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Educational Technology: A Review of the Integration, Resources, and Effectiveness of Technology in K-12 Classrooms

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Abstract

There is no questioning that the way people live, interact, communicate, and conduct business is undergoing a profound, rapid change. This change is often referred to as the "digital revolution," which is the advancement of technology from analog, electronic and mechanical tools to the digital tools available today. Moreover, technology has begun to change education, affecting how students acquire the skill sets needed to prepare for college and a career and how educators integrate digital technological instructional strategies to teach. Numerous studies have been published discussing the barriers of integrating technology, the estimated amount of investment that is needed in order to fully support educational technology, and, of course, the effectiveness of technology in the classroom. As such, this article presents a critical review of the transitions that technology integration has made over the years; the amount of resources and funding that has been allocated to immerse school with technology; and the conflicting results presented on effectiveness of using is technology in education. Through synthesis of selected themes, we found a plethora of technological instructional strategies being used to integrate technology into K-12 classrooms. Also, though there have been large investments made to integrate technology into K-12 classrooms to equip students with the skills needed to prepare for college and a career, the practical use of this investment has not been impressive. Lastly, several meta-analyses showed promising results of effectiveness of technology in the classroom. However, several inherent methodological and study design issues dampen the amount of variance that technology accounts for.

Keywords: K-12, digital learning, devices, one-to-one, technology, u-

dents in the United States are able to

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access the Internet from home or school (Pearson, 2013; Madden, 2013; Project Tomorrow, 2014; Information Capsule Research Services, 2014), meaning tha

1. How is technology currently being integrated into schools?
2. What investments have been made to support educational technology? How does investments increase technology integration and use in schools?
3. How effective is educational technology?

The catalyst for the first question stemmed from a prominent study conducted by Hew and Brush (2007), in which a total of 123 technology integration barriers were identified in previous empirical studies. Hew and Brush systematical investigated the previous literature and concluded that there were 6 main categories that limited and hindered technology integration: (a) resources, (b) knowledge and skills, (c) institution, (d) attitudes and beliefs, (e) assessment, and (f) subject culture.

The last question is a question that has been a topic of numerous debates. Numerous studies and several meta-analyses have been conducted in order to answer this question. However, there have been some inherent issues that have risen in the process. For example, the term “educational technology” is a generic and ambiguous term that has been used to reference computer-assisted instruction (CAI), simulations, games, or laboratory instruments, or technology software/hardware. Another issue is how to measure effectiveness. Some studies measure the effectiveness of the tool while others measure the effectiveness of knowledge gained. Our research question aims to amalgamate the most prominent research and meta-analyses and report the overall impact educational technology across different methodologies.

Method

Article Selection

Articles that were selected for this literature review span from 1986 to 2014. The literature primarily focuses on technology use in education; outcomes of technology in the classroom; and online learning environments. The purpose of selecting these key themes was to convey how technology integration has changed across the years; accurately report the amount of resources and funding that has been allocated to immerse school with technology; and what has the scientific community found in regard to the effectiveness of using is technology in education.

WorldCat and Google Scholar were the two databases used to search for articles related to technology in education. The articles were selected and identified by primarily using the search terms or keywords ‘technology,’ ‘education,’ ‘classroom immersion,’ ‘one-to-one computing,’ ‘K-12,’ ‘online learning’ and ‘digital learning.’ Hundreds of abstracts were investigated but, ironically, only a few provided relevant information that would enable this literature ri-ois5(r)c(t)1c(r)(r)(i)2rtf sand fus2(a)(t)-3(0.0

Table 1: Technology course description

Proportion of Content	Type of Course	Typical Description
0%	Traditional	Course where no online technology used—content is delivered in writing or orally
1 to 29%	Web Facilitated	Course that uses web-based technology to facilitate what is essentially face-to-face course. May use a course management system (CMS) or web pages to post the syllabus and assignments.
30 to 37%	Blended/Hybrid	Course that blends online and face-to-face delivery. Substantial proportion of the content is delivered online, typically uses online discussions, and typically has a reduced number of face-to-face meetings.
80+%	Online	A course where most or all of the content is delivered online. Typically have no face-to-face meetings.

Source: I. E. Allen and Seaman (2011)

Bring your own device (BYOD)

The idea behind BYOD is simple, though implementation can be complicated. In a BYOD environment, every student brings a personally owned digital device to school to use for academic purposes (Grant & Barbour, 2013). BYOD environments are possible in part because the costs of digital devices are low enough that many families have at least one device. One advantage of a BYOD program is the reduced cost to the school district. After all, if students are able to supply their own devices, at minimum that reduces the hardware and insurance costs to the school. Another advantage is that students are able to use technology that they are not only already familiar with but that they also have access to at home for homework (Ally & Tsinakos, 2014). A disadvantage is that students will likely have different types of devices with different capabilities (Ally & Tsinakos, 2014). This adds a layer of logistical support with which schools, districts and teachers must cope. This is not a minor or uncomplicated issue with easy answers. Currently, schools and districts are finding and developing solutions, which may serve to inform other stakeholders who adopt a BYOD program in the future.

