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Barriers of technology integration in kindergarten through fifth grade

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Abstract

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For the purposes of this review, the barriers to integration have been divided into two categories: first and second-order barriers. First-order barriers are extrinsic to the teacher and include issues such as lack of time, money, and technical support. Second-order barriers are intrinsic to the teacher and are often the underlying causes that prevent integration from occurring.

The results of this review conclude that for true technology integration to occur, second-order barriers must be addressed. Within this review, several ideas are presented that will assist educators in removing the barriers that currently exist in technology integration.

BARRIERS OF TECHNOLOGY INTEGRATION IN KINDERGARTEN THROUGH FIFTH GRADE CLASSROOMS

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ABSTRACT

Many teachers understand the benefits of integrating technology in K through 5th grade classrooms, however, technology is not being effectively integrated. The purpose of this review is to identify the barriers of technology integration in kindergarten through 5th grade and discuss ways in which to remove those barriers. This review includes many research articles, books, websites, a blog, and an interview.

For the purposes of this review, the barriers to integration have been divided into two categories: first and second-order barriers. First-order barriers are extrinsic to the teacher and include issues such as lack of time, money, and technical support. Second-order barriers are intrinsic to the teacher and are often the underlying causes that prevent integration from occurring.

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INTRODUCTION

A great deal has been written regarding the use of technology in schools and whether or not it is age appropriate, effective, and cost efficient. However, society has become dependant on technology to operate, from business to healthcare to personal communications. Technology is all around us and woven into everything we do. Therefore, there is a social demand for schools to teach children how to use technology at early ages. (Cuban, 1986; Healy, 1998). However, the one area in which technology seems to be less noticeable is in our elementary school systems. Society has deemed technology as vital to our society and economy, yet schools fall behind in implementing the integration of technology in the classrooms. Why? There are many reasons that teachers are not moving toward technology integration within their classrooms. At the top of that list are pedagogical beliefs about technology's place in the classroom (Ertmer, 2005), teacher's confidence levels with technology (Palloff & Pratt, 1999), and the availability of technology (Ertmer, 1999). However, much research has been done to show the benefits of technology integration in the classroom. "Few argue that technology will not become even more embedded in student experience" (Judson, 2006, p.582). For the purposes of this paper, the reviewer has made the assumption that technology is beneficial when integrated into the daily routine of the classroom.

The children that are coming into our schools today are very different from those of the past. They are coming into school with knowledge of technology that they have gained by using home computers, I-Pods, laptops, and years of gaming experience. Today's children are more technologically advanced than any other generation that we have seen. According to Prensky (2007), "Students report they are engaging in highly creative activities on social

networking Internet sites including writing, art, and contributing to collaborative online projects whether or not these activities are related to schoolwork" (para. 5). The students are already using technology to improve skills such as writing, collaboration, and communication. Why then, are students not allowed to integrate technology into our schools to improve upon those same skills with the guidance of an instructor?

This review will seek to answer the following questions:

- What is t*echnology integration*?
- What barriers currently exist in educational settings that prevent *technology integration* from being successful?
- What can be done to remove those barriers?

METHODOLOGY

In researching barriers to technology integration in elementary classrooms for this paper, many sources of information were used. The researcher used the Internet to search many databases. The University of Northern Iowa Rod Library was the primary resource used to begin the search. The resources accessed through the Rod Library included Education Full Text (Wilson Web), UNIstar, and ERIC (Ebsco). The researcher also searched using search engines such as Google and Google Scholar. The key phrases used to locate information included: technology in elementary classrooms; barriers to technology integration; technology rich environment; technology in elementary education; technology integration; and technology to improve achievement.

The searches were limited to articles that were peer-reviewed. All articles came from reputable journals. Both of these facts added to their reliability and credibility. Articles were evaluated based on relevance to topic, publication date, and whether any author bias was apparent to the reviewer.

The reviewer also selected textbooks that pertained to the topic. The texts used were cited by many other researchers as good sources. The texts provided good sources for examples of technology integration, developmentally appropriate technology uses, and barriers that exist in teacher pedagogy.

ANALYSIS AND DISCUSSION

Technology Integration

The term, *technology integration*, has many different meanings. Bauer and Kenton (2005) define technology integration as "a reliance on computer technology for regular lesson delivery" (p. 4). According to Hooper and Rieber (1995) integration only occurs when "teachers consciously decide to designate certain tasks and responsibilities to technology, so that if the technology is suddenly removed or is unavailable, the teacher can not proceed with the instruction as planned" (p. 4). Both of these definitions imply that the technology must be available when needed or the lesson cannot be taught.

