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Teacher Technology Professional Development and Policy in the United States

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Outline of Formal Initial and Continued ICT Teacher Training in the United States

Educational reform (Current status & Best practices)

Technology has the potential to increase teaching and learning outcomes. Researchers purport that best practices associated with technology are associated with student-centered practices (e.g., collaborative, authentic, situated learning, problem-based work) (Hannafin, Hill, & Land, 1997; Jonassen, Howland, Moore, & Marra, 2003; Sandholtz, Ringstaff, & Dwyer, 1997). Although technology has the capacity to "make it quicker or easier to teach the same things in routine ways," it also makes it possible to "adopt new and arguably better approaches to instruction and/or change the content or context of learning, instruction, and assessment" (Lawless & Pellegrino, 2007, p. 581). These second referenced uses are the targeted ways researchers suggest teachers should use technology.

Recent U.S. national (CDW-G, 2006) reports paint a promising picture of classroom teachers' current efforts to use technology to support student learning. For example, among the 1000 teachers who responded to the *Teachers Talk Tech* survey, 790 teachers (79%) self-reported using computers "to teach students" (CDW-G). However, other research, resulting from both large (Project Tomorrow, 2008) and small-scale (Bauer & Kenton, 2005) efforts, suggests that we still have not solved the problem of technology integration in the United States (U.S.). That is to say, technology is not being used to support the kinds of instruction (e.g., student-centered) believed to be most powerful (International Society for Technology in Education [ISTE], 2008; Partnership for 21st Century Learning, 2007).

In the *Teachers Talk Tech* survey (CDW-G, 2006), teachers reported using technology for administrative tasks (88%) and for communication tasks (86%). Similarly, almost all teachers (93%) in the *Speak Up 2007* survey reported using technology to communicate with colleagues or parents (Project Tomorrow, 2008). Half of the teachers reported that their primary uses of technology had students completing homework assignments using the computer (e.g., writing reports, finding information on the Internet) and assigning practice work at the computer (e.g., drill and practice software). This was verified by the large percentage of students who reported using technology to write assignments (74%), conduct online research (72%), and check assignments or grades online (58%).

Although survey data may suggest that teachers are implementing best practices (CDW-G, 2006; Project Tomorrow, 2008), current data from classroom observations (Andrew, 2007; Bauer & Kenton, 2005; Schaumburg, cited in Schulz-Zander, Pfeifer, & Voss, 2008) do not support this view. Even among teachers who report student-centered practices, technology uses are described as not being particularly powerful or innovative (Cuban, Kirkpatrick, & Peck; 2001; Hermans, Tondeur, van Braak, & Valcke, 2008).

In a recent investigation of teachers' technology uses, Palak and Walls (2009) found the following results: (a) teachers use technology most frequently for preparation, management, and administrative purposes; (b) teachers' use of technology to support student-centered practice is rare even among those who work at technology-rich schools and hold student-centered beliefs; (c) teachers in technology-rich schools continue to use technology in ways that support their already existing teacher-centered instructional practices (Palak & Walls, 2009). Watson (2001) suggested the reason for the lack of student-centered is that "many teachers and schools are in the 'adoption' stage of this model – that is, they are integrating IT into their existing teaching practices" (p. 276).

ICT and educational reform (Agent, Different Adoption, & Barriers)

ICT as an agent for educational reform

While some researchers suggest technology can be a catalyst for educational reform toward student-centered pedagogies (Thomas & Knezek, 2008), others suggest technology can only facilitate this reform for teachers (Harris, 2005). Culp, Honey, and Mandinach (2005) reviewed 20 years of educational technology policy and found technology described as the catalyst for change:

> Many reports present strong assertions that *technology can catalyze various other changes* in the content, methods, and overall quality of the teaching and learning process, most frequently, *triggering changes* away from lecture-driven instruction and toward constructivist, inquiry-oriented classrooms…Although these reports also reference the importance of adequately trained and motivated teachers, *they foreground the potential of the digital tools themselves to change the learning environment and the teaching process*, making it more flexible, more engaging, and more challenging for students. (p. 283, emphasis added)

The policy reports focused more on *technology's* role in facilitating constructivist, inquiry-oriented classrooms instead of the teacher's role, thus becoming an agent of change for educational reform (Culp et al., 2005). In other words, policymakers perceived technology as the agent of change.

Although much has been promised for integrating technology into education, Fisher (2006) cautioned against viewing technology as an agent of change. Rather, teachers must assume this role. As Harris (2005) noted, "despite more than two decades of effort, technology as a 'Trojan horse' for educational reform has succeeded in only a minority of K-12 contexts" (pp. 39-40).

Although research communities have purported student-centered uses of technology as best practices, few teachers are implementing these approaches. Instead, teachers are using technology to support their existing practices such as presentation software or locating resources on the Internet (Harris, 2005). When teachers do implement the recommended best practices, they typically attribute this to "experience, organized professional learning, and school culture as the primary factors provoking instructional changes. Educational technology use, it turns out, is no Trojan horse, despite the wishes and hopes of many of its advocates" (Harris, p. 120).

In addition, evidence shows that increased student achievement results from high-quality instruction and assessment, not the technology (Goldman, Lawless, Pellegrino, & Plants, 2005–2006; Newman, Smith, Allensworth, & Bryk, 2001). In other words, technology helps to support and facilitate a student-centered pedagogy, but it is not the reason for the change: Teachers are the reason for the change.

Educational reform and technology adoption

Technology adoption is different than other adoptions of educational reform as technology "…is qualitatively different from learning other new skills, knowledge, and activities" (Schrum, 1999, p. 85). Technology adoption is more difficult than other new teaching practices because (1) technology takes longer to learn (more than 30 hours required), (2) requires teacher home and school access to practice and build confidence, (3) teachers are more threatened and fearful of technology, and (4) technology requires dramatics changes to complete typical tasks. Therefore, in order to adopt technology, teachers need to be reasonably convinced that technology will improve teaching and learning. Mandates will only result in tenuous teacher acceptance of technology and teachers will not use technology (Schrum, 1999).

Teacher change: Barriers and influential factors

Perhaps the most researched aspect of technology in education is the adoption of technology by teachers and schools, and the barriers that impede, or factors that influence adoption. In one review of 48 barrier articles, Hew and Brush (2006) synthesized the following barriers to technology integration: (a) resources (e.g., hardware, access, time, technical support); (b) institution (e.g., leadership, school planning); (c) subject culture (e.g., institutionalized practices in subject areas); (d) attitudes and beliefs (e.g., pedagogical beliefs, personal attitudes toward technology); (e) knowledge and skills (e.g., technology skills, how to integrate technology into the classroom); and (f) assessment (e.g., standardized testing).

Others have looked at school-wide technology adoption with the intent of defining the factors that influence technology integration into K-12 schools. Kozma (2008) found five factors included in plans and policies that contribute to the adoption of technology: infrastructure development, teacher training, technical support, pedagogical and curricular change, and content development. Others have investigated the influential factors from a teacher perspective. Ertmer, Ottenbreit-Leftwich, and York (2006) surveyed expert technology-using teachers to investigate the factors influencing them to integrate technology. These factors were all perceived to be influential and are ranked in order of influence: inner drive, personal beliefs, commitment, confidence, previous success, access to hardware, access to software, professional development, time, access to Internet. All of these factors seem to influence technology adoption, but how does one measure the impact of these educational reform initiatives?

