Professional Development in Technology: Catalyst for School Reform

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This case study of teachers’ professional development in instructional technology explores three assumptions. The first is that teachers are at various levels in their knowledge and use of technology, and that these levels are developmental. Teachers’ levels of knowledge and use are described using a classification of teachers’ developmental levels of knowledge and skill in applying technology in the classroom along a continuum of “nonreadiness,” “survival,” “mastery,” “impact,” and “innovation.” The second assumption is that staff development for instructional technology needs to be based on what are currently construed as “best practices” for teachers’ professional development. Current best practices suggest that while staff development may begin with conventional inservice training, it should move quickly beyond to efforts that support teachers’ development as professionals involved in decision-making, inquiry, and leadership in their classroom teaching. In order to develop as professionals, teachers specifically need help and support in integrating new knowledge and skills into their classroom practice. The case data offer valuable support for theorizing about teachers’ professional development in technology that characterizes the professional literature. The third assumption for this study is that teachers’ professional development in technology may
well serve to further larger goals of school reform. This assumption is addressed in a discussion of what was observed to be the infrastructure that already exists and that is still needed to support teachers’ continuing development in technology at the school studied. Attention must be paid to this infrastructure both to understand and to affect the kind of change necessary for school reform. As technology changes the ways that schools themselves are structured, efforts to meld innovation in instructional technology with best practices in teachers’ professional development catalyzes other elements of school reform.

For over three years the middle school that was the site for this study developed a reputation in the district for doing a good job helping teachers become knowledgeable about technology and how to integrate it into their curriculum. This particular school offers an interesting site for investigation because it is representative of a great many schools in this country in terms of what is available in the way of technology equipment and support for its use, as well as in terms of where teachers are in their knowledge and use of technology (Fabry & Higgs, 1997). Although roughly 90% of the teachers in this particular school have completed district training requirements necessary to receive a personal computer (a “teacher tool,” to use the district language) for their classroom use, the school is hardly on the cutting edge of technology. Computers remain centrally located in “labs,” school-wide access to the Internet and the district network have recently occurred, both software and hardware are at least three to five years behind current technology standards, and most teachers still view technology as adjunct rather than integral to their teaching. Nonetheless, this school is one where attention is being paid to teachers’ professional development in the area of technology, and where there is interest in how that development can best be encouraged and supported.¹

On the basis of this reputation the school was chosen for a case study of how the efforts in staff development in technology were supporting teachers in learning and using technology, and also whether this emphasis on technology was causing changes on a school wide level. The study of this school employed mixed qualitative methods of survey, field observations and interviews to explore teachers’ professional development needs, and how meeting these needs can lead to changes in conventional school structures and practices that reflect current ideas about school reform (Hargreaves, 1994; Jones, Valdez, Nowakowski, & Rasmussen; Means, Blando, Olson, Middleton, Morocco, Remz, & Zorfass). These data
provide information about where teachers are in their knowledge and use of technology, both in terms of their personal levels of learning and skill, and also in terms of their use of technology in their teaching. The data also provide information about the kinds of professional development opportunities that meet teachers’ developmental needs and support them at the various levels of their knowledge and use of instructional technology.2

THREE ASSUMPTIONS

This study of teachers’ professional development in instructional technology is based in three assumptions. The first is that teachers are at various levels in their knowledge and use of technology, and that these levels are developmental. This assumption reflects Madinach and Cline’s (1992) classification of teachers’ developmental levels of knowledge and skill in applying technology in the classroom along a continuum of “survival,” “mastery,” “impact,” and “innovation.” It is also consistent with models of staff development that recognize and support the developmental growth of teachers (Bents & Howey, 1981; Sprinthall & Thies-Sprinthall, 1982), including the now classic Concerns Based Adoption Model (CBAM) (Hall & Loucks, 1978) which identifies teachers’ reactions to any change initiative as occurring at six developmental levels. These models assume that to be successful, staff development must take into account the level of knowledge and commitment that teachers bring to staff development; and address the differing personal learning needs, satisfactions, frustrations, concerns, motivations, and perceptions that teachers have at different stages of their professional development.

