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The Emergence of Technology Skills Divide (TSD) For Educators in the United States: A Synthesis through the Lens of Digital Divide

Uriel Onye
urielonye@yahoo.com

Hammad R. Khan
coolwater2xl@yahoo.com

Charity N. Aniche
charityaniche@gmail.com

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Abstract

   Technology in education is raising unprecedented levels of new concerns for educators across schools with great potentials to improve student learning outcomes. However, by synthesizing data from a study conducted by PBS in 2012 on "teacher technology use", the researchers found that educators were experiencing TSD due to rapid changes in ICT. Hence, like digital divide, TSD impacted the technical skills required to sustain technology mediated educational delivery in the classroom. Whiles the late 1990s and early 2000s struggled with the emergence of digital divide, the rampant innovations in information communication technology (ICT) posed problems to educators, especially teachers who lacked the proper skills to confidently manipulate emerging technologies. Data was collected through a research synthesis of a study conducted by PBS in 2012 on "teacher technology use", the researchers found TSD can be viewed as an entropy in technology skills of teachers created by the exponential growth in ICT. The findings show that educators in the United States experienced technology skills divide that was like digital divide.

Keywords

   Education, Technology in Education, Digital Divide, Learning Technologies, ICT

Introduction

   Educational delivery in the 21st century has evolved tremendously from its predecessor years,

with the early 1990s, when information communication technology (ICT) was on the rise, most

institutions in the US began adopting technology to mediate educational delivery to the benefit of

students, teachers and even the institutions (Kennedy & Archambault, 2012). Many believed and still do

to this day, that the emergence of ICT has redefined education and schools to the extent that students

and educators now depend on innovation in technology for effective and efficient teaching-learning

activities. Presently in the United States, education policy is advancing technology-driven schools

throughout the country (Watson et al., 2011).

   No doubt, blending ICT in high school educational is complex and tasking. Nonetheless, the duty

of teachers remains to prepare students in becoming successful and productive citizens in this

information age. To achieve this educational goal, educators are challenged to incorporate ICT in the

school curriculum. Unfortunately, ICT is not a static state. Rather, it is a constantly changing field that has attracted immeasurable innovations within and outside of the education system. Teaching and educational delivery require teachers to adapt to the new technologies that are being introduced in classrooms and integrated into pedagogy. These new pedagogies and curriculum built on technology are suitable for students' learning outcomes. Basically, providing complete cyberinfrastructure of ICT in schools does not ensure usage. Without the right technology skills, teachers will not be able to use such technology for active participation in guided learning (Onye, 2016).

Despite emphasis on the need to advance technology in schools, mechanisms are not enough to enforce technology skills for teachers that are commensurate with the fast-paced technology skills of students (NCATE, 2007). Presently, all 50 states in the United States have embraced, in different capacities, online learning opportunities and require each student to complete at least one program online before leaving high school (Kennedy & Archambault, 2012). If the aim is to produce high school students compliant with innovative learning technologies, on the contrary, not carrying along schools' students and their teachers could create a gap in technology like that of digital divide.

It is counterproductive and meaningless that while schools are providing current and emerging technologies capable of facilitating teaching-learning for their students, teachers cannot manipulate ICT to achieve teaching expectations due to inadequate technology skills. In fact, the success of technology-mediated learning in school rests on the competence technology skills of teachers (Archambault, 2011). To enable teachers to keep up with the fast-learning pace of students, certain technology skills are required, albeit, in advance before employment. This will keep teachers abreast with current technology used in schools and prepare them to embrace emerging technologies. The questions that guided this research synthesis were as follows:

1. How can we model technology skills for high school teachers in an era of exponential growth, innovations, and rapid changes in ICT?

2. How can innovations, rapid changes and exponential growth in ICT give rise to technology skills divide for high school teachers in the United States?

Purpose

This study emphasizes the need to synthesize technology skills for teachers in U.S. high schools because emerging innovations in ICT can create gaps in technology skills that may lead to another form of digital divide. The researchers see an imperative to study the effects that the rapid developments in ICT play on high school teachers' technology skills. This will foster a research focus to address any possibilities of a technology skills divide (TSD) from hiding under the innovations in ICT in schools.

Literature Review

The digital divide lessons

The concept of a digital divide reminds us of a period when gaps in ICT among children and families were widespread in the United States: the era of Presnky's (2001) digital natives and digital immigrants. Today, based on the innovations, rapid changes and exponential growth in ICT, a similar concern is arising through the expanding and diversifying knowledge base of ICT (Torraco, 2005). Suffix to say that, as technology grows, the digital divide takes new forms and re-emerges differently as illustrated using TSD. Teachers could face a new form of digital divide in schools since the innovations in technology require them to constantly acquire new technology skills to function effectively in an ICT-based classroom.

