Rethinking the Technology Integration Challenge: Cases from Three Urban Elementary Schools

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Abstract

Case studies of three urban elementary schools were conducted to document the integration of technology given identical resources from a local university's PT³ grant. Data sources for this qualitative study included participant observers' field notes and journal entries, school personnel interviews, timeline and chronicle of technology-related priorities and events, and children's and teachers' technology artifacts. Cases were summarized with respect to prior technology context, agents of growth and development, and changes and future directions. The analysis identified three scaffolds that appear to have a significant influence on—and redefine the challenge of—technology integration: alignment with the curriculum/mission, teacher leadership, and public/private roles for technology recognition. (Keywords: technology, technology integration, urban education, case study, elementary, qualitative.)

During the 1990s, schools began spending more money on technology than capital goods (Trilling & Hood, 1999). The rapid growth in the types of available technological tools, paired with the decline in the price of these resources, captivated schools and parents alike, who wanted to prepare their children for a society where learning and employment were increasingly dependent on digital access and expertise. Prior to the 1990s, many schools had computers, perhaps one or two per classroom, but the flood of technology acquisition in the 1990s created a different context and opportunity for learning. Computers, the Internet, and software became increasingly available to more and more students.

The task for schools became that of determining how technology and curriculum would operate to strengthen student learning. Companies offering games, educational software, networking equipment, accessories and the like sprang up overnight, offering a multitude of options from which to choose for teachers and administrators. Acquisition, however, was not the end of the road. Teachers, administrators, and researchers alike were coupling their excitement concerning the possibilities and potential power of technology with the underlying question of whether technology was truly needed or beneficial. Studies began to be conducted that examined the effectiveness of technology use in various contexts. Teachers and schools adhering to constructivist orientations seemed to reap the benefits of technology quickly. For example, Wenglinsky (1998), in a large-scale study, found that students who used computers in constructivist ways to learn mathematics (e.g., using simulations and spreadsheets) scored

significantly higher on math achievement assessments than students whose only exposure was to computer-based drill-and-practice programs. These simulations and spreadsheets enabled students to relate information to real life and solve problems logically.

Despite studies documenting the effectiveness of technology to support student learning, barriers to technology integration have been identified. For example, the issue of preparedness of teachers to respond to the influx of technology resources, and of schools to keep up with the mechanical functioning and maintenance of equipment, was one major barrier. Further, many teachers had not been prepared to utilize technology in their teacher preparation programs. The U.S. Office of Technology Assessment (1995) found that schools devoted no more than 15% of their technology budgets to professional development. More recently, Carvin (2000) suggested that professional development should be closer to 30%, but unfortunately was as low as 3% in some districts. Without time and monetary resources devoted to increasing staff expertise in technology use, effective integration was a struggle. Still, optimism regarding the power of technology remained.

Barriers to technology integration have been identified that span practical issues of time for professional development (Jones, 1998), lack of systemic planning (Cradler, n.d.), and lack of support for networks and hardware at individual school sites (Fulton & Sibley, 2003). However, although much of what is written regarding technology integration focuses on barriers to its use, others have theorized conditions under which integration might best occur (Chang et al., 1998; Gooler, Kautzer, & Knuth, 2000; Wested, 2002; White, Ringstad, & Kelly, 2002), namely, providing ample professional development for teachers, making certain that technology supports the curriculum, and providing a solid infrastructure to support the technology itself. Still other researchers have examined particular technologies with students in specific content areas, measuring the effect of technology on achievement (Butzin, 2000; Zhang, 2000; Doty, Popplewell, & Byers, 2001).

So although instructional technology has been a routine part of the educational landscape for several decades, the integration of technology in classrooms still lags behind expectations for its use (Cuban, 2001; Jones, 1998; Rogers, 2000), and especially for traditionally underserved populations (Solomon, Allen, & Resta, 2003). For example, in 1999, in schools where the free lunch rate was 70% or higher, only 39% of classrooms had Internet access, while schools where free lunch was less than 11% reported that 74% of classrooms had Internet access (Solomon et al., 2003). Even though Hativa (1988), in a meta-analysis of the use of computer-based drill-and-practice in arithmetic, determined that it was widening the gap between high and low achieving students, teachers continue to use technology as a drill-and-practice remediation tool, particularly with students of color. Similarly, researchers have noted that teachers in poorer schools utilize technology to reinforce basic skills, rather than to support higher-order thinking (CEO Forum, 2001).

Fewer research studies, however, have paid close attention to contextual variables and factors that might impact the nature and degree of technology inte-

gration in schools, particularly urban schools. One longitudinal research effort examining systemic reform in Union City, New Jersey determined that in the absence of school reform, technology would not have a sustained positive effect on learning (Honey, Culp, & Carrigg, 2000). In particular, they found that variables such as instructional leadership, extensive professional development, a whole-language approach to learning, establishment of libraries, de-emphasis on remediation, and emphasis on fostering student creativity were necessary to maximize the effect of technology on student learning.

The purpose of this study was to describe the ways in which three urban elementary schools, in partnership with a local, publicly funded multipurpose university, used a similar array of material and human resources to improve their integration of technology. This paper is framed from the perspective of how new technology resources are absorbed into an existing, normative ecosystem, namely, the school culture (Bronfenbrenner, 1994; Sarason, 1982) in each of these buildings. Our interest in framing the study from this perspective was to capture the different aspects of these three school cultures that might contribute to increases in the use of technology. We were interested in how these differences inform our understanding of what it means to prepare schools, administrators, and teachers to use instructional technology effectively. In particular, the following research questions guided the study:

> How do schools use fiscal and human resources to support technology use?
> How does the existing culture or ecosystem of the school impact technology integration?
> What factors mediate decisions regarding technology integration in schools?

The three sites in the study represent an interesting array of urban schools. One is a multi-site year-round neighborhood school with roughly 700 students, 85% of whom are African-American and 83% of whom qualify for free or reduced lunch. Their students with disabilities are integrated into general education settings. The second is a school whose 650 students are largely African-American (72%). Two-thirds of the student body qualifies for free or reduced lunch. The school has adopted a social justice orientation to its curriculum. And the third is a 350-student, multi-age classroom school committed to discovery project-based learning that began as a single early childhood site. Its students with disabilities, comprising 20% of the school population, are included in general education settings. As with the other schools, most of its students are African-American (80%) and most qualify for free or reduced lunch (80%). All three sites were either already, or were in the process of becoming, K–8 schools.

Using qualitative methods of research, we conducted a case study of technology integration at each school to describe each local school context and document in detail how each school used the technology resources made available to it through its partnership with the local university. This technology-focused partnership was funded through the U.S. Department of Education's PT^3 initiative.

