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SUPPORTING TECHNOLOGY INTEGRATION ONSITE: THEORY, CASES, AND LESSONS LEARNED

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APPALACHIAN TECHNOLOGY IN EDUCATION CONSORTIUM

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Introduction

Access to technological resources and equipment appears to be improving. However, computers continue to remain idle in many classrooms and laboratories. Many teachers successfully use technology for productivity, but they are unable to integrate meaningful uses into their curricula (Schwab & Foa 2001). Some factors that impede teachers' readiness to purposefully integrate technology are differences in teaching style and philosophy, fear of loss of control, deficiencies in technical expertise and lack of release time for concentrated study. Successful professional development can change teacher philosophies and pedagogy. Professional development for technology integration must include active learning, curricular alignment, collaboration, in-classroom assistance, remunerations and a sustained training effort.

Teachers, students, state departments of education and school districts across the country are implementing a variety of initiatives to facilitate technology integration and improve student performance. Teacher programs, such as technology coaches in Tennessee and technology resource teachers in Kentucky and North Carolina, are moving seasoned instructors out of the classroom to direct concentrated technology integration school-wide. In addition, student programs, such as the Student Technology Leadership Program in Kentucky, Multimedia Masters in Texas and the Mouse Patrol in Tennessee, are providing technical assistance, preventative maintenance and instructional development. Finally, the State Department of Education and school districts across Missouri are implementing eMINTS (enhancing Missouri's Instructional Networked Teaching Strategies) as a widespread effort to equip classrooms and teachers with the technologies and skills they need to use technology as a learning tool. This report recommends ways to use these programs as models for further professional development in other geographical locales.

Access, Teacher Readiness, and Professional Development

The gains that have been made to equip schools with computer technologies for the 21st century are evident: In 1984, the ratio of students to computers was 125 to 1 (Smerdon & Cronen 2000). By 2000, the ratio had improved significantly: one computer for every five public school children.

Access to the Internet and the World Wide Web continues to increase, as well. Approximately 35 percent of elementary and secondary schools in 1994 had access to the Internet. By 1998, access had increased to 89 percent (National Center for Educational Statistics 1998). More recently, in 2000, about 98 percent of schools were connected to the Internet (National Center for Educational Statistics 2001).

These gains are promising, but even more telling is the proportion of instructional rooms with Internet access. The number of classrooms, computer labs and library/media centers with access improved from 51 percent in 1998 to over 75 percent in 2000 (National Center for Educational Statistics 2001). It is in these areas dedicated to teaching and learning that the greatest potential for integrating technology into the curricula exists.

Even though access to technological resources and equipment appears to be improving, computers continue to remain idle in many classrooms and laboratories. Becker and Ravitz (2001) report that only 25 percent of English, 17 percent of science, 13 percent of social studies and 11 percent of mathematics teachers use computers every week. In addition, dominant student use of computers is outside of core curricula, and it is primarily for word processing (Becker 2001).

Schwab and Foa (2001) encapsulate the problem:

> *And even if there are computers in the classroom, there are still many more thousands of teachers who, while they know how to do word processing or even to search the Internet, don't have the slightest clue how to truly integrate technology into their teaching. The problem for educators nationwide is how to scale up effective training to reach tens of thousands of teachers quickly (p. 640).*

Teacher Readiness to Integrate Technology

What factors continue to impede teachers' readiness to purposefully integrate technology into everyday instruction? Several explanations have been proposed. Cuban (1986) suggested that the problem may be teachers' inability to reconcile their instructional philosophy and teaching style to technology's purposes. Nisan-Nelson (2001) argues that teachers' perceptions of autonomy and control may influence their potential to move beyond cursory uses of computer technologies. Similarly, Morrison and Lowther (2002) and Bickford et al. (2002) emphasize that to make the most of technology's potential, teachers must use more student-centered strategies, such as project-based learning and problem-based learning. These strategies may be incongruent with a teacher's personal teaching style and philosophy, making technology integration an unachievable goal. Becker (2001) argues that teacher-specific variables, such as technical expertise, leadership roles and teaching philosophy, consistently predict teachers' uses of computers in classrooms and instruction.

Teachers have a lack of release time for significant dedication to technology related professional development.

The National Center for Education Statistics (2000-2002) and Brand (1998) report that teachers have a lack of release time for significant dedication to technology-related professional development. More than one-third of teachers have received one to five hours of technology-related professional development, and another third have received none (Trotter 1999). Moreover, few school districts and colleges of education offer sufficient professional development to ensure meaningful technology integration (Farenga & Joyce 2001). Only about 17 percent of technology budgets is currently dedicated to professional development and training (Web-Based Education Commission 2000). In 1995, the Office of Technology Assessment advocated spending at least 30 percent of technology budgets on ongoing instruction, and today, the National Education Association endorses allocating at least 40 percent to teacher training (Web-Based Education Commission 2000).

