Availability and Use of Digital Technologies in P-12 Classrooms of Selected Countries

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Abstract

This study examined what digital technologies were available and how they were used in classrooms in 14 countries around the world. The findings of the study indicated that there was an enormous difference in terms of access to digital technologies available in the classrooms between developed countries and developing countries. Classrooms in the U.S had more digital technologies than other classrooms around the world, but they did not use technology the most. Within the group of developed countries, the difference in digital technologies available in the classrooms was not large. However, within the group of developing countries, there was a large difference in terms of different technologies available in the classrooms. The findings of the study also revealed a universal issue of technology integration in education around the world: schools may have the funds to spend on technology, but they did not always have the funds to hire people to help teachers with technology integration.

Keywords: *Technology integration; educational technology, digital literacy*

Introduction

There is no doubt that instructional technology is a major component of education today. The Pew Internet and American Life Project reported that 92% of American teachers state that technology and Internet access have a "major impact" on their teaching resources (Purcell, 2013, para. 3). In the United States alone, the federal, states, and local governments spend more than $3 trillion annually on technology for schools (Boser, 2013, para. 13). It is almost impossible to walk into an American P-12 school and not find it filled with various forms of instructional technology.

In American classrooms and libraries, an observer will find a variety of technologies being used in teaching and learning. According to the U.S. Department of Education National Center for Education Statistics (2010) 97% of P-12 teachers had one or more computers in their classrooms, and Internet access was available for 93% of those classroom computers. Additionally, P-12 teachers have LCD or DLP projectors, interactive whiteboards, and digital cameras "either in their classrooms or available to them daily" (para 2). Over three-quarters of American libraries circulate e-books (American Library Association [ALA], 2013) and the number is rising in school libraries as well (Polanka, 2012). It is obvious that technology is prevalent in P-12 settings across the country, though its use in student education has not always proven to be effective.

> Far too often, school leaders fail to consider how technology might dramatically improve teaching and learning, and schools frequently acquire digital devices without discrete learning goals and ultimately use these devices in ways that fail to adequately serve students, schools, or taxpayers. (Boser, 2013, para. 2)

The reasons why technology can be ineffective tools for teachers include lack of time, lack of adequate funding, lack of training, and incompatibility with school culture (Su, 2009). Certainly, collaboration with technology savvy teachers, instructional technology specialists, and librarians can help teachers bridge the gap (American Association of School Librarians [AASL], 2009).

While research and statistics on the availability and use of technology in American classrooms is plentiful (Market Data Retrieval [MDR], 2003), information on available technology for use in P-12 classrooms outside of the United States is less so. In the current study, researchers were interested in 1) which digital technologies are used in classrooms worldwide, 2) how often are teachers using digital technologies in those classrooms, and 3) who is available to help with integrating technology into curriculums in schools worldwide. Further, researchers were interested in determining the differences (if any) in technology availability and use between developed and developing countries.

Literature Review

A common framework in examining the availability and use of digital technologies in P-12 education is one proposed by Ertmer (1999) that elaborates on first- and second-order barriers to integrating technology in education (e.g., Cuban, 1993; Khan, Hasan, & Clemet, 2012; Su, 2009; Tsai & Chai, 2012). First-order barriers are external obstacles, such as lack of resources, time, support, and training. Second-order barriers are those that are internal to the teacher and more deeply rooted in daily instruction, including beliefs and philosophies of education.

First-order Barriers

The first-order barrier of lack of technology resources has been dissipating in U.S. classrooms. As early as 2002, U.S. federal government investments in P-12 technology-related projects topped 3.2 billion dollars (MDR, 2003). More recently, the data show that there is now a focus in U. S. schools on one-per-student technologies, primarily tablets. In their budgets for 2013-2014, about 25% of U.S. school districts expected to increase their hardware budgets, with 77% planning to purchase tablets and 85% already reporting use of tablets at some level (MDR, 2014).