Blended learning

Blended learning, also known as hybrid, refers to an educational environment where teachers use digital technology in traditional or flipped classrooms on a regular basis. That is, blended classrooms utilize both device-driven instruction and face-to-face instruction. The objective is to overcome the weaknesses associated with fully online instruction, such as isolation (Islam, 2002), while taking advantage of the benefits associated with technology-driven instruction such as increased achievement of learning objectives (Singh & Reed, 2001; Lim, Morris, & Kupritz, 2014; Rosen & Beck-Hill, 2012). There are many choices and variables involved in determining the structure of a blended classroom. The decisions regarding that structure should be made with respect to the objectives and capabilities of the instructor, the students, and the environment (McGee & Reis, 2012).

Evidence of the efficacy of blended learning is moderate, yet promising (Vignare, 2007). Findings from studies on online environments show mixed results; however, findings from meta-analyses show that online courses are at least as effective as traditional classrooms (c.f., Russell, 1999; Zhao, Lei, Yan, Lai, & Tan, 2005). Zhao et al.'s (2005) meta-analysis found no significant

differences between blended learning and traditional classrooms; they did, however, report that blended learning could be better than traditional classrooms, when instructors' involvement, interaction, content, student capabilities, and the right amount of human to technology were combined. A more recent meta-analysis by Means, Toyama, Murphy, Bakia, and Jones (2009) found promising results. Forty-six studies comparing online and face-to-face conditions, yielded sufficient data to produce 51 effect sizes. Eleven of the 51 effect sizes supported blended learning over traditional face-to-face conditions. As the digital revolution gains momentum, providing increasing opportunities for blended learning options, the number of enrollments into hybrid classrooms will become fluid. Also, with the research bolstering the potential of blended learning, policy support will continue to transform the education system.

rooms. The changes included increased student engagement and interaction and increased learning goal attainment particularly amongst the least advanced and most advanced students.

In 2014, the Flipped Learning Network and Sophia Learning distributed a

prepared and fully dedicated to learning new teaching strategies and teach online courses (Kennedy & Archambault, 2012

Industry Association, 122 education technology vendors reported a combined revenue of $2.4 billion, which is a 2.7% increase from 2012 and a 6.4% increase from 2010 (Richards & Struminger, 2013).

Digital tools and internet access

How has this investment in technology and e-learning translated into access in the classroom? According to the most recent report from the National Center for Education Statistics, approximately 97% of teachers now have one or more computers in the classroom every day (Gray et al., 2010). Also, teachers report having access to the following technological devices, either as needed or in the classroom every day (Table 2).

Table 2: Most commonly used technological devices

Technological devices	% available as needed	% in classroom every day
Liquid Crystal Displays (LCDs)/ Digital Light Processing (DLP) projector	36	48
Videoconferencing unit	21	1
Interactive whiteboard	28	23

Ouyang, 1993; Penuel, 2006; Rakes, Valentine, McGatha, & Ronau, 2010; Slavin & Lake, 2008; Slavin, Lake, & Groff, 2009). Equally as lengthy has been the long standing debate on the effective of educational technology. In 1983, Richard E. Clark argued that "media have no more effect on learning than a grocery truck has on the nutritional value of the produce it brings to market" (Glick, Aviram, & Greeener, 2011, p. 30). Since the 1980s, over 60 meta-analyses have been conducted on different areas of educational technology, subject matter, grade level, answering different questions. Most of the reviews have reported positive effect of education on a wide variety of subjects, specifically on mathematical gains. However, other meta-analyses report varying strengths of effect sizes. (See Table 3.)

Table 3: Meta-analyses of effectiveness of technology

Author	Grade	Number of Studies	Type of Technology	Effect Size

poor methodologies seemed to report much higher effect sizes compared to those with more rigorous methods.

Conclusion/Discussion

This paper presents an overview of the literature surrounding the rapid transitions that technology integration has made over the years; the amount of resources and funding that has been allocated to immerse school with technology; and the conflicting results presented on effectiveness of using is technology in education. We found a plethora of instructional strategies being used to integrate technology into K-12 classrooms. Also, though there have been large investments made to integrate technology into K-12 classrooms to equip students with the skills needed to prepare for college and a career, the practical use of this investment has not been impressive. Lastly, several meta-analyses showed promising results of effectiveness of technology in the classroom. However, several inherent methodological and study design issues dampen the amount of variance that technology accounts for. Based on both the experimental and quasi-experimental evidence to date, we highlight a couple of conclusions:

- Currently, the reported ratio of students-to-devices has been reduced from 11:1 to 1.7:1.
- Schools with higher ratios of students per device likely reflect limited resources to purchase the hardware, software, and infrastructure for more devices rather than a belief that having multiple students per device is preferable to a 1:1 ratio.
- Some schools and districts have been able to reduce the ratio of devices to students down to 1:1, which is often thought to be the best-case scenario.