Impact of Professional Development

Successful professional development models can affect teachers' practices and philosophies (Birman et al. 2000). To support technology integration and to influence pedagogy, professional development must include specific factors:

- Active learning, including hands-on instruction (Birman et al. 2000, CEO Forum on Education and Technology 1999, Mouza 2002-2003)
- Curricular alignment (Birman et al. 2000, Mouza 2002-2003)
- Collaboration, including common planning, discussions and brainstorming (Birman et al. 2000; Cole, Simkins, & Penuel 2002; Mouza 2002-2003)
- In-classroom assistance, as follow-up support and just-in-time learning (CEO Forum on Education and Technology 1999, Mouza 2002-2003)
- Remunerations, such as recognition and compensation (Cole et al. 2002, Scribner 1999)
- Sustained training efforts (Birman et al. 2000, Cole et al. 2002).

These factors have the potential to effect substantial change in the ways teachers teach and students learn.

These professional development factors in a variety of combinations are being implemented in isolation throughout the country. Teachers, students, school districts and state departments of education are attempting to support technology integration to achieve curricular goals and improve student performance. As a partner in the Appalachian Technology in Education Consortium (ATEC), the University of Memphis has provided a substantial amount of professional development to teachers, staff, and students across Tennessee, Kentucky, Virginia and West Virginia, who are on the frontlines of technology integration in K-12 schools. In many cases, we have heard the triumphs and challenges these individuals have faced. In other instances, we have observed impressive, mediocre and what Bickford et al. (2002) describe as counterfeit technology integration in classrooms.

The continuum of technology integration persists, and many best practices and model initiatives exist.

The continuum of technology integration persists, and many best practices and model initiatives exist. The purpose of this paper is to explore how technology integration is supported onsite within schools, with an emphasis on the literature base to sufficiently ground the various programs. We examine classroom teachers, K-12 students, and, finally, state departments of education and school districts. For each of these stakeholders, we present case studies documenting their various approaches, illuminating which of the factors above have been incorporated, in an effort to detect the elements that have made these projects successful. These cases were chosen based on their support from the literature (research, evaluation and documentation), their successes and challenges, as well as their unique perspectives on technology support and integration.

Teacher Roles in Onsite Support for Technology Integration

In an effort to provide the support necessary to sustain technology integration on site, some classroom teachers are changing their roles and responsibilities. Some teachers are moving out of the classroom to lead technology integration initiatives for their peers (Owen 2003). Dedicated teacher aid for technology integration ranges from one class period to full-time positions (Cole et al. 2002). These technology facilitators may support just their own school or multiple schools (Cole et al. 2002, Fayette County Public Schools Department of Education Technology 2001). Some travel to other school campuses may be necessary, but the strongest relationships and concentrated efforts exist at the teacher's home school (Cole et al. 2002).

These teachers—often called technology facilitators, technology coaches, technology resource teachers, technology learning coordinators or technology integration specialists—fill a variety of functions. Their jobs may encompass positions such as technician, advocator (Cole et al. 2002), instructional/ curricular coordinator (Moallem, Mory, & Rizzo 1996), trainers (Moallem et al.1996, Ross et al. 2002), instructional designer and developer, classroom observer and facilitator of reflection (Showers & Joyce 1996). These teachers offer peer support through countless activities.

Peer support and coaching can be a powerful method to effect change within a school. Showers and Joyce (1996) contend that:

> *Teachers who had a coaching relationship—that is, who shared aspects of teaching, planned together and pooled their experiences—practiced new skills and strategies more frequently and applied them more appropriately . . . Members of peer-coaching groups exhibited greater long-term retention of new strategies and more appropriate use of new teaching models over time (p. 14).*

Mouza (2002-2003) agrees that when teachers "collaboratively identify and solve problems and develop new practice," teacher practice can change (p. 274).

McKinsey (1999) argues that the factors listed below will influence peer technology support:

- Choosing effective mentors who are adept at tact, engagement and emotional support
- Planning with each teacher to create technology integration lessons appropriate to his or her level of expertise and comfort
- Creating a simple job description, available to distribute to teachers and building administrators
- Teaming with teachers as collaborators in the learning process
- Respecting the expertise of teachers
- Devoting the necessary time away from the classroom to plan and develop technology-rich lessons
- Communicating clear expectations to faculty about growth and development regarding technology integration
- Supporting teachers' emotional needs
- Customizing peer support to fit the teacher's individual style, while encouraging growth with pedagogy
- Transferring deliverance of the need for support to promote independence
- Assessing successes and challenges that teachers have encountered and overcome.

