Eğitimde Kuram ve Uygulama
Journal of Theory and Practice in Education
ISSN: 1304-9496

Articles /Makaleler
2015, 11(1), 33-50

NURTURING THE INTEGRATION OF TECHNOLOGY IN EDUCATION

(EĞİTİMDE TEKNOLOJİ ENTEGRASYONU)

Thomas RYAN[1]
Gillian BAGLEY[2]

ABSTRACT

Herein we argue that technology integration in education can be understood and characterized as a struggle to overcome external and internal barriers. External barriers include the ever-changing nature of technology, deficiency of hardware and software; and inadequate professional development, and ongoing technological support. Internal obstacles involve personal beliefs, perceptions and understanding associated with technology use which may result in personal distress, angst and a lack of user confidence.

Key Words: technology, integration, change, barriers.

ÖZET

Bu çalışmada, eğitimde teknoloji entegrasyonunun dış ve iç engelleri aşmak için bir mücadele olarak anlaşılabilceği ve karakterize edilebileceğini savunmaktayız. Dış engeller teknolojinin sürekli değişen doğasını, donanım ve yazılım eksikliğini; yetersiz mesleki gelişimi ve süregelen teknolojik desteği içermektedir. İç engeller kişisel sıkıntı, endişe ve kullanıcı güveni eksikliği ile sonuçlanabilen teknoloji kullanımı ile ilişkili kişisel inançları, algıları ve anlayışı kapsamaktadır.

Anahtar kelimeler: teknoloji, entegrasyon, değişim, engeller.

INTRODUCTION

We embark upon this integrative review to provide a collective image of the information and communication technologies (ICT) landscape which may assist educators in seeing, succinctly, what has occurred in past research concerning the integration of technology in schools. We do this to also focus upon recent international research outcomes which suggest technology is not being utilized effectively within classrooms (Ertmer & Ottenbreit-Leftwich, 2010; Jenson, Taylor, & Fisher, 2010; People for Education, 2014) and there are many teachers in training who feel unprepared to implement ICT (Funkhouser & Mouza, 2013; Tondeur, van Braak, Sang, Voogt, Fisser, & Ottenbreit-Leftwich, 2012). This realization is alarming since some educators continue to purchase 'tech' tools in step with an increasing presence in society (Hixon & Buckenmeyer, 2009; People for Education, 2014), yet technology in classrooms has had a muted impact on educational processes and outcomes (Hixon & Buckenmeyer, 2009, p. 130). This could be interpreted to mean that technology is not

[1] Professor , Nipissing University Faculty of Education, thomasr@nipissingu.ca
[2] Educator, Nipissing University Faculty of Education, glbagley584@community.nipissingu.ca

positively changing test scores, which have become a major indicator in the accountability movement over the past 20 years (Gabriel & Richtel, 2011; Richtel, 2012; Selwyn, 2010). Technology is however positively increasing student engagement (Annetta, Minogue, Holmes, & Cheng, 2009) which arguably is one of the significant tasks in the education of children and adolescents (Ertmer & Ottenbreit-Leftwich, 2010).

School administrators continue to operate on an, *if you build it they will come* belief, while tech resources remain underutilized (Hixon & Buckenmeyer, 2009, p. 131). Unfortunately, many educators continue to struggle with the integration of technology into classroom routines, processes and instruction (Funkhouser & Mouza, 2013; Groff & Mouza, 2008; People for Education, 2014). For this reason we find that many teachers continue to use tools that are outdated, no longer meeting the needs or interests of many current students (Ertmer & Ottenbreit-Leftwich, 2010, p. 257).

Despite improved access to technology, teachers are not utilizing it within instruction efforts (Ertmer & Ottenbreit-Leftwich, 2010, p. 255). Teachers that use technology in their practices primarily use it for organizational purposes and low-level forms of instruction (Ertmer & Ottenbreit-Leftwich, 2010; Klieger, Ben-Hur & Bar-Yossef, 2010; Polly & Hannafin, 2010) such as demonstrations, information transfer, and management (Levin & Wadmany, 2008, p. 235). In order to prepare student-teachers for the future, it is imperative that we improve teacher use of ICT (Funkhouser & Mouza, 2013).

One means to move ICT forward is via the Technological Pedagogical Knowledge (TPK) concept (model) scribed by Mishra and Koehler in 2006, which built upon Shulman's (1986) framework. TPK is a combination of Technological, Pedagogical and Content Knowledge within various education contexts. TPK suggests educators need to have confidence and informed to integrate current technologies in an effective manner in schools. A recent effort by Kereluik, Mishra, Fahnoe, and Terry (2013) to infuse precision and clarity in TPK highlighted the importance of timing, and presence of mind (knowing when and where) to utilize a current technology in a competent manner. Educational reformers have always seemed to encourage teachers to use technology to engage students through richer inquiry-based student-centered learning (Polly & Hannafin, 2010), to help them develop capacities such as higher-order thinking skills (Ertmer, Ottenbreit-Leftwich & York, 2007) while becoming digitally literate (Alper, 2013). Overall, it is clear that teacher beliefs need to shift in response to the fact that teaching is less effective without information and communication technologies (ICT) learning resources (Ertmer & Ottenbreit-Leftwich, 2010, p. 255).