Some definitions involve more than using hardware. Ertmer (1999) has a very different view of technology integration. She sees "technology integration that is both curriculum-based and future-oriented" (p.49). In her view, technology integration is not about counting the computers that are available and how often children are using them, rather she focuses on "technology [that] adds value to the curriculum not by affecting quantitative changes... but by facilitating qualitative ones..." (p. 49-50). Edutopia (2008) states that "effective technology integration must happen across the curriculum in ways that research shows deepen and enhance the learning process" (para. 2). They also include four key components of learning that technology integration must support. These include active engagement, participation in groups, frequent interaction and feedback as well as a connection to real world experts. Both Ertmer and Edutopia's ideas of technology integration focus more on curriculum and content. The technology is seen as a way to support the learning, a tool by which the learning can occur.

It is no wonder that with these many very different definitions, teachers are confused about technology integration. Simply using technology in the classroom is not enough. According to Healy (1998), thoughtful consideration, selection, and guidance of technology must occur in order for technology to be used meaningfully. "The best results from all technology use for children come accompanied by a skilled adult *coach* who adds language, empathy, and flexibility" (p. 247).

Two types of definitions for technology integration come from two very different schools of thought. As mentioned above, the first two definitions by Bauer and Kenton and Hooper and Rieber focus on the technology and what it can do for the students, a more traditional way of learning. While the second two by Ertmer and Edutopia focus on the learner and what the learner can do with the technology to solve problems and construct meaning - a more constructivist way of thinking.

Using technology and constructivist-based teaching are very well suited for each other. Healy (1998) states that "For the technologies to be used optimally, teachers must be comfortable with a constructivist or project based problem-solving approach to learning..." (p. 68). The connectedness that technology provides supports the ideas of constructivism in that learners are able to connect to others and collaborate to solve real problems and construct knowledge along the way. The International Society of Technology in Education (ISTE) supports this idea. ISTE created the National Educational Technology Standards for students (NETS-S). This document, which was updated in 2007, identifies six standards that include (a) creativity and innovation; (b) communication and collaboration; (c) research and information fluency; (d) critical thinking/problem solving/and decision-making; (e) digital citizenship; and (f) technology operations and concepts (International Society of Technology

in Education [ISTE], 2007). These standards include basic computer skills but do not list them specifically; rather they focus on learners and how they will use technology to "construct *knowledge*."

Barriers

With so much emphasis on technology in the lives of students, it is important that this powerful tool be used to help students become successful. However, many problems can exist within the culture of the classroom that prevents technology integration from being fully implemented.

There are many barriers that exist when it comes to fully integrating technology into the curriculum. Brickner (cited in Ertmer, 1999) categorized these barriers into two categories, first-order and second-order barriers. First-order barriers are those barriers that are extrinsic to the teacher and can be reversed. Second-order barriers are those barriers that are intrinsic to the teacher and are often seen as irreversible. (Ertmer, 2005).

First-Order Barriers

First-order barriers are typically "described in terms of the types of resources… that are either missing or inadequately provided in teachers' implementation environments" (Ertmer, 1999, p. 4). These barriers include:

- lack of time,
- lack of administrative support,
- accessibility,
- lack of technical support, and
- lack of proper in-service training.

First-order barriers typically cannot be controlled by the teacher and are therefore extrinsic conditions that exist. These barriers are the first things that teachers often see as the problems with technology integration. Teachers who teach with a traditional teaching style are often impeded by first-order barriers because first-order barriers often focus on the accessibility of the tool instead of on the learner. They often feel that without the tool, the instruction is not possible. However, these first-order barriers are the easiest to reverse.

First-order barriers can be difficult to overcome, but by themselves do not provide sufficient reason for not integrating technology within the classroom. Many teachers overcome these obstacles everyday and successfully implement technology into their classrooms. A closer examination of each of these barriers can help determine methods to overcome them.

Lack of Time

Lack of time is a very common problem identified in the research (Ertmer, 1999; Whitehead, Jensen, & Boschee, 2003). Many teachers are not given enough time to receive the proper training that is required to learn, plan, and implement technology effectively. There is also the issue of location and availability, which is directly linked to time. Teachers do not want to leave their learning communities in order to go to the lab to do a project that might take five to ten minutes. The transition between the classroom and the lab setting not only takes time, but also inhibits the momentum of the lesson being taught. Technology needs to be readily available and without technical issues or many teachers simply see it as a hassle to an already very busy day. Shoeyink and Ertmer (2001-2002) state that "To many teachers, technology integration does not appear worth the time sacrificed or the learning curve endured" (p. 88).

