U.S.A.: A Model of implementation Effectiveness

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Abstract

The U.S.A. cases discussed here had all implemented an instructionally focused, technology-supported innovation across most of the school. This makes it possible to observe attributes of the school context that appeared to be critical for successful implementation of innovative teaching practices utilizing educational technology. The learning environments model supported by our cross-case analysis was derived from adapting the principles learning of Bransford, et al. (1999) to teachers and merging them with the theory of learning organizations (Senge, 2001). Organizational actions, such as policies and staffing, can shape teachers' learning environments. Structural characteristics of organizations, such as hierarchy and communication patterns, may also influence these learning environments. Such factors not only are important to effective implementation of instructional practices appropriating technology, but they are also likely to be essential to sustaining and refining such practices.

U.S.A.: A Model of implementation Effectiveness

The purpose of the Exemplary Technology-Supported Schooling Case Studies Project was to identify K12 sites that had implemented a school-wide improvement that was supported by the use of educational technology. In most of the eleven schools studied, the school was engaged in an effort to implement reformed pedagogy, with technology identified as an explicit strategy or support for achieving their goal. Specifically, the pedagogies were a variation of inquiry- or project-based learning.

Together, the implementation of the innovation and the educational technology required teachers to adopt new roles, as well as revise instruction and assessment practices and curriculum with state standards and achievement tests in mind. In addition, it required that they learn to operate new hardware and software as well as determine how to incorporate it into their pedagogy. This technology use demanded teachers have access to and technical and instructional support for its use. In other words, the changes made involved several parts of both the instructional and technology systems in place at the school.

The systemic nature of the improvements and their school-wide implementation required that not only did teachers learn individually, but that they process together the knowledge about their school level goals and their collective responsibility for them. Much of the reform and technology literature documents the difficulty of implementing either a pedagogical reform or technology on a school-wide basis, but these sites were quite successful on both counts. Thus, these schools provide an opportunity to learn about the attributes of the school context that were critical for teachers to individually learn about and to work together to successfully implement innovative teaching practices utilizing educational technology. This information will contribute to understanding the implementation success of such innovations by detailing the necessary elements of the environment that support individual teacher as well as organizational learning, and that will help to make such efforts sustainable.

Theoretical Perspectives

The recent synthesis of the last ten years on research on learning documented in *How People Learn* (Bransford, Brown, & Cocking, 1999) identified four essential elements for the design of effective learning environments. It should be learner-centered, and take individual learner knowledge and prior experience into account. It should be knowledge-centered, or directed toward developing deep understanding. It should be assessment-centered, and use feedback and other assessment mechanisms to guide the learner. And it should be community-centered, allowing for common sharing of information. While *How People Learn* (HPL) book focused mainly on learning environments for students, its four-part framework can be used to imagine what should be present in teachers' learning environments. For example, at a school that is learner-centered professional development opportunities would build upon the strengths, interests and knowledge of the teachers. This might mean that teachers have customized or one-on-one help, or be able to choose from among the topics and ways to learn. A knowledge-centered workplace learning environment would mean that an instructional reform and integrated technology use would be presented in terms of concepts and principles not just routine procedures. An assessment-centered environment would provide teachers with opportunities to try new approaches out in real settings, and receive feedback on their efforts, so they could refine their approach. Community-centered learning environments for teachers operate with norms of

trust and collaboration. They encourage teachers' discussion about specific aspects of instruction and student performance.

These recommendations for teachers' learning environments are congruent with previous research on teachers' implementation of new pedagogy. They also echo work on professional community among teachers and its correlation with student achievement (Louis, Marks & Kruse, 1996). It is also in keeping with our previous work on quality technology support, that it include one on one support, teacher discussion, and be focused on integration topics (Dexter, Anderson & Ronnkvist, 2002).

The learning organization research discusses how an organization's elements, such as its hierarchical structure, use of time and space, communication patterns, and leadership can enhance or impede its ability to learn---meaning to see alternative perspectives, create new understandings or behaviors (Argyris & Schon, 1996) and help the school staff "to restructure, reculture, and otherwise reorient themselves to new challenges" (Leithwood, Leonard & Sharratt, 1998, p. 271)." Presumably such capabilities would be key in schools where the improvement effort underway required teachers to collectively process knowledge in order to implement system-wide goals and assume responsibility for them. Further, we argue that effective and widespread tech use requires a capability for organizational learning beyond the school because technology planning and implementation crosses levels (i.e. district, school and classroom) and boundaries (i.e. technical and instructional) and requires coordination among them.

