

Challenges and solutions when using technologies in the classroom

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Challenges and solutions when using technologies in the classroom

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Introduction

Technology is perhaps the strongest factor shaping the educational landscape today. Many school districts are showing support for increased levels of technology in the classroom by providing hardware such as tablets and computers, enhancing internet connectivity, and implementing programs designed to improve computer literacy for both teachers and students. Although teachers generally appreciate the benefits of educational technologies, they often find smooth and effective integration of new educational technologies challenging. From acquisition of new technology equipment to adaptation of curricula and teaching techniques to incorporate new educational tools, technology integration presents significant challenges to educators at each level of school systems.

The purpose of this chapter is to present common challenges faced by educators when attempting to integrate technology in the classroom, and offer potential solutions to those problems. Examination of these issues should be valuable to current and future educators, school administrators, as well as educational technology researchers. The chapter begins by introducing the challenges to technology integration that are external (extrinsic) to the teacher, including access to resources, training, and support. We then present barriers that are internal to teachers, including their attitudes and beliefs, resistance toward technology in the classroom, and their knowledge and skills. The next section presents international perspectives on the technology integration problem, focusing on a case in Chile. The chapter concludes with a short summary of the chapter and condensed recommendations for effective technology implementation.

External Challenges to Classroom Technology

First-order barriers to the successful integration of technology into the classroom are factors external to teachers implementing technology. External barriers must be addressed at the

institutional level and changes are typically incremental (e.g., rolling out access to technology one level at a time). Although there is growing evidence that, in the United States, first-order barriers are being tackled (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012), more effort is needed to entirely overcome these challenges. In this section, we introduce some of the external barriers to classroom technology integration and present strategies to address them.

First, we address issues surrounding insufficient equipment or connectivity, termed the *access* constraint. If a teacher's school does not possess adequate computers and fast internet connection, the implementation of educational technology is not feasible. Next, we introduce the challenge of inadequate *training* related to technology. If teachers are not provided effective professional development on new technologies, they will not be capable of using it to its full potential. Finally, we discuss factors related to the *support* constraint. Support barriers to technology integration include inadequate technical support and administrative/peer support.

Access

Early accounts of technology integration focused much of their interest on increasing the availability of computers in schools (Fisher, Dwyer, & Yocam, 1996). Certainly, the most basic step toward effective technology integration is widespread access to equipment necessary to run educational computer programs. If computer lab time is limited to one hour per week, persistent use of educational technology is not viable. While many schools across the country are making the transition to one-to-one (1:1) computing (Warschauer, Zheng, Niiya, Cotton, & Farkas, 2014), many students do not have regular and reliable access to a computer. Inconsistent computer access makes it extremely difficult for instructors to integrate technology into existing

lesson plans. Routine access to hardware (i.e., laptops or tablets), software (e.g., reading and writing software, internet browsers), and internet connection is a fundamental requirement.

Research demonstrates that much progress had been made to improve equipment and internet access in schools over the last 20 years. Results from the National Center for Education Statistics' (NCES) 2009 survey of public school teachers revealed that 97% of all teachers have at least one computer in their classroom every day (Gray, Thomas, & Lewis, 2010). Compare this result to the 1999 survey which found that only 84% of public school teachers had computers available in the classroom (Smerdon, Cronen, Lanahan, Anderson, Ionnotti, & Angeles, 2000). The 2009 results indicated that, on average, classrooms had 5.3 students to every computer in the classroom (Gray et al., 2010). Results also showed that 93% of classroom computers had internet access by 2009 (compared to 64% in the 1999 survey; Smerdon et al., 2000). These results demonstrate that, by the year 2009, the ideal 1:1 computing model had not been broadly realized, but computers are widely accessible in the modern classroom. Further advances have presumably been made since the 2009 study, but up-to-date statistics are not available.