Evaluating Impact: Program, Teacher, and Student Outcomes

Many suggest that educational reform and teacher professional development are interchangeable terms (Desimone, 2009; Schlager & Fusco, 2003). Therefore, to investigate the success of educational reform efforts (such as technology integration), we might investigate the success of professional development programs.

For evaluation of technology professional development, there are three common units of analysis: program outcomes (formative issues such as implementation, sustainability), teacher outcomes (cognitive and affective components such as teacher knowledge or teacher confidence), and student outcomes (student technology skills or student academic achievement) (Lawless & Pellegrino, 2007). To measure the effectiveness of technology professional development, many suggested measuring all three outcomes. Although the quantity of rigorous evaluations to date is limited, high-quality professional development may change teacher learning and classroom practice (Porter et al. 2000) and those changes, in turn, may affect the academic performance of students (Cohen and Hill 2000; Wenglinsky 2002).

Although national stakeholders are pushing to require student outcomes as a measure of success, the majority of technology professional development literature measures program outcomes and teacher outcomes. In a review of 21 comprehensive technology professional development studies, Pellegrino and Lawless only found two studies collected any data from students of teachers participating in the professional developments. They concluded that, “The dearth of data collected on student outcomes from teacher professional development programs provides little insight into how technology is affecting our classrooms" (p. 598).

As increased student achievement is the goal for teacher technology professional development, measurement of student outcomes is critical to understanding the effectiveness of professional development. However, this can often be difficult as evaluation of professional development requires "testing both a theory of teacher change (e.g., that professional development alters teacher knowledge, beliefs, or practice) and a theory of instruction (e.g., that changed practice influences student achievement) - both of which are necessary to complete our understanding of how professional development works" (Wayne, Yoon, Zhu, Cronen, & Garet, 2008, p. 185).

Program outcomes

Program outcome studies are important as they place a large emphasis on the context of the technology innovation; various studies have indicated the importance of the context such as school culture or district vision (Lowther, Inan, Strahl, & Ross, 2008). Program outcome studies typically use case study methodology to collect information from a variety of representatives (e.g., administration, technology coaches, teachers, students) and sources (e.g., surveys, interviews, documents). More often than not, these are longitudinal, large-scale studies and provide context-rich information regarding successful professional development practices (Lawless & Pellegrino, 2007). Program outcome studies tend to focus on formative issues (e.g., implementation, cost, feasibility) in order to revise for future implementation. Although program studies are large, their reports typically do not provide enough information on how to replicate the program for other contexts, as well as why this particular program should be transferred to other contexts (Lawless & Pellegrino, 2007).

Teacher Outcomes

The most common method for evaluating technology innovations or professional development is through teacher outcomes (Lawless & Pellegrino, 2007). Typically, teachers are asked to self-report knowledge, confidence, or skills (Bielefeldt, 2002). However, when teachers are asked to self-report their practices and attitudes, this "may yield data that are inaccurate because they indicate greater-than-actual teacher use of these practices" (Kopcha & Sullivan, 2007, p. 640). For example, teachers are asked to self-report their skills via surveys, some have indicated that this actually measures teacher confidence about the skill, as opposed to their actual skill level (Lawless, Kulikowich, & Smith, 2002; Schrader & Lawless, 2004). In addition to self-reported data, evaluations should include performance measures (e.g., teacher lesson plans) and teacher observations to improve the accuracy of the evaluation (Kopcha & Sullivan, 2007).

The various teacher outcomes that have been measured to evaluate technology professional development activities include the following: attitudes toward technology, confidence (self-efficacy), technology skills, knowledge, and practice. These constructs have been measured through interviews, performance observations, surveys, documents, and assessments.

Attitudes/confidence

Most of the initial research on teacher technology use focused on attitudinal data. Evidence clearly showed that teacher attitudes and self-efficacy have an impact on teacher technology use (Bauer & Kenton, 2005; Piper, 2003; Wozney et el., 2006). As confidence (or self-efficacy) is an internal quality, most studies use self-reported data collected through surveys (Piper, 2003; Piper & Perry, 2008).

Research suggests that time and effort should be devoted to increasing teachers' confidence for using technology, not just to accomplish administrative and communicative tasks, but to facilitate student learning (Ertmer & Ottenbreit-Leftwich, in press). Building teacher confidence with technology can result from incorporating some of the following options: provide teachers time to practice with technology (Somekh, 2008); link new technology uses with individual teacher needs (Kanaya, Light, & Culp, 2005; Zhao & Cziko, 2001); focus on small, successful experiences (Mueller et al., 2008; Ottenbreit-Leftwich, 2007); collaborating with colleagues (Ertmer, Ottenbreit-Leftwich, & York, 2006); provide teachers with models (Ertmer, 2005); and experiences over extended periods of time (Hennessey, Ruthven, & Brindley, 2005).

Knowledge/beliefs/practice

Although most teachers seem to be developing basic knowledge on how to operate technology such as emailing and creating presentations (CDW-G, 2006; Project Tomorrow, 2008), knowing how to use the tools is only the foundation. Teachers are also required to know how to integrate the tool into the classroom (e.g., develop plans for teaching software to students, select appropriate computer applications to meet the instructional needs of the curriculum and the learning needs of their students, and manage computer hardware and software) (Coppola, 2004). According to Hew and Brush (2007), lack of technology-related management skills can inhibit technology integration.

Haney, Lumpe, Czerniak, and Egan (2002) found that teacher beliefs predicted subsequent classroom action for five of the six teachers observed. In general, teachers with more traditional beliefs implement more traditional or ‘low-level’ technology uses, while teachers with more constructivist beliefs implement more student-centered or ‘high-level’ technology uses (Judson, 2006; Roehrig et al., 2007).

Teacher outcome measures for knowledge and beliefs can include observations (Haney et al., 2002; Windschitl & Sahl, 2002), questionnaire (Mills & Tischner, 2003; U.S. ED, 2000), repeated questionnaire measures (Watson, 2006), interview (Haney et al.; Windschitl & Sahl), field notes, and student focus group interviews (Windschitl & Sahl).

Teacher practice has been measured through interviews (Hughes & Ooms, 2004; Martin et al., 2003), self-reported technology use through surveys (Keller et al., 2004; Mills & Tincher, 2003), and analysis of teacher lesson plans (Mitchem et al., 2003; Yamagata-Lynch, 2003). Mouza (2009) collected surveys, interviews, observations, and artifacts over three years to measure the impact of technology professional development on teacher practice. Findings showed three factors that affected teachers' practice over time: student characteristics, access to resources, and social support and opportunities for peer collaboration.

Student Outcomes

As previously mentioned, student outcomes are the least common measurement for evaluation studies (Lawless & Pellegrino, 2007). In one example, after reviewing student multimedia artifacts from classroom projects, students with teachers who participated in the professional development initiative scored higher in content, design, and overall quality (Cole et al., 2002). Student outcome measures can include projects (Cole et al., 2002), student interviews, and student achievement tests (Lowther, Inan, Strahl, & Ross, 2008).