The HPL framework is reminiscent of that of Probst and Buchel (1997) who described three elements essential to an organization's ability to learn. First is knowledge, which must be supported by tools for knowledge building, such as a vision and discussion and analysis mechanisms. A second element is ability, described as the structures and processes to share information, and third was intention, or the social norms for and willingness to share.

Marks and Louis (1999) extended this work by identifying indicators of a school's capacity for organizational learning in six areas. They included within "knowledge and skills" such items as professional development, openness to innovation, and professional competence. Under "leadership" they included a supportive and non-authoritarian leadership style as well as its substance, such as for intellectual topics. Within "feedback and accountability" the indicators included being held to standards as well as teachers' perceptions of respect from their peers. "Structure" of the setting included factors such as smaller size and decentralized authority, as well as time to meet with colleagues. The "shared commitment and collaborative activity" capacity was indicated by features such as professional community, goal consensus, and the staff's problem-solving capability. "Measures of teacher empowerment" emphasized teachers' influence over school policy and their participation on key decisions that impact their work life.

In this paper we use the four dimensions of a learning environment from the *How People Learn* framework (Bransford et al., 2000) and selected literature on learning organizations (Probst & Buchel, 1997; Marks & Louis, 1999) to examine the attributes of school contexts that appeared to be critical for successful implementation of innovative teaching practices utilizing educational technology. The *How People Learn* framework suggests the components necessary in a school so as to support teacher learning and the learning organization literature points to the features of a school that would support their creating such an environment. We refer to this conjunction as the Teacher Learning Environments framework. Table 1 embodies this framework giving specific examples in the table cells.

Table 1

Teacher Learning Environments: Designs for Teacher Learning Environments and How Organizations may Facilitate Them

Learning Environment Designs	Learning Environment Elements for Teacher Learning	Organizational Features that May Facilitate Teachers' Learning Environments
Learner Centered	• professional development opportunities built upon teachers' strengths, interests and experience • availability of customized/one-on-one help, • choice from among topics and ways to learn	• smaller size • decentralized authority • structures and processes to share information and help learning occur, such as time to meet with colleagues • adaptable systems that support pedagogical and technical learning
Knowledge Centered	• contextualized professional development • focus on in-depth understanding of instructional issues and how teachers learn	• intellectual leadership and tools for knowledge building, such as a vision • supportive and non-authoritarian leadership style
Assessment Centered	• opportunities to try new approaches out in real settings, and receive feedback on their efforts	• policies that orient assessment to goal of enhanced learning, not just external accountability
Community Centered	• norms of trust, sharing and collaboration • Teachers discuss instruction and their own strategies and performance	• policy that encourages professional community • goal and vision consensus among staff, teachers, and external community • teachers' school, especially participation in key decisions impacting their work life

Methods and Data

Each site visit involved a team of two researchers working at the school site for five days. These five days were used for conducting interviews with the principal, one or more technology coordinators, other administrators relevant to the technology reform program, four to six teachers, several students in these teachers' classrooms, and several parents of these students. In addition, the researchers at each site systematically observed two to four classrooms, and created observation notes. All interviews were recorded and most were videotaped. The classroom observation periods were videotaped with one to three cameras. Researchers also collected relevant site documents.

As soon as the site visit had been completed, the interviews (including the focus group interviews) were transcribed into document files. All interview transcripts and documents were analyzed with a structured coding scheme that was derived from the conceptual framework for the study. This scheme contained seven main coding areas. The first was about the innovation or reform itself and is designed to capture information about the technology-supported school-wide innovation or improvement, the history and scope of the innovation, including its goals and origin, the curricular/subject areas involved and its instructional organization. This allowed us to compare reforms on the basis of their purpose and intent to improve the quality of instruction. A second code area is about the school itself and allowed us to organize information about the site,

including background information on and the demographics of the school and its community. With this code we also tagged pertinent information about the school culture, its leadership, and any external relationships the school established to aid their technology implementation. This group of codes allowed us to capture relevant meso-level information about the school's setting and how together they helped to create a favorable context for the classroom uses of technology.

Another set of codes focused on the technology and the technology support present at the site. These codes supported our analysis of the vision for technology and the specifics of what the site has put into place, how it is kept working, and how teachers are prepared for its use. The next two sets of codes focused on students and teachers and their roles, practices, and outcomes. Together, these codes support the description and analysis of the classroom-based teaching and learning with technology. The final two sets of codes allow us to capture the elements of the site that contribute to the sustainability and transferability of its innovation. We differentiated between elements of the innovation itself, the classroom, school, and district components. These two codes were often used in conjunction with other codes.