We were principally interested in documenting changes that occurred during the three-year period of the effort, from 1999–2002. At the start of the project, each of the three participating schools had low levels of technology integration.

The significance of this study lies in its ability to provide detailed descriptions of local urban school contexts where technology integration is occurring in the context of an active partnership between the university and the schools as part of a larger community-wide P–16 effort. Further, it provides not only individual cases, but a cross-case analysis that addresses how schools might more effectively plan for the introduction and integration of technology. It is especially important because of the continued digital divide and the need to ensure that children in urban schools are prepared to draw on technology as a regular, transparent part not only of their education, but of their future work. Although the literature has documented difficulties with technology integration, prior studies often focus on surveys of technology use by individual teachers or groups of teachers rather than a cultural view of technology integration in the school ecosystem. Finally, few studies focus on technology integration in the context of urban school partnerships.

CONTEXT

The context for this study was a mid-sized urban school district in the Midwest. The partnership between the three schools and the university involved in this study is part of a larger community-wide partnership to improve urban education under the auspices of an active local P–16 council whose members are committed to sharing the work of achieving student success. The three schools that were selected had a history of partnerships with the university.

For each of three years of the federal PT^3 grant, these three partner schools were provided with $32,000 each to support hiring a half-time technology specialist at their school. One morning per week of consultative support from a university-employed instructional technology specialist who coordinated the federal grant further supported the schools as they implemented new instructional technology activities. In addition, the three technology support specialists hired at the schools with project funds networked on a monthly basis under the leadership and guidance of the university technology grant coordinator. At the same time that these technology initiatives were taking place in these three partner schools—also as part of the same PT^3 grant—the university's preservice programs were undergoing significant redesign to improve technology preparation for their teacher candidates. Several preservice students were regularly placed in the three project partner schools for early field experiences as well as for student teaching.

Although throughout this project each of the three partner schools was provided with the same technology resources, each utilized those resources in very different ways. Prior to the project, all three principals had prioritized the acquisition of computer equipment for their teachers and students, resulting in an average of five computers per classroom as well as a computer lab. None of the schools, however, was wired for Internet access beyond a single connection in the building. At the outset of the project, survey data indicated that although

teachers reported a high belief in the value of technology integration, they acknowledged that their belief was inconsistent with their practice, and that they were not using technology often or well. Computer use ranged from free choice periods to transferring students' "sloppy copies" to word-processed essays and reports. The modal use, however, was for skill-and-drill or free-time activities, rather than computer use directly connected to or integrated with the curriculum and classroom instruction. Also, prior to receiving funds through the federal grant, none of the three schools had a full-time instructional technology support person.

In addition, shortly after the PT³ grant had begun, one of the project directors wrote grants to support three additional technology projects, one in each of these buildings, funded through a state-level competition that focused on technology in P–16 partnerships. Working directly with the technology specialists, the schools identified projects they valued that were specifically connected to the relationship between technology and learning to be funded by these supplemental grants.

The budgeting process in the district in which these schools were located was decentralized for the purchase of hardware, software, and local network support. The district housed a centralized technology division that brought an Internet connection into each building and that provided various centralized professional development opportunities. The plan for wiring the buildings began with high schools, then middle schools, and then the elementary schools. At the start of this project the wave of wiring was just beginning to reach the elementary schools. School-wide Internet use was dependent on building-based administrator decisions regarding local hardware and networking capacity. On a district-wide basis, although every employee was eligible for an e-mail account, the use of e-mail was not well established in most buildings, and it was difficult for teachers to meet district criteria for its use. Communication between the centralized district resources and schools was dependent on the initiative of the local school principal, and individual teacher priorities and decision making.

METHOD AND DATA SOURCES

Qualitative research methods were used to examine how a common set of technology support resources made available through the grant were used at three different urban elementary schools within one urban school district. Multiple sources of data were gathered across the three years of the project to support the three case studies, including: (1) field notes and logs from participant observers, (2) interviews with school personnel, (3) timeline and chronicle of technology-related priorities and events, and (4) a compilation of technology artifacts produced by the children and teachers. Each of these data sources was used to validate and crosscheck findings within and across the three schools.

Field notes and logs reflecting observations in classrooms, staff development activities, discussions with principals and teachers, and meetings and school events were compiled by two individuals who were participant observers: the grant coordinator and one of the grant's principal investigators. These individuals were involved in providing staff development and also providing ongoing

support to the grant-funded technology coordinators in each building. The grant coordinator was the key participant observer at one of the schools; the principal investigator was the key participant observer at another school, and they shared the participant observer role at the third school. Situations they observed included classrooms, technology laboratories, staff development/retreats, and monthly collaboration meetings with the technology coordinators from each school. Additionally, participant observers had ongoing, regular interactions during the three years with the building principals and at least weekly meetings with the technology coordinators.

Interviews with key school personnel, both during and at the conclusion of the project, were conducted and then transcribed for analysis. Interviews conducted during the course of the project were informal, unstructured interviews (Merriam, 1998); formal semi-structured interviews were conducted at the close of the project, in the beginning of the year that followed the project's conclusion. Interviewees included the building principals, technology coordinators (two per building as each school had a change in this position during the course of the project), one classroom teacher nominated by project staff as a technology-using teacher, and one classroom teacher nominated by project staff as a technology-novice teacher. In all, a total of 15 formal, semi-structured interviews were conducted. A common interview schedule was used for all those interviewed, with additional questions for building principals and classroom teachers. The interview schedule for the formal interviews appears in the Appendix (page 311). These interviews were conducted either by one of the grant's principal investigators, the grant coordinator, or two graduate students who were trained for this role. Graduate students working with the grant transcribed all interviews to convert them to text for analysis.

For each school, a timeline summarizing school-wide technology goals and their implementation was developed, as well as a chronology of other technology-related events to clarify within and cross-school efforts. Initial drafts of these documents were developed by the grant coordinator and one of the principal investigators and then reviewed by both principal investigators. Finally, a list of technology artifacts such as iMovies, slideshows, computerized drawings, and written work were compiled by the grant coordinator to provide an understanding of student outcomes related to the project's technology efforts.

Data were then assembled by school. Each piece of data, which existed primarily as written text, was read and analyzed by one of the principal investigators. Interviews were read and coded first, then field notes, followed by the timeline and compilation of artifacts. Preliminary drafts of the three cases were prepared by the principal investigators as a departure point for discussing within-case themes. All discussions included the two principal investigators and the project coordinator. As tentative themes surfaced from the data, each theme was discussed, sources of evidence were located within the data to support the proposed theme, and alternate explanations were proposed and discussed to determine whether the theme held up across the various data sources available to support the thematic analyses. In particular, during the analysis stage the authors actively sought out negative cases and nonconfirming evidence to

challenge the interpretations being posed and to suggest alternative explanations. Once consensus was reached for each case, the next draft of the case was prepared. Based on readings and rereadings of the second draft of each case, the cross-case analysis was conducted. To develop the cross-case analysis, prominent issues in each individual case were discussed and noted. Then, each issue was discussed in depth to determine whether or not the particular issue held up and/or was represented over the three cases. Through this analysis, a finite set of themes was developed that characterized all three cases. Again, the researchers actively challenged each theme to determine whether evidence existed to support it; themes were discarded until the final set of themes was determined.