Although impressive recent advances have been made, effective use of educational technologies for literacy may require more frequent instructional time on computers than currently afforded by the ratio of students to computers. Intelligent tutoring systems such as those detailed in this book can individualize instruction to student progress within the system, but consistent 1:1 computer access is highly desirable given this pedagogical approach. With limited federal, state, and local funding, schools may often need to pursue unconventional funding options for obtaining classroom technologies. Budgets may be supplemented using crowdfunding sites, some of which specifically target education funding (e.g.,

AdoptAClassroom, DonorsChoose, IncitED). One challenge with crowdfunding is retaining donors; a recent study by Althoff and Leskovec (2015) reported that 74% of donors only contribute to one project. The authors found that donors were more likely to make additional donations when teachers are prompt in sending recognition messages to donors and in communicating the eventual impact. Thus, teachers who use crowdfunding sites must consider more than how useful a project is; they must also consider how to best communicate with donors to increase the likelihood of repeat donations. Educators can also apply for grants to support technology infrastructure, and websites make identifying funding opportunities easier (e.g., Edutopia, Fund for Teachers). Additionally, schools or teachers may seek support through partnerships with local businesses or universities. Some schools have also moved toward a Bring Your Own Device (BYOD) strategy in which students bring their own computing device to school to use for educational purposes. BYOD has obvious cost-cutting benefits, but schools must also be prepared with a network infrastructure that can accommodate the additional number of devices and that is appropriately secure (Afreen, 2014).

Training

According to Ertmer et al. (2012), the most commonly cited reason for lack of technology implementation in the classroom is inadequate professional development and training. The National Education Association (NEA) includes expanding professional development in technology as one of their policy recommendations (NEA, 2008). According to NEA results (2008) teachers today report increasing confidence using classroom technology, operating software, and searching the internet, but given that technology is constantly changing, it is more important than ever that teachers stay up-to-date with their technological expertise. Even if a school district were to hire only teachers who were literate in current classroom technology,

countless new technologies will be developed during their teaching careers, and they will need to undergo additional training to keep their skills current. Without the necessary resources to provide continuous technological training, schools and districts will continue to cite inadequate professional development as a major barrier to technology implementation.

Survey results from public school teachers suggest that educational technology professional development is reasonably widespread. In a 2009 survey, only 18% of teachers reported having completed no educational technology training over the previous year; the majority (53%) reported completing 1 to 8 hours training (Gray et al., 2010). Further, they generally had positive perceptions of their training. Eighty-one percent agreed with the statement “It met my goals and needs” and 88% agreed with the statement “It supported the goals and standards of my state, district, and school.” Unfortunately, some research suggests that professional development has a greater impact on teachers’ noninstructional (e.g., research, administrative) tasks than on student instruction. A 2006 survey revealed that around two-thirds of teachers felt their training was adequate for using the internet for research, using technology equipment, and using administrative software (NEA – AFT, 2008). Fewer teachers regarded the training adequate for the following instructional goals: evaluating student progress (57.6%); integrating technology into instruction (55.7%); and designing individual lessons (45.6%). Given limited budgets for professional development at the institution level, schools should verify their chosen training focuses on technology for student instruction. As with issues regarding technology access, more recent progress has likely been made in addressing these issues, but more recent survey results from NCES or NEA were not available at the time of writing this chapter.

The specific type of training that is available to teachers is also an important consideration. For example, many schools are purchasing iPads; however, the usefulness of iPads for education is not always immediately clear. One weakness of the iPad is the difficulty in typing using the touch keyboard, making it less ideal for activities requiring students to generate text, such as writing practice. One recent study with a sample of 21 teachers who had access to at least one iPad reported that the perceived usefulness of iPads was mixed, with an average rating of 2.75 on a 5 point scale. Several teachers reported not using the iPads frequently, with one explanation being lack of familiarity with apps that would be useful for particular lessons. In another study, nine teachers were provided with professional development that focused on using iPads in science and math classrooms (Hu & Garimella, 2014). A pre-post comparison showed that teachers perceived the iPad as being more useful and felt more proficient in using particular apps (including organizational and communication apps such as Dropbox and Evernote) after completing the professional development. Additionally, teachers felt more confident overall about using the iPad and planned to integrate it into their classes. This study thus demonstrates the effectiveness of professional development that is targeted to a specific technology. The iPad, and mobile devices in general, are particularly appropriate technologies to target given their pervasiveness and the abundance of educational software available that is often difficult to sort through.