Lack of Administrative Support

Another first-order barrier that must be discussed is *lack of support from administrators*. When administrators are not behind a teacher's desire to implement technology, it becomes very difficult for teachers to implement technologies in ways that can reach all learners. An administrator's role has changed from that of a manager to that of a visionary leader (Whitehead et al., 2003). Administrators must support their students and their teachers in ways that they have not had to in the past. Instead of fixing what is broken (managing a situation), administrators must begin to look toward the future to determine how to best acquire what the school needs both in terms of equipment and training for staff. "Technology-supported curricular transformation demands visionary leadership and effective management from school [administrators]" (p. 18). Without this type of support, many teachers will simply give up on technology integration and return to teaching the way they always have (Whitehead et al., 2003).

Accessibility/ Availability

In the fall of 2001, 99% of our nation's schools had connectivity (Institute of Education Sciences, 2001). Now that more students than ever have Internet access, the question is, how available *is* technology to students within the school. In the race to get all schools online, many schools have created computer labs within their buildings. These labs are convenient for technicians and technology teachers, but hinder technology integration in the classrooms. Whitehead et al., (2003) created a list of barriers that exist with computer labs. They include,

- Limits access to teachers and students
- Reduces teacher ownership

- Limits integrated learning
- Limits cooperative learning
- Limits internal and external communication and interaction
- Available time to complete student assignments is short
- Lab times may not align with a student's schedule. (p. 85)

Placing computers in lab situations does not effectively integrate technology in classrooms. Students and teachers need access to computers where they do their learning - in the classroom. Researchers have studied the effects of computer labs on the learning situation and results have shown that the basic design of the computer lab is not an efficient way to deliver instruction or integrate technology into a school (Whitehead et al., 2003; Peneul, 2006).

Peneul (2006) states that

> ...computer use in labs has been found to be effective at least over the short term... but researchers have long argued that for technology to make a powerful difference in student learning, students must be able to use computers more than once or twice a week in a lab. (p. 331)

Computer labs can actually hinder the development and effectiveness of technology integration into school curriculum. Teachers often do not find time to book the computer lab when needed and many teachable moments are lost because of this. Administrators and teachers are now beginning to understand that technology should be used daily in all subjects to have the greatest effect (Whitehead et al., 2003).

Lack of Technical Support

Technology is only good if it works. Often times when the technology fails, teachers give up and revert to teaching the way they have always taught. As technology fails, teachers learn very quickly that technology can be unreliable and therefore may not be worth the time and effort that they put into it. According to Feil (1996), "Technical support in elementary schools is considerably limited, with only 6% of these schools employing a full time computer coordinator..." (p. 112). According to the National Center for Education Statistics (2000), 66% of teachers reported that they are somewhat or not at all prepared to use computers and the Internet in the classroom. With so little technical support, it is no wonder that teacher have problems in this area.

Lack of Training

Directly tied to a teacher's lack of preparedness in computing is the lack of training provided by the teacher's school or district. "It takes five to six years for teachers to accumulate enough expertise to use technology in ways advocated..." (Ertmer, 2005, p.27). Teachers need to feel comfortable using technology themselves if they ever hope to feel comfortable integrating it into their daily curriculum. Funding for staff training in technology is often very limited. The money that is spent on training is used on training that is mostly administrative in nature and does not address curricular integration. Examples of administrative training include using e-mail; using electronic report card software; or using Excel and/or other record keeping software. This training makes life easier for teachers, but does not directly impact students. "Staff development courses only reinforce administrative use" (McCannon & Crews, 2000, p.111). According to McCannon and Crews (2000), "research indicates that one of the largest factors which determines computer integration in

elementary schools is the amount of computer knowledge the teacher possesses" (p. 112). Until teachers begin to receive training to increase their computer knowledge regarding the technology integration into the curriculum, little will change.

Just like all learners, teachers need to see the benefits of using technology with their students by having it modeled for them. Therefore, staff development should focus on using technology with students. "When teachers see technology modeled using constructivist compatible, student-centered approaches, they are likely to use it in that way" (Matzen & Edmunds, 2007, p.427). This modeling can come in many forms, from in-service training, workshops, or college courses. The focus needs to be on technology integration, however, not the mechanics of how to use the programs properly.

Over the last few years, many of these first-order barriers have been addressed through programs such as 1-to-1 initiatives, No Child Left Behind funding, etc. However, technology integration has not occurred as hoped. Even if teachers have the proper time, support, accessibility, and training, it does not mean that full technology implementation has occurred. Why? Second-order barriers have to do with teachers' beliefs and they have a large impact on integration.