RESULTS: THE CASE STUDIES

Each of the three case studies begins with a brief description of the school, followed by the technology context that existed prior to the inception of the grant. We then describe agents of technology growth and development that occurred during the project period. Each case concludes with a discussion of changes and future directions for the school. Following the individual cases, we offer a cross-case analysis. In order to protect the identity of the schools, pseudonyms replace the actual school names.

Case 1: Rosa Parks Elementary

The first school was Rosa Parks Elementary School. Approximately 80% of its 350 students qualified for free or reduced lunch at the time of the study, and approximately 70% of the students were bussed in from other neighborhoods in the city. The school is diverse, inclusive, project oriented, and family focused. Although most of its students are African-American (80%), 5% are Hmong, and the remaining 15% are Caucasian, with a very small number of Native American students. Additionally, Rosa Parks provides an inclusive education for the 20% of its population who qualify for special education services. These children's disabilities include emotional disturbance, cognitive disability, learning disability, attention deficit hyperactivity disorder, and other health impairments such as cerebral palsy. The school is committed to strengthening its ties to key major figures within the urban community. The school's philosophy of constructivist education and project-based learning is emphasized with the goal of empowering its children through applied learning about themselves, their community, and the world.

Technology context prior to the project. When the project began, the single technology lab at Rosa Parks had older Macintosh computers. The library and the lab also housed a few newer models. There were older black-and-white laser printers and a server, primarily for the skill-and-drill program that the computer lab was designed to support. Although there was a wiring closet in the school, nothing had been connected or set up at the start of the project. A new server had been delivered, but with no assistance from the district as to how to set it up. Wiring had been started at the school during a changeover in contractors the district hired. As a result, the school had been left in the middle of the wiring job and had been placed at the bottom of the list for wiring for two reasons:

first, it was an elementary school and not a top priority, and second, on paper it was already listed as having been wired. In addition to the computers, the school had purchased digital cameras for the teachers that required a connection to the computer to view, edit, or print images. The school also had a standing technology committee prior to the start of the project.

Teachers used the computer class/lab as a drop-off point; it was treated as a "special" parallel to music or physical education, and teachers were not expected to remain in the lab with their students. The lab teacher supervised the students' use of a required skill-and-drill program. Students worked at their own pace, and the results of their work were recorded in a central database from which teachers could print progress reports at a later time. The office at Rosa Parks housed a variety of Macintosh and Windows machines. The principal and one of the secretaries each used newer Macintosh computers. The rest of the administrative staff used Windows-based machines.

Agents of technology growth and development. This school chose to use its project funds to support teachers who were already employed by the school. A teacher with an interest in technology became the official technology specialist, shifting from her role as a part-time physical education teacher and part-time technology support person. She took on the primary responsibility of supporting the network and maintaining the working condition of the technology resources in the school. An instructional technology consultant to the school, funded through a prior early childhood technology grant, continued her services. The presence of these two individuals enabled a complementary sharing of technology support. One person focused on the mechanical and system-wide use of technology while the other person worked with teachers to assist with integrating technology into the curriculum.

The PT^3 grant coordinator provided support in a number of ways. Because of his previous experience as a network manager, he worked with the technology specialist to ensure that the network and computers were working, that software was installed properly and legally, and consulted with her regarding software purchases. He also worked with the instructional technology specialist to develop ideas for sound, high-quality technology projects at the school, as well as to provide staff development so the teachers felt capable of using technology effectively.

The grant coordinator met weekly with the technology staff to develop new projects, plan and provide staff development with input from the technology specialist, and support the growing use of technology in the school. Staff development was offered prior to the start of the school day and on weekends. Before-school staff development opportunities were often attended not only by teachers but also by students. Staff development and technology projects were always considered within the context of current themes and projects at the school. Topics included, for example: HyperStudio, KidPix, iMovie, digital imaging, and how to integrate iMovie and HyperStudio. In effect, the coordinator served as a facilitator while the school technology staff served as support and change agents. The coordinator was welcomed as a part of the school community, was visible to teachers and staff, and was invited to school events, including an annual two-day retreat.

The principal at Rosa Parks welcomed the opportunity to continue to support the integration of technology into the school through this grant. She empowered the two technology specialists whose work was supported by the grant to take a joint leadership role in the school for technology. To extend the grant's reach, she utilized the permanent school budget to purchase new hardware and software for the school, including new Macintosh computers for the computer lab. With the additional state-sponsored grant funds mentioned earlier, four digital cameras, two digital video cameras, and a scanner were purchased to support technology use at the school. She also understood that staff development time was required in order for teachers to learn how to use technology and worked with the technology specialists to make this time available. She noted, "We have been able ourselves to purchase a number of new machines, the hardware, so we've really taken on the responsibility of the hardware for the program. The grant afforded us the opportunity to understand how to use it better." As agendas for staff development got squeezed, the time originally set for technology was sometimes reduced in these formal staff development workshops/activities.

The principal described technology as a tool to help teachers integrate the curriculum, which is foundational to the school's philosophy. She believed that it was important that teachers have newer and better equipped computers; digital cameras and iMovie were also now available for teachers to use as they chose interdisciplinary projects for their students that incorporated some aspect of technology use.

The principal also supported opportunities for students' uses of technology to be shared on a school-wide basis. She used public opportunities that already existed within the school's culture for technology to be featured—for example, at regularly scheduled school-wide gatherings whose purpose was to celebrate various strides the school and its students were making. This gave technology a visible platform in the school across all grade levels, and alongside the technology specialists, the principal became a "cheerleader" for technology. These public occasions also provided an opportunity for students who had become heavily involved with technology and who had joined the school's new Technology Club to display their accomplishments.

The role of teachers was defined generally by the expectation the principal set that each teacher would use technology to have students support their required interdisciplinary projects. The specific relationship of technology to particular aspects of the curriculum, however, was not identified from the top down. It was up to the teachers themselves to figure out the most appropriate ways to integrate technology. To the extent that a high value was placed on project-based learning, technology was aligned with the curriculum for this requirement. There was no discussion about the specific ways technology could actually be used to advance student learning in particular content areas of the curriculum.