The second assumption is that staff development for instructional technology needs to be based on what are currently construed as “best practices” for teachers’ professional development. To date, the primary focus of staff development in technology has been to provide teachers with knowledge and skills about the technology available to them for use in their classrooms (Bozeman, 1995; Knapp, 1996). This focus has led to staff development in technology in the form of traditional inservice sessions that train teachers in specific skills or instructional techniques (Bailey & Lumley, 1997; Glennan & Melmed, 1996; Harris, 1980). However, current best practices suggest that while staff development may begin with such training, it should move quickly beyond to efforts that support teachers’ development as professionals involved in decision-making, inquiry, and leadership in their classroom teaching (Guskey, 1987; Harvey & Purnell, 1995; Lieberman, 1995; Little, 1993). This idea is strongly supported by current scholarship on teachers’ professional development (Lieberman & Miller, 1991;
According to such scholarship, teachers do not get what they need from traditional staff development in the form of inservice sessions that distribute knowledge to teachers in bite-sized pieces (Butler, 1997; Lieberman, 1995). Staff development in technology which, to date, has relied heavily on just such inservice training (Bailey & Lumley, 1997; Glennan & Melmed, 1996), is not meeting teachers’ needs. What teachers really need to develop as professionals is help and support in integrating new knowledge and skills into their classroom practice (Little, 1993; McLaughlin & Oberman, 1996).

The third assumption for this study is that teacher professional development in technology may well serve to further larger goals of school reform. Providing teachers with professional development that addresses their particular needs in terms of their knowledge and use of technology requires support for teachers’ self-directive and collaborative efforts to integrate technology with other elements of their classroom practice (Lieberman, 1994). Such professional development not only allows teachers to learn about technology, it also involves them in decision-making, inquiry, and leadership about how technology can best be used in their instructional practice (Boyd, 1997; Maddin, 1997). Thus, technology changes the ways that schools themselves are structured, and efforts to meld innovation in instructional technology with best practices in teachers’ professional development catalyzes other elements of school reform (Harvey & Purnell, 1995; Means et al., 1993).

The following sections present information from the study about one middle school’s staff development efforts in technology. The first two assumptions are addressed in a discussion of five developmental levels of teachers’ knowledge and use of technology. These levels occur along a continuum from “nonreadiness,” to “survival,” to “mastery,” to “impact,” and “innovation.” This continuum reflects the addition of an initial stage of nonreadiness to the classification by Madinach and Cline (1992) of teachers’ developmental levels in technology according to the other four levels. These case data offer valuable support for the theorizing about teachers’ professional development in technology that characterizes the professional literature.

The third assumption is addressed in a discussion of what was observed to be the infrastructure that already exists and that is still needed to support teachers’ continuing professional development in technology in the school that was studied. Attention must be paid to this infrastructure both to understand and to affect the kind of change necessary for school reform.
DEVELOPMENTAL LEVELS IN TECHNOLOGY

Nonreadiness

A nonreadiness developmental level was included in this study to account for those teachers who are resistant to using computers, and have little if any knowledge of how to use them. Teachers at a nonreadiness level characteristically dismiss the value of technology for their personal or instructional use, and may criticize technology as just another educational “bandwagon” that will soon pass by leaving no lasting impact on teaching and learning. These teachers also exhibit almost phobic fears that if they operate a computer they are likely to damage programs or the machine itself. Furthermore, they often see technology as too difficult and complex to learn, much less incorporate into their teaching.

In the school that is the subject of this study, there were only a few teachers at a nonreadiness level. The fact that there are any is a continual challenge as well as a source of frustration to the principal who minces no words about her goal within the next year of having every teacher complete the 30 hours of staff development training that the district rewards with a “teacher tool” (a personal computer and projection capability). “They’re cheating the kids if they don’t,” say the principals of the fewer than 10 teachers yet to complete the training. Of course, completing the training and having a computer in the classroom does not insure that it will be used.

That there are still a few holdouts among the faculty is supported by the survey data. Responses indicated that only 8 of the 61 teachers completing the survey see little benefit for their own teaching or their students’ learning from technology. Nine teachers question whether technology is just another educational fad, and one teacher is sure that it is. Observations in the five technology lab classrooms in the school also suggest evidence of nonreadiness. While it can be argued that even teachers’ compliance with administrative directives to use these classrooms for instruction in language arts, social studies, math and science is evidence of progress beyond nonreadiness; teachers were observed who completely turned the instruction of their students over to the technology specialists during classes held in the computer lab, despite the explicit policy that teachers co-teach with the technology specialist. One teacher who was observed stood and watched from the back of the room with arms crossed over his chest; another went to great lengths to avoid ever touching a computer. These teachers never responded to questions directly asked of them by students, referring all instructional responsibility to the technology specialist instead.
This portrayal of nonreadiness is consistent with the first level of the CBAM model, “Awareness,” which describes teachers having little interest in involvement with an innovation that they are expected to adopt (Hall & Loucks, 1978). In the case of technology, the situation becomes more complicated because the innovation is not a single skill or practice, but rather a menu from which teachers select those skills and practices that suit the subject matter they teach and their own teaching style. As a result, teachers who may be at higher developmental levels in some areas of technology, may still be at a nonreadiness level in others. Besides which, the rapidity of change in all areas of technology requires a willingness to remain open to learning and using new hardware and software applications. Also, change occurs on any faculty; as new faculty members come into a school, they may be at a nonreadiness level in some or all aspects of technology. Thus it is important not to become complacent about staff development in technology, and assume that nonreadiness is a state that teachers move beyond once and for all in their knowledge and use of technology.

