional development in leadership for school renewal initiatives involving professional learning communities and technology integration for OK-ACTS schools. The program goals were accomplished in two phases. OK-ACTS Phase I provided professional development for principals and superintendents to

create learning communities utilizing technology to impact student achievement in positive ways. School superintendents and principals who completed the year-long leadership development were eligible to apply for the project.

The purpose of Phase II was to sustain the efforts begun in OK-ACTS Phase I and to extend the professional development to involve teachers, parents, and community members. The application required superintendent and principals to conceptualize programs that would improve student achievement through technology integration, professional development, and effective shared leadership. Through the grant application process, districts or schools have developed action plans to implement three of the *10 Practices of the High Achieving School* (O'Hair, McLaughlin, & Reitzug, 2000) using technology to impact student achievement. For the 2003- 2004 school year, 21 schools and districts were selected through a competitive grant process. Components of professional learning communities involve school leaders, teachers, students, and community members in processes to move the school towards a shared vision of effective teaching for student learning. Studies have shown that the availability of technology does not translate to use by students and teachers in the classroom. If a relationship exists between professional learning communities and technology integration, these findings demonstrate important practices for today's classrooms and students' becoming technologically literate and impacting student achievement.

Research Questions

This study examined the nature of the relationship between professional learning communities and technology integration. Three questions guided the investigation.

RQ₁: *What is the relationship between professional learning communities and the integration of technology in the teaching and learning process?*

RQ₂: *What are the relationships between the dimensions of professional learning communities and factors of*

integration of technology for teaching and learning?

RQ₃: *What are the long-term effects and sustainability of the relationship between professional learning communities and the integration of technology in the teaching and learning process?*

Method

This empirical study investigated the longitudinal impact of a state-wide project that delivered professional development, collaborative networking, and technology equipment to 21 school/district staffs as they participated in learning community development and technology integration. Quantitative data from teachers' pre- and post-intervention surveys were analyzed using correlational analysis to determine the nature of the relationship between dimensions of learning communities and factors of technology integration. Qualitative data from state level performance data, interviews with school administrators and teachers, classroom observations, and field notes were collected to provide a deeper understanding of the sustained cultural changes in the schools.

Sample

The sample comprised of teachers and administrators in the 21 districts or schools who were recipients of a 2003 Grants-to-Schools award. The school levels represented by the 21 awards included: three districts, five high schools, one middle school, and 12 elementary schools. Fifty-three percent of the students in the sample qualified for the free and reduced lunch program, indicating high levels of poverty in the grant schools. There were 676 teachers in the grant districts or schools. The sample frame was the completion of the pre and post-surveys for both instruments utilized in the study, resulting in a purposive sample of 218 teachers.

Descriptive information gathered by the survey instruments and the grant application provided demographic data about the sample. Of the 218 teachers, 90 percent ($n = 197$) were female and 10 percent ($n = 21$) were male. Three levels of school organizations were represented, with 21 percent ($n = 46$) of teachers at the secondary school level, 71 percent (n

= 154) at the elementary level, and 8 percent ($n = 18$) representing districts. Teaching assignments varied from self-contained or subject-specific at one grade level to pre-kindergarten through twelfth grade.

The majority of the teachers (75.6 percent) had been employed as teachers for a mean of 13.57 years with the range of 41 ($SD = 9.304$). Data indicated that 25.8 percent of the teachers were in the first five years of teaching. This percentage decreased steadily in five year increments until reaching over 25 years in the profession. Teachers had been teaching in the current school from 1 to 33 years ($M = 8.78$, $SD = 7.34$); however, nearly half of the teachers (48.8 percent) had been teaching in the current school for one to five years.

Instrumentation

Two pre and post-intervention survey instruments, *School Professional Staff as a Learning Community (SPSLC)* (Hord, Meehan, Orletsky, & Sattes, 1999) and *Technology Integration (TI)* (SEDL, 2003) were distributed to all teachers ($N = 676$) in the 2003 Grants-to-School project.¹

Professional Learning Communities Instrument:

SPSLC assessed the school's team work in the following five areas:

- the collegial and facilitative participation of the principal, who shares leadership (power and authority) in decision-making with the staff (with two descriptors);
- a shared vision that is developed from the staff's unswerving commitment to students' learning and that is consistently articulated and referenced for the staff's work (with three descriptors).
- learning that is collectively pursued to create solutions that address students' need (with five descriptors)
- the visitation and review of each teachers' classroom practices by peers including feedback and assistance that actively supports individual and community improvement (with two descriptors); and,

- physical conditions and human capacities that support such an operation (with five descriptors) (Hord et al., 1999, p 1).