In other words, it was up to the individual teacher to determine how far he or she wished to go with technology use within the general parameter of the school-wide commitment to project-based learning. Teachers could get involved to a greater or lesser extent depending on their personal interest and motiva-

tion, as long as technology use showed up in their projects. This might range from a simple use of technology for typing a written assignment to a complex use such as the development of a PowerPoint presentation on a famous leader in the Civil Rights movement with an iMovie embedded in the presentation. The technology specialists and grant coordinator provided ongoing opportunities for teachers to develop their skills in a variety of works, painting, and graphic organizer software packages. For example, one high-technology-use teacher created a movie of a field trip.

On a school-wide basis, students played a major role in technology use. An active Technology Club was formed that was empowered to document various events of importance to the school and the community. These activities included, for example, filming an urban technology exposition featuring work from all three partner schools and filming a bird count at a local urban nature center. Also, as noted above, consistent with the culture of the school, technology was given the same berth on the school's regular public celebration as other issues and developments considered to be of school-wide importance. Students were empowered to share the fruits of their technology labor at these events; this public sharing also served to make sure that teachers and other students became familiar with the students who were knowledgeable about technology. They could then draw on these students as resources to further support technology use.

Changes and future directions. Describing the effect of this project, the principal noted, "In the beginning our computers collected dust. Our partnership allowed us an opportunity, afforded us an opportunity to begin some real staff development...and because now teachers are able to access it more readily, and have a better understanding of how to use it, it is being used more often." One of the technology specialists stated a similar sentiment: "Getting to use the computer was more or less the goal [rather] than learning something on the computer. So the whole focus of the use of the computer has changed. It's now become a tool for learning rather than a Game Boy. And we've pulled a lot of programs off of our computers after analyzing whether they were really meeting the curriculum goals of the school."

In other words, the school leadership—both from the perspective of the administration and of technology teacher leaders—noted and were encouraged by the increased use of technology. With the end of the project in sight, however, the motivation for the staff to go on growing with regard to technology use seems to have waned. Although hard money from the school budget was used to bolster and update hardware, insufficient funding was available in the face of serious budget cuts to provide support teachers needed to move ahead with technology integration.

One of the former technology specialists did note that the school was moving to online performance assessments in certain content areas. However, in the absence of targeted funds for staff development and for funding an individual for network support, she doubted whether any other new technology projects could be launched. The principal believes that budgetary constraints hamper setting long-term technology goals. Her hope in terms of extending staff development is that enough "staff who really want to be pioneers" will be hired into

the school to keep pushing technology use forward. Internal leadership among teachers, based on a "star teacher" technology model, then, is her best hope for an ongoing commitment to integrating technology.

Case 2: Central Elementary

The second site was Central Elementary School, whose 650 students also reside in the largely poor urban center of a Midwestern city. Approximately 80% of the students are bussed from other neighborhoods to this school, with 68% of the student population qualifying for free or reduced lunch. At Central, literacy is a school-wide priority. Seventy-two percent of the students are African-American, 16% are Caucasian, and the remainder are Native American, Asian, or Hispanic. The curriculum focus of the school is social justice.

Prior technology context. At the start of the project, Central Elementary had older Macintosh equipment and inkjet printers. Computers were grouped into small local networks to maximize the few printers. The lab, located just off of the library, had the most up-to-date computers, which were Macintoshes. Every class had scheduled time in the lab for about 45 minutes per week, but this period functioned as a "special" and teachers were not expected to stay in the lab with their students. A technology committee was in existence prior to the start of the project.

The equipment and programs were very old; teachers reported this made using them difficult for other than an "extra" activity. Software that was available was mostly of the skill-and-drill variety and also included several games. The school had the beginnings of a wiring closet. The frame for the server and routers were there, but the final wiring to a fast connection to the district network had not been established.

Agents of technology growth and development. Several years prior to the funding of the PT³ grant, the school had employed a technology specialist. That individual departed two years prior to the PT³ grant and was not replaced. The principal used her PT³ funds to hire a knowledgeable person to serve as a full-time technology specialist. He installed and maintained a network server, warehoused ancient or broken equipment, made sure software licenses were up to date, and removed programs that he believed had no educational benefit. He worked with teachers to increase their technology skills as well. The third year of the grant brought a new technology specialist to the school. This individual spent a significant amount of time maintaining the network and technology, as well as trying to provide instructional support for the teachers and students.

Each school determined how they utilized the grant coordinator's services. In the case of this school, the PT³ coordinator worked with the technology specialist in a much more behind-the-scenes fashion. He communicated regularly with the technology specialist through face-to-face meetings or e-mail. He was not called upon to help teachers develop projects, provide staff development, or to have a visible presence in the building. During the third year, the new technology specialist chose not to make use of the grant coordinator, but he did attend monthly meetings led by the grant coordinator along with the specialists from the other partner schools.

Central's principal served as a facilitator and guide for her teachers and staff and relied on the expertise of the technology specialist and her classroom teachers to guide her in decision making. The technology specialist was encouraged to develop both short- and long-term plans for technology acquisition and use. The principal supported his decisions to shift the lab from a special class to a place in which students could work on an as-needed basis. As a result, the lab was used more often—and more effectively—by those who wanted to integrate technology into their curriculum. When the principal at Central talked about technology, she did so in the context of the curriculum goals of the school. In this way, she did not treat technology as a separate, fragmented activity in the school. She seemed to believe that technology had the potential to improve instruction.

The commitment to curriculum was evident in how new initiatives were supported. Central's principal encouraged her teaching and support staff to propose new projects and acquisitions. Her criterion for responding to these requests was the degree to which they made sense given the school's philosophy, curriculum focus on social justice, and academic needs of the students. For example, when the technology specialist proposed securing interactive white boards, wireless laptop carts, and wiring the upper grades classrooms, the initiative was funded. The principal understood that wireless Internet access and portable computers could strengthen students' research and composition skills and enable them to access content relevant to social justice themes.

In another example, as kindergarten, first, and second grade teachers worked with university professors to write a supplemental grant to bring wireless laptop computers into balanced literacy instruction, the principal not only supported the project philosophically, but also committed matching funds for a portion of the project and reserved staff development days so that the teachers could become familiar with the new technology and how it could best be integrated into their literacy instruction. If grant funds were not available, she paid for the technology specialist to attend these meetings so that he could absorb supporting the maintenance and use of the equipment into his duties.

Despite the leadership of the principal, teachers at Central varied in their technology interest, use, and expertise. Available technology resources were public knowledge in the school. Technology growth took place from the classroom level up, based on teachers' individual decisions to integrate technology. The teachers used technology in ways and at times that seemed sensible to them given their instructional goals and technology knowledge. If technology was perceived by them to increase the power of their instruction, they used it; if it did not, they chose not to use it. Teachers were not required to use technology for any predetermined length of time or manner, nor were they expected to document or publicly display their students' progress in this area. Each grade level seemed to have at least one strong technology-using teacher. Other teachers sought out these grade level experts for ideas on how to use technology with their students.