Each team of two researchers divided up the interviews to code; codes were assigned to sections of transcripts with the qualitative analysis program NUD*IST NVIVO. This program allows any length of the segment of text to be coded with as many codes as the analyst sees fit to apply. After all coding was complete, the NVIVO program was used to gather all text segments from that site's transcripts into a report for each code. These reports were then analyzed to determine the main points and themes within each code area. These points provided the basis for the findings presented in this paper.

Sample of Schools

Only five of the eleven schools in the study are reported upon in this paper. The data were not fully analyzed in time to include four of the other six schools. One school was not included because its improvement effort was technological in nature, i.e. laptops for all students, and not instructional. The final school was an online school and the fact that it was comprised of teachers from dozens of schools, each of whom was teaching one online course, meant it did not lend itself to the analytic framework undertaken in this paper. Demographic information about the five sites analyzed in this paper is provided in Table 2.

Table 2

Demographic Information for School Sites

School Name	Level	Grades Served	Enroll-ment	Size of Place	Percent Minority	Percent Poverty+
Newsome Park	Elem.	K-5	768	Urban	60%	60%
Canutillo	Elem.	K-6	665	Suburban	95	100
Lemon Grove	Middle	6-8	800	Suburban	65	75
Jennings	Middle	7-8	500	Urban	95	80
New Tech High School	High	11-12	240	Small town	46	-

+Poverty indicator was percent of students eligible for free or reduced cost lunch.

Findings

In nearly all of the schools reported upon here, the innovation was implemented school wide, with a majority of teachers still participating in the innovation one to three years following the time period of the main implementation effort. The exception was Jennings Junior High, where the innovation was targeted at the core subject areas of science, social studies, and English only. In all five schools the innovation combined instructional and technological aspects. (See also Table 3.)

The improvement effort emanated from the school in three of the five schools. The teachers at Jennings Junior High were participating in district-led effort. The improvement effort that Lemon Grove Middle School participated in was also led at the district level; however, we categorize it as a school level effort because the principal actively led the implementation of it in the school, including getting the whole school staff involved in the effort more quickly than the phased-in participation the district had scheduled for them.

Table 3
Summary of Innovative Technology-Supported Reforms

School	Level	Reform/Innovation	Teachers Participating
Newsome Park	Elem.	Project learning using wireless laptops	100%
Velaquez	Elem.	Constructivist model of learning, supported by technology	80%
Lemon Grove	Middle	Thin clients supporting academic performance	100%
Jennings	Middle	Inquiry based, technology-integrated lessons	75%
New Tech	High	Developing in students the necessary knowledge, skills and dispositions for a high-tech world	100%

Learner-centered

All five of these schools' (or in one case the districts') leaders had facilitated their teachers in a process of setting school-wide goals. These focused improvement efforts were either an extension of the school's core mission or were closely tied to student achievement. Because they resonated with the ongoing work of the school staff, or were connected to the very reason the staff had come to the school to begin with, the school-wide goal both by definition and desire became an individual goal for the schools' teachers. As a result, the school set up structures and processes to create environments that would meet the learning needs of both students and teachers.

New Tech High School illustrates an approach to creating a learner-centered environment for its teachers made possible by its small size, with 9 full time teachers. The school improvement effort was to educate students in capabilities most essential to the 21st century, especially problem-solving, project construction, knowledge management, and teamwork. Towards that end, they required their students to successfully complete community service, an internship, four community college courses, as well as the courses at the high school, which used a project-based instructional approach. The interdisciplinary and team-taught classes (American Studies (social science and literature), Scientific Studies (science and math), and Political Studies

(government and economics)) demanded teachers develop new curriculum, rethink their instruction, and design assessments. To meet the teachers' learning needs, the school provided opportunities to take professional development courses off-site, but mostly they turned to one another as the best source of one-on-one help. Within teams, teachers shared the load of creating curricula and organizing class activities. Because the school was small, the entire staff conferred to address the issues that a dramatic restructuring of the curriculum and instructional activities implies.