The research indicates that teachers at a nonreadiness level may receive the nudge they need to develop their awareness and knowledge of technology from clearly directive administrative policies and practices. In the school studied, the principal’s unequivocal expectation that all teachers will learn and use technology has, in the three years of her tenure, been accepted by all but a few teachers. More importantly, the principal has responded to the teachers’ excuse that they don’t have time to learn about technology by providing them release time for training. For some teachers, just being exposed to the training was enough to spark their interest and calm their fears about technology. For others, the principal’s own enthusiasm, commitment, and support has been contagious. From information about what teachers at higher developmental levels in their use of technology see as helping them move beyond nonreadiness, formal training showing them how to operate the machines and how to use them in their classrooms is most frequently credited. The value teachers place on what can only be described as traditional inservice training suggests that such training does play an important role in teachers’ development. It is, however, as data about higher developmental levels will show, a supporting rather than a starring role.

Survival Level

At the next developmental level of “survival,” teachers are focused on their own personal learning and use of technology. Teachers at this level
tend to be preoccupied with their own learning about technology and how
they themselves can use it. These teachers may have acquired proficiency in
one or more particular computer applications, such as word processing or
PowerPoint presentations, but they have not yet developed either sufficient
skill or confidence to look beyond technology as a thing in itself, to see it as
a tool that can be used to further their curricular goals. So, rather than dis-
cuss their teaching in terms, for example, of students’ learning writing skills
and how technology is used to support such learning, these teachers speak
of “word processing lessons” or “PowerPoint lessons.” They see technolo-
gy as the primary structure rather than the supporting foundation.

Because their own knowledge and skill in technology is limited, these
teachers can quickly run into problems they are incapable of solving on
their own. In one survival level teacher’s class, for example, a student
changed the commands for his keyboard so no letters would appear. The
teacher became quite flustered and irritated, saying, “I don’t know what you
did” and “I don’t know how to fix that...Don’t touch it!” She sent for the
computer specialist who was working with another class, and would not al-
low the student to use another computer until the specialist arrived. Instead
she made the student hand write the poetry he was composing for the les-
son. Not only does this incident illustrate a limited understanding of tech-
nology per se, it also illustrates a lack of understanding of how technology
enhances instructional content. In this case, the teacher missed the point that
word processing encourages the poetry composition process by giving stu-
dents the freedom to manipulate word choice and order.

This example also points to survival level teachers’ need for support as
they use technology in their classrooms. The co-teaching model is no doubt
the ideal support for survival level teachers in that it offers immediate and
continuous assistance. Planning and teaching with a more experienced co-
teacher also provides a survival level teacher with models of good use of in-
structional technology (Browne & Ritchie, 1991), and forestalls some of the
technical problems that an inexperienced user of technology may encoun-
ter. Although co-teaching does occur in the school, with few exceptions, the
two technology specialists are the only co-teachers. While for many
schools, it would seem a luxury to have two skilled teachers to assist with
instructional technology, even two isn’t enough when substantial numbers
of teachers are at a survival level. This conclusion is borne out by the sur-
vey responses of nearly half of the teachers who indicated feeling pressured
to use technology without sufficient support.

While somewhat less than the ideal for co-teaching, the designation of
two faculty members as full-time technology specialists does provide survival
level teachers with a ready, if not always present, source of support. In the school that was studied, the two full-time technology specialist positions were created by distributing the students who would have been assigned to these teachers—one a science teacher, the other a social studies teacher—to the other teachers in those subject areas. The trade off is worth it to the faculty, because, of course, it leaves the specialists free to work with teachers throughout the school day. The two technology specialists are physically located in a complex of five adjoining computer laboratory classrooms, and are never more than a classroom away from a teacher who needs assistance. For survival level teachers, this close proximity to the specialists is particularly reassuring, and in this school teachers have come to count on personal support from the specialists who are available to them as they learn new things about technology and as they use it in new ways in their teaching.

This study suggests that teachers who are at a survival level need opportunities to build their personal knowledge and use of technology. The more occasions teachers have to practice their technology skills, the more comfortable and confident they become, and the better they are at recognizing the possibilities of particular applications for instructional use. The data indicate that teachers find formal inservice sessions devoted to hands-on practice a particularly good way to meet their survival level needs. Teachers especially appreciate such inservice sessions being held in their own school, either as brief mini-lessons during the regular school day or on scheduled inservice days. While the primary purpose of such sessions is to bring the teachers together with a facilitator who assists and coaches them as they practice particular applications in a safe and controlled context, the sessions are also an excellent opportunity to help teachers move beyond a narrow focus on their personal use of technology by introducing ideas and examples of how particular technology applications can be used in classrooms.