To realize effective technology integration, school administrators should seek assistance to identify and provide ongoing training. The International Society for Technology in Education approves materials aligned to their standards for integration of technology into the classroom (<http://www.iste.org/standards/iste-standards>), including student curricula that integrate technology (addressing student standards), professional development resources (training teacher

standards), as well as assessments (evaluating student standards). Professional development programs approved by the ISTE include face-to-face instruction, online courses, online communities of learning, online learning modules, and in-class mentoring, and target development of different levels of teacher technology skills. Using guidance provided by ISTE, schools can identify professional development programs that best fit their needs. Additionally, some school districts use master teachers successful in implementing educational technologies to lead professional learning communities, meeting regularly to train and support technology integration. Finally, schools and teachers should pursue training from educational software companies and educational technology researchers. Many software companies offer free professional development courses, online training, and continuing support to educators. For example, Apple sales representatives offer formal training for iPads (Vu, McIntyre, & Cepero, 2014).

Support

Though we cannot say for certain how the future will impact professional development, it is clear that the teachers of today do not have optimal access to technological support. According to statistics reported by the U. S. Department of Education (2010), 68% of school districts reported having adequate support for educational technology. While it is encouraging to see that the majority of responding districts feel that they have access to adequate support, there is clearly room for improvement. With additional technology support, teachers can worry less about technological barriers and instead focus on teaching their students.

Adopting a new educational technology can be a time-consuming process. If a technology is adopted school-wide, teachers should have access to extended support from trained professionals, as opposed to a single hour long meeting before the school day begins. Of course,

this will most likely require additional funding for schools, but creators of educational technologies should also place increased emphasis on user support. With high quality support from both creators of educational technologies and school employees, teachers will have access to the resources they deserve. The knowledge that support is readily available may in turn increase acceptance of classroom technologies.

Ertmer (1999) notes that the most essential form of support to teachers can change as the technology integration project matures. During the earlier phases of a project, teachers require more technical support just to use the new technology, which could be accomplished by hiring educational technology and information technology professionals. As teachers become more proficient in the technical skills required for the new technology, their needs may shift to administrative and peer support to help develop and apply new uses for the technology in their classrooms. This type of support may be provided in professional learning communities through regular discussions regarding novel, domain-relevant uses of the technology.

Internal Challenges to Classroom Technology

In the previous section, we discussed external barriers to the classroom integration of educational technologies. Of course, as Ertmer points out (1999), even with first-order barriers removed, digital technology would not immediately and seamlessly appear within all classrooms using appropriate pedagogy. Individual educators are ultimately responsible for using technology, and thus even when given resources, they have choices about how to use technology. In this section, we describe barriers that relate specifically to teachers, their beliefs, and their knowledge. These issues are, by their nature, personal and thus vary greatly from teacher to teacher even within the same environment. Consequently, it is difficult to address these issues broadly. However, we attempt to provide an overview of common frameworks, provide

examples of the research being done using these frameworks as guides, and discuss implications with regard to literacy technology.

First, we will discuss educators' attitudes and beliefs, referred to as second-order barriers (Ertmer, 1999). If teachers do not expect new technology to be useful or do not think they have the required experience to use such technologies, they are more likely to persist using more traditional methods. Closely related to the attitudes and beliefs, teacher resistance may present a barrier to technology integration. Finally, we discuss the influence of teachers' skills and knowledge as they pertain to technology.

Teacher Attitudes and Beliefs

Teachers' attitudes and beliefs are crucial factors in determining the role and effectiveness of technology in classrooms. Attitudes and beliefs about both educational technology and pedagogy in general will ultimately influence how teachers implement technology. In the following sections, we discuss these issues and ways to promote positive attitudes that can optimize technology use. Now that technology is being widely used in schools, perhaps the most important question is *how* to best implement technology, rather than *whether* technology will be used (Ertmer, 1999; Ertmer et al., 2012; Keengwe, Onchwari, & Wachira, 2008; Lowther, Inan, Strahl, & Ross, 2008).