The Lemon Grove School District took a different approach to meeting teachers' learning needs. Theirs was a district-wide effort to improve teaching and learning utilizing an information infrastructure dominated by thin clients (network PCs lacking local diskette or CD-ROM storage devices) in classrooms. Rather than trying to gain consensus on the one instructional approach to promote throughout the district, the program encouraged and supported all types of pedagogical approaches, including inquiry and project learning, as well as remedial activities and other technology applications that help to improve student achievement. The middle school site's teachers all participated in the 120-hour professional development program, consisting of a two-week, paid summer "camp" and follow-up sessions throughout the school year. The program's design allowed for teachers to choose from offerings, which reflected both more constructivist and more remediation oriented approaches to technology use. Thus, teachers were able to enter into technology use in ways that met their interests and needs. At Lemon Grove Middle School, several processes led to teachers then getting additional help from their peers. First, the teachers attended the professional development sessions in teams, which built up a nearby resource of expertise. Second, the principal made sure there was time on the bi-weekly staff meetings to discuss instruction and technology issues. Through these processes teachers learned about additional sorts of approaches to technology use from their grade-level or subject area peers.

To summarize, when school staff, including teachers, come to consensus about school improvement goals, successful organizations create teacher-centered learning environments that support teachers' implementation of the goals. The organization needs to prioritize resources for teacher learning, and to reduce the competing demands for time and attention that teachers face.

Knowledge-centered

In these five sites the improvement effort was focused on implementing new instruction and assessment methods, with technology as a support to the new methods. In all cases the school staff could describe how the innovation would benefit their students. These instructionally oriented improvements required, by their nature, that teachers develop an understanding of the pedagogy such that they could apply it in their own classroom. The organization's leaders, having provided intellectual leadership towards the improvement or innovation, then helped to put discussion and analysis mechanisms into place so as to support teachers' knowledge construction, specifically the redesign of classroom strategies.

For example, Newsome Park Elementary chose the goal of project-based learning supported by technology and then put into place a professional development program to support teachers' construction of knowledge about it. The school opened in 1995 as a math science and technology magnet school with a handpicked staff who reflected the principal's belief that students construct their own knowledge and come to deep understanding through active experiences. In the years following the school's inception the principal and staff experimented with a variety of innovative instructional movements, including student projects, character education, and service learning. It was through an application for a Comprehensive School

Reform Demonstration grant that the authoring team articulated the goal of implementing a three-part approach to project-based learning and using educational technology as a support for it. The Constructivist Teaching and Coaching (CTAC) school improvement team consisting of 9 teachers representing all grade levels formed to lead the grant activities. Because they felt that this approach required a theoretical understanding and knowledge of how to best implement it they planned a professional development program. This program also provided specific opportunities to learn about technology and set up the expectation that teachers use technology tools to collect evidence of student work using spreadsheets, databases, word processing, multimedia, and communications tools and share them quarterly grade-level instructional meetings. An outside vendor provided 45 hours of customized, hands-on instruction to teaching staff from computer basics, to telecommunications, multimedia, and instructional unit creation. These activities focused the teachers' learning goals on developing the knowledge and skills necessary to apply a specific approach to instruction and assessment, and the mechanisms by which to share what they learned with their peers.

The example of Jennings Junior High illustrates a district led effort to create a knowledge-centered learning environment for teachers. This school district's superintendent set a goal of integrating technology to raise student achievement by using technology to support inquiry-based instruction. The district planned a strategic implementation, inviting the participation of teachers in grades three to six, and in the areas of social studies, science, and English in grades seven to twelve, and adding mathematics at the high school level. Thus the professional development program was established at a district level and created a network of participating teachers from a elementary, junior and senior high schools. At Jennings Junior High all the science and social studies teachers learned an inquiry-based instruction approach and how to integrate Internet resources in support of it. The participating teachers signed up in pairs and attended weekly professional development meetings for the school year prior to receiving a "tech room." The first part of the year emphasized the operation of hardware and software and the latter part emphasized an inquiry-based approach to its integration. Within this course, its leaders asserted that "now that there's a tech room, these things are totally different: You become a facilitator. You're not in charge of the information. They [the students] are in charge and actively involved in finding the information themselves. You're there to facilitate." Teacher pairs applied what they learned by co-developing an inquiry- and standards-based unit that they then shared with their classmates. The following year, when they received their 'advanced technology classroom,' they worked together to implement inquiry-based lessons and attended follow up professional development sessions; the two professional development leaders also stopped by classrooms to lend support and check on teachers' implementation progress.

To summarize, in these examples, as in the other three schools, the organizations contributed to creating knowledge-centered environments by collaboratively setting school-wide instructional goals, which in order to be achieved demanded that teachers understand it well enough to apply it. To support teachers the sites established professional development programs, which provided a structure for developing this deep understanding.