These factors can determine the success of a professional development program guided by peer coaching.

Sample Cases

We examined two cases of teacher support for technology integration: technology coaches in Tennessee and technology resource teachers in Kentucky and North Carolina. These cases, although similar, portray the diversity of programs incorporating factors necessary to sustain long-term change in technology integration by using classroom teachers to direct the projects.

Technology coaches in Tennessee. In 2001 as part of a Technology Literacy Challenge Fund (TLCF) grant through the Tennessee Department of Education, 26 elementary and secondary schools across the state received funding to support a dedicated full-time technology coach onsite, along with significant upgrades to computer hardware and software applications. These coaches received professional development on how to use technology as a tool for learning in the classroom. They then designed a professional development program of their own to reach the other teachers in their schools. A comprehensive external evaluation documented the results of this program and its impact on students and teachers. See Sheekey (2003) for the experiences of two Tennessee technology coaches. See *http://www.state.tn.us/education/acct-tlcf-report.pdf* for a full evaluation report.

Ross et al. (2002) report on specific indicators. Teacher and student growth was impressive. Table 1 summarizes these results. Teacher effectiveness at the 26 schools with the technology coaches improved. The teachers' abilities to plan and implement technology-integrated lessons almost doubled in each case. At the close of the evaluation, over 80 percent of the teachers felt they had received enough training to integrate technology into their classrooms.

Table 1. Summary of selected technology coach evaluation results from Ross et al. (2002)

Indicator	Fall	Spring
1. Teachers feel able to align technology to district standards	39%	74%
2. Teachers feel they received adequate training to integrate	39%	84%
3. Observed students as producers of knowledge	73%	90%
4. Observed meaningful use of computers frequently or extensively	23%	40%

Students were also using technology more purposefully. Students at the schools with technology coaches were observed as producers of knowledge 90 percent of the time, and meaningful use of computers almost doubled from the fall to spring semesters (Ross et al. 2002).

Ross et al. (2002) note that the most influential characteristics of the technology coach program contributing to the overall gains were (a) preparation and dedication of the technology coaches, (b) organization of the program by the Tennessee Department of Education, (c) principals' support, (d) coaching model/metaphor to support the teachers, (e) focus on classroom integration—not simply software applications—and (f) positive school climates. Many of these elements parallel those factors we described earlier that are essential for successful professional development, such as active learning, curricular alignment and collaboration. This program also reflects many of the characteristics McKenzie (1999) denotes, including teaming, time and support.

Some challenges to the technology coach initiative include lack of personal time, technical equipment difficulties, negative teacher attitudes and the program's late start (Ross et al. 2002).

Some challenges ... include lack of personal time, technical equipment difficulties, and negative teacher attitudes

In 2003, the program evolved as a result of the No-Child-Left-Behind legislation, specifically Title II, Part D ("NCLB" 2001). Thirteen elementary and secondary schools were awarded competitive grants to start EdTech LAUNCH (Leading All Users to New and Challenging Heights) sites with technology coach programs. Previous TLCF coach schools applied to become mentor schools to the LAUNCH sites (see *http://www.state.tn.us/education/acctedtech3.htm* for complete program review). The 39 (26 TLCF plus 13 LAUNCH) schools across Tennessee will expand into regional educational technology resource centers, called ORBITs (Orchestrate Regional Bases for Instructional Technology). This improved program teams library media specialists with the technology coaches to provide a stronger foundation for technology and curriculum integration onsite. Extensive professional development, both job-embedded and dedicated times outside of classrooms, is the hallmark of this initiative.

Technology resource teachers in Kentucky and North Carolina. Like technology coaches in Tennessee, technology resource teachers (TRTs) in Kentucky and North Carolina offer on-site assistance to teachers and students to integrate technology into teaching and learning (Kentucky Department of Education 2003a, Moallem & Micallef 1997). In Kentucky, technology resource teachers provide on-the-job and on-site support during the school day. However, some technology resource teachers are shared among multiple schools within a district (Fayette County Public Schools Department of Education Technology 2001). As a result, some schools have allocated resources to fund a full-time technology resource teacher position. See figure 1 for a sample technology resource teacher job description from Scott County Schools in Georgetown, Kentucky.