Validity and reliability analyses were conducted by Appalachia Education Laboratory (AEL) (Meehan, Orletsky, & Sattes, 1997). Three types of validity analyses were conducted - content validity², concurrent validity³, and construct validity⁴.

Descriptive statistics were computed for the full sample of $n = 690$, followed by computations for the school level, elementary, middle/junior high, and high school; and finally, these results were compared to the mean scores of the 21 schools in the field test. These results indicated that the instrument did differentiate among all schools and within the subgroups of schools (Hord et al., 1999). Internal consistency reliability coefficient was computed using the Cronbach's Alpha formula and indicated satisfactory reliabilities for the full group ($n = 690$) was 94. The Alphas for the individual school levels ranged from .62 -.95. The stability test reliability coefficient was computed, using test-retest, on a small sample ($n = 23$) and was marginally satisfactory (.61). The small sample size was due to problems with matching identification numbers.

Integration of Technology:

The second instrument was the *Technology Integration (TI)* (SEDL, 2003) survey. The primary focus of the instrument was to explore teachers' and students' use of technology and the extent to which technology was integrated into

²For content validity, three stages of review were conducted with minor changes in wording that met the original intent and the author's approval. It was determined that the instrument had "sufficient content validity for its original intention of measuring the concept of a community of learners within the professional staff of K-12 schools" (Hord et al., 1999, p. 7).

³A school climate instrument was administered to assess concurrent validity of the instrument. The SPSLC demonstrated concurrent validity with the school climate instrument with a correlation of .75, $p < .001$.

⁴For construct validity a t-test compared a known group of teachers with the teachers in the field test ($n = 690$). The results indicated the known group of teachers, who were known to function as a professional learning community, differed significantly ($p = .0001$) from teachers in the field test (Hord et al., 1999). Lastly, a factor analysis using an unconstrained principal components analysis followed by a varimax and oblique rotations was conducted. "Based on factor analysis results, it appears that the 17-item instrument represents a unitary construct of a professional learning community within schools" (Hord et al., 1999, p. 4).

¹Survey instruments are available from the Oklahoma Educational Technology Trust.

the classroom. The *TI* survey assessed the following factors of integrating technology in teaching and learning:

- Teachers' use of technology (five factors: teachers' use of technology for instructional purposes, planning and collaborating for technology, using technology to communicate with others, using technology for decisions about students' learning needs, and sharing practices for technology integration)
- Students' use of technology
- Support received by teachers for using technology
- Teachers' beliefs regarding use of technology (two factors: positive and negative)

The *TI* instrument served as a pre and post- survey with slight variations. The pre-survey instrument consisted of 14 questions, of which 10 were structured questions; the remaining four questions were open-ended. The open-ended questions were not included in the post-survey; therefore, the responses were not used in the data analysis. Six of the structured questions had 1 to 31 items with response choices having descriptors for the possible ratings, and were scaled from one to four or five. The choice descriptors varied from one (never) to five (daily or always); one (not at all) to five (expert); one (none) to five (total support); and one (strongly disagree) to four (strongly agree).

An exploratory factor analysis was performed on questions five through eight of the *TI* post-survey to investigate the constructs being measured by the items included under each question. The questions contained items focusing on teachers' use of technology in their work (question five), students' technology use in learning tasks (question six), the support received by teachers for using technology in their work (question seven), and teachers' general beliefs regarding technology use (question eight).

Using principle component analysis with varimax rotation, eigen values of one or greater constituted the criteria for factor extraction. For the first analysis, no factor solution was requested, resulting in an eleven factor solution. This structure was not easily interpretable, especially for items within question five. The items in a factor had to meet the

.50/.30 strength and purity standard for factor loadings. Many of these items formed singular categories, others combined with some of the items in questions six through eight.