Purpose

Our purpose is to review teacher education literature from both pre-service and in-service orientations and also analyze related professional development publications

in order to determine the current state of affairs and determine what recommendations inform educators as they integrate ICT in education and what barriers exist.

Research Questions

Primary question. Can technology integration in education be understood and described as a struggle to overcome external and internal barriers?

Sub-questions. What are the external barriers impeding technological integration in education? What are the internal barriers impeding technological integration in education?

METHOD

Our method of inquiry is widely known as an integrative literature review which is a form of research that "reviews, critiques, and synthesizes representative literature on a topic in an integrated way" (Torraco, 2011, p. 356). Its purpose is to make "a significant and value-added contribution" to a particular field (Torraco, 2011, p. 358). The product will not be synthesis but rather the generation of perspectives and viewpoints. A review of the ICT literature in education was completed to generate standpoints and identify, collectively, barriers and benefits to the integration of ICT in education.

Definition of Terms

External barriers to technology integration: External barriers to technology integration are obstacles that are out of teacher control, such as the amount of computer hardware available at their school or the type of professional development offered (Hixon & Buckenmeyer, 2009).

Higher-order thinking skills: Higher-order thinking skills involve the transfer of knowledge from one situation to another. In contrast, lower-level thinking skills typically involve retention of information (Brookhart, 2010).

Inquiry-based learning: Inquiry-based learning is a type of active learning whereby student development is "assessed by how well students develop experimental and analytical skills rather than how much knowledge they possess" (Jonker, n.d.).

In-service teachers: In-service teachers are practicing teachers who have graduated from a teacher education program and are therefore licensed.

Internal barriers to technology integration: Internal barriers to technology integration are a teacher's personal beliefs about teaching and learning (Hixon & Buckenmeyer, 2009).

Pre-service teachers: Pre-service teachers are post-secondary-level students who are pursuing the teaching career through a teacher education program.

Teacher self-efficacy: Teacher self-efficacy relates to a teacher's confidence in their abilities. In reference to this research project, teacher self-efficacy is associated

with their belief in their ability to effectively integrate technology into their teaching practices.

Technology (tech) integration: Technology or tech integration involves incorporating technology into the teaching of course content, instead of teaching about the tech tool itself.

Factors Affecting ICT Integration in Education

A model common in the literature today is Hall and Hord's (1987) Concerns-Based Adoption Model (CBAM), modified by Bailey and Palsha (1992) suggests, as innovation, in this case ICT emerges, people (teachers) move through progressive levels (three categories – Stages of Concern, Levels of Use, and Innovation Configurations) of concern in sequence, yet one (level) improvement may not transfer to usage of the newest innovation (Hall & Hord, 1987). The shortcoming of the model is that CBAM assumes innovation is static and all individuals progress in a linear manner to eventually adopt the innovation (Slough, 1999). For the latter reasons this model was not embraced herein. Instead we turned to Rogers' (2003) Diffusion of Innovation Theory (DIT), built upon previous theoretical models and also include a stage by stage process developed to illustrate how one adopts technology. Rodgers (2003) also suggested "a Technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p. 13). This understanding was utilized and noted herein. This model clarifies the terms hardware and software, and further suggests knowledge (first stage) can persuade (second stage), leading to a decision (third stage) to implement (fourth stage) and latter confirmation (fifth stage) to continue or discontinue technology usage. Educators can move through these stages but be unable to name the DIT model or identify its elements as many lack the theoretical background knowledge of the model. This is neither a barrier nor obstacle to ICT integration we believe.

Before we can figure out ways to improve the integration of technology in education, we first have to determine the reasons why it is happening. Evidently, many teachers lack adequate knowledge about technology (stage 1) in general, and are unaware of how to use it in relation to their course material (Ertmer & Ottenbreit-Leftwich, 2010). According to Groff and Mouza (2008), a teacher's lack of knowledge (stage 1) and skills using a tech tool is quite often the major barrier that prevents them from integrating it into their classroom. Yet, Groff and Mouza (2008) determined that it was in fact accessibility to technologies that played a major factor in the implementation of the tools in the classroom. More recently, scholars have concluded that there is more to it, as evidence points towards a lack of technology integration due to many issues including access, time, and training (Hixon & Buckenmeyer, 2009, p. 135). While lack of access and knowledge is part of the problem, numerous researchers now believe that the primary determinants of a teacher's ability to integrate

tech use in the classroom are actually their beliefs and values as educators (Ertmer & Ottenbreit-Leftwich, 2010; Uslu & Bümen, 2012).

While there is some debate, it is clear that technology integration in the classroom is impacted by a number of varied factors, although they can largely be divided into external and internal influences (Hixon & Buckenmeyer, 2009). External issues are characterized as factors that are out of teacher control, such as the amount of computer hardware available at the school or the type of professional development offered. Bingimlas (2009) concluded: "Barriers were insufficient numbers of computers, insufficient peripherals, insufficient numbers of copies of software, and insufficient simultaneous Internet access" (p. 240). Internal factors can include teachers' personal beliefs about ICT infusion within teaching and learning (Hixon & Buckenmeyer, 2009). People for Education (2014) surveyed Ontario elementary teachers and concluded that the use of computers, even when widely available, varies from school to school and region to region in the province of Ontario within Canada. At the Ontario secondary level gaming and social media was found to be limited to non-existent and money to keep up-to-date was scarce (People for Education, 2014).