Figure 1: Technology resource teacher job description from Scott County, KY

Job Description

Technology Resource Teacher
Scott County Schools

Position Title:

Technology Resource Teacher

Reports to:

Director of Technology

Qualifications:

- Three years or more of successful teaching experience
- Three years using technology as integral part of instruction
- Current Kentucky teacher certification
- An understanding of ISTE technology standards for teachers, students, and administrators
- An understanding of Kentucky's Core Content and Program of Studies
- Portfolio demonstrating effective technology use with students
- Basic understanding of Working on the Work (CLSR)

Position Goal:

Assist teachers in effective integration of technology for designing high quality and engaging student work.

Physical Requirements:

Shall have the ability for sitting, light lifting, stooping, any and all body movements as related to the job description.

Performance Responsibilities:

- Advocate for, through mentoring and modeling, the design of engaging student work in all Core Content areas for all students through technology
- Maintain and model an innovative and progressive vision for instructional technology
- Consult on curriculum planning to integrate technology
- Provide a variety of types of training to meet teacher needs for technology integration
- Advocate for technology integration in all professional development
- Recommend materials, resources, and strategies
- Participate in training workshops and conferences
- Serve on the school technology committee(s)
- Serve as a resource person for the STLP Program(s)
- Attend required state, district and school technology meetings
- Stay current with the latest technology
- Serve as liaison between the district technology office and the school
- Assist in coordination of district projects and/or programs
- Collect data to evaluate how well the goals and objectives of the technology plan/grants have been met
- Participate in other technology related responsibilities as assigned by supervisor

Days of employment:

185 days

Salary:

Commensurate with the Scott County Schools Certified Salary Schedule July 1, 2003

As in Tennessee, the preliminary results for on-site support is promising. Fayette County Public Schools (2001) in Kentucky reported that their results "seem to indicate that schools with a full-time instructionally oriented TRT are more prone to show improvement in CATS [Childrens Attitudes Toward Technology Scale]" (p. 26). Other research, Cole et al. for example, also indicates that a technology resource teacher's home school is more effectively served than the other schools visited.

Like those in Kentucky, North Carolina technology resource teachers provide professional development through training, workshops and software applications instruction (Fayette County Public Schools Department of Education Technology 2001, Moallem et al. 1996). One study in North Carolina described the technology resource teacher's role as "primarily instruction, although technical and administrative responsibilities were also expected" (Moallem, Mory & Ruzzo 1996, p. 525). The technology resource teachers estimated that 75 percent of their time was spent on technical support. However, the classroom teachers' vision of the technology resource teachers "was one of instructional support through training, workshops and demonstrations of the applications of the computer" (p. 525). By the end of the second year of the evaluation, the technology resource teachers reported spending more time dedicated to instructional and curricular processes (Moallem & Micallef 1997).

Consistent with Cole, Simkins and Penuel (2002) and Birman et al. (2000), Moallem and Micallef's (1997) evaluation of North Carolina's technology resource teachers emphasizes that if classroom teachers are to successfully and meaningfully integrate technology and influences pedagogy, training must be sustained and the focus must shift to curricular needs, including subject/grade level partnerships. This assertion reflects many of the factors essential for the successful professional development articulated above.

Summary. Tennessee, Kentucky and North Carolina cases represent three strategies for implementing a professional development initiative to facilitate technology integration in classrooms, where teachers are the principal support personnel. The technology coaches and technology resource teachers in these states provide peer support for planning instruction, teaching, classroom management and assessment. In full-time, part-time, dedicated or shared appointments, their roles may include technical support, advising, instructional design and development and training. The initial reports of the results from the work of these former classroom teachers are optimistic. Time and persistent evaluation are necessary to document their long-term impact on teaching and learning. These programs may well offer models for other states to follow.

Student Roles in Onsite Support for Technology Integration

Similar to the role of teachers described above, K-12 students in school districts around the country are also providing building-level services to facilitate technology integration for classroom teachers and students. These services fall into three broad categories: (1) manage technical problems, maintenance and everyday care, (2) aid in instructional development, and (3) provide professional development. Each of these categories is discussed below.

> *In order for students and teachers to use computer technologies ... hardware equipment and software applications must operate properly.*

In order for students and teachers to use computer technologies with curricular content, hardware equipment and software applications must operate properly. In many schools, students are providing this service for computers, peripherals and software (Bryan 2000, Haraway 2003, Hodari & Wenger 2002, Stevens 2000). Through clubs and classes, student teams diagnose technical problems with hard drives, operating systems, software applications, printers, scanners and digital cameras. They also provide the routine preventative maintenance necessary to avert problems, such as cleaning devices and updating computer virus definitions. In many instances, the student teams have provided an initial "line of defense" to alert staff technology specialists about serious complications (Haraway 2003, Stevens 2000), allowing more of the staff's time to be allocated to instructional and curricular needs.