This study also suggests that another way to meet teachers’ survival level needs is to allay their fears of technology by making help readily available. The teachers who were studied received such help not only as responses to the specific issues and problems encountered as they learned and practiced technology applications, but also as direct assistance in their classrooms from the technology specialists as the teachers began to use technology as an element of their instruction. Providing such personal assistance to teachers’ addresses what Joyce and Showers (1983) years ago described as the “problem of transfer” and the development of “executive control” by which teachers become competent to adapt new instructional strategies to their own teaching situations. Recognizing and providing teachers with such individualized assistance even at this early stage of their
knowledge and skill development already moves professional development beyond inservice training.

**Mastery Level**

At the mastery level it becomes clear that teachers’ knowledge and use of technology does not develop consistently in all areas. Because a teacher competently uses one technology application does not necessarily mean that she has similar competence with other applications.

Not surprisingly, the teachers in this study most frequently demonstrated competence with those applications that were most useful in their content area. Thus, language arts teachers were likely to be most personally proficient in the use of word processing and to incorporate it into their instruction, similarly for science and social studies teachers with database applications, and math teachers with spreadsheets. The diversity that becomes obvious as teachers develop mastery in their use of technology also captures something of the heterogeneous, and non-linear nature of technology itself. This recognition that teachers’ growing knowledge and use of technology increases diversity not only across content areas, but also among individual teachers, offers further support to what this study indicated to be an escalating need for differentiating professional development opportunities according to teachers’ needs and interests (Glickman, Gordon, & Ross-Gordon, 1995), a need that is in direct proportion with their expanding knowledge and use of technology.

In addition to the diversity that characterizes mastery level knowledge and use of technology, the teachers in this study provide evidence that mastery is a somewhat illusive concept in terms of technology. Because teachers have achieved “mastery” in their own ability to understand and use particular applications does not mean they have achieved mastery in their instructional use of that application. In other words, teachers’ understanding and use of technology as an element of instruction often remains fairly unsophisticated. For example, while teachers’ personal mastery makes them capable to plan lessons that integrate technology with learning objectives, the instructional activities they plan usually involve the whole class doing the same thing, and using only a single software application. Such lessons make only minimal use of technology’s instructional potential.

Observation of teachers at a mastery level did show them to be adept in their use of a lexicon of computer terminology in their directions to the class and in their responses to individual students’ questions. However, the
fact that such technical direction is often the only talking these teachers do
during lessons involving technology, suggests that they are still seeing tech-
nology as the main instructional focus—as end rather than means. This in-
fERENCE IS SUPPORTED BY OTHER OBSERVATION EVIDENCE THAT REVEALS TEACHERS AT
this level are inclined to turn students loose with a particular lesson using a
computer application, and then either retreat to their own work or—some-
WHAT BETTER—ONLY RESPOND INDIVIDUALLY TO STUDENTS’ TECHNICAL QUESTIONS.
There is a sense of technology isolating students in these classrooms.

Observations of teachers for this study, as well as their survey respons-
es, serve to point out what it is that teachers at a mastery level need to sup-
port their professional development in technology. Survey data indicate that
these teachers again desire training, but at this level they recognize that
such training must include personal assistance from resource people as well
as formal training. This recognition by the teachers that formal inservice
training alone is not enough for them to learn how to use technology for in-
structional purposes is corroborated by other information from the survey
data that inservice training on particular applications does not translate into
teachers using those application in their classrooms. The most striking ex-
ample of this lack of transfer is that, despite efforts on the part of the prin-
cipal and technology specialists to train teachers how to create and use Pow-
erPoint multi-media presentations, a third of the teachers report that they
don’t use *PowerPoint*, and another third indicate that they are only survival
level users.

These findings suggest that peer coaching (Alfonso & Goldsberry,
1982; Joyce & Showers 1982; Costa & Garmston, 1994)—particularly in
the form of what Garmston (1987) calls “technical coaching” which is used
to transfer training to classroom practices—is an excellent way for teachers
at a mastery level to continue to develop in their knowledge and use of
technology, particularly in their use of technology in their classrooms. Un-
fortunately, peer coaching is not available to teachers in the school studied.
The absence of technical peer coaching not only stretches the two technolo-
gy specialists thin, it also is a missed opportunity for teachers to engage in
the kind of collaborative interactions that characterize schools that are most
receptive and responsive to innovation (Little, 1982). Involving teachers
who have reached a mastery level in peer coaching not only provides them
with support in planning for the use of instructional technology and feed-
back from classroom observations, it also creates a new context for learning
technology’s use in classrooms.