In other parts of the world there are also hopeful indications of increased governmental spending in the area of educational technology in P-12 classrooms. In 1997, a Master Plan for Information Technology in Education was implemented in Singapore, and resulted in an investment of 1.2 billion dollars in ICT for schools. In 2002, the government unveiled a second master plan supposedly with similar or increased investments (Hew & Brush, 2007). In Turkey from 1998 to 2008, the Ministry of National Education invested more

than one billion U.S. dollars in "personal computers, printers, notebooks, projections, and scanners" as well as connecting 98% of secondary students, and 93% of all primary students to the internet in their schools (Uluyol, 2013, p. E10). In 2010, the Turkish government continued its push for technology infusion through the FAITH project, which stands for *Fırsatları Artırma ve Teknolojiyi İyileştirme Hareketi,* or 'Movement to Increase Opportunities and Technology, "the biggest resource allocation to education in the history of modern Turkey", investing $1.8 billion dollars (U.S.) into teachers' guidebooks and tablet computers for students (Uluyol, p. E11). A project of the International Association for the Evaluation of Educational Achievement (consisting of research teams from 28 countries) found that innovations in ICT in classrooms worldwide included "use of productivity tools (78%), web resources (71%), and email (68%). . . . Some used web design tools (34%) . . . and education software such as simulations and micro-computer based laboratories (13%)" (Kozma, 2003).

This evidence of increased governmental spending indicate progress in dispelling the first-order barrier of lack of resources in international P-12 classrooms, but they are far from typical (Khan, Hasan, & Clement, 2012). Lim and Pannen (2012) indicated a lack of technology funding and support for staff in Indonesia. Dionys (2012) reported a dearth of both digital resources and the infrastructure (e.g., electricity) to sustain them in Cambodia. Khan, Hasan, and Clement explain that the lack of technology in P-12 education in Bangladesh is not only due to the need for equipment and hardware, but also to the lack of appropriate infrastructure, for instance electricity. "Most of the rural areas of Bangladesh do not have electricity and therefore one cannot even run a computer in the first place." (2012, p. 68). As would be expected, ICT use in education has increased significantly over the last few years, but at much faster rates for developed than for developing countries (Khan, Hasan, & Clement, 2012).

Lack of administrative and technical support, as well as lack of professional development for teachers are other areas of first-order barriers to technology integration. Fox and Henri (2005) reported that teachers in Hong Kong perceived that principals' lack of technology understanding restricted their ICT practices in the classroom. Conversely, Granger et al. (2002) found that teachers in Canada appreciated and responded to principals' encouragement for their integration of ICT into classrooms. In Bangladesh, the reasons found for ineffective implementation of ICT in classrooms included poor administrative support, lack of training for teachers, and too few qualified ICT coordinators to help teachers integrate technology into their classrooms (Khan, Hasan, & Clement, 2012).

Second-order Barriers

Second-order barriers, those that have at their roots teachers' beliefs and philosophies of education, "are not always apparent to others or even to the teachers themselves" (Kerr, 1996). Even if first-order barriers are overcome, meaningful technology integration will not be achieved automatically. Pre-conceived ideas of what teachers think teaching and learning look like can be "major limiting factors to integrating technology" (Ritchie and Wiburg, 1994, p. 152). Zhao et al. (2002) found that "lack of vision or rationale for

technology use/lack of relevance to the curriculum/incompatible with pedagogical belief" was one the major barriers to technology integration for the teachers in their study. Moseley and Higgins (1999) indicated that the teachers in British classrooms who were positively disposed to ICT itself were more likely to use it in their classrooms than those who were not. In Saudi Arabia, teachers' attitudes were found to be strong indicators of their use of ICT in classroom settings (Almusalam, 2001). A study in Australia showed that the majority of secondary teachers in the study did not believe that computers would lead to faster learning or better understanding of content (Newhouse, 2001). While teachers in Cyprus indicated that they saw the importance of using technology in other areas, they were not convinced of technology's effectiveness in education (Karagiorgi, 2005). As technology becomes more and more available in developing countries, the more critical these second-order barriers become (Ertmer, 2005, Hasselbring et al., 2000, Zhao et al., 2002).