After considering the results of the initial factor analysis and looking more closely at the items in question five, a separate factor analysis was performed on this question. The result was a five factor solution suggesting subscales within this question measuring (i) providing technology-based learning activities for students, (ii) planning and collaborating for technology integration, (iii) using technology to communicate with others, (iv) using technology for decisions about student's learning needs, and (v) sharing practices for technology integration. Reliabilities calculated on these factors resulted in .95, .83, .82, .87, and .87, respectively, indicating good instrument reliability.

The next three questions elicited responses concerning students' use of technology (question six), level of support for teachers' use of technology (question seven), and teachers' beliefs about technology use in instructional practices (question eight). Factor analysis of these questions resulted in four factors. Question six reflected one factor with a reliability coefficient of .89. Also, the analysis showed question seven as one factor, with a reliability coefficient of .88. Question eight divided into two factors, reflecting teachers' beliefs regarding the use of technology, positive and negative, with reliability coefficients of .83 and .76, respectively. In summary, factor analyses generated nine constructs - the five constructs from question five: (i) providing technology-based learning activities for students, (ii) planning and collaborating for technology integration, (iii) using technology to communicate with others, (iv) using technology for decisions about student's learning needs, and (v) sharing practices for technology integration; the construct for question six - students' use of technology; the construct for question seven - level of support for teachers' use of technology; and the constructs for the two factors for question eight - teachers' beliefs about technology use in instructional practices, both positive and negative. Cronbach's Alpha for the total scale reliability is .96.

The construct validity of the survey was supported by the literature explained above. Teachers engaged in professional development were more likely to integrate technology into the teaching and learning processes for their students (Becker & Riel, 2000; Burns, 2002). During the development of the survey, items were written and checked by experts to see if the items reflected their understanding of technology integration. The initial survey was piloted with teachers to establish item relevance and clarity. As these processes were conducted and feedback was received, items were refined (SEDL, 2003). To standardize the metric scales of all survey instrument items, Z-scores were computed and utilized for the correlation procedures. To minimize the chance of committing Type I errors by computing multiple correlations, corrected significance levels were computed by dividing $p = .05$ by the number of correlations calculated.

Qualitative Data Analysis

Complete interview transcriptions from each teacher and administrator were analyzed through a process of organizing, reducing and describing the data into codes. A spreadsheet was used to categorize the analyzed data by individual respondents, and then a composite description of the meanings of the experience was developed that represented each school site as a whole group. Interviews were conducted, transcribed, coded and themed by each researcher to provide inter-coder reliability for the codes and themes. Participants in the study were asked to verify the accuracy of the written interview transcriptions, codes, and themes using member checking. This trustworthiness technique of member checking established credibility during the qualitative analysis (Lincoln & Guba, 1985). Data from state-level student performance reports, classroom observations, and field notes were also analyzed to enrich and clarify the findings. This document analysis helped to support the primary quantitative and qualitative data sources. The narrative data were examined for examples of items from the primary qualitative themes and significant correlations in the quantitative data. These data provided a deeper understanding of how the

schools had been developed and changed.

Results

Relationship Between PLC and TI

Research Question One explored the nature of the relationship between professional learning communities and the integration of technology. An overall correlation coefficient was calculated using the change score means of the pre- and post-intervention survey results. Additionally, correlation coefficients were computed for the paired *SPSLC* (Hord et al., 1999) and the *TI* (SEDL, 2003) post-intervention surveys of professional learning communities' dimensions and the technology integration factors. Coefficients of determinations (R^2) were computed to assess the practical significance of the correlation coefficients. The values were interpreted using Cohen's scale of .1, .3 and .5 as small, medium, and large correlations respectively (Cohen, 1988).

The correlation between professional learning communities and technology integration scales was significant, $r(216) = .33$, $p < .000$, $R^2 = .11$. The results of the correlations between these variables demonstrated the positive effects of the staffs' interactions as professional learning communities and the influence on the integration of technology into the culture of learning for teachers and students. Using the paired *SPSLC* and *TI* post-intervention survey results, the overall relationship between professional learning communities and technology integration demonstrated a medium positive, statistically significant correlation $r(218) = .23$, $p < .05$, $R^2 = .05$. For the *SPSLC* and *TI* paired post-intervention survey responses, the correlation coefficient was $r(218) = .32$, $p < .05$, $R^2 = .12$.