External barriers. External issues widely known as first-order barriers (Hixon & Buckenmeyer, 2009, p. 135), represent the starting point when considering the lack of technology integration in today's schools. One significant external barrier to tech integration is the ever-changing nature of technology (Ryan, 2014). In many cases, teachers may be fearful of using technology in their classrooms because the tools are always changing (Ertmer & Ottenbreit-Leftwich, 2010). Learning and knowledge (stage one DIT) of technology is an ongoing and moving target (Ertmer & Ottenbreit-Leftwich, 2010, p. 260). For this reason, staying up-to-date with technology trends can be very difficult for today's time starved teachers (Harris, Mishra & Koehler, 2009, p. 398).

Another major external barrier to tech integration involves the quantity of tech tools available in the school setting (Ryan, 2014). Some teachers struggle with a lack of hardware or potentially limited Internet (bandwidth) access in schools (Levin & Wadmany, 2008; People for Education, 2014). In some cases, the physical school structure can represent a barrier to technology integration (Groff & Mouza, 2008). For example, in some schools, most of the computers are located in standalone labs that must be booked for class use in advance. Depending on the size of the school, this can create issues of limited accessibility, potentially preventing teachers from using the technology when they really need it (Groff & Mouza, 2008). Newer mobile technologies such as tablets are needed (Ryan, 2014).

There are also qualitative external issues to tech integration, including out-of-date hardware and software (Brinkerhoff, 2006), as well as tech-related problems like system crashes and insufficient computer memory (Groff & Mouza, 2008); and limited or non-existent tech support (Buabeng-Andoh, 2012). Schools often cannot afford new technology because of the staggering costs associated with replacing outdated

equipment, which often leads to incompatibility issues when transitioning between models (Groff & Mouza, 2008).

Both pre-service and in-service teachers also struggle with institutional barriers to tech integration, which include limited and inadequate professional development and a lack of ongoing support (Brinkerhoff, 2006; Levin & Wadmany, 2008; People for Education, 2014; Tondeur, et al., 2012). In a study regarding teacher education programs, Brown and Warschauer (2006) discovered that teacher candidates were not exposed to enough technology in their studies, as technology only played a marginal role within teacher preparation programs (p. 607). For this reason, new teachers are inadequately prepared to use ICT (Brown & Warschauer, 2006, p. 615). Unfortunately, in-service teachers are not much better off, as professional development fails to include new pedagogies for ICT implementation (Groff & Mouza, 2008, p. 29). Despite the push by administrators to improve technology integration, they have largely been met with resistance and failed to alter professional development accordingly (Harris et al., 2009):

> Typical approaches to technology-related professional development are based upon assumptions that it may be enough to just expose teachers to particular educational technologies and possible curriculum based uses of those tools and resources. Approaches that track only skills (technology or otherwise) are insufficient. Learning about technology is different than learning what to do with it instructionally. (Harris et al., 2009, p. 402)

Regardless of where they are in their own tech-related learning, teachers are typically lumped together in a one-size-fits-all type of professional development that fails to take into consideration various individual learning needs and styles (Hixon & Buckenmeyer, 2009, p. 141-142). Professional development opportunities usually take place outside of the classroom, disconnected from classroom contexts (Polly & Hannafin, 2010, p. 564).

Internal barriers. While external obstacles to technology integration are part of the problem, they do not present the whole picture. Internal teacher issues also affect tech integration within schools; in fact, according to researchers, teachers represent the greatest impact on technology integration in the classroom (Groff & Mouza, 2008; Levin & Wadmany, 2008). Teachers' values are primary impediments to technology integration (Hixon & Buckenmeyer, 2009, p. 130).

Teachers with traditional beliefs typically use technology in more low level ways within their classrooms, while more constructivist-thinking teachers tend to have *high level* student-centered teaching practices (Ertmer & Ottenbreit-Leftwich, 2010). Increased technological integration in the classroom requires adopting more student-centered teaching practices, which means a change in the role of the teacher (Hixon & Buckenmeyer, 2009). On any given day, teachers in a technologically integrated classroom may find themselves playing many roles such as designer, mentor, collaborator, team leader, consultant and assessment specialist (Groff & Mouza, 2008,

p. 30). According to researchers, some teachers feel technology will threaten their control in the classroom, or potentially dehumanize teaching and learning (Hixon & Buckenmeyer, 2009, p. 136-137). There is the added fear of reducing the position of teacher by making the roles of student and teacher interchangeable (Hixon & Buckenmeyer, 2009). Some teachers may be apprehensive of this changing of roles, as it would likely interrupt typical classroom routines (Ertmer & Ottenbreit-Leftwich, 2010), a thought that can create considerable anxiety (persuade - second stage DIT) for some teachers (Groff & Mouza, 2008). In this sense, technological integration in the classroom is influenced by a teacher's attitude and personality; leading to a negative decision (third stage) to not implement (fourth stage) ICT.