Perhaps one of the weakest knowledge areas is the lack of knowledge on how technology professional development impacts student learning. As part of a program evaluation, the TnETL program used student performance assessments, focus groups, and student achievement scores to measure student outcomes. The program attempted to engage in educational technology reform by addressing typical key barriers to technology integration. Unfortunately, although school culture demonstrated progress, student achievement gains presented mixed results.

Critical Features and Examples of Technology Professional Development

To evaluate the effectiveness of professional development programs, we can examine the various categories. Technology professional development can be categorized based on delivery method (one-shot workshops, design-based, coaching/mentoring, train-the-trainers, collective participation), context (duration, intensity, support), and content focus (skills, coherence, student-centered).

Technology Professional Development Delivery Method

Although these delivery methods have distinct characteristics, they are not necessarily mutually exclusive: one-shot workshops, design-based, coaching/mentoring, train-the-trainers, and collective participation.

One-Shot Workshop Method

The most common professional development approach in the U.S. is the 'one-shot workshop'. Teachers participate in a workshop for one to eight hours covering a specific topic (Choy, Chen, & Bugarin, 2006; Prasad, Lewis, & Farris, 2001). Evidence has suggested that this approach has not created lasting teacher change (Sorge & Russell, 2000).

In 1999, two-thirds of teachers participated in a within-district workshop with regards to formal technology-related professional development (U.S. ED, 2000, Teachers' tools for 21^{st} century). When one-shot workshops are utilized for technology professional development, the topic is typically focused on operational technology skills as opposed to integrating technology into the curriculum (McCannon & Crews, 2000). Researchers suggest the field is evolving from this type of professional development in accordance with best practices (Lawless & Pellegrino, 2007). However, it seems practitioners are still utilizing this method to quickly deliver technology content. For example, in 2005, 83% of public school teachers attended workshops on how to integrate the Internet into the school curriculum (Wells & Lewis, 2006).

The challenge associated with this approach is often difficult for teachers to transfer this knowledge back to their classrooms as it is disconnected from pedagogical practices (Hughes, 2005). The advantages are that schools can quickly target necessary topics such as a new school-wide grading system.

Design-Based Method

Design-based professional development promotes the importance of having teachers use technology in authentic contexts, whereby they learn the technology skills as they address a situation in their own classroom (Koehler, Mishra, & Yayna, 2007). Through semester-long college classes, teachers worked in collaborative groups to develop technology solutions to authentic pedagogical problems (Koehler et al.). Once teachers propose a solution, they are required to learn about the technology and apply newly learned skills to solve the authentic pedagogical problem. Teachers learn new technology skills, but also learn how to teach themselves to use technology.

In a meta-analysis on technology professional development, Wells (2007) found that a teacher's ability to actively experience the technology innovation during professional development was one of the five key design factors for success. Successful professional development should include opportunities for teachers to build and create their own technology-based materials. Teachers are more likely to use these materials in their classrooms thus transferring the knowledge gained from the professional development (Kanaya et al., 2005).

Because there is no one solution, teachers are likely to encounter multiple solutions and ways to use technology (Koehler et al., 2007). In addition, when teachers have ownership over technology uses, they are more likely to be confident in implementing these uses in their classrooms (Hughes, 2005).

The challenges associated with the approach could be time and resources. Customizing each professional development activity to meet the needs of each teacher may prove to be time consuming. Sustainability and scheduling these professional development situations may also require more one-on-one attention.

Coaching or Mentoring Method

The mentoring (or coaching) approach is facilitated through a colleague that works with the teacher to provide individual professional development to meet his/her specific needs (MacArthur & Pilato, 1995). Within technology professional development, the mentor typically assists the teacher with technology skill development, integration of technology, and management of technology resources within the specific classroom context. A mentoring approach can provide onsite, ongoing, and just-in-time professional development (Glazer & Hannafin, 2008).

Many have suggested mentoring as an ideal solution to encouraging teachers to integrate technology into their practices (e.g., Di Benedetto, 2005). In one comparison study, May (2000) found that teachers in mentoring technology professional developments showed three times the growth in their abilities than those teachers in traditional technology professional developments. Mentoring has the capacity to increase the amount and level of technology use in teacher practices (May; Sugar, 2005; Swan & Dixon, 2006).

A key purpose for this approach is to promote teacher confidence levels in using technology. As mentoring typically occurs within the teacher's environment, the teacher tends to build confidence in using the technologies within their classrooms (Cole, Simkins, & Penul, 2002; Sugar, 2005; Swan & Dixon, 2006). Technology mentors also help teachers overcome specific barriers or obstacles to technology that they are experiencing within their specific environments (May, 2000; Sugar; Zhao & Bryant, 2007). Although the individual attention provided during this process makes it highly successful, it may not be appropriate for all. This approach appears to be successful for more reluctant or fearful teachers, as opposed to those teachers who are more comfortable using technology (Sugar).

The challenges associated with the mentoring approach are that the process can sometimes take precedence over technology integration (Barron, Dawson, & Yendol-Hoppey, 2009). In addition, the time and resources associated with technology mentoring programs may impact the sustainability of such programs (Barron et al.; Richardson, Ertmer, Aagard, Ottenbreit, Yang, & Mack, 2007; Swan & Dixon, 2006). Perhaps utilizing technology tools could assist with sustainability of mentoring (e.g., technology-enhanced professional development coupled with access to a mentor, electronic mail, and online discussion forums) (Gentry, Denton, & Kurz, 2008).

Train-the-Trainers Method

The train-the-trainer model is typically utilized for reaching a larger audience. First, the trainers will first attend a training session to learn the approach. Then, those trainers return to their schools to deliver the training to their colleagues (Poplin, 2003). One popular program implementing this approach was *Intel: Teach to the Future*. This program focused on the development of teachers' ability to integrate technology into classrooms. *Master teachers* were selected by districts to be trained by the Intel corporation. Those *master teachers* would conduct three trainings within their districts for 60 K-12 *participant teachers*. During the training program, *participant teachers* were introduced new software applications and then, with the guidance of the *master teachers*, developed a technology-rich unit plan (Kanaya et al., 2005).

Train-the-trainer programs are advantageous for implementing large-scale innovations. They tend to be cost effective and can deliver a fairly consistent message to teachers throughout a large district. It is also successful due to the on-site nature of this approach that affords more intimate and personally relevant situations (Hofer, 2001). In addition, since the trainers are teachers from the school or district, they are better suited to understand the culture and requirements within that particular environment (Howard, McGee, Schwartz, & Purcell, 2000).

The challenge of this approach is associated with the large number of teachers involved in the training. Management of this professional development approach can be quite complex. In addition, as this is typically a large deployment effort, training can be more general and less personally relevant in order to apply to a variety of educational settings and individual teacher needs (Gonzales, Oickett, Hupert, & Martin, 2002).

Collective Participation Method

Collective participation can be defined as any form of collaboration between teachers in the same school, grade, or content area (Desimone, 2009). In terms of technology professional development, collaborative participation was found to be one of the top five influential factors associated with a large, three-year professional development model (Wells, 2007).