Students used technology to support their learning in a variety of ways. Although for some students technology was more often a replacement for paper and pencil work or a reward, for others, it was a tool for pursuing questions,

learning content at a deeper level, and sharing what was learned. By the time the grant ended, more students at all grade levels in the school were using technology to support their learning of content and were demonstrating the ability to use all of the technologies available to them.

Changes and future directions. At the start of the project, teachers reported that technology was viewed as an add-on. It was used to reward students, to keep them busy, and to teach basic computing skills. As time passed and personnel and hardware resources were committed, more teachers began integrating technology into their curriculum. Evidence can be seen in video productions created by upper grades students, the study of African-American poets by second graders with disabilities, lost pet books developed by first graders; and research on Mother Jones conducted and disseminated by second graders. Technology-based activities supported content. Some teachers used technology to supplant usual instruction, others used it to augment or follow up instruction. Technology shifted from being used three to four students at a time to being used in whole group instruction as well as small group, paired, and independent use. At this school, technology became a tool for collaborative learning, a tool made increasingly available through lab and wireless resources.

At Central, the principal relied on the expertise of the technology coordinator to provide the knowledge and skills to make widespread technology use possible. Working with two different technology coordinators during the span of this project, the principal trusted their judgment. As a result, she supported the first technology coordinator in bringing network capacity to the school as a means of getting the Internet into the hands of the students well before district had scheduled it. She took her direction from her technology-savvy staff as they made recommendations for purchases of hardware and software. Her criterion for responding to these requests was the degree to which they made sense given the school's philosophy, curriculum focus on social justice, and academic needs of the students.

Case 3: Michigan Street Elementary

The third school was Michigan Street Elementary School, which enrolls approximately 700 students, of whom 88% are African-American, 8% are Caucasian, and 4% are Southeast Asian. Approximately 83% of its children qualify for free or reduced lunch. Only about 9% of the students at this school are bussed in from other neighborhoods; it is therefore essentially a neighborhood school. Michigan Street has a philosophy of integration of students with disabilities and houses a high population of students with autism.

Prior technology context. At the start of the project, Michigan Street had a computer lab with approximately 30 basic Windows machines. The lab was used as a drop off point and teachers were not required to stay with their students during the time they were in the computer lab. During these periods, the lab teacher, previously an early childhood teacher, supervised the students' use of a skill and activities program. The students worked at their own pace and the results were recorded in a central database that teachers could print out at a later time. Much of the software consisted of single use licenses. The principal con-

nected to the Internet through her own service provider using a phone line and a Macintosh laptop. No standing technology committee existed at Michigan Street prior to the project.

In general, the classrooms themselves housed older Macintoshes. Each teacher in the building had a Windows machine at his or her desk that was wired to a television monitor suspended from the wall. The platform of this computer, as well as the software, was inconsistent with the student-used computers. Software spanned skill-and-drill, works programs, and paint programs. Students were allowed to use computers as a reward in learning centers, or for typing up their writing. In other words, computers were not integrated into classroom instruction, but rather functioned as an add-on activity. One classroom, however, was equipped with newer Macintosh computers. In that classroom, each student had his or her own station. There was no server connecting them, although a server had been purchased to do so. The teacher in the classroom was attempting to integrate technology into the curriculum using word processing and HyperStudio. Classroom printers were largely inkjet, but the computer lab had a color laser printer and a black and white laser printer, as well as a printer that would enable teachers to print posters and banners.

In addition to the computers, the school had a range of other technology equipment such as a cart with portable word processors, video equipment, and a digital camera. Teachers were not made aware of this equipment and as a result it was rarely used during the time of the PT³ grant.

Agents of technology growth and development. During the course of the grant, the school purchased newer Windows machines for the computer lab, keeping the Macintoshes in the classroom. Technology staff worked to develop a database of technology hardware and software throughout the school. A server was purchased and connected so that the classroom computers were connected to one another. The lab computers were connected to a separate server. As a result, work that students began in the lab could not easily be finished in the classroom and vice versa.

As a result of PT³ grant funds, a teacher was shifted from the classroom to the role of technology specialist. This teacher had an interest in technology and was viewed as a leader by her principal but was by no means an expert regarding hardware and software and had no knowledge of networks. In addition to her role as a technology specialist, which she assumed as half of her job, she also worked to write grants and secure funds for additional projects at the school. The degree of her communication/collaboration with the computer lab instructor was somewhat low.

The grant coordinator met with this individual on a nearly weekly basis, either at the university or at the school to discuss hardware and curricular issues. There was no clear focus or direction to these discussions. Ideas were discussed about workshop topics for teachers or how to make the server work. The grant coordinator provided five staff development workshops on: video editing, databases, web design, and how to use the electronic report cards that were developed as part of the grant. These workshops, with the exception of the electronic report cards, were not directly connected to any curricular goal.

During the third year of the grant, a new technology specialist was named. Also a former classroom teacher at this school, also assigned to this role half-time, this individual sought the support of the grant coordinator on a regular basis to support the teachers' administrative needs. The technology specialist had a basic knowledge of how technology might support instruction but had a narrow range of expertise regarding software and hardware. She was very eager to learn, however, and spent a considerable amount of time broadening her knowledge base. Although the bulk of the work focused on developing online report cards for teachers, occasional workshops demonstrating software use were held as well.

The principal at Michigan Street viewed her role as developing teacher leaders. She supported teachers' staff development through their attendance at local and national conferences. Michigan Street's principal trusted that her teachers knew what they needed to develop as professionals and what their students needed to grow academically. She encouraged her teachers to conceptualize innovative projects and seek funds to support their implementation. In other words, she put great faith in her staff's ability to follow through on whatever she and/or they committed to and intervened only when problems were brought to her attention. With regard to technology, the principal was interested in acquiring media and materials she thought would benefit her teachers and students. The teachers were to make a choice whether to learn about and take advantage of the resources. No common mission or thread connected these initiatives, however, and once monies were obtained, there was inconsistent administrative support to ensure that projects were carried out as they were intended.

In response to receiving grant funds from the PT^3 grant, the principal placed one of her teachers in the role of school-based technology specialist. A computer lab instructor was already in place. The grant-funded position was to serve as a conduit between the university and school. The person was to learn about technology, collaborate with the other technology partner schools, conceptualize projects for the school that might support technology integration, and so on. In other words, this person was to become a technology leader.