In the current study, the first and third research questions, 1) which digital technologies are used in classrooms worldwide, and 3) who is available to help with integrating technology into curriculum in schools worldwide, have to do with first-order barriers in the international community. Specifically, question one deals with the actual resources available to teachers and students in the classroom, and question three with support and leadership. Question two, 2) how often teachers are using digital technologies in those classrooms, pertains to both availability of resources (first-order) as well as educational philosophy and instructional beliefs (second-order).

Methodology

The current study is descriptive research, using data from an online survey. In summer 2013, one of the researchers in this study hosted an open online course in computer-assisted language learning for 525 in-service teachers from 23 nations. Those teachers were invited to participate in this study, and asked to share the link to the survey with their colleagues in their countries. Our survey has six questions. The first three questions are used to identify participants' geographic locations and grade levels they are teaching, and the remaining three address the research questions. Within three months, 412 responses from 19 countries were made to our online survey. Since this study only focused on P-12 education, we excluded 72 responses identified as higher education. To increase the validity and reliability of our collected data, a triangulation process was conducted in which each country needed to have at least 10 responses/participants to be included in this study. According to Maxwell (2005), the triangulation process of collecting information from different sources and/or many participants reduced the risk that conclusions would reflect systematic biases and allowed a broader understanding of the study's issues. The comparison of data gathered from at least 10 different responses in each country supported the triangulation process and therefore enhanced internal validity. The actual total number of responses included in this study was 248.

Based on our selecting criterion of each country having at least 10 responses, 14 countries were included in this study, respectively listed in the order of having the most responses

to the least responses: Vietnam (32 responses), the United States of America (29 responses), China (25 responses), Russia (21 responses), France (20 responses), Spain (18 responses), Korea (17 responses), Japan (15 responses), Thailand (14 responses), Canada (13 responses), Mexico (13 responses), Philippines (11 responses), Honduras (10 responses), and Ivory Coast (10 responses). Upon identifying 14 participating countries, we included all of the responses within that country into one informational unit. For example, Korea was included in this study since we had 17 responses from this country. However, we realized that not all of 17 responses were from the same school building or the same city. Some of them were elementary teachers in Seoul, the capital of the Republic of Korea. Others were high school teachers in Asan city. Therefore, we included all the information those 17 participants provided into one data unit for the case of Korea.

Results

Question 1: What "digital" technologies do classrooms in those countries have?

For this first question, three researchers brainstormed and created a list of digital technologies they were aware of that may be used in the classroom. To make sure that no technology was excluded in this study, the option "Other" for participants to fill in was also provided in the survey. Below is a list of digital technologies included in the survey.

1. One or two desktop computers
2. More than three desktop computers
3. One TV set
4. One or two laptop computers
5. More than three laptop computers
6. LCD projector(s)
7. Overhead projector(s)
8. Smartboard
9. Cassette player
10. Video player
11. Tablet (such as iPad)
12. Internet wireless network (Wi-Fi)
13. Internet cable
14. Printer
15. Scanner
16. Speakers
17. Online quiz or activity subscription
18. Microphone
19. Camera
20. Video camera recorder
21. E-reader(s)
22. Access to e-book(s)
23. Access to virtual encyclopedias

24. Access to information databases
25. Others (please specify)……

Our data showed that there was a huge difference in term of access to different digital technologies available in the classrooms between developed countries such as the USA, France, Canada, Spain, Japan and Korea and developing countries such as Vietnam, China, Russia, Thailand, Mexico, Philippines, Honduras, and Ivory Coast. Developed countries and developing countries were classified based on the World Bank (2012)'s criterion. Specifically, developing countries are countries with Gross National Income (GNI) per capita per year of US$ 11,905 and less. On average, the classrooms in developed countries in this study had access to 12 out of 24 (12/24) different digital technologies while the classrooms in developing countries in this study had five out of 24 (5/24) as showed in the table below. Among those countries, classrooms in the USA have the most access to different technologies (15/24).