Assessment-centered

The improvement efforts underway all operated within an air of accountability. These six school locations were spread across five different states, each of which had state curriculum standards and standardized tests used to measure students' progress on them. The school sites had to attend to the state tests and were focused on their students scoring well on them. But by

and large, the students' standardized tests were not considered by the teachers to be key feedback on their own success in implementing the innovation. Instead, the discussions and work during the adoption and implementation of the innovation helped them to imagine the additional sorts of student outcomes they wanted to see. Thus being accountable to standards and test served as a means for prompting the staff members to analysis the innovation for its impact on learning. The professional development experiences and other peer to peer collaborations within the school helped to deprivatize teachers' practices and generate feedback on them.

At Canutillo Elementary, the staff felt the pressure to demonstrate that their students mastered the Texas Essential Knowledge and Skills (TEKS) through their strong performances on the Texas Assessment of Academic Skills (TAAS) test. The school's improvement effort was to create constructivist learning environments supported by technology, which they formulated in the spring of 1998 from its involvement with the Southwest Educational Development Laboratory's (SEDL) Technology Assistance Program (TAP) grant. Through participating in TAP, the staff developed an understanding of how to mold the curriculum into thematic units that require hands-on projects. Students' products, which were often technology-based, serves as way to establish what students know and can do. Thus, the accountability context and the professional development program experience led the staff to focus on how students products and projects could demonstrate their mastery of the TEKS. Because the TAP program was designed for whole school participation it fostered an assessment-centered environment for the teachers through structured sharing and observation among teachers at the school, TAP staff members, and teachers at other schools participating in the TAP program. Thus, from the beginning teachers had the understanding that they were obligated to share their efforts and give and receive feedback on them---they even had to sign a letter of intent stating this.

Newsome Park Elementary, due to low scores on the tests related to the Virginia Standards of Learning (SOL), had received a warning from the its State Department of Education. Consequently, the principal, the Constructivist Teaching and Coaching (CTAC) committee, and the teaching staff made it a major priority to align the district's curricular content and requirements and its use of technology to the state's SOLs. The warning provided a test to their commitment to implement project-based learning. After discussion, they firmly resolved themselves to their improvement effort and the CTAC published a written school improvement plan that guided the implementation of project-based learning and articulated how technology could be used to support that approach. The staff decided to implement project-based learning through three distinct phases: planning, fieldwork, and celebration of learning. After each phase, the teachers represent their classes work on a tagboard, which is shared with the rest of the school. In addition, teachers completed a weekly work plan, identifying the SOLs to be addressed and outlining the concepts, skills, questions, and assessment strategies related to the curriculum area. Teachers submitted this information to the principal and shared it during their weekly grade-level meetings.

To summarize, being held to standards of achievement helped these school staff members focus in on what success would look like. However, they defined what teachers should be able to do and what should be seen in students' performance in the context of their larger improvement goals. The professional development programs put into place deprivatized the teachers' instruction, and made getting and receiving feedback an ongoing activity, which helped teachers to learn and adjust their instruction.

Community-centered

The improvement effort underway in these five schools reflected some goal consensus among the school staff members. In each case the principal or district leaders had played a large role in setting the goal but the sites also had systems for involving teachers in the decision making. As a result, the staff had helped to determine the specifics of the improvement, were invested in implementing it, and they had a sense that by working together on it, they would be more successful in achieving it. This shared need to learn helped to create an air of trust and collaboration among staff and to determine parameters for sharing and discussing instruction and student performance.

As mentioned in the previous section, at Lemon Grove Middle School it was a regular occurrence for the teachers to discuss instruction and students performance, both with grade level peers and at school staff meetings. These interactions were facilitated by the fact that there was goal consensus among these peers and that they had established over the years a climate of trust that allowed them to share successes and failures with one another. The principal commented on how teacher collaboration on technology use is a part of the teaching culture, "They share curriculum, things they have developed through the Internet, or web pages they have for their class." He described his role as encouraging its use and pushing people to grow in their use of technology, "My job is to continue to support that and work with the technology and work with teachers in integrating that. And making sure that they understand that it is an expectation from my leadership. That we will all embrace technology and that we will all continue to work with it. Now I will see teachers at different stages of that development. My job is to make sure that they continue to move ahead." Thus, the principal helped the school to set a goal and encouraged the staff to work collaboratively toward it.