An interesting gap in teachers’ knowledge that showed up in the survey
data could be related to the absence of peer coaching as a component of
professional development for teachers in the school under study. Many teachers (38) indicated that they are unaware of infrastructure issues such as scheduling and technical maintenance that support instructional technology. Their being unaware of such issues suggests that teachers may be too passive in their efforts to integrate technology into their instruction. While their attitudes that such issues are no problem for them might also be interpreted as speaking well for the current state of technology management in the school, problems are apt to arise quickly as teachers’ knowledge and use outstrip the limits of the present infrastructure. Here again, having peer coaching in place could help teachers anticipate as well as solve the problems that present themselves as new technology—such as the recent acquisition of school-wide Internet access—is introduced and new instructional uses for technology are devised.

**Impact Level**

Teachers at an impact level are working on integrating technology into their curriculum and their teaching. They are able to recognize that technology is best used as an instructional tool rather than a separate instructional component. They are, however, still experimenting with how best to use that tool in their own practice. Nonetheless, it is quite apparent that these teachers have shifted in their focus from attention to their own personal use of technology to attention to its instructional use. According to the evidence in this study, it is not until teachers have achieved mastery in their personal use of technology that they are ready to attend fully to how technology can be the used in the classroom. The significance of this shift from personal to instructional use in terms of teachers’ professional development is that they have now moved beyond the somewhat isolating solipsism and preoccupation with technology for its own sake that characterize earlier developmental levels. Teachers can now consider the effects of technology on the curriculum, the school, and most immediately, on their students’ learning.

Both the survey and observation data provide evidence of this shift to the instructional use of technology among roughly one-quarter of the faculty who, according to the survey data, are at an impact level. The principal and technology specialists indicate that—with few exceptions—teachers have only achieved this level within the past year to eighteen months. Teachers at an impact level not only reported being familiar with several technology applications in their classrooms, they also indicated that they require students to use one or more of these applications weekly, or sometimes
even daily. Furthermore, they indicated that they are focusing on the particular learning needs they see in their students as they attempt to use available technology in new ways to modify instruction. Impact level teachers are also concerned about how technology can be used to support and enhance students’ learning of content in their particular subject area.

Observation data showed the classrooms of impact level teachers to be more varied in terms of instructional delivery methods and student grouping strategies. There was also evidence that these teachers use electronic sources and computer tools to design projects for students that require use of higher level thinking skills. The competence of these teachers to use technology to support instruction and learning means that they require little assistance from the technology specialists in planning instruction or in trouble shooting. They do, however, appear to be challenged to develop sophisticated management strategies for monitoring students’ work and for responding to the questions students raise as they work at computer terminals individually or in small groups. In one class, for instance, students worked independently on various phases of a science project from color coded assignment sheets. The teacher would stamp these colored pages when the student showed her the database screen developed for the assignment sheet of that particular color. Although this teacher was obviously familiar with the application, with students’ needs, with requirements of the assignment, and with what to expect to see displayed on students’ monitors at any point in the lesson, she still had difficulty responding to all of the students who raised their hands to ask questions during the lesson.

Both the interest that impact level teachers have in meeting students’ learning needs and the challenges that they face in their classrooms as they attempt to use technology to meet these needs, suggest that professional development for impact level teachers must focus on this interest. To do so means that professional development for these teachers can best occur in the process of planning, implementing, and studying their actual classroom practice—in other words, by being reflective practitioners (Schon, 1983). Further evidence from the survey data points to how to accomplish this goal. The teachers report that they are eager for and receptive to opportunities to discuss and work collaboratively with colleagues in order to create, modify, and improve their instructional use of technology. In the school under study, teachers have experienced working with the technology specialists, and have found it helpful to have these more experienced colleagues to guide their learning and use of technology. But at impact level, teachers report that they think they can best continue to learn how to use technology by working closely with a partner. While they may still look to the technology
specialists for the kind of mentoring needed to learn new skills, they want a peer to share their excitement about the potential of instructional technology, and to talk about and share classroom experiences. These characteristics lend themselves well to more teacher directed forms of peer coaching, namely “collegial coaching” which is used to refine teaching practices, and “challenge coaching” which is used to solve persistent problems (Garmston, 1987). The characteristics of impact level teachers also point to collaborative action research (Sagor, 1997) as a structure to support their professional development. As these teachers have opportunities to engage in action research and to systematically evaluate the content and the effectiveness of their instructional use of technology, they can continue to grow in their knowledge and use of technology.