The teachers at Michigan Street were committed to their students. They consciously worked towards inclusion of all their students and celebration of individual differences. Much of the staff was also involved in one of the many after-school programs offered for the students at the school. Regarding technology, each teacher had several computers in the classroom and access to the school's technology lab. Teachers differed in their use of technology. Technology was viewed by the principal as a valued tool teachers were to utilize as they deemed appropriate. Although most teachers utilized low-end technology such as tape recorders or VCRs and some of the teachers supported the high-end technology needed by the students with special needs such as augmentative communication devices, for most teachers computer technology was not integrated into their curriculum.

Many of the teachers reported feeling uncertain, however, about how to use technology effectively and felt their own skills were weak. For example, in the after-school program developed to focus on students learning to use computer-

based graphic organizers to support their writing, some teachers checked out laptop computers loaded with the educational software so they could become more familiar with the technology. Other teachers abandoned the technology component of the after-school program and used paper-based organizers.

The students at Michigan Street were exposed to a wide array of learning and personal growth experiences. During the school day they learned about basic content but also engaged in thematic learning such as their annual World Fest projects. After school they could take advantage of several programs, from athletic teams to literacy/writing groups to camp. Essentially, they were provided with a fertile landscape upon which to grow. Students approached these opportunities in a cafeteria fashion, taking what they liked and leaving the rest. With regard to technology, they appeared to enjoy using technology such as computers and digital cameras. These resources were utilized sporadically as the teachers made them available.

Changes and future directions. At the outset of the grant, teachers' views of technology at Michigan Street were consistent with the view of the teachers at the other schools regarding its role and use. It appeared that the principal saw technology as a way to level the playing field for her largely poor urban students. Her goal was to provide them with exposure to technology tools to close the digital divide. Students used technology as a free choice item, to write final composition drafts, and to learn basic skills. Teachers reported that they believed in the notion of technology integration but admittedly were not practicing it. The inconsistencies in availability, connectivity, and compatibility of technology throughout the school made it challenging to use technology across multiple learning environments.

During the course of the grant, technology was addressed on a range of fronts, primarily at the administrative and system level. The first point of business was to get servers working properly so that teachers could communicate with one another and have a secure place to store files. The second activity of the grant involved creating online report cards. At the end of the grant, the school was connected to the Internet at the classroom level and teachers began thinking more about how to integrate technology into their instruction. In response to this interest, workshops on digital video production, graphic organizers, and other software programs were provided by the grant coordinator.

More efforts were made to try to link what was happening in the computer lab to what was happening in the classrooms, and vice versa. The lab at Michigan Street shifted from a place for special instruction to a place where teachers could take their students to work on classroom-related projects. In the classroom, upper grade students created book reports with multimedia software, e-mailed children in a foreign country and used graphic organizers to support their writing. Younger students used phonemic awareness skill-and-drill programs to support their reading while teachers worked with small reading groups. Once the school became wired at the classroom level for Internet use, children began to use online reference sources as well. These were decontextualized projects however, not aligned with curriculum. The enduring focus of technology reform at this school was electronic report cards.

SCAFFOLDING TECHNOLOGY INTEGRATION

One of the most commonly held beliefs about implementing technology across a school is that the commitment and leadership of the principal is essential to reaching this goal. These three cases portray three principals who were all committed to implementing technology and who voiced their commitment in terms of support for the project itself and for their technology-savvy teachers. The three principals also made time for university-based project staff, were respectful of project staff and, although to different degrees, welcomed them into their buildings. Technology was viewed positively at all three sites. Professional development for technology was definitely "on the radar screen" in each building, with resources that were augmented through the auxiliary grants funded for each school through the state university grant program.

In addition, all three principals used funds from their regular school budgets to purchase hardware and software, as well as to make decisions regarding funding technology support personnel beyond the small contributions made through the PT^3 grant. By most measures, these actions by the schools' three leaders suggest that leadership was in place in every site. Follow-up interviews with each principal also attested to their valuing of technology and their contributions to enhancing the technology environment in their particular building.

However, despite the general valuing of technology, as well as the local investment in technology resources, each school had very different results. In this analysis, we suggest that beyond a generalized support for and investment in technology, both in terms of hardware and professional development, other considerations appear important to technology integration and use, and serve in a sense as scaffolds in this regard. The analysis of qualitative data from these three sites suggests three scaffolds that support technology integration. They are: (1) alignment with the school's curriculum/mission, (2) teacher leadership, and (3) public/private roles for technology recognition.

Alignment with the Curriculum/Mission of the School

In each of the three schools, the principals viewed the relationship between technology and the curriculum/mission in three very different ways. The degree to which this *alignment* was recognized and embraced by the school leader resulted in different technology implementation trajectories.

At Rosa Parks, technology was connected to the broad mission of project-based learning. When teachers were able to begin using technology for student presentations, they were using it to meet the school's mission of project-based learning. Further, the public displays of technology skill and activity that were initiated through this project were consistent with the family/community orientation of the school. The specific relationship between technology and particular content areas was not well articulated, however. In fact, the goal for the students was to use technology to demonstrate learning rather than enhance learning. Although some teachers noticed that learning was deepened through the use of technology, these were individual rather than school-wide insights. The principal at Rosa Parks talked about technology in relationship to curriculum as a general concept, but did not discuss the specific connection between technology

and content areas. Although technology was aligned with the general school mission, it did not appear to be well aligned with the curriculum itself.

At Central, the principal talked about technology as a means of moving the students ahead in the curriculum. She discussed technology and literacy, technology and writing, and technology and student research. She seemed to view technology as a means of improving instruction and, in the long run, as a means of improving student achievement. The alignment with the school's social justice mission was not discussed, but the alignment with day-to-day instruction was articulated well. Although individual teachers could determine the degree to which they used technology, there was an expectation from the principal that its use should serve the curriculum goals of the school.

At Michigan Street, technology was not discussed in relationship to a specific direction of the curriculum or the school. Rather, it was viewed as another new project that was not necessarily connected to other initiatives at the school. Although very supportive of the project, the principal did not discuss technology specifically in relationship to its potential in any given curriculum area. Student achievement was conceptualized more in terms of test scores than in terms of curriculum goals. Although individual teachers used technology—and if they were particularly interested they were recognized by the principal for doing so—the primary, lasting use was in the administrative work of creating electronic report cards. Staff development to provide technology expertise included specific software that featured graphic organizers; the potential for its use, however, was not discussed from an administrative level. The alignment between technology and the curriculum was loosely coupled.

These differences appear to indicate that the question of alignment is a critical one for the implementation of technology. Whether it is seen as central to the work of teaching relies on the degree to which the principal and the teachers recognize and affirm the alignment. From the outset the discussion of technology integration must first be a discussion of the curriculum—and the leadership role has to be curriculum-based. The initial discussion of technology makes sense only insofar as it is directly related to the curriculum and is not focused on the acquisition of technology resources—either hardware or software.