Confidence in skills and knowledge

Given the abundance of available educational technology, it is essential that teachers feel comfortable and confident about their ability to use them effectively. Many current teachers grew up without access to technologies like the personal computer and the internet, but students today are raised in an environment saturated by computer technology. These “digital natives” can intimidate teachers, especially teachers with little technological experience. If teachers feel they

do not have the necessary competencies when using technology, they may feel less in control of the class, use less technology, and be unlikely to explore new possibilities that utilize technology when designing their classes (Hughes, 2005; Rakes & Casey, 2002). By sticking to traditional teaching methods, teachers who are less fluent with technology maintain a feeling of control in the classroom and will not have to prepare to face the challenges of instructing digital natives in a digital environment.

In a survey of 764 teachers, Wozney, Venkatesh, and Abrami (2006) found that one of the two strongest predictors of teachers' technology use was confidence in achieving instructional goals using technology. Teachers who believe they lack training can either decide to work with technology at their current level of expertise, or postpone the use of technology until they consider that they have sufficient competence (Ertmer, 1999). To build teachers' knowledge to a sufficient level, boosting confidence in the process, training and support from the educational administrators is necessary.

About technology and learning

Teachers may use technology throughout the curriculum or to complement a specific lesson. Variations in technology usage reflect important differences in teachers' beliefs about the utility of technology in the educational process. Ertmer found that “teachers were able to enact technology integration practices that closely aligned with their beliefs.”(Ertmer et al., 2012). These beliefs are greatly influenced by the teachers' philosophy regarding how students learn. If the teacher regards student learning as primarily dependent on explicit teacher teaching, classroom activities will be driven by the traditional chalk-and-talk approach. More traditional educational beliefs have been related to less integration of computer-based technology in

classrooms (Hermans, Tondeur, van Braak, & Valcke, 2008). Thus, the use of technology will likely be limited to supplementary demonstrative activities within particular educational units.

For teachers to achieve effective use of computers, they must experience a paradigm shift from the teacher centered classroom to the student-centered classroom (Adams & Burns, 1999; Bitner & Bitner, 2002; Hannafin & Savenye, 1993; Harris & Grandgenett, 1999; Mandinach & Cline, 2000). In this situation, educational technologies will likely have a more central role because they permit active student learning activities in which the teacher serves as facilitator of the learning process. Ravitz, Becker, and Wong (2000) reported that teacher implementation of constructivist learning environments were often limited by difficulties meeting individual student needs, balancing multiple objectives, and responding to external forces and expectations. Teachers in these situations will thus more frequently use technology when they believe that it connects directly with their specific content areas and/or grade levels, allowing them to more readily meet their classroom goals (Hughes, 2005; Snoeyink & Ertmer, 2001).

The increasing acceptance of constructivist learning philosophies, along with intelligent learning technologies offer new possibilities to address individual differences of the student, one of the emphases of modern educational pedagogy. However, new technologies should incorporate student performance visualization tools that permit teachers to easily understand student progress on their educational objectives. Although technologies can be powerful means to improve learning, the teacher remains the critical factor to student success, and must be informed of student progress in order to intervene directly with his/her students.

Teacher Resistance to Technology in the Classroom

Browsing online teacher forums makes it clear that implementing new technologies into lesson plans can be a difficult task. Perhaps the most common reason mentioned by teachers for

not actively integrating new technologies is that many teachers are satisfied with their current lesson plans. A teacher's desire for their students to learn effectively drives classroom instruction, and if current lesson plans meet the needs of students, there is very little motivation for the teacher to alter them. Educators spend countless hours creating lesson plans that will hold attention and make learning exciting. Revising lesson plans means several hours of additional work for the teacher, which is problematic given an already demanding schedule.