A major concern of teachers at an impact level, however, is that they don’t have enough time to manage the change process of integrating technology into their teaching. The issue of time is probably of particular importance to teachers in this study because they are also responding to a directive to provide evidence that they are integrating new, state mandated curriculum standards (Texas Essential Knowledge and Skills, or “TEKS”) into their teaching. Here again, the opportunity to work with a partner to plan and integrate technology into instruction is a way to help teachers use time effectively. Time spent observing in classrooms in order to gain new ideas for using instructional technology, and leaderless discussions to share ideas and experiences are also valuable for impact level teachers. These nondirective activities offer appropriate staff development alternatives to time spent in formal inservice sessions (Glickman, et al., 1995).

Innovation Level

With the notable exceptions of the two technology specialists who are officially classified as teachers, other teachers in the school that was studied have not yet reached the level of innovation. This fact became clear as proposed survey items were discussed with the technology specialists and the principal. In fact, these discussions recast the understanding of what the innovation level involves, at least in the context of this particular school. Originally, innovation had been thought of in terms of teachers’ using a variety of applications in their teaching, of being able to integrate the teaching of complex applications with subject area content, and of maximizing the potential for student learning through discovery (Seymour, 1999). The thinking was that at the innovation level teachers would also be aware that
different technology applications as well as different ways of using these applications reflect particular conceptual orientations to teaching and learning. Furthermore, it was thought that to realize the potential of technology in their teaching, these teachers would have substantially changed the way they teach and relate to the students. Until teachers recognize and understand that such changes are an inevitable part of instructional technology they will not reach a level of innovation. The survey data indicated that teachers do not perceive technology to have influenced them to change their teaching. While teachers in the case study school are very proud of what they have accomplished with new technologies, they don’t see themselves as having changed significantly in their teaching.

What became evident was that, while the innovation level certainly requires teachers to change their instructional practice, innovation actually has more to do with teachers being sophisticated in the use of technology for their own research, planning, and management, and in working collaboratively with other educators to plan for and use instructional technology. In fact, activities such as these bring about change in teaching practices, but, more importantly, they will move teachers beyond the walls of the classroom in both their professional knowledge and their use of technology. Innovation level teachers will use technology to gain access to and have a voice in a larger professional community of discourse. Recognizing this element of innovation, led to the conclusion that innovation is not yet present among the teachers in the school studied. This conclusion was reinforced by the review of survey items with the principal and technology specialists who said, for example, that teachers were still a year or two away from being able to use technology to track students’ grades, attendance, and assignments. It was also learned that because software decisions are made top-down at the district level, that teachers do not have an opportunity to review and evaluate new programs for adoption. Nor can they select software for such activities as drill and practice, tutorials, or simulations to help students meet specific learning objectives because district level curriculum coordinators have reservations about such uses of technology. This district level control of technology limits teachers to authority only within the confines of their own classrooms, and prevents them from participating in technology at a truly professional level of decision-making where decisions would extend beyond their own personal practice and have an impact on school-wide, district, and even state and national policy and practice.

For teachers to attain a level of innovation it is necessary for them to have opportunities to work with other impact and innovation level teachers to develop curriculum integrating technology applications into the content
areas. While teachers in the school that was studied do work together informally to develop curriculum, such work remains largely unrecognized and, for the most part, is not shared beyond the group in which it takes place. Similarly, innovation level teachers can benefit from opportunities to participate in formal studies of the impact of technology on student learning, either as part of their own professional education or in conjunction with professional or academic researchers. Such formal structures for curriculum development and research allow innovation level teachers to gain visibility for their expertise, and provide them with opportunities to share their knowledge about instructional technology with colleagues. As such, they represent the form of professional development that supports an innovation level of development in teachers’ knowledge and use of technology.

There is one obvious example of such structures that already exists in the school that was studied. It is the role of the technology specialists. The two teachers in these positions report that they have grown in their knowledge and use of technology by virtue of the demands placed on them in their positions as specialists, and from observation data they do appear to have reached a level of innovation. For other teachers to reach this same level of innovation, both the school and the district must accept responsibility for developing the formal structures that will encourage and support an innovation level of instructional technology.