In other words, the real leadership act regarding technology may be to *resist* the temptation to acquire hardware and software decontextualized from a specific curricular goal and instead to commit to limited purchases and to doing a few things well with technology as a first step. For technology to have an enduring effect, principals themselves have to take an active role in defining and communicating a *sensible* role for technology integration. For example, it might be prudent to limit the scope of software acquisition to a few packages that enable high levels of student communication (e.g., painting, works, and graphic organizers) as a specific starting point. A school could, for example, purchase three good software programs to begin with, and ensure that teachers master those as they relate directly to the curriculum—and look toward increased student learning as a result. This is not meant to suggest that teachers who see themselves as "techies" are held back, but rather that teachers who might otherwise be reticent might be willing to learn to do a few things well technologically and be rein-

forced by results related to student learning. Principals themselves do not at first need to be technology experts, but they do need to understand the alignment issues and the importance of the curriculum connection. A commitment to the curriculum is one critical scaffold for integrating technology.

At the same time, because they are responsible for the fiscal well being of the school, principals also need to be concerned with the practical aspects of supporting hardware, networks, and so on, both from a human and fiscal resource basis—even if initial technology resources are limited purposefully. They also need to be prepared to expand technology resources on a regular basis as teachers practice how technology specifically enhances the curriculum and begin to see its uses and use it effectively.

These alignment issues had different implications at the three schools. The principal at Central used the grant as a catalyst to embed technology more permanently as a means of advancing the curriculum goals of the school. The principal at Rosa Parks realized the potential of technology in a more general way; in her school, technology leadership was not permanently planned for although new hardware and software had been purchased and there were high hopes for its use. At Michigan Street, a systematic understanding of the potential of technology vis-a-vis the curriculum was not in place; rather, the enduring effect was the administrative decision to create electronic report cards.

Teacher Leadership

The leadership function of principals, however, can only go so far. A second scaffold we believe may hold importance across these case studies is *teacher leadership*. The principal at Rosa Parks talked eloquently about the role of teacher leadership in the future of the school. In the face of budget cuts, she chose to discontinue a dedicated technology specialist. Instead, she discussed the importance of hiring staff members who were technology savvy as a means to moving the school ahead.

During the course of the project, the leadership for technology resided in the staff that was made available during the project, including the project coordinator, who was a major player in technology at the school. The visibility of technology was brokered by the grant staff much more than it was by permanent staff at Rosa Parks. All teachers at the school were mandated to use technology in their students' project-based work; it was a top-down imperative but ample support was provided for teachers to acquire the skills to produce the ends the principal desired. Teachers at the school responded to and participated in technology workshops but did not determine independently how they wished to use it. The principal trusted the teachers to learn how to use the technology, but she prescribed the conditions under which it had to be used. She empowered the technology project staff and held a very high degree of respect for their expertise, but their charge was directly related to the goal of public presentations associated with project-based learning.

A different situation existed at Central, where the teachers could approach either the technology specialist or the principal with an idea about technology—and were encouraged to do so. If they could justify their idea in relation

to the curriculum and student learning, the principal was prepared to give it serious consideration and respond positively and from a permanent funding and staffing perspective. In other words, once teachers understood the potential of technology and got more involved in using it, they had an avenue for pursuing it and could expect that such use would likely be supported. Further, the principal at Central deferred to the expertise of the technology specialist, but sought justification for suggestions that were made. This put the responsibility on the teachers for creating the pathways for technology and arguing for the resources to support it. At Rosa Parks, that avenue was effectively closed off once the project ended and there was no internal leadership for technology. Therefore, the future of technology seemed to lie in the chance hiring of staff who were technology savvy.

At Michigan Street, the decision to get involved with technology remained with individual teachers. They could choose whether to participate in workshops and whether to use technology heavily. A similar situation existed at Central, but at Central the principal talked about technology use in relationship to the curriculum and saw it as a potential source of instruction across the staff. She created a context in which technology became an integral part of the school's culture. At Michigan Street, teachers who used technology might be rewarded by having the principal arrange for them to attend a technology conference and feature the school publicly. Although there was a fair amount of technology activity during the grant, technology seemed to remain an add-on, except in the case of electronic report cards, which persisted after the grant ended. Teacher leadership was anticipated while the grant resources were available, but occurred on an individual basis. When the grant was able to provide the resources, technology was a high priority. With the end of the grant, the potential was recognized but supporting it was not viewed as a priority.

The teacher leadership scaffold is an important consideration for several reasons. First, it is unlikely that principals themselves will possess the technology expertise required to move a school ahead. Therefore, principals must often look to teacher leaders to inform and guide technology integration. Next, the relationship between classroom teachers who use technology well and the school itself is an important aspect of teacher leadership; in other words, how does the expertise of classroom teachers get shared? A formal structure for technology-using teachers to share their expertise and coach their peers should be implemented. Finally, what is the relationship between technology experts and technology-using classroom teachers in implementing technology in a focused manner? How often are technology specialists—teachers themselves—expected to be professional development leaders rather than custodians of equipment?

Public/Private Roles for Technology

A third scaffold for technology integration in these cases is public/private roles for technology related to teacher and student empowerment. In terms of the students, the most public roles existed at Rosa Parks, where public recognition was integrated into the regular recognition avenues that were practiced in that school. Everyone knew that technology was being used in new and exciting

ways and this accomplishment was celebrated publicly. The recognition was showered on the students rather than the teachers. In many ways, the students were carrying the technology ball, so to speak, along with the technology specialists. Certainly individual teachers were beginning to use technology, but in the context of the principal's mandate.

At Michigan Street, it was individual teachers who were recognized more than the students. There was not school-wide public recognition, but rather those teachers who were ahead in technology integration were asked to present their work publicly outside of the school at conferences. Within the school, technology was not featured publicly on a regular basis. The absence of recognition within the school conveyed the message that technology was not a high priority.

At Central, it was also the case that there was not school-wide public recognition of technology in the way it existed at Rosa Parks, for example. However, once technology was on the principal's radar screen, she began to talk about instances of technology use in her regular descriptions of the school's progress. She herself began to integrate the discussion about technology, not as an add-on, but more as an integral part of her understanding of the school. She knew which teachers were technology savvy and at some level could talk about how they were using technology, their students' accomplishments, and so on. Once the teachers began to demonstrate leadership in technology integration, she in effect praised their work as part of her regular praise of her staff and their accomplishments. She also discussed student use of technology across content areas.

It may be the case that different levels of recognition for students and teachers alike are needed to support technology integration. These various kinds of recognition may not necessarily need to be connected with flashy uses of technology, however. Rather, they may be day-to-day uses that demonstrate higher levels of student understanding and achievement.