Simply revising lesson plans can occupy a great deal of time, but revising lesson plans to incorporate technology is even more labor intensive. When adopting new classroom technologies, educators face the problem known online as the "double innovation" problem (Cleaver, 2014). Double innovation essentially adds an additional layer of preparation teachers must work through. The teacher must first learn the technology well enough to utilize it in a classroom setting before deciding how to integrate the technology with classroom objectives and curriculum. While educational technologies are becoming easier to learn, the double innovation problem still results in additional preparation time. Data collected from teacher interviews conducted by Ertmer et al. (2012) showed time as being the sixth most influential barrier to integrating new classroom technologies. A teacher's time is extremely valuable, and it should come as no surprise that time is one of the most commonly cited barriers to integrating new technologies in the classroom.

Clearly, there are numerous reasons a teacher might shy away from new technology in the classroom, but once teachers decide to further incorporate technology into lesson plans, they must first choose what technologies to use. There are thousands of internet technologies, tutoring systems and learning environments for teachers to choose from, so deciding which ones will enhance the student learning experience and align with curricula is a daunting task. Even if

teachers find a technology they believe will help their students, it is not always clear if these programs are actually effective. Many technologies claim to improve the academic and cognitive abilities of students, but claims can be false and are often only created as advertisement. Having to verify the truthfulness of these claims is an additional burden placed on the educator, who may not have time to search for classroom technologies in the first place. Perhaps as a consequence, decisions about technology are often made by school or district administrators without input from teachers. In some ways, this can be helpful by saving teachers the time and effort required to evaluate technologies, but lack of choice can also negatively impact an instructor's perception of the technology. Teachers may view the new technology as an imposition, when in reality the technology may make their teaching experience easier and more enjoyable.

Solutions to Increase Acceptance of Classroom Technology

Time will inevitably bring about the increased adoption of classroom technology on a large scale, so here we suggest some strategies that can be used by educators and researchers alike to encourage technology integration now. First, it is extremely important that teachers have a say in what technologies they will use in their instruction. Teaching is a deeply personal experience, and when educators feel as though they have lost the ability to teach in a manner that best suits them, it can be frustrating and discouraging. No single educational technology will be perfect for every teacher, and educators should have the ability to select a technology that they feel most comfortable with. By allowing teachers more freedom of choice they will retain the very important sense of classroom control.

While the importance of teacher autonomy in the selection of educational technology cannot be understated, it does introduce the burden of sifting through a vast number of available technologies. A second solution to encouraging acceptance of classroom technology is a call for

better organization of available technologies. While a typical internet search will turn up thousands of results for educational technology tools, there are very few places that effectively organize and evaluate available technologies. Teachers should be able to easily find and access rigorously tested technologies within a specific learning domain. In fact, this book can serve as a valuable resource to teachers looking to find such technologies. Better organization of empirically validated educational technologies will serve to save valuable time and will place less of a burden on the teacher.

Teacher Skills and Knowledge

Pedagogical content knowledge (PCK) has long been discussed as crucial for effective teaching (Shulman, 1986). Effective educators must not only be domain experts, but also understand how to flexibly use the affordances of different pedagogies for particular content topics. With the advent of numerous novel technologies over the past decades, educators have an abundance of technologies to leverage to make their teaching more effective. Although the potential benefits are clear, the sheer number of possible combinations of technologies and pedagogies for different tasks and students is overwhelming. The TPACK framework expands on the focus of PCK to also include technology as a knowledge domain (Mishra & Koehler, 2006). TPACK focuses on technology, pedagogy, and content knowledge individually, and also on their interactive combinations; this leads to a sum of seven types of knowledge that TPACK supporters argue are crucial for ideal integration: content knowledge, pedagogical knowledge, technological knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge (see Figure 1).

INSERT FIGURE 1 ABOUT HERE

Clearly, educators with expertise in the three core knowledge types will have some proficiency in the combined types. However, there is specialized knowledge in the combined domains. Technological pedagogical knowledge (TPK) requires more than knowing useful pedagogical techniques and familiarity with technologies; it requires an understanding of how particular technologies can provide support for particular pedagogical strategies or techniques. As an example, the selection of a social networking tool for collaborative learning must be informed by the affordances specific to each platform (e.g., Twitter might encourage a great number of messages to be shared, but following threads of conversations between numerous students would be very difficult). Technological pedagogical content knowledge (TPACK) additionally requires an understanding of how technologies can support pedagogies for specific domains.