One popular form of collective participation is *Communities of Practice (CoP)*. Teachers in CoPs meet on a continuous basis to discuss timely issues they are currently dealing within their classrooms. The culture of the group is critical to the success of any CoP. When teachers feel supported and trust others, they feel comfortable trying new technologies and seeking advice and failing (Glazer et al., 2009). Developing this trust takes time and so it is important to devote enough shared time to promote reciprocal interactions (Frank, Zhao, & Borman, 2004; Glazer et al., 2009).

In addition to building trust, the culture of the CoP also needs to be directly relevant to all teachers participating. If teachers fail to identify with the community, they will not advance their professional knowledge (Glazer et al., 2009). Studies have shown that CoPs help teachers maintain clearer focus on their own technology integration goals (Kanaya et al., 2005) and encourage them to integrate new technologies and pedagogies (Glazer et al., 2009). As both a benefit and limitation to this particular approach, communities of practice allow teachers to direct their own professional development. This can lead to highly individualized and just-in-time professional development, or it can lead to disorganized and unproductive professional development.

Technology Professional Development Context

Duration and Intensity

Most acknowledge that teacher professional development of longer duration is more likely to result in changed teacher knowledge and practice (Brinkerhoff, 2006; Wells, 2007). In an effort to examine which professional development factors and strategies result in teacher change with technology, Wells (2007) found that the variable 'duration and intensity' was one of the top five most influential key design factors in successful technology professional development. Lawless and Pellegrino (2007) found that high-quality technology professional development was typically longer in duration, but their measurement of duration included contact hours and follow-up support. Typically, the more technology professional development teachers receive, the more likely they are to use technology integration at school (Dawson & Rakes, 2003).

In addition to duration, the intensity can also impact the success of professional development. While duration is defined as the number of total contact hours involved, intensity is the frequency or length of training sessions. Kanaya and colleagues (2005) found that low intensity was problematic. Teachers were more likely to implement technology-rich units they designed in higher-intensity professional development. When teachers participate in low-intensity trainings, they have difficulty maintaining a focus on the goals of the program; each time they meet, they need to revisit the goals. However, when the intensity of the program is high, teachers participate in more concrete (thought short-lived) communities of practice and maintain focus on the program goals (Kanaya et al., 2005).

Brinkerhoff (2006) also found that duration could impact teachers' computer self-efficacy. After the first summer session (consisting of 90 contact hours) teachers showed no significant increase in computer self-efficacy, however, by the end of the academy, teachers showed a significant increase in computer self-efficacy. While Brinkerhoff attributes this increase to the increased duration, the change could have been a result of the intensity (longer overall time span) or the continuous support.

Additional Support

Regardless of the duration or intensity of a particular program, many suggest the main purpose of supporting prolonged duration is the importance of on-going support (e.g., providing technical and pedagogical support for technology integration, or time to collaborate and explore technologies) (Lawless & Pellegrino, 2007; Vrasidas & Glass, 2007). One study examined the difference between teachers that had participated in the same professional development, but one group received one-on-one follow-up support (Davis, 2002). The teachers receiving the follow-up support were found using higher levels of technology integration while the teachers who did not receive support expressed difficulties implementing technology. Follow-up support can also facilitate collaboration, address typical issues encountered by teachers, and leads to increased frequency and higher levels of quality technology integration (Davis).

Another level of support that assists in technology integration is the school culture or vision for technology. Although the concrete elements such as resources and infrastructure are important, these elements will most likely not be successful without a school or district-wide vision for how technology should be used (Ertmer & Ottenbreit-Leftwich, in press; Zhao & Frank, 2003).

Technology Professional Development Content Focus

Technology has recently become a popular topic area for teachers to choose to participate in for their professional development requirements. In a 2000 U.S. national study, teachers were asked to select their top priorities for their own future professional development from a list of seven topics. The use of technology in instruction was the second most popular topic area selected (21%) following their main subject field (24 percent) (Choy et al., 2006).

Skills and Integration Content Focus

Although this trend has been decreasing, many technology professional developments tend to focus on specific technology skills such as how to use gradebook software or how to manage the attendance system. When technology skills are the focus of professional development, it is likely that those skills will not be transferred to the classroom. This could be due, in part, to the fact that when teachers approach an unfamiliar tool, "they tend to implement it in the ways in which they have been shown" (Matzen & Edmunds, 2007, p. 427). Therefore, they would be unable to transfer these skills to their classroom in any other way.

Technology professional development has been found to be more successful when it focused on integrating technology into the content as opposed to technology skills focused (Wells, 2007). Based on a review of the literature, Hew and Brush (2007) concluded that effective professional development for technology integration required a focus on content that included 1) technology knowledge and skills; 2) technology-supported pedagogy knowledge and skills (the ability to see a clear connection between the technology being used and the subject content being taught); and 3) technology-related classroom management knowledge and skills.

Coherence with Existing Beliefs Content Focus

Content covered in technology professional development is more likely to transfer to the classroom if it aligns with the teacher's goals for learning and the goals for their students. In other words, if the teacher can work on problems they encounter in their classrooms, it is more likely that the solution they develop through the technology professional development will be transferred and used in the classroom (Kanaya et al., 2005). For example, one situated technology professional development had teachers sharing 45 minutes of planning time to collaborate. However, when topics were perceived as irrelevant, teachers tended to tune out and direct attention to individual responsibilities such as grading student papers or checking email (Glazer et al., 2009).

School and subject culture should also be taken into account when deciding on content for technology professional development (Ertmer & Ottenbreit-Leftwich, in press). Several research studies have found that a technology innovation was less likely to be adopted if it deviated too greatly from the existing values, beliefs, and practices of the teachers and administrators in the school (Abbott & Faris, 2000; Windschitl & Sahl, 2002). Conversely, when colleagues have a positive view about technology, this can influence a teachers' use of technology (Zhao & Frank, 2003).

Student-Centered Technology Content Focus

Many professional developments have focused on teaching student-centered or constructivist uses of technology (Mills & Tinschner, 2003; Levin and Wadmany, 2005). Technology professional developments often focus on this content with the hope that these practices will transfer to the teachers' classroom, thereby furthering educational reform. Yet, these efforts are not always successful. One study found that although student-centered technology professional development did increase positive attitudes and frequency of use, there was no significant change in use of technology with students or student-centered learning (Di Benedetto, 2005).

However, most researchers agree that this particular transformation from traditional to constructivist practices takes time (Wells, 2007). Longitudinal studies investigating teachers' adoption of technology have described a pedagogical evolution as teachers incorporate more technology into their practices (Mills & Tischner, 2003; Windschitl & Sahl, 2002; Matzen & Edmunds, 2007). Perhaps the most recognized study is the ten-year longitudinal, Apple Classrooms of Tomorrow (ACOT) program. In ACOT, teachers' observations of changes in their students prompted them to reflect on their current beliefs about teaching and learning, which then led to changes in their beliefs (Sandholtz & Ringstaff, 1996; Sandholtz, Ringstaff, & Dwyer, 1997).

U.S. Educational Policy: Technology and Professional Development

General U.S. Education Policies

Unlike most countries, the U.S. education system is not centrally controlled. State and local education agencies (SEAs/LEAs) have primary control over educational policies and practices. The U.S. is comprised of over 15,000 LEAs across the country. Each state establishes specific policies, but the LEAs address these policies in a variety of ways. More recently, the federal government has attempted to influence state policies by tying new policies (e.g., No Child Left Behind Act) to federal funding. Most LEAs will accept the funding and address the federal requirements, thus providing the federal government with more influence on national education policy than in the past (Goldmann, 2007).