**INFRASTRUCTURE**

The third assumption for this study—that professional development in technology may serve to further larger goals of school reform—can be addressed in a discussion of what was observed to be the infrastructure that already exists and that is still needed to support teachers’ continuing professional development in technology. It is important that attention be paid to this infrastructure to understand and affect the kind of changes that support both teachers’ continuing development and school reform. Studies of educational innovation support this view that a critical variable in the reform process is teacher learning which must be sustained by school structures that support school improvement (Fullan, 1990; Nunnery, 1998). Data from this study suggest that while teachers are progressing through levels of professional development, it is also necessary to consider the kinds of district and school structures—in other words, the infrastructure—that can encourage and support collaboration, inquiry and innovation as teachers move to higher levels in their instructional use of technology.
The school in this study is at a pivotal point in use of technology as a catalyst for school reform. The principal recognizes and advocates for the teachers at the campus and district levels in pushing for continual infrastructure changes that support reform. She understands Cuban’s (1990) assertion: “The assumption that teachers can create and maintain the conditions that make school living and school learning stimulating for children, without the same conditions for teachers, has no warrant in the history of humankind.” Though technology in and of itself creates new and stimulating learning environments for teachers and students, without the necessary supporting infrastructure to support teachers’ knowledge and instructional use of that technology, it will be difficult if not impossible for technology to realize its potential as a catalyst for school reform.

District Support Structures

The district has provided a set of structures that reflect a commitment to technology. Organizationally, the district created a department of technology, which reports to both the instruction and administrative divisions. To the extent that the department is service oriented, providing not only the master plan for wiring, purchases, and installation of hardware, but curricular and staff development support for teachers, it provides an infrastructure that contributes to teachers’ professional development. Support for campus personnel, for example, include: a “Help Desk,” district technical support personnel who make regular rounds to schools to repair and maintain the equipment, and a faculty member from each campus who is appointed as the local technical support person, and who also serves on the district-wide technology committee.

The majority of the district’s resources in the area of technology, however, have been allocated to expanding hardware and maintaining equipment on every campus, sometimes at the expense of teachers’ professional development and assistance (Glennan & Melmed, 1996; Nunnery, 1998; Pink, 1990). What is known, is that in the end for technology to succeed, as much time and money must be invested in teachers as is invested in the actual hardware and software (Hodas, 1993). Interestingly, the principal in the school studied has found a way to maximize their allocated computer hardware resources by having centrally located computer labs, which not only allow for a sufficient mass of computers and space so that content area teachers could have single classes or interdisciplinary classes, but also makes the technology specialists readily available for support. It is no wonder,
though, that the district has trouble investing in teachers’ use of technology when just keeping up with the continual upgrading and maintenance of the computer labs is expensive, limited and slow, at best.

The district has, nonetheless, made a commendable effort to distribute hardware to teachers for completing 30 hours of technology training. As incentive, and to give teachers the opportunity to practice the skills they have learned in the training sessions, they are eligible for a “teacher tool” on a temporary basis after completing 15 of the 30 hours of training. While this process supports professional development of teachers, the reality is that there are not enough “teaching tools” available for the teachers when they have completed the training. Moreover, the district has no plan for replacing or upgrading teaching tools that were given to teachers two years ago. A district level administrator offered the following excuse: “Even if we were able to buy enough teaching tools, the computer companies are not prepared to supply that many at one time.” There seems to be no solution, so teachers continue to “…receive less technical support than does any other group of professionals. Computers occupy desktops of most professionals in the United States, but not in classrooms: there, computers are often used exclusively by students” (Hodas, 1993).

Perhaps, however, the major challenge the district faces in terms of its responsibility to provide and maintain an infrastructure for teachers’ use of technology is how to equitably distribute equipment and programs to campuses. While equity is commendable and certainly must be considered, current procedures intended to ensure that all campuses are treated equally are hampering the change process on individual campuses. The school in this study, for instance, has had problems with the implementation of Internet access. Roughly one-fourth of the teachers in the school understood how the Internet could enhance their instructional capability, yet they were forced to wait four months beyond the originally scheduled date for Internet access, because all of the schools in the district had not yet been wired. No school was given access until all the schools were ready to go online. This kind of uniformity in the name of equity creates an infrastructure that impedes rather than promotes the kind of differentiated teacher professional development discussed previously (Fryatt, 1995).

While the district’s efforts to support the infrastructure of instructional technology have not always been an unqualified success in terms of teacher development, they are moving in the right direction in terms of providing equipment and maintenance. Recently, the district campaigned relentlessly for the passage of a bond issue, which included a sizable amount of money to equip new schools with technology. The plan for the use of these funds is
now coming to fruition, as the district committee creates an action plan for their expenditure. Thus, changes in the technical side of technology move forward, although the district continues to supply only minimal support for teachers’ efforts to integrate technology into their teaching. The promise of change from technology continues, in this district as in so many others, to be far greater than the actual effects of such change (Nunnery, 1998).

**Curriculum**

An ideal example of the kind of infrastructure support that curriculum can offer is provided by the curriculum defined by the Cognition and Technology Group at Vanderbilt (1994). This curriculum emphasizes technology used for active, problem-focused teaching and learning; integration of subject areas; and varying instructional strategies depending on student needs; while at the same time giving attention to the development of key concepts and skills. This curriculum is consistent with national technology curriculum and instruction standards that describe using technology as a tool (National Education Summit Policy Statement, 1996), and also with references to technology in the national curriculum standards developed for various academic content areas.