Table 1

Digital Technologies Available among 14 Countries' Classrooms

	Country	**Total of types of educational technologies available in the classrooms per country**
1.	USA	15
2.	Canada	13
3.	Japan	12
4.	France	12
5.	Korea	11
6.	Spain	11
7.	Russia	10
8.	Mexico	9
9.	Thailand	8
10.	China	6
11.	Honduras	4
12.	Philippines	3
13.	Vietnam	2
14.	Ivory Coast	1

Within the group of developed countries, the difference in digital technologies available in the classroom was not large. However, within the group of developing countries, there was a large difference in term of different technologies available in their classrooms.

While classrooms in Russia had 10 out of 24 (10/24) digital technologies, classrooms in Ivory Coast had only one (1/24). The most common digital technologies available in the classrooms were "*desktop computer*", "*cassette player*", "*video player*", "*TV*", and "*overhead projector*". Classrooms in the USA were the only place where "*tablet*" was available.

Question 2. How often are technologies used in the classrooms?

For ease of data analysis, four options in the survey: "*Everyday*", "*More than three times/ week*", "*One or two times/week*", and "*Rarely*" were coded as 4, 3, 2, and 1 respectively. Below is a table of how often technologies were used in the classrooms among 14 countries.

Table 2

Frequency of Technology Use in Classrooms

	Countries	No.	Min	Max	Median	Mode	Mean	S.D.
1.	France	20	1	4	3	3	2.75	0.85
2.	Canada	13	1	4	2	2	2.55	0.80
3.	Korea	17	1	4	2	2.0	2.35	0.85
4.	Japan	15	1	4	2	2.0	2.35	0.90
5.	USA	29	1	4	2	2.0	2.25	0.95
6.	Russia	21	1	4	2	2.0	2.15	0.90
7.	Spain	18	1	4	2	2.0	2.15	0.90
8.	China	25	1	4	2	2.0	1.95	0.75
9.	Mexico	13	1	4	2	1.2	1.95	0.85
10.	Thailand	14	1	4	2	1.2	1.90	0.80
11.	Philippines	11	1	4	2	1.0	1.85	0.85
12.	Honduras	10	1	4	1.5	1.2	1.50	0.80
13.	Vietnam	32	1	4	1.5	1.0	1.50	0.80
14.	Ivory Coast	10	1	4	1	1.0	1.25	0.75

As shown in Table 2 above, technologies were most often used in classrooms in France (*Mdn* = 3, mode = 3) equivalent with approximately three times/week while technologies in the Ivory Coast classroom were least used (*Mdn* = 1, mode =1) equivalent with almost rarely used. The findings also showed that having more technologies did not lead to more frequency of technology use in the classroom in developed countries. For instance, although classrooms in the United States had the most technologies, the frequency of technology use ranked only fourth among five developed countries. However, this

trend did not apply to classrooms in developing countries. The more technologies the classrooms in developing countries had, the more often they were used in classrooms .

Question 3. Who is available at your school to help with integrating technologies into your curriculum?

We provided the participants with four options: "*Technology coordinator*", "*Tech savvy teachers*", "*Library media specialist*" and "*Other*". The data offered quite similar results among countries regardless of whether it was a developed or developing country and/or the classroom has many or limited technologies as shown below.