The most influential federal education policy is currently the No Child Left Behind (NCLB) Act. The NCLB Act attempted to promote a rigorous plan for educational reform, focusing heavily on increasing student achievement and teacher quality. To achieve these ends, schools are held accountable for students' assessment scores. This directly relates to the curriculum, professional development, and materials selected by LEAs. LEAs are responsible for ensuring that these selections are high quality and research-based best practices in order to increase student achievement.

U.S. Educational Technology Policy

Since 2006, the budget for the Department of Education has slightly increased (see Figure 1).

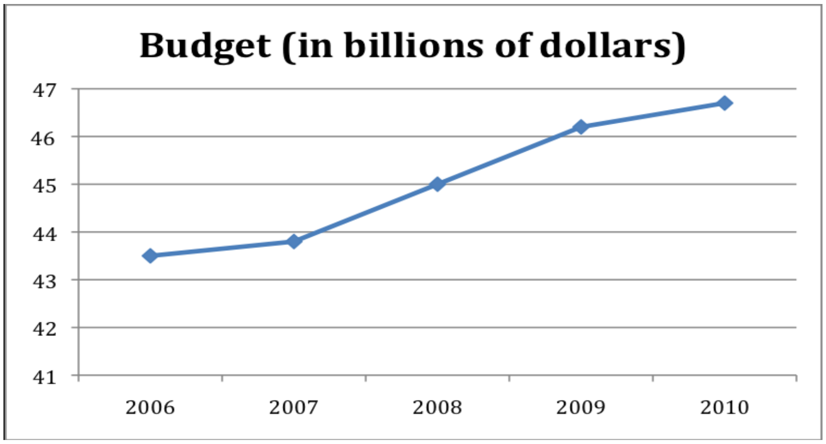

Figure 1. *Department of Education Budget (2006-2010).*

Although the federal government only supplies eight percent of the total spending for education in the U.S., they provide up to 50% of the technology spending in some districts across the U.S. (Patrick, 2008). This tends to support the notion that the federal government views technology as critical to education. Without this support, technology may not be as heavily implemented.

History of the Office of Educational Technology

The importance of technology in education emerged in 1983 when the federal education report, *A Nation at Risk*, identified the importance of computers, electronics, and related technologies in students' futures (National Commission on Excellence in Education, 1983). Concerns related to technology use in schools prompted the U.S. Congress to create a federal Office of Educational Technology (OET) in 1996. The goal of this office was to increase the effectiveness of technology use in schools by funding research and development projects to investigate the effectiveness of technology in schools. The OET has also created three official national technology plans.

Getting America's Students Ready for the 21st Century (1996)

The first national technology plan, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*, was created in 1996. The plan had four primary goals: (1) All teachers and students will have modern multimedia computers in their classrooms, (2) Every classroom will be connected to the information superhighway (3) Effective software and online learning resources will be an integral part of every school's curriculum, and (4) All teachers in the nation will have the training and support they need to help students learn using computers and the information superhighway (OET, 1996). Overall, this plan focused on baseline infrastructure items: increasing technology access, equipping teachers with technology skills, and using technology within the curriculum (e.g., drill-and-practice software). Since this represented initial technology use in schools, the plan focused on building the capacity for educational technology use.

Increased computers. The first goal focused on increasing the number of multimedia computers in classrooms. As of 1999, 99% of public school teachers reported having access to computers somewhere within their school (U.S. ED, 1999). In a 1998-2001 survey, educators reported having access to computers, but claimed student access was still inadequate; most teachers had one or two computers for students to access in their classrooms (NEA, 2004).

Increased Internet access. To achieve the second goal, the U.S. congress approved a national technology program titled E-Rate. E-Rate was (and still is) a federally funded program providing discounts on telecommunication services, Internet access, and internal connections to schools and libraries. This program has provided 2.25 billion dollars per year to schools and libraries (U.S. ED, n.d.). Many attribute the dramatic increase in school connectivity to this program (Goldmann, 2007). Internet access in public school instructional rooms increased from 14% in 1996 to 77% by 2000 (Wells & Lewis, 2006).

Increased effective software and online resources. Although there was a dramatic increase in resources, several studies showed that teachers were still not utilizing the technology. As the third goal, software and online learning resources were still not integrated into every school's curriculum (U.S. ED, 1999) although most educators reported that software was considered adequate (NEA, 2004).

By 1999, teachers reported using computers "a lot" at school to create instructional materials (39%); administrative record-keeping (34%); communicate with colleagues (23%); and gather information for planning lesson (16%). In addition, teachers reported using technology to a moderate or large extent for the following instructional purposes: classroom instruction (53%), computer applications (e.g., word processing, spreadsheets)(41%), practice drills (31%), research using the Internet (30%), solve problems and analyze data (27%), research using CD-ROMs (27%), produce multimedia reports/projects (24%), graphical presentations of materials (19%), demonstrations/simulations (17%), (U.S. ED, 1999). Although this may have been an increase from previous uses, teachers were still not using technology at the desired level, regardless of almost all schools having access to at least one computer with the Internet.

Increased teacher training and support. Lack of technology use was typically attributed to a lack of teacher training. Therefore, the fourth goal of the plan sought to provide teachers with training and support to help students learn with technology. In 1995, the Office of Technology Assessment urged LEAs to devote at least 30% of technology budgets to teacher training and support (OTA, 1995). While K-12 schools spent only 6% of their $4.2 billion technology budget on training in 1996 (CEO Forum, 1996), this increased to 17% by 1999 (Market Data Retrieval, 1999).

Even with the increase in technology training for teachers, teachers reported being uncomfortable with their level of training: 53% reported themselves as somewhat prepared to use technology and 13% reported themselves as not at all prepared to use technology (U.S. ED, 1999). Likewise, nearly half of teachers indicated that upgrades and technical support were inadequate and served as a barrier to their technology use (NEA, 2004).

Typically, during this time, technology training was too basic and/or short to prepare teachers to use technology. One study found that although 78% of teachers received some technology professional development, it was often too brief (less than five hours) to make an impact (Market Data Retrieval, 2000). In terms of focus, 96% of technology training focused on basic skills (U.S. ED, 2000). However, almost two-thirds of teachers (65%) had never used a computer before and basic skills may have been a necessary focus (Moe & Blodgett, 2000). The most common formal technology-related professional development topics were email, word processing, Internet browsers, and desktop publishing or presentation programs. Although they were learning skills, the vast majority of teachers still indicated a need for professional development in integrating technology into instruction (U.S. ED, 2000).

To support an effort of increasing teachers skills with regards to technology, the U.S. Department of Education funded a new program: Preparing Tomorrow's Teachers to Use Technology (PT3). The PT3 program was created to "prepare prospective teachers to use advanced technology to help all students to meet challenging state and local academic achievement standards and to improve the ability of institutions of higher education to carry out such training" (Goldmann, 2007, p. 141). Many of these programs focused on developing both technology skills and technology integration abilities (Mims, Polly, Shepard, & Inan, 2006). There was an extraordinary growth in publications and presentations related to increasing teacher technology professional development.