Teacher fears and anxiety surrounding the implementation of technology in their classroom practices is linked to teacher self-efficacy in using technology (Ertmer & Ottenbreit-Leftwich, 2010). In fact, "self-efficacy may be more important than skills and knowledge among teachers who implement technology in their classrooms" (Ertmer & Ottenbreit-Leftwich, 2010, p. 261). In this sense, teachers' lack of familiarity with technology and fear of looking "stupid" in front of their students prevents them from using technology in their classroom (Hixon & Buckenmeyer, 2009, p. 137), especially given the number of potential technical difficulties associated with modern technology (Hixon & Buckenmeyer, 2009). Researchers now realize that some teachers experience anxiety as they struggle to stay ahead of the students (Buabeng-Andoh, 2012). New teachers may also express anxiety when integrating tech into their practices, as they listen to veteran teachers who disagree with their ideas. Alternatively, veteran teachers may abandon attempts to integrate technology into their classrooms if they do not see value (confirmation - fifth stage DIT) in their efforts (Brinkerhoff, 2006).

Promoting ICT Integration

While it is clear that there are a number of factors that affect technology integration in education, reforming teacher education and professional development represent a potential answer to both external *and* internal barriers to tech integration. While improvements to teacher education and professional development cannot improve the quantity and quality of tech tools available to teachers, they can help teachers improve their mastery of skills, offer continual support as technology continues to change, provide ways to create more rich student-centered learning opportunities, and boost teacher self-efficacy while lessening fears and anxiety associated with using technology in the classroom.

Up until now, efforts to integrate technology into education have followed similar approaches. For pre-service teachers, teacher education programs have offered educational technology courses both in-person and online, while in-service teachers have been exposed to standard workshops and courses (Harris et al., 2009). Whether for pre-service or in-service teachers, such traditional professional development has

operated on the belief that simply exposing teachers to the educational technology tool will be enough. Unfortunately, this approach has proven ineffective because learning about technology differs from learning how to implement it effectively (Harris et al., 2009, p. 402). When learning how to integrate technology into their practices, it is imperative that teachers plan, implement and evaluate different pedagogical strategies (Ertmer & Ottenbreit-Leftwich, 2010). This will help teachers develop the knowledge and skills necessary to effectively integrate technology into their classrooms.

Improving tech integration requires making changes to teacher education and professional development programs (Ertmer & Ottenbreit-Leftwich, 2010). Instead of the current approach, teachers need a more individualized attention via professional development (Hixon & Buckenmeyer, 2009, p. 142), in which external *and* internal barriers to tech integration are addressed. The goals for all pre-service and in-service teachers should be to understand the educational technology tools (stage 1 - Knowledge DIT), and to use them to better teach course content through meaningful learning opportunities for students (Ertmer & Ottenbreit-Leftwich, 2010). Through improved teacher education and professional development, necessary changes to teachers' knowledge of educational technology and pedagogical beliefs and approaches will take place (Ertmer & Ottenbreit-Leftwich, 2010). Throughout the process, it is important that administrators treat professional development as an growth process (Groff & Mouza, 2008), utilizing different approaches throughout as teachers move through the DIT stages towards technological integration (Hixon & Buckenmeyer, 2008). Certainly, DIT with its first stage of awareness (knowledge) can persuade (second stage) teachers to decide (third stage) to implement (fourth stage) or discontinue technology usage.

Changing teacher education. In order to improve technological integration in the classroom, changes to professional development must begin in teacher education programs. Reforms to teacher education programs are necessary in order to adequately prepare pre-service teachers to utilize technology to enhance learning and achievement (Brown & Warschauer, 2006; Tondeur, et al., 2012) through student-centered learning (Ertmer & Ottenbreit-Leftwich, 2010). The two areas most in need of change in teacher education programs are the integration of technology into instructional strategies and improved experiences alongside technologically proficient teachers in authentic school placements (Brown & Warschauer, 2006). The DIT model can support these desired outcomes.

First and foremost, teacher education programs need to model effective use of educational technology in order to promote the use of technology as valuable teaching and learning tools (Ertmer & Ottenbreit-Leftwich, 2010; Koch, Heo & Kush, 2012). Such modeling of successful technology use should take place throughout the program, though especially by instructors in the information technology and methods courses (Brown & Warschauer, 2006; Ertmer & Ottenbreit-Leftwich, 2010). While promoting the value of educational technology tools, modeling would also help pre-service

teachers build the confidence they need to use similar tools in their own classrooms (Ertmer & Ottenbreit-Leftwich, 2010). By effectively integrating technology use into teacher education courses, pre-service teachers would benefit from student-centered learning environments that encourage collaboration with peers to use technology to explore curricular issues (Brown & Warschauer, 2006).

In a recent study, Koch, Heo & Kush (2012) discovered that pre-service teachers are not being exposed to sufficient modeling of technology use as professors often prefer antiquated means of developing lessons (Cuban, 2001; Fabry & Higgs, 1997). Koch et al., (2012) studied a group of pre-service teachers over a four-year period in order to determine changes in their perceptions of their ability to integrate technology use into their practices. Throughout their four-year university program, the pre-service teachers were exposed to modeling of technology integration from their professors and their practicum mentor teachers. Koch et al. (2012) assessed changes in participant perception using the International Society for Technology in Education (ISTE) National Educational Technology Standards for Teachers (NETS*T). Created in 2000 and revised in 2008, the NETS*T performance standards act as performance indicators for 21st century teachers, and include a framework for pre-service education (Koch et al., 2012). The results of the study demonstrated a boost in participant confidence and skill in using technology, thus supporting the importance of effective modeling of technology integration in pre-service teacher education. While there are some weaknesses within the study, including the fact that only self-reported survey data was collected, the results are still important and help to bring attention to a critical area in need of further research.