How can the TPACK framework be useful? It has been conceptualized in different ways, but most relevant for our current discussion is that it is often viewed as the complete set of knowledge necessary to teach with technology (Mishra & Koehler, 2006). Thus, a goal is to promote these knowledge domains; clearly, most of these knowledge domains are *already* heavily emphasized during teacher training and professional development (e.g., mastering the content in which a teacher specializes). The intersections between technological knowledge and content/pedagogical knowledge, however, is more specialized and less frequently taught. For example, consider the case of writing instruction. Teaching writing techniques and strategies (requiring content knowledge) through deliberate writing practice and feedback (requiring pedagogical knowledge) is something successful writing teachers do and an example of pedagogical content knowledge. Digital technology can further support instruction by allowing

teachers to provide feedback through word documents. This is an example of TPACK; however, training on the capabilities of different technologies might allow teachers to further optimize the experience for students. Programs such as myAccess or the Writing Pal can provide automated immediate feedback, increasing the efficiency with which students receive feedback (Allen, Jacovina, & McNamara, 2015). Without training, teachers are unlikely to understand exactly how these feedback mechanisms work and therefore will not optimize their effectiveness (e.g., Grimes & Warschauer, 2010). Thus, training on TPACK might be helpful for writing instructors. TPACK can be taught effectively, making this goal tenable. Researchers investigating how TPACK knowledge in preservice teachers developed over an 11-month Master of Arts in Education (M.A.Ed.) program generally showed positive increases in knowledge (Hofer & Grandgenett, 2012).

Brantley-Dias and Ertmer (2013) urge caution in extending TPACK too far; although it might seem advantageous to encourage teachers to develop their knowledge in each of the 7 domains, there is little evidence that such a practice leads to more effective teaching. We respect this caution and view TPACK as something that teachers should be aware of and discuss, but that does not have a definitive end goal. Despite any weaknesses in the TPACK framework, there have been interesting, though not strongly empirically supported, activities and suggestions that have come from it. First, it does provide common language for educators to discuss methods and techniques for improving knowledge related to technology. Second, these discussions can be made into activities that promote flexible thinking about technology affordances. For example, a TPACK game has been used by various groups as part of professional development (Richardson, 2010; https://www.youtube.com/watch?v=7z3aP_Chj6c). Such activities are ways for teachers to increase their knowledge of technology.

Considerations from an International Perspective

When educators or researchers grapple with technology integration issues in only their own country, they may lose perspective regarding variables that could influence results when using technology in the classroom. Thus, examination of comparative studies across various nations may help us to reconsider important factors in the planning of school interventions. Ample evidence indicates that, in the U.S., many first order barriers have largely been conquered (Ertmer et al., 2012). Thus, current challenges relate to identifying and implementing methods to most effectively integrate technology in the educational context. Measuring integration success is potentially an even more difficult task. Will it be possible to assess the progress made in the U.S. and other countries, and compare outcomes across countries? The answer is potentially linked to diverse standards adopted by different countries regarding educational technology development. The U.S. follows educational technology standards defined by the ISTE, the United Kingdom the Qualified Teacher Status (QTS), and other European countries often follow the European Pedagogical Informational and Communication Technology (ICT), and so on. Because different criteria are used, researchers seeking evidence concerning international experiences in educational technology integration face substantial challenges.

When considering the educational technology progress in various countries, one discovers provocative cases of failures and successes. For example, in Chile, progress may be different than other countries of Latin America. The Education Ministry of Chile has been promoting systematic development in educational technology since 1992, with the aim of contributing to improving the quality and equity of public education (Cancino & Donoso, 2004). In terms of access to technology, the ENLACES program has made Chile a pioneer country in Latin America. From 2000 to 2010, the number of Chilean students per computer went from 80

to approximately 10 students per computer. Furthermore, in 1998, fewer than 1,000 schools in Chile had access to the internet; in 2008, around 7,000 schools had access, reaching broad national coverage.