CONCLUSION

A dichotomy is often invoked in discussing the implementation of technology in the schools. In this dichotomy, the purchase and upkeep of hardware and software is pitted against investing in professional development for teachers. The conventional wisdom is that the investment in professional development is almost always slighted in favor of the acquisition of equipment and software—which is then used inappropriately or inadequately. Although we agree with this analysis, we believe that these three case studies illustrate a more complex situation with regard to technology integration. This analysis suggests that the ability of a school staff, through professional development activities, to use technology well—defined here as using technology in the service of the curriculum—is not simply the flip side of investing in hardware/software.

Preparing a school well for technology integration appears to represent a special instance of professional development, one that has a unique identity requiring a unique kind of stewardship. To use technology effectively, principals and other technology leaders who contribute to decision making regarding how a school will invest in technology first need a solid understanding of the difference between technology use to enhance learning of the curriculum and tech-

nology use for productivity—as well as the ability to make distinctions in the various kinds of supports that will be required for each. We would argue that it is not a case of privileging professional development over acquisition, but rather that in planning for technology integration, professional development and acquisition considerations need to take place simultaneously. Curriculum needs to be the overriding framework for these deliberations. In other words, good planning for technology integration takes a special understanding of the acquisition of hardware and software specifically *as it relates to the curriculum.* This requires graduated staff development that anchors technology in the curriculum, but that also recognizes the need for teachers to have the opportunity to learn the technology well so that it can be used easily and transparently to support the curriculum. It goes without saying that teachers must be deeply informed about content and pedagogy in a particular content area to use technology to enhance learning effectively. Neither can be shortchanged. In short, preparing for technology integration requires a much more nuanced understanding of what it means to provide leadership and professional development at a school site, with the ability to move back and forth in a very sophisticated manner between learning technology itself and the curriculum. But why is this the case?

Traditionally, professional development encourages teachers to change their practice within a relatively familiar zone of operation. New approaches to literacy, mathematics, writing across the curriculum, block scheduling, or project-based learning all pose challenges—but they exist within a relatively safe, traditional classroom structure and school context that is known to the players. As technology is introduced, teachers and principals *must always juggle multiple levels of professional development and expertise,* moving back and forth between the technology itself and the curriculum. Simply put, the territory becomes much more complex for teachers and administrators alike. The reality is that although technology always needs to serve the curriculum first, it also requires administrators and teachers to invest real time and effort, real fiscal and human resources in acquiring and learning to use the technology itself and keeping up the technology precisely so that it *can* serve the curriculum.

Without a clear vision of the goal of technology as it relates directly to the curriculum, it is possible to get distracted along the way with the details of acquisition, with productivity goals, or with generalized uses of technology—but not uses that are specific to various aspects of the curriculum. Administrators who themselves may feel insecure about technology may take technology advice that will not serve the curriculum well (Wasser, 1996; Radlick, 1998; Thomas, 1999). Planning for technology should directly address the complexities of this endeavor, the juggling act between acquisition, network support, professional development directly related to the curriculum, and technology for professional productivity.

Technology integration may be likely to pose a special challenge in urban schools, which tend to be under-resourced to begin with. When the budgetary chips are down, so to speak, the failure to support technology may be tempting, and in the face of shrinking dollars technology may quickly be seen as a real stretch, an unaffordable luxury. This stance may be mitigated when administrators and teachers anchor their understanding of technology deep within the

curriculum. But it is also made more complex with the reality that schools will need to update technology not only to serve the curriculum, but also to continue supporting professional productivity.

We have argued that the initial understanding on the part of the principal of the complexity of technology is crucial to a measured, reasonable introduction to the goals and progress of technology integration. Although the principal may set the tone, it is equally important to have a trusted technology leader in the school who knows technology itself. This technology knowledge then needs to be aligned strongly with the curriculum, based on a sound understanding of the curriculum itself. Where there is strong technology knowledge but a weak sense of alignment, technology may absorb scarce resources but not add substantially to students' progress. When principals and technology leaders themselves connect all discussions about technology acquisition to the curriculum, the alignment is much more likely to take place. It seems important that schools identify and understand their school context and mission, identify curricular goals for the future, and consider how technology growth and development goals would serve curricular goals. Both agendas, technology acquisition and use and curriculum, need to move forward simultaneously, with the understanding that quite often the two will be intertwined, reciprocally supporting one another.

However, technology integration is not simply a top-down affair. When either a principal or a technology leader in a school is more focused on technology acquisition and less focused on alignment, it will be critical to have a teacher leader who can step up to address the curriculum question. Leadership from teachers and children can support, and in some cases drive, school-wide technology and curricular agendas. The enthusiasm of children and thoughtful risk-taking of teachers can combine to create atmospheres of a mutually defined learning space—a space where children have a broader array of tools to explore ideas and demonstrate skill. When schools make these innovations public, even to themselves, the opportunity for increased use and collaboration becomes more likely. For this to occur, technology must permeate all aspects of a school's ecological system, including students, teachers, classrooms, and administrative leaders.

The analysis of these cases provides a greater understanding of the complex interplay of curriculum, technology, and professional growth and development activities. The study illustrates some of the subtleties associated with planning for and implementing technology integration in the schools—subtleties that often go unvoiced at the school level, where principals and teachers make important decisions about the role of technology. These three cases illustrate a range of understanding of what it takes to integrate technology on the part of principals who all considered themselves to be—and were, to some extent—technology supporters.

What are the implications for future research? Case studies of how principals make decisions regarding technology purchases, guided by the role of the curriculum in these decisions, is one area that could be explored. Further research could also be structured to look at the existing matches between technology and the curriculum and the presence or lack of alignment. Finally, research could also be conducted on whether or how technology and curriculum are connected in the process of professional development.

To be integrated successfully, there must be a clear understanding that technology creates a new layer for professional development. It is not just another resource to be added and considered haphazardly, with its promise and commitment easily falling away in times of fiscal crisis. Instead, technology can be a powerful tool for moving schools towards their fundamental goals of supporting student learning. What seems critical for this to happen, however, is a deep understanding of how technology relates to curricular goals, how professional development must be layered to embrace both technology learning and curricular alignment in relationship to one another, and how carefully constructed professional development can support technology's most judicious use.

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APPENDIX

Formal Interview Schedule

Questions asked of all interviewees:

- Describe how technology is used in your school.
- Describe how technology is used to support instruction in your school.
- Describe how the use of technology has changed over the past three years.
- Describe how the use of technology resources has changed over the past three years.
- What are your future plans with regard to technology? Short term? Long term?
- What might help or hinder reaching these goals?

Additional questions for building administrators:

- What role did you play in the changes you described?
- What were your goals for the school?
- What did you accomplish?

Additional question for teachers:

- Give us an example of technology use in your classroom and/or in the technology lab (if applicable).

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