The other primary area of improvement involves the practical component of teacher education programs. Teacher training is disconnected from what is happening in K-12 classrooms (Koch et al., 2012) therefore teacher education programs need to build improved partnerships with local schools (Brown & Warschauer, 2006; Ertmer & Ottenbreit-Leftwich, 2010). Improved partnerships would boost collaboration through the creation of "communities of practice" that in turn benefit both pre-service and in-service teachers (Ertmer & Ottenbreit-Leftwich, 2010, p. 271). During practicum placements, teacher candidates would have the opportunity to witness examples of successful technology integration, a major contributing factor to their use of technology within their future classrooms. At the same time, well-selected placements would also allow student teachers to try technology integration strategies in real classroom situations, from planning and implementing the lesson to dealing with technical issues (Ertmer & Ottenbreit-Leftwich, 2010, Koch et al., 2012).

Several studies have illuminated the importance of field experience to the pre-service teacher education program (Brown & Warschaur, 2006; Ertmer & Ottenbreit-Leftwich, 2010; Koch et al., 2012). Recognizing the *peripheral role* of technology in most teacher education programs, Brown and Warschauer (2006) conducted a case study into technology integration within a teacher education program at a public

university in the United States. As part of the findings of the study, Brown and Warschauer (2006) determined that the primary determinant of technology integration by the pre-service teacher participants was their observation of effective technology integration by their practicum mentor teacher, thus demonstrating the critical role of practicum (field placements). The pre-service teachers and their placement mentor teachers demonstrated "essentially identical patterns in both the frequency and the nature of technology use" (Brown & Warschauer, 2006, p. 613). Therefore, while modeling of technology integration is crucial within teacher preparation courses, it is also central to pre-service teacher development while in field placements (Ryan, 2009). For this reason, although there are a lot of factors to consider when placing pre-service teachers with in-service teacher mentors, the technological ability of the mentor teachers should be strongly considered in the overall decision.

Improving in-service professional development. Traditional technology-related professional development has not been able to effectively move forward technology integration in many contemporary classrooms. Conventional technology-related professional development typically involves short one-time workshops (Uslu & Bümen, 2012) in settings far removed from the classroom, which have largely proven inadequate in producing true technology integration (Polly & Hannafin, 2010). At the same time, the majority of technology-related professional development focuses on teaching the tech tool, and not on how to integrate the use of the tool into teacher pedagogy (Brinkerhoff, 2006; Valanides & Angeli, 2008). In this sense, conventional professional development is not directly related to the curriculum and therefore does not provide teachers with knowledge of how to integrate technology into specific course content (Hixon & Buckenmeyer, 2009; Klieger et al., 2010). Lastly, typical professional development instructors use traditional lecture-style teaching approaches, often not providing teachers with opportunity for active learning (Levin & Wadmany, 2008).

One of the major ways technology-related professional development can be improved is by creating ongoing learning opportunities for teachers. Creating ongoing, continuous professional development gives teachers the support they need to promote mastery of skills, while also providing time for change to individual teacher beliefs toward technology and pedagogy. Brinkerhoff (2006) conducted a study into the effects of long-term professional development by creating a two-year professional development academy on technology skills. The results of the study showed an increase in the teacher participants' knowledge of technology, partially because the additional time provided opportunity for experimentation. Brinkerhoff (2006) reported that the teachers involved in the study were more confident in their use of technology, explaining that the long duration of the study was fundamental to the results. While a two-year academy is preferential over the typical one-time professional development workshop, it still is not continuous and therefore does not provide the ongoing support teachers need. This uncovers a potential weakness in Brinkerhoff's (2006) study, as

well as a consideration for future research, in that after the two-year academy there was no follow-up to determine the long-standing effects of the academy on technology integration.

Alternatively, Levin and Wadmany (2008) conducted a similar study, although they extended the length of the study to three years. The results of their study led to questioning of the assumption that teacher's use of technology follows a linear development. According to Levin and Wadmany (2008), teacher's use of technology does happen in stages, but it does not necessarily move from one to the next in an orderly fashion. Instead, grasp of technology happens at an individual pace, according to the teacher. For this reason, the study demonstrated two important components of effective technology-related professional development: (1) professional development must be ongoing in order to facilitate technology integration for *all* individual teachers; and (2) teachers need to be exposed to a variety of teaching experiences involving technology in order to develop the ability to successfully integrate technology use into their *own* practices (Levin & Wadmany, 2008). During the initial stage of development, throughout which teachers master the technology itself, teachers benefit from training by experts. At later stages, as teachers learn how to integrate the use of technology into the teaching of course content, teachers benefit from opportunities for collaboration with fellow teachers, self-inquiry, and mentorship, "sometimes in addition to, but mainly instead of, authoritative training" (Levin & Wadmany, 2008, p. 259). In order to use technology to promote the development of higher-order thinking skills we must overcome the internal barriers to technology integration. This takes time and therefore can only be accomplished if professional development opportunities are ongoing and continuous.