Unfortunately, new statewide curriculum guidelines developed for Texas public schools (TEKS) only suggest that “...districts have the flexibility of offering technology applications (computer literacy) in a variety of settings, including a specific class or integrated into other subject areas” (TEKS, Texas Educational Code, Chapter 126). The guidelines do not present a strong case for curriculum change that supports technology integration. The case for technology integration is further weakened by the emphasis in Texas on the statewide mandated assessment instrument (Texas Assessment of Academic Skills, or “TAAS”), which operates as the defacto curriculum in most districts. In this district as in others in Texas, the energy that would go into the infrastructure to support the integration of technology into the curriculum has been diverted to focus on aligning the TEKS curriculum guidelines with the TAAS test. Teachers have been directed by district administrators to use staff development time to revise and develop their curriculum to accomplish this alignment, but have been given no time to integrate technology. Perhaps, once the push to implement TEKS is past, then the campus can return to focus on technology curriculum and instructional changes. However, the teachers will need considerable support to view the development of technology instruction and curriculum as different from the TEKS/TAAS alignment.
In addition, teachers need a shared discourse about using technology as a tool for instruction and curriculum. Developing that discourse requires time for teachers to think about and talk about and experiment in their teaching with technology as a tool. However, the attitude among district administrators is that training in technology applications is sufficient for teachers to be able to integrate technology. One example of this attitude is a comment a staff development trainer made after an e-mail use training session: “Next, teachers will have to integrate technology into their instruction,” as if being trained in a single application prepared teachers to accomplish global technology integration.

Finally, an ideal integrated technology curriculum is not part of the infrastructure at the school in this study because the campus still lacks full autonomy for teacher empowerment. Already mentioned, for example, is that teachers have no decision-making role in the selection of software applications. It would seem that on the one hand the district has so finely tuned the centralized structure, that the opportunity for teachers to meet and collaborate about teaching and instruction as it relates to technology is lost. Unfortunately, teachers miss out on the kind of collaborative environment that would provide them with the opportunity to develop a common language with which to engage in a professional conversation about practice (Hargreaves, 1994).

Campus Leadership

Leadership at the campus level is necessary to broker and negotiate for the kind of infrastructure that supports teachers’ learning and use of technology (Conyers, Kappel, & Rooney, 1999; Pink, 1990; Sparks & Loucks-Horsley, 1990). Such leadership includes the empowerment of teachers, the development of a collaborative vision, and the management of a technology plan. The principal in the school that was studied offers a fine example of this kind of campus leadership. She has demonstrated her strong commitment to the technology changes at the school. She is known in the district as one who will make changes to implement technology, and will win the support of teachers to do so. The principal’s strategy for integrating technology has included a series of what she refers to as grade level “summits”—day-long, released-time meetings that allow teachers time to plan the campus changes necessary for technology integration. These conferences have been successful in empowering teachers to make decisions. For instance, it was the teachers’ decision to implement a scheduling shift that allows the
two faculty members to be full-time campus technology specialists. The teachers in the building demonstrated their agreement with the vision and shared purpose (Fullan, 1990) of technology by agreeing to have more students in their classes, as a trade off for the availability of support from these specialists.

The principal also provides continuing support for teachers’ efforts to learn and use technology. She is tireless in her championing of instructional technology as the future for learning; and she, along with the two technology specialists, remain open to the challenges of managing a campus infrastructure that supports teachers’ professional development in instructional technology. The next step for technology as a catalyst for change in the school is the revision and articulation of a full-scale technology plan. Such a plan—created, developed and monitored by the teachers on the campus—would give ongoing clarity, relevance, and practicality to changes as they occur in the building (Nunnery, 1998; Conyers, et al., 1999).

SUMMARY

The bottom line of this study is to affirm that the human element in school reform cannot be overemphasized. District and campus administrators, and teachers themselves must recognize that as Scheingold (1990) has aptly put it: “...the challenge of integrating technology into schools and classrooms is much more human than it is technological...it is not fundamentally about helping people to operate machines. Rather it is about helping people, primarily teachers, integrate these technologies into their teaching as tools of a profession that is being redefined through the incorporation process.” It is a point worth remembering if teachers’ continuing professional development in technology is to be supported.

References


Texas Education Code Chapter 126: Texas essential knowledge and skills for technology applications. Subchapter B: Middle school. §126.11: Implementation of Texas essential knowledge and skills for technology applications: Middle school.

**Notes**

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