Table 3

Technology Integration Support

	Countries	No.	Tech Coordinator	Tech Savvy Teachers	Library Media Specialist	Other
1.	France	20	5	12	1	2
2.	Canada	13	3	7	1	2
3.	Korea	17	2	9	0	6
4.	Japan	15	3	8	1	3
5.	USA	29	5	14	4	6
6.	Russia	21	1	17	0	4
7.	Spain	18	3	13	0	2
8.	China	25	1	20	0	4
9.	Mexico	13	1	10	0	2
10.	Thailand	14	0	12	0	2
11.	Philippines	11	0	9	0	2
12.	Honduras	10	0	7	0	3
13.	Vietnam	32	0	15	0	17
14.	Ivory Coast	10	0	7	0	3
Total			24	160	7	58

As indicated in Table 3 above, *technology savvy teachers* were the most available resource to help their colleagues with technology integration. *Technology coordinators* were only available in schools in developed countries. This also held true for *library media specialists.* Only schools in developed countries had this resource to help teachers with technology integration. However, their numbers were still limited compared with the resource of "*technology savvy teachers*".

Discussion

The results of question 1 in this study help connect and validate what has been reported in the literature about technology integration around the world and provide educational administrators, educators, researchers and teachers with more evidence-based information about how technology is being integrated internationally. First, the findings of this study indicated that there was an enormous difference in term of access to digital technologies available in classrooms between developed countries and developing countries. This finding reflects what has been reported in the literature about developed countries such as the United States, Singapore, and Australia spending millions of dollars in educational technology (Hew & Brush, 2007; Kozma, 2003; Market Data Retrieval, 2014; Uluyol, 2013) and the limited educational technology resources in developing countries such as Indonesia (Lim & Pannen, 2012), Cambodia (Dionys, 2012), and Bangladesh (Khan, Hasan, & Clement, 2012). The fact that this study found that classrooms in the U.S had more digital technologies than other classrooms around the world is actually in line with what has been reported in the United Nations' Educational Spending Reports (2003). Accordingly, the U.S. leads in educational spending at $809.6 billion per year. The results of the study also indicated that within the group of developed countries, the difference in digital technologies available in the classrooms was not large. Within the group of developing countries, however, there was a large difference in terms of the variety of technologies available in the classrooms. While classrooms in Russia had 10 digital technologies available, almost as many as classrooms in developed countries have, classrooms in Ivory Coast had only one.

This huge gap in terms of technology availability in classrooms among countries continues to create creating a digital divide, a condition that had been forewarned by the World Economic Forum (2012). While developed countries such as Sweden, Singapore, Finland, Denmark, Switzerland, Netherlands, Norway, United States, Canada and Britain are using technology to improve business, education, government and the lives of individuals, many poor countries in sub-Saharan Africa as well as Nepal, Syria, East Timor and Haiti are still teaching their children with limited digital technology resources. It is interesting to note that although there may be different teaching approaches and/or philosophies among cultures and countries, the approach to integrating technologies into classrooms was quite similar among cultures and countries. As reported in this study, the most common digital technologies available in the classrooms among countries were "desktop computer", "cassette player", "video player", "TV" and "overhead projector." We did not have additional information sources, however, to identify the effectiveness/efficiency of use of different categories of technology in each country. Finally, the fact that only classrooms in the U.S had tablet PCs echoes what Fletcher (2003) observed: technological innovations have always excited American educators and the use of technology has always been a consistent trend in the American education system.

Findings for the second question also pointed out an issue, the availability of technology and the use of technology in classrooms, that has been discussed in education for many years. In this study, it is revealed that classrooms in the U.S had the largest range of

technologies, but classrooms in the U.S. did not use technology the most. This outcome reflects Boser's (2013) argument that schools often buy digital devices without discrete learning goals and eventually use these devices in ways that fail to adequately serve learners, schools, or taxpayers. It is also necessary to point out, however, that frequency of use is not always synonymous with effectiveness. Further studies are needed to verify whether the frequency of technology use in classrooms correlates with effectiveness. Finally, the findings of the third question reveal a universal issue of technology integration in education around the world: schools may have the funds to spend on technology, but they do not always have the funds to hire people to help teachers with technology integration. Without technical assistance and proper training for teachers, discrepancies between technology access and integration in developing countries and developed countries will continue, as will ineffective educational use of classroom technology worldwide.