Technology-related professional development can also be drastically improved by altering the focus of the professional development. Traditional tech-related PD opportunities have failed because they focus on the technology itself, instead of how to integrate the tools into pedagogy (Valanides & Angeli, 2008). This often leaves teachers wondering how they are going to actually use the information they gain at a PD session. In a recent study analyzing professional development in Turkey, Uslu and Bümen (2012) discovered that conventional modes of professional development are ineffectual because they do not offer opportunity for practice, follow-up, or reflection (p. 117). As part of the study, participants completed the Intel Teach Program, a program designed to improve teacher ability to integrate technology into their practices. The Intel program was divided into two parts, the first part whereby participants were given expert training about the technology itself, and the second part during which participants learned how to integrate the technology directly into their practices through collaborative learning opportunities. Uslu and Bümen (2012) assessed teacher skill using both a pre-test before the initiation of the program and a post-test six weeks after the program concluded, thus boosting participant accountability. According to Uslu and Bümen (2012), the results of the study

demonstrated an increase in technology integration within the classrooms of the participants, results that remained, as proven by the retention test (post-test), six weeks after.

Although there are some clear weaknesses in Uslu and Bümen's (2012) study, including an insufficient length and small sample size, the findings still carry some credibility because of the inclusion of follow-up data collection. The findings of the study demonstrate the importance of a developmental focus in technology-related professional development, as teachers move from mastery of technology tools to integration of technology into pedagogy via the DIT model.

CONCLUSIONS AND RECOMMENDATIONS

Our primary question asked: Can technology integration in education be understood and described as a struggle to overcome external and internal barriers? As we have demonstrated herein the literature clearly lays out these barriers as findings. There are several noteworthy external barriers impeding technological integration in education and there are similarly internal barriers impeding technological integration in education.

According to various studies, external barriers to technology include: the ever-changing nature of technology (Buabeng-Andoh, 2012; Ertmer & Ottenbreit-Leftwich, 2010; Funkhouser & Mouza, 2013), lack of quantity and poor quality of hardware and software (Groff & Mouza, 2008; Levin & Wadmany, 2008), and inadequate professional development and lack of ongoing support (Groff & Mouza, 2008; Funkhouser & Mouza, 2013; Harris et al., 2009). Yet, internal obstacles to technology integration involve teacher's personal beliefs about the changing roles and routines associated with tech use, often sparking fear, anxiety and a lack of confidence in using technology in the classroom (Ertmer & Ottenbreit-Leftwich, 2010; Hixon & Buckenmeyer, 2009). While many researchers focus on the division of external and internal factors, some researchers emphasize the belief that effective technology integration is a developmental process that takes time and therefore occurs at an individual pace (Kereluik, et al., 2013; Levin & Wadmany, 2008).

Considering the nature of factors affecting technology integration in education and scope of research on the topic, we believe that reforms to teacher education and professional development have the potential to overcome external *and* internal barriers to technology integration. We believe pre-service teachers can learn to integrate technology effectively through two major changes to teacher education programs. The first reform to teacher education programs should be improved modeling of technology integration in teacher education information technology and methods courses. Improved modeling would promote the use of tech tools, while also building pre-service teacher confidence in using the tools through active and collaborative learning opportunities. Teacher education programs can also be improved by offering supplementary strategic and authentic field placements alongside technologically

proficient mentor teachers who can demonstrate successful technology integration in their teaching practices. In our experiences, field placements represent the greatest learning opportunity for pre-service teachers because they provide real-life (authentic) classroom experience. Therefore, the more technology integration pre-service teachers are exposed to during placements, the greater their skill and confidence once they are in their own classrooms.

While reforms to teacher education programs can create initial change, improvements to professional development opportunities can help in-service teachers achieve technology integration within their classrooms. By creating ongoing professional development and support, administrators and school board executives can help to promote the mastery of technological skills, while also boosting teacher self-efficacy in using technology. At the same time, the goal of technology-related professional development must progress from a focus on teaching about the tech tools themselves, towards an emphasis on how to integrate technology into the teaching of course curriculum and content. Throughout the development of technology integration through professional development, in-service teachers would benefit from a shift from expert training to more active, hands-on, collaborative work alongside their peers. Lastly, professional development should be more practical and authentic (MacGregor & Ryan, 2009). This can be achieved by offering PD opportunities within school and classroom environments that teachers are already comfortable working in. To make professional development even more practical, we believe teachers should be separated according to department, where teachers are given opportunity to work on projects from their actual classes alongside their colleagues.

Future Research

After conducting this integrative review of technology integration in education, we have identified six components which merit future examination.

First, future studies in technology integration in education must be longitudinal to establish causal relationships that can lead to reliable inferences; and demonstrate how changing individuals align with systemic educational change. While Brinkerhoff's (2006) two-year study duration was too short, Levin and Wadmany (2008) determined that their three-year study was sufficient in determining progress through the developmental stages of tech integration. They were able to separate actual trends from chance occurrence and provide deep coverage of many variables, from the onset and emergent. Therefore, we believe future studies need to be at least three years in length, though a four- or five-year study would be optimal.

Second, additional research into technology integration should incorporate secondary school teachers as a separate entity. All studies reviewed either involved education generally or were specific to the elementary level, thus demonstrating a gap in the research. While we realize the potential challenges associated with studying high school teachers, given that they teach many separate groups (classes) of students

on a daily basis, we believe it is still important to study any differences in achieving technology integration as experienced by teachers at the secondary level.