Relationships Among the Dimensions of PLC and the Factors of TI

Analyses were conducted using the mean scores for the dimensions of professional learning communities and the factors for technology integration in order to address Research Question Two. Correlation coefficients were calculated for change scores from the *SPSLC* (Hord et al., 1999) and *TI* (SEDL, 2003) pre- to post-intervention surveys. For each of the analyses, a correlation matrix was

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Leadership	—	.26	.28	.20	.40	.21*	.05	.11	.04	.12	.09	.16	.19	.10
Vision		—	.27	.21	.34	.16	.09	.01	-.07	.09	.08	.02	.11	-.10
Collective learning			—	.31	.42	.14	.04	.28*	.05	.14	.09	.17	.03	-.02
Peer review				—	.35	.31*	.09	.16	.09	.27*	.20*	.15	.24*	.05
Supportive conditions					—	.28*	.10	.20*	.12	.18	.09	.26*	.10	.02
Instructional						—	.41	.40	.21	.59	.56	.23	.27	-.02
Planning							—	.27	.21	.47	.28	.10	.09	.02
Communicating								—	.27	.35	.33	.27	.14	-.09
Decisions									—	.17	.14	.20	.06	.05
Shared practices										—	.38	.18	.16	-.06
Students' use											—	.17	.18	-.11
Support												—	.08	-.13
Beliefs positive													—	.31
Beliefs negative														—
Mean	0.05	0.03	0.06	0.12	0.00	0.43	0.70	0.25	0.42	0.26	0.26	0.55	0.11	0.05
Standard deviation	0.87	0.75	0.72	1.07	0.00	0.68	0.77	0.67	0.89	0.76	0.73	0.85	0.37	0.33
Range	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-4	1-4

* Correlation is significant at the corrected 0.05 level (2-tailed)

Table 1. Professional Learning Communities and Technology Integration Change Scores Correlation

structured using the dimensions of professional learning communities and factors of technology integration. These analyses are presented in Table 1.

For the data set of the change scores means from *SPSLC* and *TI* pre-surveys to *SPSLC* and *TI* post-intervention surveys, there were nine statistically significant correlations listed in Table 2.

Discussion of Findings

This study provided evidence of robust findings for

Dimensions of Professional Learning Communities	Factors of Technology Integration
<ul style="list-style-type: none"> Peer review and feedback 	<ul style="list-style-type: none"> Teachers' use of technology Sharing best technology practices Student' use of technology Teachers' positive beliefs about use
<ul style="list-style-type: none"> Supportive conditions 	<ul style="list-style-type: none"> Teachers' use of technology Using technology to communicate Support teachers received
<ul style="list-style-type: none"> Shared leadership Collective learning 	<ul style="list-style-type: none"> Teachers' use of technology Using technology to communicate

Table 2. Change Scores from SPSLC and TI Pre - to Post - intervention Surveys

organizational learning through the development of professional learning communities and enriching the learning environment through technology integration. The overall relationship of the dimensions of professional learning communities and the factors of technology integration reflects that as the schools' staffs became more involved in the characteristics of professional learning communities, there was a similar involvement in integrating technology into the school experiences. Likewise, the relationship demonstrated as technology was integrated into the teaching and learning processes of the school, there was a corresponding involvement in the characteristics of professional learning communities. In a study of professional engagement and teaching practice, Becker and Riel (2000) found a strong association between teachers' involvement in being leaders among peers, mentoring and providing professional development and their effective use of computers with students. This study's results provided empirical data to support their findings.

Not only was there a medium statistically significant overall correlation between professional learning communities and technology integration, the number of statistically significant correlations using the change scores from pre- to post-intervention data demonstrated nine significant intercorrelations among all dimensions of professional learning communities and six of the factors of integration technology into teaching and learning. Through an examination of the correlations between the separate dimensions of professional learning communities and the factors contributing to technology integration, the dimension of peer review and feedback correlated with four of the nine factors that influenced incorporating technology: teachers' use of technology for students' learning activities, sharing best technology practices, students' use of technology, and positive beliefs towards the use of technology. These findings add empirical data to support the study by Burns (2002) that found professional development that integrated technology with learner-centered approaches resulted in teachers having inquiry and discourse about best practices for the classroom, followed by changing their

instructional practices to reflect lessons that incorporated activities that promoted student learning. Peer review and feedback involved teachers in observing others' classrooms and having inquiry and discourse centered on practices or strategies observed in these classrooms. These interactions demonstrated an atmosphere of mutual respect, provided ideas for them to use in their classrooms, and promoted the adoption of new practices (Hord, 2004). Teachers' learning was enhanced through receiving constructive feedback on specific innovations (King & Newmann, 2000). Knapp, Copland, Ford, McLaughlin, Milliken et al. (2003) identified interactions of professionals contributing ideas of effective practices and providing feedback as the most valuable form of professional learning to improve practice. Findings from this study enhanced the empirical data supporting the contribution of these shared practices.