The role of this first plan seemed to emphasize developing the infrastructure for technology and basic teacher technology skills. The national standards for students (created in 1998) and teachers (created in 2000) were primarily focused on building technology skills (International Society for Technology in Education, n.d.). Subsequent plans would expand on these themes from the first plan, building on the infrastructure and skills, moving towards a heavier focus on integration and application of technology resources for learning.

Putting a World-Class Education at the Fingertips of All Children (2000)

The second plan, *e-Learning: Putting a World-Class Education at the Fingertips of All Children*, was created in 2000 (OET, 2000). This plan outlined five national goals: (1) All students and teachers will have access to information technology in their classrooms, schools, communities and homes, (2) All teachers will use technology effectively to help students achieve high academic standards, (3) Research and evaluation will improve the next generation of technology applications for teaching and learning, (4) All students will have technology and information literacy skills, and (5) Digital content and networked applications will transform teaching and learning (OET, 2000). Of these four goals, this paper will focus on the first three goals, as they pertain more directly to teachers and teacher training.

Increased Internet access (home, schools, and communities). Like its predecessor, this plan focused on improving access to schools. With the help of the E-rate program, the percentage of all public school instructional rooms with Internet access increased from 77% in 2000 to 93% in 2003 (Wells & Lewis, 2006). However, teachers reported that less than 20% of schools had at least one computer for every four students in 2000 (Becker, 2001). Conversely, in another national survey that same years, teachers reported on their perceived availability of technology in their classrooms: while 57% of teachers reported that computers were sufficiently available, 35% of all teachers disagreed (U.S. ED, 2001).

Increase teacher use of technology and research on best practices. As of 2000, teachers were still not using technology in the ways research suggested. Teachers reported using technologies that targeted primarily lower-level teaching and learning tasks: email (68%), telephones (56%), Internet classroom access (61%), and CD-ROM reference materials (51%) (U.S. ED, 2001). This was contrary to the discussions associated with best technology education practices that suggested more student-centered uses of technology (Cuban, 2001).
Cuban (2001) further iterated this problem with his infamous publication, *Oversold and underused: Computers in the classroom*. Although U.S. schools had abundant resources and educational technology was perceived as a method for transforming education, technology use was not widespread or consistent. When technology was used, it was only employed as a method to reinforce traditional teaching practices (Cuban).

It became evident that technology skills were not enough to encourage teachers to integrate best practices of technology. Although teachers had begun to develop technology skills, they were not knowledgeable about how to integrate technology into the curriculum (Web-Based Education Commission [WBEC], 2000). In order to investigate methods of transforming education with technology, the third goal of the plan emphasized research to investigate best practices.

The Department of Education funded a review of research findings to examine the impact of technology on teaching and learning (Ringstaff & Kelley, 2002). Based on this review, studies showed technology had the capacity to "increase student motivation and engagement, prepare students for jobs, and enhance students' ability to work collaboratively" (p. 24), although these claims still required further research (Ringstaff & Kelley).

The review also found that effective technology use depended heavily on teachers. Teachers needed adequate and appropriate training, and to achieve effective technology use, teachers had to believe that technology benefited their students (Ringstaff & Kelley, 2002). In fact, another review of over 300 research studies found the most significant factor to improve student achievement through the use of technology was teacher training (Sivin-Kachala & Bialo, 2000).

During this period, professional development in technology was a high priority (WBEC, 2000). The Higher Education Act Amendments (passed in 1998) included requirements for teacher training in the effective uses of technology in the classroom. Following this priority, 42 states required teachers to demonstrate proficiency in technology to receive certification (Trotter, 1999).

New funding initiatives were also implemented to promote best practices for teacher technology use and development. The National Science Foundation supported the "Inquiry Learning Forum" which provided teachers with an online community of other teachers and engage in discussions and activities of best practice. The PT3 program had distributed $150 million to 352 teacher education programs (WBEC, 2000). However, the funding for the PT3 program was eliminated and the last round of projects were funded for 2003-2006.

Finally, research investigated school and district level factors that influenced the successful use of technology. One such factor was sufficient and accessible equipment: adequate computer-to-student ratio, placing computers in the classroom as opposed to computer labs, and increasing computer access at home all increased the effectiveness of technology use in schools. Long-term planning, technical support, and instructional support were also found to be significant influences for positive effects of technology in education (Ringstaff & Kelley, 2002).

To promote educational technology as it impacts student achievement, the federal government included the Enhancing Education Through Technology (EETT) program as part of the No Child Left Behind Act. The purpose of EETT was to use technology to (1) improve student academic achievement, (2) ensure every student achieves technology literacy by eighth grade, and (3) encourage best practices associated with technology integration in teacher training and curriculum development. States receive funds based on the number of underprivileged students and states accepting EETT monies are required to (a) use at least 25 percent of the funds for teacher professional development, and (b) submit a federally-approved state technology plan.

Increased digital content. As the fifth goal of the 2000 plan, digital content and networked applications were proposed to transform teaching and learning. As of 1999, a small number of K-12 schools (13%) were already subscribed to online curriculum (Market Data Retrieval, 1999), but the federal government sought to increase the number of schools accessing digital content and online curriculums in a number of policy documents (OET, 2000; WBEC, 2000). To promote the use of digital content, the U.S. Department of Education sponsored the Gateway to Educational Materials, which contained more than 14,000 lesson ideas and learning resources from over 200 organizations.

Toward a New Golden Age in American Education (2004)

The 2004 National Education Technology Plan (*Toward a New Golden Age in American Education: How Today's Students, the Internet and the Law are Revolutionizing Expectations*) shifted from setting goals to providing a vision of systemic approaches to transforming education by using technology to support broader education goals (OET, 2005). The plan included the following seven action steps for using technology to improve student achievement: 1. Strengthen leadership, 2. Consider innovative budgeting, 3. Improve teacher training, 4. Support e-learning and virtual schools, 5. Encourage broadband access, 6. Move toward digital content, 7. Integrate data systems. Of these major action steps, this paper will focus on the third major action step, as it directly pertains to teachers and teacher training.

Access to research, examples, and innovations. Within this step, "Teachers have more resources available through technology than ever before, but some have not received sufficient training in the... effective use of technology to enhance learning. Teachers need access to research, examples and innovations as well as staff development to learn best practices" (U.S. ED, 2004, p. 40). To support teacher access to research, examples, and innovations, the Department of Education website hosts various reports. For example, one report currently available on the website (*Innovations in education: Connecting students to advanced courses online*) serves as a guide to schools that lack the resources to provide a broad array of advanced courses in order to consider innovative methods for implementing online learning. In another report (*Evaluating online learning: Challenges and strategies for success*), rigorous evaluations have been conducted to assist evaluators and program leaders who seek to use data to inform program improvement aimed at achieving positive outcomes for our nation's students.

The plan also provided recommendations for SEAs/LEAs: (1) improve the preparation of new teachers in the use of technology, (2) ensure that every teacher has the opportunity to take online courses, (3) improve the quality and consistency of teacher education through measurement, accountability and increase technology resources, and (4) ensure that every teacher knows how to use data to personalize instruction. These recommendations are discussed in the following sections.