In addition to providing technical support and preventative maintenance, some students also provide assistance with instructional development for teachers. A small number of students are working with teacher clients to develop a specific instructional aid or module that incorporates curricular content inside technology (Pierson et al. 2001). For example, students are building multimedia modules to correspond with units of instruction. Through these collaborations, student technology skills are advanced, and teacher visions for technology integration are broadened.

Another way that students contribute to technology integration efforts is through professional development. Students provide both formal (Pierson et al. 2001) and informal (Bryan 2000, Haraway 2003) professional development to teachers. Students have provided formal workshops and training on software applications, as well as just-in-time assistance in class to teachers. One teacher emphasized that technology in the classroom has consented for students to become experts, redefining the student-teacher relationship (see Bryan 2000).

These student technology programs, like their teacher counterparts, reflect many of the traits of successful professional development discussed earlier, including in-class support, just-in-time assistance, hands-on instruction and collaborations. Still other benefits of student technology teams exist, such as media literacy, fluency, teamwork and character education, but they are beyond the scope of this paper. There appears to be a symbiotic community among students and teachers and technology, creating a synergy for teaching and learning.

Sample Cases

We explore three cases of student support for technology integration. First, we review the Student Technology Leadership Program (STLP) in Kentucky, followed by the Mouse Patrol from Memphis, Tennessee. Finally, we consider the Multimedia Masters program in Spring, Texas.

Student Technology Leadership Program in Kentucky. Launched in 1994, the Student Technology Leadership Program is a "project-based learning program that empowers students in all grade levels to use technology in and out of the classroom" (Kentucky Department of Education 2003b, para. 1). The program is available to all elementary, middle and high schools in the state of Kentucky, with about 60 percent of them participating (Hodari & Wenger 2002). The program is informal, exploratory and flexible to accommodate the students, school and community needs and resources.

Due to the flexibility inherent in the design, some programs meet daily, while others meet weekly, monthly or less often (Hodari & Wenger 2002). Projects fall into four broad categories: instructional, community, technical and entrepreneurial. The majority of projects involve intra-school media, such as television/news production and website development; products, such as clocks, tote bags and mouse pads; and technical service desks for intra-school and intra-community assistance.

Through the technical and service projects, primarily service desks and preventative maintenance, student technology leaders are providing technology integration support to teachers. In an evaluation of the Student Technology Leadership Program (Hodari & Wenger 2002), 69 percent of elementary school STLP coordinators reported students servicing classroom computers. In addition, 72 percent of middle school and 74 percent of high school coordinators stated that students troubleshot and maintained the classroom computers. Overall, 15 percent of the STLP coordinators reported that the most common computer problems were resolved by student technology leaders. Moreover, the evaluators discerned that student technology leaders helped "to minimize the amount of time the computers were inoperative," reasoning "that these students play a substantial role in keeping Kentucky's classroom computers functioning" (Hodari & Wenger 2002, p. 18).

The Mouse Patrol in Memphis, Tennessee. As part of the funds authorized by No-Child-Left-Behind legislation, E. A. Harrold Elementary School received funding to establish a technology troubleshooting team of students, dubbed the Mouse Patrol (Haraway 2003). A small number of fourth and fifth graders who showed interest were trained to perform basic cleaning and hardware maintenance, as well as to execute basic technical support. These students also assisted with software installation.

As with many of the technology coaches, technology resource teachers and student technology leaders, the Mouse Patrol's purpose was to decrease computer "down time" by supplying onsite technical support for educational software and equipment (Haraway 2003). In addition, the Mouse Patrol students were able to alert the school technology coach and curriculum technology specialist to the more challenging computer problems. Having the Mouse Patrol perform many of the routine functions allowed the school technology coach and district curriculum/technology specialist to dedicate more of their time to instructional applications with technology.

Multimedia Masters in Spring, Texas. Spring Independent School District and the University of Houston College of Education formed a partnership to design and develop professional training for teachers at their individual levels of technology expertise (Pierson et al. 2001). The collaboration tapped skilled and energetic eighth graders to work with teachers as clients. The students worked with their teacher-clients and university faculty to learn technical, instructional design and instructional development skills to produce learning products. The students taught "their clients the technology skills as they learn[ed] them" (Pierson 2000, p. 69).