Second-Order Barriers

The other type of barrier that teachers face is called *second-order barriers*. These barriers are intrinsic to the teacher and include things such as teachers' "beliefs about teaching, beliefs about computers, established classroom practices, and unwillingness to change" (Ertmer, 1999). These second-order barriers are much harder to address than the first-order barriers. Second-order barriers cannot be changed by obtaining a grant, providing in-service training, or purchasing new equipment. These changes must happen over time and

be done very carefully. Research done by Keller and Bichelmeyer (2004) revealed that schools need to "return to an emphasis on pedagogy rather than on technology" (p. 6). Their research found that teachers have gotten so wrapped up in standards-based education and technology integration that they are forgetting about the pedagogy behind teaching. They go on to state that, "If pedagogy is promoted to its rightful rank of first priority, high achievement and technology integration will follow" (p. 6).

Computer Knowledge

Many teachers are digital immigrants (Prensky, 2001). They have not grown up in the digital age and have limited computer knowledge as compared to the students that they teach. This situation makes many teachers feel uncomfortable about teaching through technology because the students know more about it than they do. This is especially true with those teachers who typically teach in a teacher-centered environment. A teacher's role needs to change for full technology integration to occur. The teacher must become a facilitator of knowledge development and not a conveyor of information. When a teacher's instruction becomes more student-centered, technology will fit more naturally into the equation since technology is a part of the student's life. In a study done by Cuban, Kirkpatrick, and Peck (2001) some of the teachers illustrated this point when they found that teachers who used technology effectively "organized their classes differently, lectured less, relied more on securing information from sources other than the textbook, gave students more independence, and acted more like a coach than a performer on stage" (p. 824).

Pedagogy

One of the biggest second-order barriers for the teacher to overcome is one of personal beliefs about teaching, a teacher's pedagogy. For the purposes of this paper,

pedagogy will be defined as the beliefs and strategies that a teacher uses that guide instructional practice. Many in the education arena have failed to see the positive benefits of integrating technology in the classroom. Much research has been done on how students and teachers use technology in the classroom. Much of that research has focused on teacher pedagogy. "There is a growing consensus in the education community, as a result of recent neurological and brain research, that learning is facilitated through active, knowledge-based, constructivist activities that contribute to students' knowledge construction in real-world situations and problems" (Palak, Walls, & Wells, 2006, p. 356). Using a traditional pedagogy, which "...allows for the instructor as expert to impart knowledge to students," (Palloff & Pratt, 1999, p. 15) does not match the learners or the technology we face today. The learners we face today demand a more active real-life learning environment. "Certainly, many instructors have begun to realize that the traditional lecture model is not the model of choice for today's more active learners and have begun to adapt their teaching methods..." (Palloff & Pratt, 1999, p. 15). As our learners have changed, so must our pedagogy. Gulek and Demirtas (2005) state that "teachers using a constructivist approach feel more empowered and spend less time lecturing, have fewer classroom management problems, and have more engaged learners in their classrooms... many of these outcomes were observed when students were provided with their own laptop..." (p. 6). Technology is a tool for many young people, so it must become a tool for teachers as well. Healy (1998) states, "Well-planned uses of computers can ground education in projects that have intrinsic meaning, while still teaching critical skills..." (p. 295). Teaching must become more project-based, with real-life connections if students are to succeed in life outside of school. As education moves into the twenty-first century, teachers must prepare students for what they will face.

> One of the basic requirements for education in the twenty-first century will be to prepare students for participation in a knowledge-based economy; knowledge will be the most critical resource for social and economic development… The traditional educational model, based primarily on the concept of the school and the teacher in a classroom as islands, standing alone and not interconnected with society or other educational institutions, will not generate competence in a knowledge based society. (Palloff & Pratt, 1999, p. 166)

A shift in pedagogy will not occur with the current technology structure and configuration that exists in many schools across our country. Educators must examine the traditional style of teaching and modify it to meet the needs of the learners.