Currently, one of the key challenges in Chile is the struggle to secure sufficient professional development and technology support to teachers through collaboration with and support of different institutions (universities, government, administrators, ENLACES and schools). On this issue, the experiences in the U.S. could be invaluable, given its relative successes in educational technology implementation (Ertmer et al. 2012). Once technology integration policies are adopted, a further challenge concerns establishment of valid instruments and methods to assess the impact of programs and determine how use of technology is affecting academic learning outcomes. Policy-makers in Chile considered whether to adopt an existing international standard, eventually deciding instead to create their own separate standards related to educational technology (Toro, 2010).

Careful deliberation of comparative studies across multiple countries may also be useful in determining a sound assessment approach. For example, a 2012 international study evaluated the impact of educational technology on academic performance, examining different factors related to educational technology and their impact on the PISA test reading results (San Martin, Jara, Preiss, Claro, & Farina, 2012). Spanish speaking countries in South America (Uruguay and Chile) were compared with countries in Europe which share characteristics (Spain and Portugal). Results revealed that the use of the educational technology led to varied improvements depending on an additional factor, class time devoted to reading. Students in Spain and Portugal spent more time reading than their counterparts in Chile and Uruguay, and the correlation between use of technology in class and PISA reading scores was higher in Chile and Uruguay.

One of the more interesting conclusions of the San Martin study is that when traditional reading time is low, reading through technology contributes positively to reading outcomes (San Martin et al., 2012). Studies by Jackson and colleagues with U.S. students seem to lend support to this interpretation (Jackson et al. 2006; Jackson, Von Eye, Witt, Zhao, & Fitzgerald 2011). The authors conclude that more internet use over time is associated with better reading results for students with low reading skills. One explanation for this is that because the internet is largely based on reading written text, its use encourages the students to read more than they typically do when not on the internet.

Reviewing international experiences may be a valuable way to obtain essential information about public policies on educational technology, helping to generate plans for implementation of key processes like teacher training and support. Moreover, international comparison studies could serve as valuable resources for assessment adoption or development, and can help us understand how technology impact learning and when other factors moderate those effects.

Conclusion

Although the task of technology integration presents significant challenges to school districts, school administrators, and teachers alike, exciting new educational technologies are increasingly available that offer teachers novel ways of presenting material to students. Research on the reading and writing technologies reviewed throughout this book demonstrates they can have considerable positive impacts on student performance. And, efforts to adopt new educational technologies in the classroom will be rewarded, albeit with some potential barriers.

Recent research on technology use in the classroom indicates that significant advances have been made to overcome the first-order (external) barriers to technology integration,

especially concerning access to computing resources. Recommendations to make further improvement include the following: 1) obtain funds for resources via non-traditional sources (e.g., crowdfunding, grants); 2) seek guidance from the ISTE to identify effective professional development programs; 3) exploit the expertise of master teachers in professional learning communities; 4) request training on newly adopted educational software directly from software companies; and 5) ensure that adequate technical, administrative, and peer support is available to teachers during the implementation. In comparison, overcoming second-order (internal) barriers to technology integration will likely be a more difficult hurdle. Our suggestions to confront the challenges internal to the teacher (i.e., attitudes, beliefs, skills, and knowledge) include the following: 1) provide teacher training that highlights constructivism and student-centered education; 2) focus professional development efforts toward those which emphasize the use of technology in instruction, rather than for administrative tasks; 3) include visualization tools in student tracking technologies which allow teachers to easily interpret student progress; 4) involve teachers in the decision-making process when adopting new technologies; and 5) offer teachers training on the intersection of technological knowledge, pedagogical knowledge, and content knowledge (TPACK). Technology integration in the classroom will require the ongoing collaborative efforts of teachers, educational technology professionals, school administrators, researchers, and educational software personnel. Fortunately, the benefits to schools, teachers, and students will yield tremendous returns.

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