The students maintained reflective journals throughout the year, considering team and teacher relationships, group dynamics and their own personal achievements (Pierson et al. 2001). During team meetings, students coached and scaffolded one another on application skills. Students practiced teaching the technical skills to preservice teachers at the university to strengthen confidence and foster critical thinking skills. Working with the student-designers fostered teachers' interest in personal uses of technology and increased awareness of technology's value within their curricula (Pierson et al. 2001). This type of relationship is unique and lends credence and authenticity to technology integration for inservice and preservice teachers.

Summary. The Student Technology Leadership Program in Kentucky, the Mouse Patrol in Tennessee and the Multimedia Masters program in Texas are three cases where students are supporting technology integration onsite, within classrooms, as well as in formal and informal arrangements. The students in these programs are providing technical support, computer maintenance, instructional development and professional development. The students' role in supporting technology within schools cannot be overstated. As one report states: "With the day-to-day computer maintenance in schools, both through staffing help desks and through less formal arrangements . . . this type of assistance is crucial in keeping school computers and networks functioning" (Hodari & Wenger 2002, p.1).

Roles of State Departments of Education and School Districts in Onsite Support for Technology Integration

State departments of education and school districts have the potential to shape and guide technology's role in teaching and learning. With the proper vision, these agencies can direct reforms to employ computer applications as tools in problem definition, data collection, problem solving, critical thinking and communication of results. In their seminal report on technology's role in education reform, Means and Olson (1995) define the states' capacity to influence technology integration. They argue that through reform philosophies states can shape the direction of educational policy. Additionally, through curricular frameworks and assessment programs, states influence content and pedagogy by emphasizing knowledge and skills. States also provide a variety of resources to districts, schools and teachers. They include specifications for equipment, collaborative purchasing arrangements, access to networks and online services, as well as technical advice for submitting E-rate applications. States also influence the use of technology by recognizing and promoting exemplary programs and identifying models for districts in other states and other state departments of education. Nevertheless, critics contend that states emphasize "high tech" models and allocate a large percentage of funds for hardware but inadequately support the training necessary to implement such programs (Farenga & Joyce 2001).

States also influence the use of technology by recognizing and promoting exemplary programs ...

Comparable to the roles of states, school districts can provide vision, focus, support and policy coordination for educational innovations and change (Corcoran, Furman, & Belcher 2001). They can also offer coherence to curricular initiatives and professional development, including technology-related programs. Means and Olson (1995) report on districts specifically influencing technology diffusion by instigating innovations and providing ongoing support.

Instigating an innovation can be accomplished through districts in three ways. First, a school district begins technology diffusion by *initially planning the project* and subsequently delegating the management and details to schools directly. Second, a district may also be an *opportunity broker*. Through connections within the community and access to vendors, districts may direct schools to specific opportunities, such as business gifts-in-kind and corporate partnerships, they otherwise may not have been able to take advantage of. Finally, districts may be what Means and Olson term a *"benevolent spectator."* These districts are aware of an individual school's initiatives but do not intercede nor impede the school's decision-making.

School districts also influence technology diffusion and integration through ongoing support (Means & Olson 1995). Districts may provide consolidated or centralized resources that individual schools need to maintain their initiatives, such as assistance with *grant writing*. Districts also offer collective *bargaining and purchasing power* to vendors, offering discounts and incentives for schools. *Technical assistance*, as well, is typically provided through districts. Although some essential technical assistance is being provided onsite, networking specialists and information technologists are generally shared across districts and often develop and maintain computing infrastructures. It is through these services that school districts enhance technology's role in the classroom.

Constraints and Barriers

State policies and regulations governing state departments of education and local school districts can also impede innovations, such as technology diffusion and integration. Many states fall short in demonstrating the capacity to promote the diffusion of successful programs and practices necessary to affect educational curricula long term. Scaling up initiatives to meet the needs of all constituents is challenging, and states and school districts find it difficult to sustain an initiative over time. States also fall victim to year-to-year budgeting. With budget uncertainties for the following year, innovations are often in jeopardy. So, financial instability may plague broad deployment of initiatives.

Changes in state and local leadership, policy, direction and funding can obstruct an individual school's long-term plans (Corcoran et al. 2001, Means & Olson 1995). Sufficient time is vital to implementing significant initiatives and school reforms and documenting their impact on student performance. Differences in leadership also affect the momentum to sustain successful programs, replication and diffusion strategies. Changing school administrations as a result of turnover can stall innovations. District superintendents and school principals focus on different areas, and some programs and initiatives are discontinued. Plus, a lack of communication between the school and district office, as well as a lack of support after the technological innovation is in place, can inhibit success.