Established Classroom Practices

For hundreds of years, teachers have established classroom practices that work effectively to meet their needs. Over the years, teachers have adapted to the changing needs of their students and their society slowly and in an incremental fashion. With this being said why have not teachers adapted to the digital natives that they are seeing in their classrooms? This is a big obstacle in the area of second-order barriers that prevents technology integration. Many digital natives that are currently in school learn to use technology very quickly and are not afraid to try new things. Many teachers (some of whom are digital immigrants), on the other hand, are more conservative by nature and do not feel comfortable with the newest forms of technology. Snoeyink and Ertmer (2001) did a two-year study in which they studied three veteran teachers as they learned and began using technology in their

classrooms. A large barrier that existed was the teachers' comfort level with the technology itself. As one teacher put it

> I'm not saying that's not the better way [using technology]- maybe, maybe not, but...right now what I want them to know, I've got other ways of getting them to know it...So now I take it slowly. It's comfortable, but I probably am not going, learning as fast as I should be because I'm just going to go at my own comfort level. (p. 95)

This passage highlights the problems that many teachers face between using established classroom practices and meeting the need of the digital natives they are teaching. Even when the teacher knows that she could be learning it faster, her comfort level prevents that from happening. The problem is that the students being taught today are beginning to demand more from their education and their teachers. Prensky (2005) recently stated that the "big difference from today is this; the kids back then (late 1960s) didn't expect to be engaged by everything they did" (p. 60). The digital natives today are connected to their environment through cell phones, the Internet, social networking tools, etc., except at school. In order to keep these natives motivated in school, teachers must begin to overcome some of the barriers of technology integration.

Resolutions

First-Order Change

In order to fully integrate technology into the classroom across the country, teachers must first determine how to remove the above mentioned barriers that exist. Simply having the technology available is not enough to ensure integration. Before integration can occur, teachers and students need to be free to use technology in a way that will enhance their

learning and prepare them for life in the 21st century. This section will present possible solutions that have been suggested in the research to surmount these barriers in an effort to advance technology integration.

Lack of Time

Many teachers insist that they do not have the time to implement the technology they would like to use. As stated earlier, the transition time between the classroom and the computer lab is often not worth the effort, because the momentum has faded. How do we solve this issue? There are many ideas that currently exist, but one of the biggest ideas is that of 1-to-1 computing. If each child has access to a personal computer all the time, than this barrier becomes non existent. "...Student access to computers in the classroom improves student engagement and achievement, and helps students acquire critical 21st-century skills," (Wamback, 2006, p.58). She also states that "what makes the difference is not individual possession of a computer, but rather the availability of computers for classroom instruction" (p. 58). As 1-to-1 computing becomes more prevalent in classrooms across America, teachers will find that they have more time to teach as transition to technology time is lessened and technology is readily available for the many teachable moments that occur throughout the day.

Lack of Administrative Support

Many teachers take their cues from administrators when it comes to the importance of technology in their lives and the lives of their students. If the administrator does not see the importance of using technology as a tool for learning, then neither will the teacher. It has become the role of administrators to help define the organizational culture of the school. "The literature on technology integration in teacher education highlights the importance of

such organizational factors as administrative support for technology integration...and administrative expectations of, and incentives for, technology use" (Adamy & Heinecke, 2005, p. 250). Administrators must become visionaries for their schools and insist that technology become part of the individual school's climate. One way to accomplish this is to create a comprehensive school plan that clearly establishes how technology will be integrated into all areas of the school curriculum. According to an interview conducted with Dr. Larry Anderson (2007) "...a technology plan should exist for and be reflective of the local school district or building writing the plan, it should be for you." Support from the administrator is vital to the creation of this plan.

Accessibility/Availability

As educators learn from the past, they must face the issue of making appropriate educational technology available to all learners. In the past, "people who control[ed] purse strings [administrators] were just buying computers...with very little thought given apparently with what we are going to do with these things or can it be used for student achievement" (Anderson, 2007). Many administrators blindly purchased hardware and software without a clear goal for their students. "Many academic institutions are swayed by the bells and whistles embedded in a fancy software package and do not consider what the learner can receive and handle as part of the learning process" (Palloff & Pratt, 1999, p. 63). In a perfect world, every child would have access to appropriate technology all day and in every subject area. One way to accomplish this is to provide 1-to-1computing in classrooms. In a study done by Grant, Ross, Wang, and Potter (2005), "teachers described that they would like to use the laptops for about 50% of the time, about 'two to three hours a day'" (p.

1027). Not only did they use the laptops but found them to be a very useful tool within their classrooms.

Promoting collaboration and community is a major benefit to technology use. Grant et al. (2005) described that the teachers in their study… "depended on one another for expertise. Proximity to one another's classrooms facilitated this learning community" (p. 1027). The use of the laptops created a strong sense of collaboration between teachers as well as students. By creating these learning communities, we are enabling the learning of the children to become deeper, more intrinsic, and transformative in nature (Palloff & Pratt, 1999). However, school districts are often financially unable to provide this type of support for all students. One way to provide this support is through the use of Computers on Wheels (COWs).