Also, there is wide spectrum of technology environments that can deliver educational content. Depending on the needs of the students and the resources of the schools/districts, coursework can be provided via:

- Bring Your Own Device (BYOD)
- Blended Learning
- Flipped Learning & Flipped Classrooms
- Online learning

In the United States, there has been a significant investment made in educational technology. However, the investment seems to be disproportionate.

- In 2010, the United States Government spent approximately $1.3 trillion dollars on education, with expenditures at the K-12 level accounting for $625 billion of that cost, which is only 5% of the total education spending.
- In 2013, the United States Government increased their spending on education to $1.5 trillion dollars, with expenditures at the K-12 level accounting for $718 billion, and K-12 e-learning accounting for 0.7% of the total K-12 education.

Although it seems that there has not been much investment for K-12 education, there certainly has been an increase in integration.

- Approximately 97% of K-12 teachers now have one or more computers in the classroom every day and also have access to additional technological devices.
- The ratio of students-to-computer has decreased from 11 to 1 to 1.7 to 1 in the classroom every day.
- Also, approximately, 93% of computers in K-12 classrooms have access to the Internet every day.
- Additionally, 96% of computers or digital devices brought from home for use in the classroom have access to the Internet every day.

However, studies conducted on the most current instructional strategies that are being used to integrate technology into K-12 classrooms show mixed results. For example, meta-analyses conducted on effects online learning found moderate effects for student achievement and student satisfaction in favor of online learning (Shachar & Neumann, 2003). The USDOE found that "students who took all or part of their class online performed better, on average, than those taking the same course through traditional face-to-face instruction" (Stansbury, 2009, p. 1). Unfortunately, the studies used in the meta-analyses were riddled with methodological flaws, thus results should be interpreted with caution (M. Allen et al., 2002; Ungerleider & Burns, 2003). Alternatively, evidence of the efficacy of blended learning were promising (Vignare, 2007). Several meta-analyses found that online courses were at least as effective as traditional classrooms (c.f., Russell, 1999; Zhao et al., 2005). A more recent meta-analysis by Means et al. (2009) found promising results. Forty-six studies compared online to face-to-face conditions, yielding sufficient data to produce 51 effect sizes. Eleven of the 51 effect sizes supported the positive effects of blended learning over traditional face-to-face conditions.

As the digital revolution gains momentum, there will be more opportunities to conduct research on the effect of new technological instructional strategies. With the digital revolution changing the quantity and quality of available information, educators are charged with the responsibility of equipping students with the necessary skills to discern between facts and fiction at a young age. By building students' critical thinking skills, students will have the cognitive skills needed to: 1) discern and identify credible information; 2) have the ability to master the Common Core State Standards; and 3) gain the skills in order to be prepared for college and/or a career.

To accomplish these feats, technological tools and instructional strategies offer teachers the ability to transform their teaching, providing students with plethora of benefits, such as more opportunities for 1 to 1 interaction with their teachers, create flexible learning environments to facilitate group study and independent study, provide students with immediate feedback, offer students advanced or college level courses, permit students who failed a course to retake it, reduce scheduling conflicts for students, and even decrease dropout for at-risk students.

Beyond the ambiguity of the findings, there remains substantial support for the acquisition of technology. Further, the use of technological instructional strategies means formations of non-tradition classrooms that range from 0% of proporti

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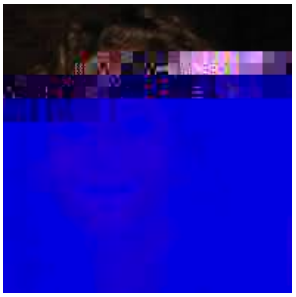

Katherine McKnight leads the Center for Educator Learning & Effectiveness. She oversees the research agenda for the Center, designs and implements research studies, collaborates with a wide range of education organizations, and shares research results via publications, presentations and social media. With Pearson since 2006, she has directed research and evaluations, focusing on whole school reform and educator effectiveness. Dr. McKnight's current projects focus on educator evaluation systems and career pathways; integration of technology for learning; and collaborative processes for enhancing instruction and learning opportunities for students. She also teaches statistics as an Adjunct Assistant Professor at George Mason University and has developed online statistics courses to train program evaluators. She holds a doctorate degree in Clinical Psychology with an emphasis on Quantitative Methods from the University of Arizona. Follow @McKni8 - See more at: http://researchnetwork.pearson.com/author/kathymcknight#sthash.dFbx9TP5.dpuf

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