Third, future studies need to include a sufficient sample size, which includes numerous teachers from more than one school while reducing type one and two errors and increasing statistical power. Levin and Wadmany (2008) only analyzed the experience of six teachers from a single elementary school, which is not enough to make generalizations based on the results. Yet, Koch et al., (2012) had a larger sample size of 278 pre-service teachers who were at different stages of their teacher education, thus providing a potentially more significant representation of the population.

Fourth, we believe it is important for research to take place within a school setting (context). Brinkerhoff's (2006) study of the effects of a long-duration professional development academy on technology integration took place in a university, which may have potentially impacted the results of the study. Conducting the study within the school can help the teachers participating feel more comfortable, while also providing a more accurate representation of the situation.

Fifth, future studies examining the role of professional development in technology integration should also provide a mixture of expert training and active, hands-on learning. Uslu and Bümen (2012) provided an effective combination of expert training and active, collaborative work in their five-week study into the effects of professional development on Turkish teachers. In fact, their study was divided into two parts. The initial stage incorporated mostly expert training on the use of specific technology tools. In the secondary stage, Uslu and Bümen promoted the development of pedagogical ideas that related specifically to the tech tool studied in the initial stage of technology integration. Interestingly, Levin and Wadmany (2008) helped make their study more practical by providing participants with time to work directly on actual projects from their classes.

Sixth, try to include mixed methods data when possible. Uslu and Bümen (2012) only utilized self-reported data in analyzing the effects of the Intel Teach Program on a group of Turkish teachers, which could challenge the validity of findings. In contrast, Brown and Warschauer (2006) compared four different means of data collection (mixed methods), including surveys, observation, interviews and online discussions, to ensure the credibility of their results. On a side note, future research on this topic should also incorporate the use of regular classroom observations when conducting data collection, just as Levin and Wadmany (2008) did during their study into teacher perception of the factors that affect technology integration. Utilizing classroom observation during data collection helps to make teachers more accountable, while also producing more authentic representations of classroom activity.

Throughout this research we have attempted to determine the factors that impact technology integration in education, in order to uncover ways to promote technology integration through improvements to teacher education and professional development. The challenge was not in finding information, but in summarizing and analyzing the

literature. While most researchers treat pre-service teacher education and in-service professional development as separate entities, we imagine a progression of teacher learning along a continuum (MacGregor & Ryan, 2009). For this reason, we believe we have filled some gaps within existing literature by presenting an analysis of the relationship between teacher education, professional development, and technology integration. It is our hope that school board administrators can work in concert with university teacher education administrators and instructors, using this information to develop improved teacher education programs and professional development initiatives that promote technology integration.

REFERENCES

Al-Fudail, M., & Mellar, H. (2007). Investigating teacher stress when using technology. *Computers & Education*, *51*, 1103-1110.

Alper, M. (2013). Developmentally appropriate new media literacies: Supporting cultural competencies and social skills in early childhood education. *Journal of Early Childhood Literacy, 13* (2), 175-196.

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M.-T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education*, *53*(1), 74–85. doi:10.1016/j.compedu.2008.12.020

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education*, *5*(3), 235-245.

Bitner, N., & Bitner, J. (2002). Integrating technology into the classroom: Eight keys to success. *Journal of Technology and Teacher Education*, *10*(1), 95-100.

Brinkerhoff, J. (2006). Effects of a long-duration professional development academy on technology skills, computer self-efficacy, and technology integration beliefs and practices. *International Society for Technology in Education*, *39*(1), 22-43.

Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. Alexandria, VA: ASCD.

Brown, D., & Warschauer, M. (2006). From the university to the elementary classrooms: Students' experiences in learning to integrate technology in instruction. *Journal of Technology and Teacher Education*, *14*(3), 599-621.

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using ICT, 8*(1), 136-155.

Çakir, R., & Yildirim, S. (2009). What do computer teachers think about the factors affecting technology integration in schools? *Elementary Education Online*, *8*(3), 952-964.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambridge, MA: Harvard University Press.

Ertmer, P. A.,& Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255-284.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., & York, C. (2007). Exemplary technology-using teachers: Perceptions of factors influencing success. *Journal of Computing in Teacher Education*, *23*(2), 55-61.

Fabry, D. L., & Higgs, J. R. (1997). Barriers to the effective use of technology in education: Current status. *Journal of Educational Computing Research*, *17*, 385-395. doi: 10.2190/CT10-AWA1-CMQR-YTYV.

Funkhouser, B. J., & Mouza, C. (2013). Drawing on technology: An investigation of preservice teacher beliefs in the context of an introductory educational technology course. *Computers & Education*, *6*(2), 271-285.

Gabriel, T., & Richtel, M. (2011, September 14). A Classroom Software Boom, but Mixed Results Despite the Hype. *The New York Times*.

Groff, J., & Mouza, C. (2008). A framework for addressing challenges to classroom technology use. *Association for the Advancement of Computing in Education Journal*, *16*(1), 21-46.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *International Society for Technology in Education*, *41*(4), 393-416.