Improve the preparation of new teachers in the use of technology. Research has indicated that although schools are currently equipped with adequate technological resources, teachers are still not utilizing those resources in their classrooms (Project Tomorrow, 2008). In the National Educational Technology Plan, the government suggested "The problem is not necessarily lack of funds, but lack of adequate training and lack of understanding of how computers can be used to enrich the learning experience" (U.S. DOE, 2004, p. 22).

SEAs (n=26) responded to this action step by including teacher technology requirements for either initial licensure or recertification; an additional five states have technology requirements for both (Education Week, 2009). This has increased the number of teacher education programs that include technology experiences within their program.

A recent report was published by the National Center for Education Statistics (Kleiner, Thomas, & Lewis, 2007) providing additional insight regarding the types of technology experiences teacher education programs provide to preservice teachers. In this study, 1,439 degree-granting four-year institutions with teacher education programs for initial licensure were surveyed to determine the types of technology experiences these institutions provided to students in their programs. Results of the survey indicated that nearly all teacher education programs included topics specifically focusing on using technology to support instruction in their technology courses and experiences for prospective teachers. These topics included "integrating technology into instruction" (100%), "the use of Internet resources and communication tools" (100%), "using technology to address content standards" (99%), "using multimedia for instruction" (95%), and "using technology to access or manipulate data to guide instruction" (90%). However, the "… reports of topics taught within programs should not be taken to mean that the topics were taught in any depth or breadth across the curriculum. Rather, the estimates only indicate that these topics were taught *at least to a minimal degree*…" (Kleiner, Thomas, & Lewis, 2007, p. 6). Although, it is difficult to determine the depth or quality of technology integration experiences, it at least indicated that programs are beginning to incorporate technology.

Provide teacher opportunities to take online courses. Technology is also being used as a tool to facilitate teacher development. Online learning is becoming an important facet of K-12 education. One of the requirements of NCLB is to have highly-qualified teachers in every classroom. In order to meet these requirements, SEAs/LEAs are supporting online teacher professional development courses as a way to develop high-quality teachers. Online course availability provides teachers with greater opportunities to engage in a variety of topics. The federal government supports this initiative through the Ready-to-Teach grant, which funds PBS Teacherline, Teacher-to-Teacher program, and e-Learning for Educators (EfE). All provide high-quality, research-based, online professional development to teachers. Of the 12,000 teachers that participated in EfE, 90% report their instructional practice has improved and 84% agree that using EfE content has increased student academic performance (SEDTA, 2008).

Approximately one-third of teachers have taken an online course for professional development. Online professional development allows teachers more flexibility: 26% of teachers indicated they prefer online professional development as it assists with scheduling concerns (66%), time savings (40%) and the ability to control their own learning pace (41%)(NetDay, 2008). In addition, the executive director of SETDA suggested using technology to meet the demands of sustainable, on-going learning opportunities for teachers: "While some school districts and states are moving toward on-going relevant and continuous learning for teachers, this is not necessarily the standard and is not scalable nationwide. Technology is key to make this happen for more teachers in more districts and states. Online learning communities, education portals, and coaching and mentoring are some of the proven methods for providing sustainable professional development for our teachers" (SEDTA, 2008).

Improve teacher education through measurement and resources. As shown through the progression of educational technology policy in the U.S., professional development and teacher training in technology has been, and continues to be, a high priority. In general, states have their own requirements for teacher education program. As of 2008, 44 states include technology standards for teachers (Education Week, 2008). For initial licensure, 19 states require technology coursework or test, and nine states require the same of administrators.

As a federally suggested method for improving teacher education, the availability of technology resources in public schools has increased. In 2005, the average public school contained 154 instructional computers, compared with 90 in 1998. In addition to this increase in instructional computers, the percentage of instructional rooms with access to the Internet increased from 51 percent in 1998 to 94 percent in 2005 (Snyder, Dillow, & Hoffman, 2009). Today, nearly 100% of public schools and 93% of instructional rooms have access to the Internet (NCES, 2006).

Teachers use data to personalize instruction. The fourth and final recommendation to SEA/LEAs is that every teacher be prepared to use data to personalize instruction. This is marked by the ability to interpret data to understand student progress and challenges, drive daily decisions and design instructional interventions to customize instruction for every student's unique needs. In other words, teachers should be able to use data systems to inform instructional decisions and differentiate for individual students.

Utilizing student data to make educational decisions has recently been strongly advocated by the federal government's NCLB Act (Gallager, Means, & Padilla, 2008; Means, Padilla, DeBarger, & Bakia, 2009). As specified by NCLB, states, districts, and schools must use data to drive instruction, professional development, fiscal decisions, to maximize student achievement, ensuring all students reach proficiency in reading and math by 2014. Many have purported that technology can assist in this endeavor, making both the collection and analysis process easier and more efficient (OET, 2004). Patrick (2008) describes the importance of data driven decision-making, its impact on U.S. education, and how technology supports this initiative:

> "Throughout the North American region, new, twenty-first-century models of education marked by personalized and individualized instruction, using formative assessment, providing feedback to instructors and students in real-time, connecting information from schools into the homes, and supplying fresh, accurate data for decision-making in the classroom and board room are made possible by online learning, providing a torrent of information in a digital environment. The focus for information and communication technology (ICT) in schools is shifting from devices to processes. Infrastructures with ubiquitous computing, wireless, high-speed networks and digital platforms, or learning management systems, support increased mobility and flexibility and are necessary drivers of a new delivery system of education." (Patrick, 2008, p. 10, emphasis added)

Teachers can access longitudinal records of student achievement to better address the needs of those particular students they are currently teaching. Yet, the only information that the majority of teachers had access to electronically were class attendance (55 percent for 2007) and course grades (50 percent in 2007). Teacher access to student data is increasing: 37% had access to standardized test scores for their current set of students in 2007 whereas only 19% reported this kind of access in 2005 (Gallagher et al., 2008).

CURRENT.

Due to globalization, the U.S. feels pressured to be innovative and increase our educational gains. As stated in a recent U.S. Department of Education report, "Our population growth will not keep pace with that in the developing world. For every child born in America today, more than four are born in China, and almost six are born in India. As these two countries also gear up their education systems for this global economy, they possess more students and thus more raw potential than we do. As such, we cannot compete sole on volume, we must compete on quality; we must do a better job of educating each and every one of our children" (U.S. ED, 2008, p. 2).

Educational quality is a key proponent to our success as a nation. Therefore, current policy places a strong emphasis on using technology to achieve educational quality and reform efforts. Policymakers especially seem to believe in the overlap between NCLB, technology, and educational reform. In 2004, Rod Paige (Secretary of Education) wrote the following statement regarding these three constructs:

> "Schools are making tremendous progress under the historic reforms in *No Child Left Behind*, and student achievement is improving. Teachers and students are transforming what can be done in schools by using technology to access primary sources, expose students to a variety of perspectives, and enhance the learning experience with media, simulations, and interactive software. In many cases, we are revolutionizing education and creating learning environments that equip teachers with new tools to individualize instruction; engage students in ways never before possible; empower teachers, parents, and students with real-time data on student performance; and expand access to resources." (OET, 2004, p. iii)

However, only a small percentage of teachers (often under 5%) report using technology to support advanced instructional practices with their students on a weekly basis, such as inquiry based strategies (3%) and solving real-world problems (3%) in school year 2004-05 (U.S. ED, 2009).