> These carts of 5 to 25 mobile computers are typically wireless and can be wheeled from classroom to classroom as needed. Schools have used this model to promote collaboration among students and aid in transitioning among groups of students and in classroom settings. In addition, these mobile carts have also offered an alternative to committing instructional space to computer laboratories. (Grant et al., p. 1018)

Using COWs would enable students and teachers to use technology where they need it most, where they are learning. The portability of COWs allows classrooms to slide the technology into the room when needed without taking up the very limited space that exists within the structure of the current classroom. Since this technology is portable, it can be taken virtually anywhere within the building and would be available for use by all teachers including Music, Art, and P.E. Technology needs to become a transparent part of the curriculum that already exists within the school, and teachers and students need to be the

ones who select age appropriate technology. When this happens, our classrooms will become active learning environments that encourage our students to take risks, problem solve, and gain confidence in their own abilities (Palloff & Pratt, 1999).

Lack of Tech Support

Although budgets are tight in schools across our nation, many schools have the technology they need, for their students. However, it often sits there without being used. Why? Perhaps the answer to that lies in the fact that there is little technology support for teachers that need it, when they need it. As stated earlier, if teachers are not comfortable using technology because they are afraid of breaking something, then they will not use it. How can we overcome this barrier without breaking the schools budget?

One way to help teachers with various technological backgrounds would be to start a technology coach program. In a study done by Sugar (2005), teachers were paired with a technology coach. In the study, the technology coach's role was to "support teachers and administrators in effectively instructing their students using an assortment of technologies" (p. 1). This was not done in a workshop environment. The technology coach met with small groups and with individual teachers and worked collaboratively to teach them the skills they needed. By meeting in this manner, the needs of the individual teachers were able to be met and teachers began to feel more comfortable using technology. Sugar (2005) states

> Based upon the results of this study and other similar studies, not only must instructional technologists provide the proper amount of technology content and skills for teachers, but instructional technologists must provide an inviting, empathetic, and patient environment for teachers to learn and adopt new technologies. (p. 11)

By using a technology coach approach to providing support, teachers can feel more comfortable learning the skills needed for technology integration.

Lack of Training

As with any new tool, teachers must have an opportunity to experience what technology can do for them and their students. "Learning through the use of technology, then, takes more than a mastery of a software program or comfort with the hardware being used. It takes an awareness of the impact that this form of learning has on the learning process itself" (Palloff & Pratt, 1999, p. 81). Many new initiatives have failed because teachers did not receive proper training on how to use a program or why it is important. In a study done by Watson (2006), it was found that "the level of a teacher's computer and Internet self-efficacy also affects student achievement and self-efficacy" (p. 155). In order to have an impact on the students' learning, teachers must understand the medium they are using. "A study of student math achievement test scores revealed a link between higher scores and teachers who had professional development in technology and computers" (Watson, 2006, p. 155). In order to give teachers proper training, "at least 20-25% of all technology money should be allocated for staff development" (Whitehead et al., 2003, p. 67). Only when the financial and professional commitment is made to training will we be able to succeed at fully implementing technology integration in our schools.

Second-Order Change

Computer Knowledge

The area of computer knowledge is considered a second-order change area because knowledge is intrinsic to the learner. The question is how to make teachers feel comfortable enough with the technology to make them want to implement it into their classroom routines.

The first thing that must be done is to model how technology can be used as a tool for accomplishing tasks more easily. Once teachers see the benefits of technology use, it can be more easily woven into the daily lives of students. As this change occurs, a change in a teacher's pedagogical beliefs will follow. Ertmer (2005) states that a "change in beliefs *follows*, rather than *precedes* practice, and that by helping teachers adopt new practices that are successful, the associated beliefs will also change" (p. 32).

Secondly, in-service training needs to be provided in a much different way than it is currently. Technology needs to be taught through modeling, demonstrating the benefits (and the pitfalls), and expecting teachers to use it daily. Ertmer, Leftwich, and York (2006) found that "the longer one has been teaching, the more important professional development, commitment to improving student learning, and previous successes are perceived to be to one's current technological success" (p. 58). Teachers must be given the opportunity to experience success through high expectations, support, and reflective collaboration with peers. According to the Iowa Professional Development Model (2005), "professional development is a continuous process rather than a one-time event...the collaborative routines necessary to support these actions must be planned for, supported, and monitored" (p. 31). When teachers are supported and begin to use technology daily, they will become much more comfortable with it and begin to implement it more successfully within their curriculum.

In many schools, our current in-service includes learning lots of different theories behind the strategies that school districts want us to use.