To prevent TSD from confronting teachers in the manner that digital divide confronted students during the early days of introducing technology in schools, when digital divide was caused by unequal distribution of technology in societies (Van Dijk, 2006), teachers need to possess technology skills and constantly update these skills to keep pace with emerging and changing trends in technology. Failure in

this direction will risk the emergence of TSD capable of destabilizing the educational delivery system in

high schools. As a government survey reveals, students between the ages of 9 and 17 from all income

homes used computers more than any other group in the United States (U.S. Census Bureau, 2002). To

overcome digital divide, government developed programs are needed to bridge gaps in technology, and

ensure all students have access to technology. As the image below shows, the importance of technology

skills for teachers started with the integrating ICT in schools.
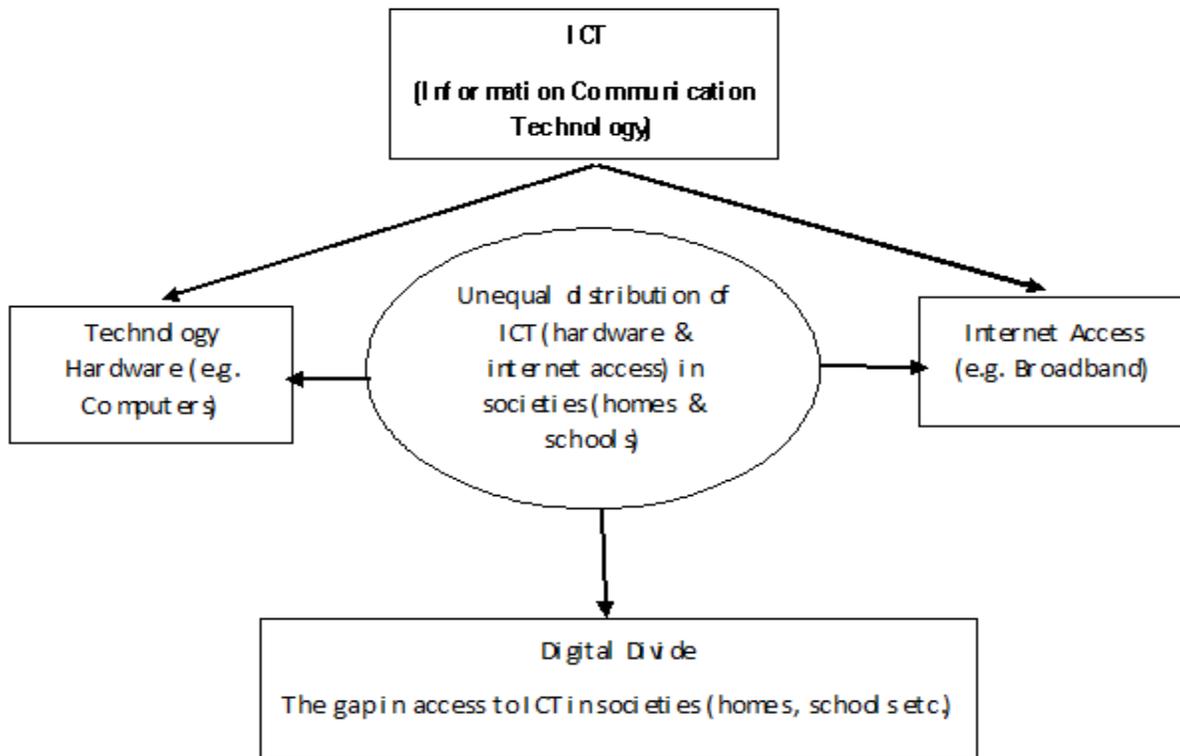
Through digital inclusion programs, government and partner agencies were able to provide

computers and Internet access to public schools across the country. This access to technology

transformed high school educational pedagogy and encouraged Prensky's (2001) narrative that

"technology drives a learning behavior change in digital native students. Hence, their tech-savvy nature

has prompted many to referred to children born post 1983, especially those digital natives born after

1993, as Net-generation, Google generation and more (Rowlands, 2010). Teachers must acquire technology to address the needs of this category of students. Instead of dwelling only on students' use of technology, schools should enforce training programs for teachers to equal the technological pace of their tech savvy students.

Schools should not allow gaps in the technology skills of teachers to create a digital divide for their schools. But, in the event of such divide, schools should implement technology skills-based programs, such as a digital inclusion campaign to resolve TSD for high school teachers. Studies have shown that technology has evolved exponentially over the years. These changes are capable of overwhelming anybody. This raises questions such as how can high school teachers stay relevant with innovative technologies in a constantly changing ICT environment? Technology is transforming the U.S. educational delivery in general, and school administrations need policies on mandatory technology skill training to enable teachers to avoid TSD. Teacher curiosity should resemble that of young people who are keen on ICT, and who are willing to experiment with new technologies (Lusoli & Miltgen, 2009).