Hernandez-Ramos, P., & Giancarlo, C. (2004). Situating teacher education: From the university classroom to the "real" classroom. *Journal of Computing in Teacher Education*, *20*(3), 121-128.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research & Development*, *55*(3), 223-252.

Hixon, E., & Buckenmeyer, J. (2009). Revisiting technology integration in schools: Implications for professional development. *Computers in the Schools*, *26*, 130-146. doi: 10.1080/07380560902906070.

Jenson, J., Taylor, N., & Fisher, S. (2010) *Critical review and analysis of the issue of "skills, technology and learning"*. Toronto, ON: Ontario Ministry of Education. Retrieved from http://www.edu.gov.on.ca/eng/research/jenson_reporteng.pdf.

Jonker, V. (n.d.). Defining inquiry-based learning. Retrieved from http://www.mascil-project.eu/IBL.html.

Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth:Teacher knowledge for 21st century learning. *Journal of Digital Learning in TeacherEducation*, *29*(4), 127-140.

Klieger, A., Ben-Hur, Y., & Bar-Yossef, N. (2010). Integrating laptop computers into classroom: Attitudes, needs, and professional development of science teachers—A case study. *Journal of Science Education and Technology*, *19*, 187-198. doi: 10.1007/s1095-0090919101.

Koch, A., Heo, M., & Kush, J. (2012). Technology integration into pre-service teacher training. *International Journal of Information and Communication Technology Education*, *8*(1), 1-14. doi: 10.4018/jicte.2012010101.

Kozma, R. B. (2003). Technology and classroom practices: An international study. *Journal of Research on Technology in Education*, *36*, 1-14.

Lee, K.S., Smith, S., & Bos, B. (2014). Pre-service teachers' technological pedagogical knowledge: A continuum of views on effective technology integration. *International Journal of E-Learning & Distance Education*, *29*(2), 1-18. Retrieved from http://ijede.ca/index.php/jde/article/view/887/1540.

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, *16*(2), 233-263.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.doi:10.1111/j.1467-9620.2006.00684.x

Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers and Education, 51*, 1523-1537.

Ormrod, J. E., Saklofske, D. H., Schwean, V. L., Harrison, G. L., & Andrews, J. J. W. (2006). *Principles of Educational Psychology*. Toronto, ON: Pearson Education Canada.

People for Education. (2014). *Digital learning in Ontario schools: The 'new normal'*. Toronto,ON: author. Retrieved from http://www.peopleforeducation.ca/wp-content/uploads/2014/03/digital-learning-2014-WEB.pdf

Polly, D., & Hannafin, M. (2010). Reexamining technology's role in learner-centered professional development. *Educational Technology Research and Development*, *58*, 557-571. doi: 10.1007/s11423-009-9146-5.

Richtel, M. (2012). Technology is changing how students learn, teachers say. *New York Times*.

Rogers, E.M. (2003). Diffusion of innovations (5th ed.). New York, NY: Free Press. MacGregor, C., & Ryan, T. G. (2009). Leading and launching the effective professional learning community in six steps. *Journal of Educational Leadership, Policy and Practice, 24* (2), 1-10.

Ryan, T.G. (2009). Teaching and technology: Issues, caution, and concerns. In R. Subramaniam (Ed.), Handbook of research on new media literacy at the K-12 level: Issues and challenges. (pp. 86 – 105). National Institute of Education Singapore Idea Group.

Ryan, T.G. (2014). Social media use in the classroom: Pedagogy & practice. In S. Van Nuland, (Ed.), Moving forward in curriculum, pedagogy and leadership (pp. 1-11). The International Council on Education for Teaching (ICET) 58th World Assembly. University of Ontario Institute for Technology, Oshawa,ON: Canada. http://sites.uoit.ca/icet/files/ICET-58th-World-Assembly-Proceedings.pdf

Selwyn, N. (2010). Looking beyond learning: notes towards the critical study of educational technology. *Journal of Computer Assisted Learning*, *26*(1), 65–73. doi:10.1111/j.1365-2729.2009.00338.x

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Slough, S. (1999). Some concerns about the Concerns-Based Adoption Model (CBAM) and technology. In J. Price et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 1999* (pp. 1949-1953). Chesapeake, VA: AACE.

Smeets, E. (2005). Does ICT contribute to powerful learning environments in primary education? *Computers & Education*, *44*, 343-355.

Torraco, R. J. (2011). Writing integrative literature reviews: Guidelines and examples.*Human Resource Development Review*,*4*(3), 356-366.

Tondeur, J., van Braak, J., & Valcke, M. (2007a). Towards a typology of computer use in primary education. *Journal of Computer Assisted Learning*, *23*, 197-206.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. *Computers & Education*,*59*, 134–144.

Uslu, O., & Bümen, N. (2012). Effects of the professional development program on Turkish teachers: Technology integration along with attitude towards ICT in education. *The Turkish Online Journal of Educational Technology, 11*(3), 115-127.

Valanides, N., & Angeli, C. (2008). Professional development for computer-enhanced learning: A case study with science teachers. *Research in Science & Technological Education*, *26*(1), 3-12. doi: 10.1080/02635140701847397.

West, R. E., & Graham, C. R. (2007). Benefits and challenges of using live modeling to help pre-service teachers transfer technology integration principles. *Journal of Computing in Teacher Education*, *23*, 131-141.