> If the teacher only hears about the theory behind the skill, there is a mere 5 to 10 percent chance the teacher will actually use that skill in the classroom. But if the teacher not only learns the theory but also sees a demonstration of the

> skill in action, practices it, and receives follow-up coaching and support from a respected peer, the chance of its being implemented increases to nearly 90 percent. (Bradburn, 2007, p. 50)

This is the way that trainers must approach in-service on technology use. However, in-service training alone will not increase technology use. Teachers' beliefs about the benefits of technology must change in order to increase the use of the technology itself (Ertmer et al., 2005).

Pedagogy

Teacher pedagogy seems to be at the heart of the issue. "Clark (1983, 1985) argued that teaching methodologies influence learning and that media alone can never be credited for positive learning outcomes" (Page, 2002, p. 390). Wenglinsky concurs stating that

> When computers are used to perform certain tasks, namely applying higher order concepts, and when teachers are proficient enough in computer use to direct students toward productive uses more generally, computers do seem to be associated with significant gains in mathematics achievement. (1998, p. 34)

Both of the aforementioned statements focused on how the technology was incorporated as well as the end results. When teachers use technology in a constructivist manner, the research suggests that it does lead to an increase in student achievement (Brooks, Libresco, & Plonczak, 2007). "For the technologies to be used optimally teachers must be comfortable with a constructivist or project-based, problem-solving approach to learning; they must be willing to tolerate students' progressing independently and at widely varying paces..." (Healy, 1998, p. 68). In order for technology to work well as a tool, many teachers must be comfortable with giving control of learning over to their students.

Ertmer et al. (2005) offers a suggestion on how to begin to change a teacher's pedagogy. They state that "three strategies seem to hold particular promise for promoting change in teacher beliefs about teaching and learning...(a) personal experience, (b) vicarious experience, and (c) social-cultural influences" (p. 32). In order to change teachers' personal experience, they must be given opportunities to successfully implement technology. As their successes add up, their beliefs about the use of technology will begin to change. Next, teachers' beliefs can be changed through vicarious experience. When teachers see other teachers succeeding with the use of technology, their own confidence begins to grow. Finally, teachers' beliefs can be changed by changing the social or cultural influences within the building. By beginning a professional learning community around the successful and repeated use of technology, teachers' beliefs will begin to transform their classroom practice (Ertmer et al., 2005).

Established Classroom Practice

This area of second-order change is directly tied to pedagogy and very difficult to change. With the advent of NCLB, many teachers are struggling to meet expected goals of their students on time or risk being shut down by the government. This has changed many teachers' classroom practices. Brooks et al. (2007) have concluded that more teachers are simply teaching curriculum to match a test and not truly using a constructivist form of teaching.

> The original definition of a *curriculum* was a track or course used for racing in ancient Rome. Today, the word still conjures a race. We want all children to hurry along a single path and get to the end as soon as possible. But, as we hurry along the curriculum, we miss the adventure of the trip. We miss people with different ideas

> who change and enlarge our perspective. We miss the opportunity to learn about content and process from our errors. We miss scholarship. We miss the time to think. Learning is not a race from point to point. It is a journey that changes pace, changes course, and, ultimately, changes us. (p.750)

NCLB has in its effort to raise expectations for all students, actually lowered expectations for all teachers.

NCLB mandates research-based curriculum. This is not a bad thing; the problem however comes when research states that "students reach a deep understanding of fundamental concepts incrementally as teachers assess and respond to their perceptions in real time, which is why curriculum needs to be contextualized and not standardized" (Brooks, et al., 2007, p. 749). The NCLB legislation standardizes curriculum and is not based upon what research finds as the best way for people to learn. Although most of the NCLB legislation should be revamped, there has been some good that has come out of it. Teachers, administrators, and legislative leaders are examining closely what is best for the children we serve. As Lipsky (2003) states, "best classroom practices … include cooperative learning; curricular adaptations and classroom differentiation…and instructional technology embedded in curriculum and classroom activities" (p. 35).

CONCLUSIONS AND RECOMMENDATIONS

After reviewing the literature, the reviewer has found that technology integration is much more than simply having technology available for use and providing time for all students to use it. True integration occurs, from the prospective of this reviewer, when teachers and students use various forms of technology daily as tools for learning within all areas of the curriculum. Technology should not be treated as an addition to curriculum, but rather as tool to better deliver that curriculum: a tool with which a learner can solve real world problems. Technology integration occurs when teachers and students use technology in the same way that a chalkboard, pencil, paper, projector, etc. are used, as transparent tools that make the learning process easier. These tools are transparent simply because when we pick up a pencil to use it, we do not concern ourselves with the operation of the pencil, but rather how it helps us to convey our learning. Ertmer (1999) and Edutopia (2008) concur that it is not about the technology itself, but how the technology is used.