Recently, staff and professional development has been emphasized as necessary to employ technology's promise of effecting student learning (Beavers 2001). While school districts have the opportunity to offer direction and coherence to staff development, centralized staff development centers often offer "hot topics" that may or may not fit within a district's plan (Corcoran et al. 2001). In addition, districts often do not followup on professional development to determine if changes in teacher practice or improvements in student performance have been made. Fragmentation of staff development initiatives by centralized district staff, schools and local agencies can dilute comprehensive and whole-school reforms by delivering isolated programs (Corcoran et al. 2001, Smith 2001). As we mentioned previously, state departments and school districts need to offer teachers a comprehensive professional development plan for technology integration that is ongoing, curricular, financially and staff supported and includes job-embedded learning (Beavers 2001, Smith 2001). One district offers this plan: 10 percent workshops, 25 percent group sharing and 65 percent individual study/reflection (Smith 2001).

> *Fragmentation of staff development ... can dilute comprehensive and whole-school reforms by delivering isolated programs.*

Sample Case

We present one case, the eMINTS (enhancing Missouri's Instructional Networked Teaching Strategies) project. This example represents a significant, comprehensive and consolidated effort by the Missouri State Department of Education, specifically the Department of Elementary and Secondary Education, and local school districts to provide the professional development that we suggest in this paper. Like other initiatives, the eMINTS project is facing challenges as it enters widespread deployment across the state.

eMINTS project. The eMINTS project was borne out of the Multimedia Interactive Networked Technologies (MINTs) pilot project. This proof-of-concept program begun in 1997 was funded through a grant from Southwestern Bell to six elementary schools in St. Louis County (Bickford et al. 2000). Through the Missouri Department of Elementary and Secondary Education and the Missouri Research and Education Network (MOREnet), 13 teachers and approximately 200 students from fourth, fifth and sixth grades were selected to participate, based on financial need, numbers of at-risk students and school leadership.

The MINTs project was distinguished in two ways. First, teacher training and development were significant (Bickford et al. 2000). Educators participated in extensive staff development prior to the project and continued throughout the school year. The focus of this professional development was on using technology as a tool for learning (Giddings 2000). Second, teachers and students were supplied with the necessary technologies to support simultaneous use. An Internet connection to the classrooms, computers for the teachers and one for every two students helped reach one of the goals of the project, eliminating technology barriers, such as obsolete and sparse equipment (Bickford et al. 2002). Coupled with the sustained staff development, the technology was used as an agent of change for teacher practice and student performance.

MINTs students demonstrated improvement on standardized tests, both the Missouri Assessment Program available to fourth graders and the TerraNova available to fifth and sixth graders (Bickford et al. 2000). However, the results were inconsistent across grade levels and subject areas. The evaluation team summarized the promising yet conflicting results:

> *The MINTs classroom has had a positive effect on student achievement. This effect is not easily summarized. In every grade MINTs students improved their performance over other students. The "performance gains," as measured by the proportion of students scoring in one of three categories, varied by grade and by subject.…The most accurate conclusion one can reach about the impact of the MINTs classrooms on student achievement is that the classrooms have a generally positive effect (pp. 11, 15).*

Notably, teachers reported changes in themselves and their students. As a result of the focus on pedagogy with technology, teachers described shifts away from teacher-centered instruction to inquiry-based learning and "becoming agents of the district curriculum" (Bickford et al. 2000, p. ii; Giddings 2000). Teachers also reported that their classrooms and curricula have evolved, increasing motivation and higher-order thinking in students.

In every grade, MINTs students improved their performance over other students.

The MINTs project matured into eMINTS in 1999. Geographical clusters across Missouri were organized for school districts, allowing teachers to collaborate and share (Giddings 2000). Classrooms were equipped with a multimedia projector, an interactive whiteboard, a teacher laptop and desktop computer station with scanner, printer and digital camera. Plus, a computer for every two students continued to be available. School districts, however, were responsible for any necessary classroom or building renovations, any additional classroom furniture and half of the student workstations. MOREnet provided the broadband Internet connection. The emphasis on professional development continued, as well. Teacher participants received 100 hours of professional development their first year, and 75 more hours their second year.

Results from eMINTS classrooms have continued to show improvement, using student performance as the primary benchmark. Student scores of statistical significance were higher in classrooms where “teaching practice consistently demonstrated the integration of inquiry-based practices into instruction and made use of the available technology,” more so than with “teachers [who] used other types of instruction” (eMINTS Evaluation Team 2003, p. 27).