Another dimension of professional learning communities that contributed to positive associations with integrating technology was supportive conditions. Supportive conditions correlated with teachers' use of technology for instructional purposes, use of technology for communicating with others, and the support teachers received for using technology. Supportive conditions included both the physical and structural factors, such as time and place for meetings, as well as the conditions which support the development of individual and organizational capacities. Supportive administrators nurture the development of human capacities through promoting social processes within a caring environment. Findings from a study by Newmann, Rutter, and Smith (1989) indicated the importance of school leaders and teachers being connected to problems and their application to current practice. Anderson and Dexter (2005) found although having the technology infrastructure is an important supportive condition, technology leadership is more influential in maximizing technology in schools. This study empirically supported the relationship between supportive conditions, both physical and the conditions for human capacity development, and the use of the innovation of

technology for instructional purposes.

The dimension of professional learning communities, termed as 'collective learning' involved the staff in addressing issues during meaningful discussions to create challenging learning opportunities that address student needs (Hord et al., 1999). The change score correlations demonstrated that sharing with others in decision-making processes and learning collectively has a positive relationship with the teachers' use of technology for students' learning activities and using technology for communication with others. Teachers were involved in decisions for designing lessons and tasks for students utilizing technology in a variety of ways, i.e., gathering information and evaluating its accuracy, utilizing data, facilitating discussions, sharing work, and presenting their products. Technology served as a tool in communicating about these educational issues with colleagues and administrators, as well as students, parents, and community members. The model, shown in Figure 1, describes these relationships and illustrates the integrative nature of the technology and professional learning communities.

Sustainability of the Relationships

To determine the long-term effects and sustainability for Research Question Three, data were analyzed for evidence of the significant relationships between professional learning communities and technology integration in the study schools over five years. Qualitative data from interviews, state-level student performance reports, classroom observations, and field notes were

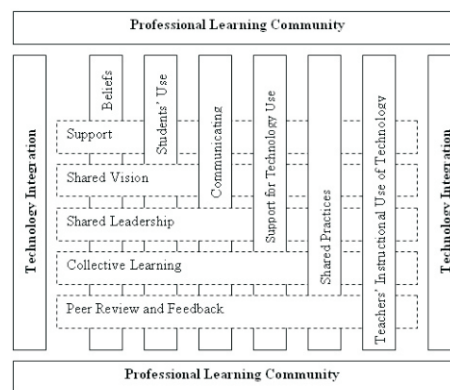


Figure 1. Schools as Technology-Enriched Learning Organizations

collected to provide a deeper understanding of the sustained cultural changes in the schools. The findings of the sustainability study were analyzed for evidence of the significant relationships found after the first year of implementation (Hamlin, 2007).

Shared leadership: Leadership, as a dimension of professional learning communities, involved processes that include the staff in discourse and shared decision-making. The majority (20 out of 21) of the staffs' reported regular meetings for sharing best practices, developing learning activities that promote students' use of technology, and using technology for assessment of student data. The focus of these collaborative efforts was for the technology to become integral to the instructional program. The collaborative learning involvement experienced by the teachers created positive beliefs, regarding the impact of using technology for students' and teachers' learning.

Collective learning: The evidence gathered from the sustainability study demonstrated many examples of collective learning. Teachers and administrators shared examples of using technology to communicate with colleagues, administrators, students, parents, and community members. Additionally, the majority of schools described opportunities to learn from each other, both within the school environment and externally. In the school environment, learning from books and observing each other and sharing ideas of 'what works' created increased integration of technology into the instructional day. Beyond the local school community, staffs opened their doors for visits from other schools, networked with other OK-ACTS schools at the University of Oklahoma's Winter Institute, and attended professional development sessions provided by the K20 Center or vendor workshops.