There are many existing barriers that prevent true technology integration from occurring within classrooms. Research by Ertmer (1999) has placed those barriers into two categories, first-order and second-order barriers. The first-order barriers are usually the ones that are often most apparent to teachers. They include anything that is out of the control of the teacher. These barriers are extrinsic to the teacher and therefore can be the most frustrating. They include such things as lack of time and administrative support, lack of technical support, and lack of or improper in-service training. Although these barriers are very frustrating, they are the barriers that are the most easily remedied. By obtaining grants, proper in-service training and creative solutions to problems, all of these barriers can be removed from the classroom.

Second-order barriers are barriers that are intrinsic to the teacher. These barriers include such things as teacher pedagogy, computer knowledge and skill, and established classroom practice. These barriers are often the biggest hurdles to overcome when trying to implement technology into the learning environment. Second-order barriers are not often recognized by teachers and sometimes require a change in a teacher's belief system in order to overcome. Perhaps the best way to overcome these barriers is by using the human tools that are available: students, administrators, and preservice teachers. When administrators raise expectations for technology use in the classroom and begin seeing students as partners in teaching and learning, teachers can successfully overcome some of these obstacles. Preservice teachers can play a unique role in this pedagogical shift. The requirement of collaborative technology integration by preservice and in-service teachers is the best way to model how this shift can and should occur.

Throughout this paper, the reviewer has shared several resolutions to the barriers that exist in the education system. The following are the reviewer's recommendations to address these barriers.

To address the need for a clear definition of technology integration, administrators need to begin the process of writing a comprehensive technology plan by creating a team of educators, community members, administrators, and students to create a plan that will benefit all learners. Administrators must then fully support its implementation. The leaders of a school must clearly define the expectations of how technology will be integrated and encourage staff to follow the plan. One way to do this might be to require proof of technology integration as part of the staff's professional development plans. When real integration becomes part of the daily curriculum, students will be better prepared for the 21st

century. To address the first-order barrier of time, it is suggested that within this technology plan, 25% of all technology budgets go to the in-service education of teachers.

To address the first-order barrier of accessibility, schools should change their current structure of using computer labs to that of 1-to-1 computing either by purchasing individual laptops or COWs. By providing students with more access to technology and by alotting teachers more time in which to use computers, technology will facilitate integration.

To remove the barrier of technology support, schools need to implement technology coaching programs within their buildings to offer the support that teachers need. By creating a technology coaching program, support can be offered regardless of the skill level of the teachers.

To address second-order barriers, specifically that of computer knowledge, it is recommended that in-service education needs to change dramatically. The focus of staff in-service training needs to be on technology integration and not the administrative duties or the *how to* of running various pieces of software. A good model for this is the Iowa Professional Development Model (Iowa Department of Education, 2005).

To address the barrier of teacher pedagogy, administrators need to work on changing the learning culture within the building. As Ertmer et al. (2005) discovered, we need to change a teacher's personal experience, vicarious experience, and social or cultural influences if we ever hope to change the pedagogy. In order to accomplish this, technology use should be brought out into the open and become part of the everyday school environment. This can be accomplished by creating technology action teams, who will be responsible for bringing technology usage to others and setting aside time to collaborate with colleagues. Teachers need to practice using technology to raise their comfort level; only then

can they integrate its use throughout their curriculum. All schools should employ some sort of technician to oversee the integration process as well as take care of technical issues that arise; this technician should also oversee the technology coach program.

Finally, to remove the barrier of established classroom practice, it is recommended that educators unite behind the research and use classroom practices that encourage children to construct the knowledge they need to learn. Teachers need to establish classroom practices that encourage collaboration, reflection, questioning, and the creating of knowledge. If students are given these tools, they will meet and often exceed the mandates of NCLB. Thomas Lord reports that, "Students in constructivist classes performed significantly better on exams, rated the course higher, and participate more in campus and regional environmental support efforts than students in traditional classes" (as cited in Brooks, et al., 2007, p. 754). The classroom teachers need to focus their attention on changing classroom practices and teacher pedagogy to fit the learner's needs, not the standards of the No Child Left Behind legislation.

More research needs to be conducted into the connections between constructivism, technology integration, social networking tools and student achievement. Teachers need to prove to legislators and the public that the best way to prepare students for the 21st century is to teach them to work collaboratively which will consist of utilizing many tools such as the Internet, podcasts, and various social networking tools. When the public comes to understand this, perhaps then, we can knock down the barriers that exist for technology integration in kindergarten through fifth grade classrooms.

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