Perhaps the most interesting issue associated educational reform is juxtaposition between best practices associated with student-centered learning and the effects of NCLB. In the U.S., practitioners struggle with educational reform (technology-rich student-centered practices) and standardized assessments (NLCB). No Child Left Behind and standardized testing present a challenge to teachers looking to develop technology integration abilities. This is due, in part, to the pressures that accompany NCLB; these pressures prevent teachers from risk-taking and experimentation (Liu & Szabo, 2009). NCLB has made it difficult for teachers to experiment with new methods and technology when schools and districts use standardized student achievement tests to measure teacher success. This often leads teachers to "teach to the test" (Liu & Szabo, 2009; Means et al., 2009).

Educational reform associated with technology-rich student-centered practices supports multiple perspectives; there is no one-way to solve a problem. Standardized tests are typically unable to measure multiple solutions. Evaluation of these new practices would require measurement tools such as portfolios and authentic assessments (Vrasidas & Glass, 2005). However, this is a difficult charge, especially with the large number of students within the U.S. to measure. Although policymakers have considered NCLB successful, most practitioners would disagree (Cobb & Rallis, 2008; Kaplan & Owings, 2003).

Recommendations for Technology Professional Development

Based on this review, three main constructs are necessary to encourage technology adoption in K-12 schools: vision, resources, and support.

Vision

Whether approaching technology adoption from a national, state, local, or school level, the first step for any successful program requires a vision. This vision should not focus on technology use; instead, the focus should be based on the broad educational goals. In other words, what should education look like?

For example, as a sponsored U.S. Department of Education project, *School 2.0* conceptualizes the next evolution of education. Learning is projected to include not just the school building, but the combination of home, school, and community collaborate together in order to provide continuous learning throughout the day while also providing a wide variety of learning opportunities. This vision focuses on learning, but illustrates how technology could support this new vision.

In general, educational visions should incorporate research-based practices and views of all stakeholders (students, parents, teachers, administrators, etc.) (Reigeluth, Carr-Chellman Beabout, & Watson, 2008). For example, one-to-one laptop initiatives (which supplies every student with a laptop) have been suggested as strong methods for successful technology integration and educational reform. Research suggests that ubiquitous access to technology can improve student achievement (e.g., Cavanaugh, Dawson, & Ritzhaupt, 2008). Based on this research, some schools have rushed into this decision without contemplating a vision or plan. One technology employee described how the lack of a plan impacted technology use in one school using this laptop initiative:

"A plan would have been nice! We had [administrators] who made the decision to supply laptops to our [students]. It was so impromptu that the technology department didn't have any input as to how these should be implemented… We had no time set aside for staff development or maintenance issues and curriculum integration ideas… Some of the teachers do okay integrating the technology. Others are using [laptops] as expensive notepads" (Livingston, 2006, p. 72)

This statement alludes to several important features of a vision or plan: the involvement of all stakeholders and the creation of plans for curriculum, maintenance, and support. The two most important factors in the success of Maine's state-wide laptop initiative were the leadership's visions and expectations and the quality of teachers' practices (Manchester, Muir, Moulton, 2004).

Resources

Research has shown that lack of access to technology resources creates barriers to technology integration (Hew & Brush, 2007). As shown through the evolution of U.S. educational technology, the infrastructure was necessary to begin the process of integrating technology into K-12 schools (Culp et al., 2005). However, educators should follow the rule that technology purchases should align with the overall vision and research-based practices. As shown through the one-to-one laptop initiative, without a plan for those resources (curriculum, maintenance, and training), technology can end up reinforcing existing practices or not be used at all. Furthermore, when budgeting for new technology resources, budgets should also include funding for curriculum, maintenance, and training. Technology resources alone cannot facilitate educational reform and technology integration.

Support

Even with a vision and technology resources, technology integration is not achievable unless teachers receive support for technology use in their classrooms. This support can include articulating school/district shared visions and expectations for technology use, negotiating access to technology resources, providing technical and pedagogical support for technology integration, and providing time to collaborate and explore technologies. These various levels of support are all critical to facilitating teachers' technology use on a daily basis.

In general, on-site, personally relevant, and just-in-time professional development seems to be the most effective contributing factor to teacher technology development. Teacher technology development depends greatly on the individual. Coppola (2004) found that even when teachers are in the same building, their developmental patterns varied. Therefore, to encourage teachers to adopt technology, effective professional development programs need to introduce content and methods that are individually relevant to each teacher (Anderson & Maninger, 2007; Watson, 2006; Zhao, Pugh, Sheldon, & Byers, 2002). For example, when teachers learn how to use technology within their specific content areas and/or grade levels, they can more readily transfer that knowledge to their own classrooms (Hughes, 2005; Snoeyink & Ertmer, 2001/2002).

Although there are difficulties with sustainability (Richardson et al., 2007), many large programs incorporate mentoring (or coaching) to personalize technology professional development for each teacher (Lowther et al., 2008). During these programs, mentors work with teachers on technology skill development, integration of technology, and management of technology resources within the specific classroom context. This approach also provides onsite, ongoing, and just-in-time professional development (Glazer & Hannafin, 2008).

Mentoring programs seem to be the most successful form of professional development as most teachers (90%) that participate in these programs report being able to implement newly learned practices into the classroom (Joyce & Showers, 2002 as cited in SEDTA, 2008). For example, North Carolina's IMPACT program used technology mentors for on-going professional development, which increased teacher retention and student achievement. In another program with similar results (increased teacher retention and student achievement), Utah and Missouri (eMINTS) provided personalized training through online communities of practice and online resources.

Technology as an Agent of Change

It is important to remember that technology is not the focus; visions, resources, and support mechanisms should all be focused on broader educational goals. Although some suggest technology as a catalyst for change (Culp et al., 2005; Thomas & Knezek, 2008), others suggest technology can only facilitate this reform for teachers (Cuban, 2001; Fisher, 2006; Harris, 2005; Schrum, 1999). As Harris (2005) noted, using technology as a Trojan horse for educational reform does not work; if teachers implement recommended best practices, it is typically attributed to experience, professional development, or school culture.

As evidence shows, increased student achievement results from high-quality instruction and assessment, not the technology (Goldman, Lawless, Pellegrino, & Plants, 2005–2006; Newman, Smith, Allensworth, & Bryk, 2001). Although technology can support and facilitate the production of high-quality instruction and assessment, using or even integrating technology will not automatically increase student achievement. Instead, our primary focus should be on establishing high-quality educational goals, and then we can examine how technology can help us achieve those goals.

Technology as a Tool to Support Educational Reform

This is not to say technology does not play a strong role in achieving those goals. On the contrary, technology has the capacity to increase the efficiency and effectiveness of teaching and learning. Recent U.S. policy has supported this vision, placing an emphasis on using technology as a tool for achieving educational reform goals. For example, data driven decision-making is made easier by technology data systems. Or in order to provide high quality content and options to those students in more rural or urban environments, the government promotes online courses in K-12 education. Perhaps the most important aspect we need to look at is continuing to use technology to help us achieve our goals with greater efficiency and effectiveness; this means we must design and evaluate various methods for using technology to achieve our broader educational reform goals.

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