Shared vision: In the original grant application, shared vision was a required component of the grant application process. After five years, the majority of schools have demonstrated a continued focus on common goals as indicated by the commitment for increasing the integration of technology into the instructional program and learning processes of the school for students, teachers, administrators, and the school communities.

The majority of the OETT/OK-ACTS 2003 schools leveraged the grant funds to provide funding for additional technology equipment for the schools. Another example of a shared vision is the majority of the schools that utilize the technology for other purposes like after school programs for children or classes for adults. Two schools serve as examples of shifts in the vision of schools for the use of technology. One school reported to be less on its reliance on the textbooks and the other school is paperless in its communication and record-keeping,

Peer review and feedback: The teachers' responses to the sustainability study illustrated that there were opportunities to observe others using technology and to share classroom technology practices. These experiences encouraged teachers to use more technology and to increase students' applications of technology for classroom assignments. Teachers utilized the technology for organizational and instructional purposes. E-mail, record-keeping, calendars, and analyzing student assessment data are examples of the organizational measures. Instructional uses included lessons to address the content areas of need from the assessment data, websites, video clips, power points, virtual field trips, and virtual dissections.

Supportive conditions: The results indicated the support received by teachers, both school conditions and capacity building processes, impacted the teachers' use of technology in the classroom. All schools had established provisions for maintenance and repair of the technology equipment. Some schools designated a teacher as a technology contact. One technology contact has compiled a notebook of quick helps for the building's equipment. Seventy-one percent of the schools reported that most of the original equipment was in use and many of the schools had leveraged the grant funds for the acquisition of new equipment. The teachers' responses indicated supportive conditions, such as, regular meeting times and book studies, creating a collaborative environment in which teachers contributed ideas about their practices with others increasing the use of technology for students' learning tasks.

After five years, the professional learning communities in

the 2003 Grant Schools still continued to thrive. Administrators had a significant influence on developing the culture that emphasized professional development opportunities and supportive conditions for integrating technology and learning experiences. Teachers involved in a community of learners, provided support and assistance to each other, incorporated activities for students through active learning strategies more often than teachers who used traditional teaching practices (Becker & Riel, 2000; Burns, 2002). The first year of the project provided empirical findings that supported these studies, and the sustainability results confirmed the long-term impact on the learning culture of the schools and student achievement. As the teachers and school leaders utilized the technologies and shared best practices, communities of practice developed facilitating the inquiry and discourse of technology integration to impact student learning (Cate, Vaughn, & O' Hair, 2006; Printy, 2004). Also, the data indicated relationships between the professional learning community's characteristics of shared leadership and shared vision and the teacher's positive beliefs about the use of technology.

Analysis of School Performance Index

One measure of a school's progress toward its educational goals is the State's accountability measure, Academic Performance Index (API), a formula for determining Adequate Yearly Progress as required by NCLB. In Oklahoma, the API index formula varies by school level. For elementary schools, the API is based on student achievement data (90 percent) and attendance (10 percent). For secondary schools, the formula includes other factors, such as, graduation rate and dropout rate, with 80 percent based on student achievement data. As a part of the grant application, the schools provided their 2002-2003 score. The 2003-2004 API scores were obtained from the School Report Card (Education Oversight Board, 2003, 2004) and compared to the 2002-2003 scores.

As shown in Table 3, the schools receiving the treatment in this study had an 82% greater increase in the schools' API than the state average increase. When analyzing the

school's API scores over the five years of the longitudinal study, continued growth and increased student achievement was evident. Eighty-two percent of the schools, which have 50% or more poverty level, have continued to have an API that is greater than the state average throughout the five years of the study.

Limitations of the Study

The pre-and post-intervention survey instruments utilized in this study relied on self-reported data from the participating teachers and administrators. The surveys' response formats utilized a five-point Likert scale producing nominal data. In the data analysis procedures, the data were treated as continuous, interval data (Punch, 2003). As the scores on the five-point Likert scale aggregated toward the higher scores on the post-intervention surveys, there was less variation in the scores (regression towards the mean or the tendency of extremes to revert toward averages).