Conclusion

Educating students today requires teachers and school librarians to learn about, use, and integrate a variety of instructional technologies in classrooms and school libraries. Although there has been significant progress over the years and most developed countries have made substantial investments in the instructional use of various technologies, there are a number of remaining difficulties to be faced. The discrepancies in technology implementation in schools between the developed countries and the developing countries is highly disconcerting and indicative of a potential and destructive increase in the digital divide. This is not, however, the sole issue that is troubling to the authors. Additional obstacles are first- and second-order barriers and the frequency (or lack of it) of the instructional uses of technology.

Although investing large sums of capital into the infrastructure of instructional technology (as is the case in all of the developed and many of the developing countries) will assist in overcoming some of the first–order barriers, funding alone will be insufficient to remove all of the barriers. Educational culture and personal educational philosophies must also be modified for instructional technologies to be used as fully and as rigorously as they should. According to Bell (2014, para. 3) more than 96.4% of the teachers, school librarians, professors, and other educators who responded to a survey reported that they knew faculty and staff who "…exhibit aversion or anxiety regarding technology." That aversion must be reduced or eliminated before students will benefit from the funding increases. To reduce the anxiety and aversion to technology, teachers and school librarians will need professional development training and the time to learn the new technology, develop technology-inclusive projects, and integrate those projects into their curriculums. They will also need ongoing technical and moral support in their quest to provide more dynamic and exciting learning experiences for their students and to prepare those students for the world they will face in the next half century and beyond.

Addressing the needs of the first-order barriers will certainly provide the additional benefit of creating environments where second-barrier issues can be addressed. In order to

do so, however, teachers, technology directors, administrators, and school librarians must incorporate into their educational philosophies the importance of technology to the instructional process in order to have a meaningful impact on the learning of their students. Training, resources, and support are essential in assisting the evolution of their educational philosophies, but faculty must also be committed to changing themselves for the betterment of their students. Without a change in educational philosophies, educators will continue to be averse to integrating instructional technology. They will continue to fail to comprehend the importance of using technologies in the development of their students, regardless of the types and quantity of technologies in their classrooms and libraries. Instructional technology must be a vital and daily component of the students' curriculums and the frequency of its use in both developed and developing countries must improve for all the students.

Students in both developed and developing countries are being exposed to a noticeable increase in the usage of technology in their classrooms. In many instances governments are providing increased funding for the technologies and teachers have some technology support and training. The researchers are strongly concerned by the apparent growing digital divide between developed and developing countries and even a divide within those groups. When the number of technologies available are examined, the developed countries are fairly consistent. They range from a high of 15 to a low of 11. Within the developing countries however, the range is 10 decreasing down to 1. This is a very large and disconcerting discrepancy. The frequency of use also indicates a significant gap between the two groups. France leads the developed countries while Spain is the lowest scoring developed country. Russian schools use technology frequently (*Mdn* = 2, mode= 2), while the developing countries of Honduras (*Mdn* = 1.5, mode = 1.2), Vietnam (*Mdn* = 1.5, mode = 1), and Ivory Coast (*Mdn* = 1, mode = 1) are clustered at the bottom of our survey results, with technologies rarely used. Students cannot learn technology if they do not use it. When looking at tech support, the situation improves slightly. As might be expected, the developed countries have a slightly larger support infrastructure, but the developing countries have relatively strong technology support system in place also.

Our concern is that with the difference in technologies available and the frequency of use of those technologies, the digital divide between developed and developing countries will continue to widen. In today's interconnected and interdependent global societies and economies, the developing countries will simply fall further behind. Technologies and their uses are a viable method for improving the educational systems and hence the lives and economies of developing countries. To not use technologies and their benefits to the fullest is cause for concern.

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