The small size of the staff at New Tech High School made collaboration less complicated and was actually required by their team teaching efforts. Yet even here a community-centered environment was consciously established and maintained. The principal of New Tech used the metaphor of a "high tech start-up" to describe the school, indicating that he believes the staff must run the school like a small, cutting edge, start-up company and provide a similar experience for students in their class assignments. The teacher culture at New Tech High reflects that of a small, innovative business that must matrix staff in order to complete complex projects. The director's involvement in leading and supporting innovation at New Tech has been positively received and he appears to be universally admired and respected by staff and students alike. Although he maintains regular contact with teachers, he gives them a great deal of freedom. The teachers took this as a sign of his trust in them, and this helped to establish collaborative norms among them. The principal also described how he has come to realize which personal attributes are essential for staff in this demanding teaching environment, "We've been able to attract people [who are] talented in a variety of ways: risk taking, resilient, creative, innovative, hard working. You know, just futurist types of people." Thus the staff consensus around their instructional goals combined with their problem-solving capacity contributed to productive collaborations among staff members.

In these and the other schools the main shared goal was an instrumental element for establishing a substantive reason for collaboration. The inclinations of the school leaders to be collaborative and their ability to create an atmosphere for staff interaction contributed to a community-centered learning environment for teachers.

Implications

On the basis of recent cognitive research on how people learn and research on how organizations learn, we would expect effective technology-supported instructional improvement efforts within schools to have specific environments conducive to teachers' learning and organizational structures and policies that help to sustain such environments. In fact this is what we found in our five exemplary sites. Thus we have confirmed that the Learning Environment framework can be useful for such analyses. We would also expect that sites with ineffective improvement programs of this type would be less likely to have built these learning environments for their teachers.

These findings are consistent with those of the Teaching Learning and Computing (TLC) 1998 study (Dexter et al, 2002) and other studies with regard to the critical nature of high quality technical and instructional support and leadership. The significance of this consistency is that the TLC findings were based upon large, representative samples of American schools (about 750) and teachers (about 3,500). The relationships were established not by examining elite or special schools but by considering all schools concurrently. Thus, we know that quality support for teachers and strong organizational leadership in the technology arena are critical to the implementation of school and teaching environments where technology was more broadly integrated into the instructional styles of more teachers.

In addition, our case study findings suggest some less predictable conclusions regarding the role of contextual dimensions:

(1) Relatively very high densities of computer units as well as investments in the latest hardware appear unlikely to be essential to the success of effective instructional reform supported by technology. From these case studies we cannot generalize to all types of instructional change that utilize technology, but it appears feasible to experience dramatically successful innovation with even somewhat average amounts of technology, so long as considerable attention is given to the design of learning environments for both students and teachers.

(2) Successful implementation of instructional reform utilizing technology is possible in remarkably diverse communities. While it is true that in selecting the case study sites we specifically tried to find diversity in race/ethnicity and in community income levels, it is noteworthy that we found as many such eligible sites as we did. As shown in Table 2, in four out of five sites, the majority of students came from racial minority families and in addition the majority came from low-income families.

(3) Successful implementation of instructional reform utilizing technology is possible in heterogeneous types of schools. We do not know to what extent this can be generalized, but from these case studies we at least know that effective implementation can be found in high schools as well as elementary schools, in large schools as well as small ones, and in older schools as well as newly opened ones.

An additional result of building effective learning environments for teachers is that they contribute to the sustainability of the innovations by building up knowledge and expertise on school change that is distributed across a large number of staff including teachers. The fewer the people with first hand knowledge and experience in school change, the more the maintenance of the change is vulnerable to turnover or loss of staff. Likewise, the more people involved in the organizational mechanics of change, the easier it can be to marshal support for ongoing refinements to the implemented innovations.

Given the rapid growth in technology and its capabilities for instruction, strategic planning, including regular evaluations and equipment renewal, is essential to long term sustainability of broadly implemented technology-supported instructional innovations. Nevertheless, relatively high levels of investment in technology per student and the acquisition of new grants for technology may not be nearly as essential as the ability to maintain the learning environments set up for helping teachers and students adapt to changes in research-based knowledge about the most effective practices for learning.

Teacher learning is essential to the success of school improvement efforts. Thus, what school leaders can do to establish an environment to help teachers implement new instructional practices involving technology-enhanced activities is critical. Organizational actions, such as policies and staffing, can shape teachers' learning environments. Structural characteristics of organizations, such as hierarchy and communication patterns, may also influence these learning environments. Such factors not only are important to effective implementation of instructional practices appropriating technology, but they are also likely to be essential to sustaining and refining such practices.

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