The participants were drawn from a purposive sample from the accessible population of 2003 Grants-to-Schools recipient schools and/or districts. This fact may limit the generalizability of the findings of the study. The schools investigated in this study had variability in school size, length of time principal or superintendent had served in the school, varied career and professional development experiences, community and school demographics, and community support; however, all administrators of the districts or schools for the year of the grant implementation had the common experience of the OK-ACTS Phase I Leadership Development. Ten of the twenty-one schools had a new administrator sometime over the five years since receiving the grant. Seventy-five percent of these new school leaders had become a qualified OK-ACTS Phase I leader.

School	API Pre Intervention	API Post Intervention	Change (Percent Increase)	Percent Comparison of Increase
2003 - 2004 Grant Schools	1086	1161	75 (6.9%)	
State of Oklahoma	1046	1086	40 (3.8%)	82% greater increase than the state increase

Table 3. Study Schools' Academic Performance Index

Conclusion & Implications for Practice

With the *No Child Left Behind* legislation that has increased accountability measures for student learning and the increased demand for technology literacy, schools are faced with the dilemma of meeting these demands while facing the various pressures that exist in today's schools. This quantitative study's results provided evidence of a model that addressed these demanding and daunting mandates. The variables in this study were the dimensions of professional learning communities and the factors of technology integration. A link has been established between schools that exhibited the characteristics of professional learning communities and improved student achievement (Lee & Smith, 1994; Morrissey, 2000; Newmann & Wehlage, 1995). In a corresponding fashion, a meta-analysis of research studies investigated the impact of technology use on student achievement with findings that indicated small to modest, positive effects of using technology for teaching and learning (Waxman et al., 2003). Yet, the overwhelming evidence provided by numerous studies and reports (Becker, 2001; Cuban, 2001; NCES, 2000) was that the actual use of technology in teaching and learning has not kept pace with the availability of technology in the classroom. The findings from this study demonstrated a moderate, positive association between the characteristics of professional learning communities and the factors contributing to the integration of technology in the teaching and learning process.

The role of the school administrator was vital to this process. Senge (1990) described school leaders as being responsible for creating an environment for learning so people can continue to learn. The formal role of school leaders established structures for shared decision-making and the development of a shared vision for the school and built a commitment towards accomplishing the shared vision (Porter, 2005). As the staffs' interactions became more collaborative, the influence of their decision making and leadership impacted teaching and learning. Further study results indicated that schools staffs' involvement with the characteristics of professional learning communities the factors of technology

integration produced changes in the dimensions and factors. In practical terms, as teachers and administrators were learning about learning community processes and the uses of technology for teaching and learning, inquiry and discourse about one variable lead to the other variable and in the opposite direction. Consequently, school administrators should move their staffs toward implementing the practices of professional learning communities and technology that are focused on accomplishing the school's vision.

Learning opportunities for teachers and administrators must address adult learning principles (Elmore, 2000). Loucks-Horsley et al. (2003) found that for adult learning to be effective, the topic should be relevant, useful immediately, experiential, and have opportunities for application of learning. The *Concerns Based Adoption Model (CBAM)* (Hall & Hord, 2001) provided a process of accessing the concerns the teachers or administrators had about the innovation being adopted. From these assessments appropriate professional development can be planned and acknowledge individual's level of concern about the innovation. Following the *CBAM* model, a similar model was developed for technology integration (Dwyer et al., 1991). The change process moves from learning about the basic aspects of the technology, to using technology for traditional instruction and student production of existing classroom activities, to creating new learning experiences, and finally, after over 80 hours of training and 4-5 years, teachers reflecting about their fundamental perceptions of instruction. School leaders should be aware of the progression of change characteristics for planning and supporting the change efforts.

To support teachers in learning and increasing the capacity of the organization, "professional development should address three dimensions of school capacity-teachers' knowledge, skills, and dispositions; the strength of the school wide professional community; and the coherence of the school program" (King & Newmann, 2000, p. 576). Through this development not only has the individual grown, but the capacity and relationships within the organization have been promoted. As teachers and

administrators developed new knowledge, skills, and dispositions about the role of technology or the dimensions of professional learning communities, the capacity of the organization also increased. This study provided evidence of "mutually reciprocal relationships" (Williams, L. A. Atkinson, L.C., Cate, J.M., & O'Hair, M.J. (2008) between professional learning community development and technology integration that impacts organizational learning and student achievement. Through constant support and job-embedded professional development, school communities continued to improve and technology-enriched learning communities were sustained.

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