The program has also experienced challenges. By 2002, the eMINTS evaluation noted that only 17 percent of participating teachers’ instructional practices were classified as “Proficient,” the highest level, representing consistent student-centered, inquiry-based instructional strategies. Teacher practices ranged from (1) student-centered, teacher-facilitated lessons to (2) hybrid lessons, where innovative technology lessons are implemented within teacher-centered instruction, to (3) complete teacher-centered classrooms to (4) student-centered lessons with no teacher guidance and facilitation (Bickford et al. 2002). It is important to note, as the evaluation team (eMINTS Evaluation Team 2003) does, that the observed results in student performance show only 17 percent of eMINTS teachers consistently employing student-centered, inquiry-based, technology-rich lessons. “Had the eMINTS professional development program helped transform the instructional practices of the majority of eMINTS teachers, the impact on student performance would have been extraordinary” (eMINTS Evaluation Team 2003, p. 28). Although this may overstate the impact on student achievement, the message remains poignant.

Currently, the eMINTS programs have spread across 165 school districts and are limited to grades 3, 4 and 5 (eMINTS Program 2003). The program is funded through state technology allocations, rebates from E-rate, federal technology funds and district participation fees. Through competitive grants established in Title II, Part D (“NCLB” 2001), districts new to the program purchase and install the requisite infrastructure, equipment and software, as well as fund the professional development for participating teachers (eMINTS Program 2003). Base professional development costs exceed $7500 per teacher, excluding stipends for overtime and substitutes, travel, lodging and meals. Other districts not awarded competitive grants may add eMINTS classrooms and teachers by assuming the full cost of the program. Unfortunately, budgetary constraints within the Missouri State Department of Education may require school districts to shoulder additional costs for growth (“MO’s eMINTS program improves student achievement” 2002).

Summary. Expanded from the MINTS program, eMINTS represents a significant effort by the Missouri State Department of Education and school districts to support technology integration with a focus on pedagogy. Offering teachers upwards of 200 hours of professional development targeted at technology use and technology application in the classroom, the eMINTS program is implementing many of the elements necessary for professional development to change teacher practice, including a sustained effort, collaboration, hands-on learning and remunerations. This program has documented success, but it is still being evaluated to identify weaknesses and challenges, such as teacher turnover in participating classrooms and consistent teacher implementation (eMINTS Evaluation Team 2003).

Lessons Learned

The programs documented above highlight exemplary initiatives to support technology integration onsite in the classroom. Endeavors such as the Technology Coaches, Technology Resource Teachers, Student Technology Leaders, Multimedia Masters, Mouse Patrol and eMINTS project are mature programs, and they offer a tremendous amount of guidance for expanded implementations. These sustained programs, though, are isolated efforts within their respective geographies; their spheres of influence are limited. However, these programs are models for other states and districts to adopt and adapt. Given that, the challenge that exists for state officials is to incorporate what we've learned from these exceptional programs into guidelines for competitive grants and documentation for other programs.

Programs such as the ones depicted here are susceptible to political climates and changes in leadership. Although administrative leadership can effect positive change within an organization (Caffarella & Zinn 1999), turnovers in principalships and superintendents can adversely influence initiatives, including loss of momentum and lack of support (Corcoran et al. 2001). Districts and state departments need to offer a unified and comprehensive staff development program designed to support and sustain technology integration in classrooms. These programs must be continually evaluated for effectiveness; plus, follow-up observations must document changes in teacher practice. These programs must focus on curricular content and not be positioned as incentives, pull-outs or add-ons. Instead, these initiatives need to be integrated with the state and district standards.

States are in a strategic position. Policies with federal education programs are flexible enough to assist states in diffusion of innovations. States have the capacity to identify the ingredients for successful programs through model and "proof-of-concept" initiatives. These essential ingredients can then be integrated into the guidelines for allocating federal monies, such as Title I, Title II teacher improvement funds and educational technology funds. With these programs combined, states have close to $20 billion to fund and sustain initiatives (U.S. Department of Education 2003).

Students and teachers do not possess the requisite skills to tap the power of the technologies available to them (Becker 2001, Becker & Ravitz 2001, Smerdon & Cronen 2000). Professional development that is active, curricular, collaborative, sustained and uses job-embedded support with remunerations remains the key to technology integration. The call for action is not new (Moallem & Micallef 1997, Web-Based Education Commission 2000). States, districts and schools must identify the model programs that are effecting change in teacher practice and documenting results in student performance. These groups must allocate resources to execute similar opportunities in their areas. Guidelines for use of funds must integrate the essential elements of proven successful and sustained programs. Failure to do so will continue to condone the haphazard and inconsistent implementations evident in many classrooms. We must find ways to reach teachers in order to reach our students.

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