The Importance to Update Technology Skills

Government has done much to provide ICT in schools and in addressing the technology training for teachers. The ongoing innovations in technology require teachers to constantly update and add new technology skills to take advantage of the expanding cyberinfrastructure relevant to them. To this end, the U.S. Department of Education emphasized the need for teachers to stay abreast with technology, and schools can help by enabling periodic technology skills update programs for teachers (U.S. Department of Education, 2002). The benefits of technology cannot be underestimated considering that teachers face students born in the information age and exposed to digital technology and mostly living their lives online (Holman, 2011). The innovations make technology skills for teachers complicated and complex to describe (Bebell, Russell, & O'Dwyer, 2004). But studies agree the usefulness of computers in the

classroom is an innovation of great importance and has been described as the beginning of transformative learning (Forte & Blouin, 2016).

Technology skills for teachers are important, and different opinions state that teachers can reshape the entire learning process, develop, and transform students' thinking minds with technology (Hutchison & Reinking, 2011; Ng'ambi, Bozalek, & Gachago, 2013; Goodwin et al., 2014). This highlights the importance of technology in education, and the need for technology skills for teachers. Otherwise, government will not invest huge funds in technology infrastructures and programs in schools. Teachers must show motivation toward learning the technology skills that will advance their schools' educational objectives. Teachers who experience burnout from an excessive workload could reduce their burden with certain technology skills. As an example, web-mediated knowledge synthesis could enable teachers to reduce the need to remember detailed information on a topic by their simply knowing how to access web-based texts (DeSchryver, 2015).

Web-based technologies and programs in schools suggest that teachers with advanced technology skills (present and emerging cyberinfrastructure) could benefit from ubiquitous web-based technologies and information. Teachers with technology skills, especially those who are digital literates, can make sense of web-based information resources, and save time to focus on other relevant issues, rather than engage in a cognitive waste of energy in memorizing lectures (McEneaney, 2011). Knowledge of web-based technology skills are important for teachers since most schools allow online programs. Technology has transformed traditional classroom instruction and made collaboration an integral part of the teaching-learning process. Teachers can communicate with students using online resources such as whiteboard, web blogs to access students work, post assignments, grade exams, and even hold meetings and advisory sessions. Having technology skills enables teachers to follow current and emerging technology trends in education, and to execute their responsibilities effectively and efficiently.

To be an effective teacher requires the ability to manipulate relevant educational technologies efficiently. In other words, to be efficient with technology requires in-depth knowledge of relevant technologies. Smith, Iversen, and Veerasawmy (2018) raised the idea of digital citizenship and digital literacy as two important concepts containing technology skill sets that enable educators to stay relevant, and actively engage students. Digital citizenship highlights comprehensive skill sets that qualify one as a digital literate. A teacher without relevant technology skills is a digital illiterate, and unlikely to make effective contributions in the educational lives of high school students using technology-mediated instructional channels. Whether in the areas of teaching or non-teaching (e.g., curriculum development, syllabus, et cetera) teachers need technology skills to succeed. Studies have shown that teachers are likely to make better course designs with technology (Guidry, Stevens, & Totaro, 2011).

The problem with mapping out technology skills for teachers is made worse by the exponential growth and often sporadic innovations in ICT that require special training. This tends to create gaps in the technology knowledge base of teachers, making it difficult to advocate a comprehensive technology skills package (Batra & Satzinger, 2006). This challenge, nonetheless, does not demean the importance of current technology skills for teachers. Studies have shown that teachers with technology skills are capable of inspiring students to achieve better academic performance (Swarlis, 2016). To avoid becoming irrelevant in today's educational system, teachers should optimize their technology skills from time to time or become moribund (DeSchryver, 2015). Knowledge of current and emerging trends in technology enables teachers to confidently generate, distribute, and apply digital knowledge in the classroom.

Technology advances creativity, innovation, and collaborative teaching-learning activities in an extraordinary manner, but the absence of the right skills could already be posing problems (Duderstadt, 2009). To help teachers succeed, skills development programs should be in place to offer periodic training on ICT and various technology skills as a critical component of capacity building in schools (Greenwood & Min Kim, 2012; Kratochwill, et al., 2007; O'Connor & Freeman, 2012). Technology has transformed the

dynamics of high school education. Teachers with the relevant technology skills will become effective and efficient mechanisms for educational delivery in the areas of independent study, computer-assisted instruction, web-based instruction, computer-based instruction, video courses, videoconferencing, and learning through online gaming (Beldarrain, 2006).

Methodological Issues

Several studies perceive research synthesis as a pivotal method of disseminating research knowledge, guiding, and shaping research focus (Suri & Clarke, 2009). This method encourages an interdisciplinary review of literature across the science domain by investigators hoping to identify potential areas of individual and collaborative study. To address the central purview of this study in the best possible way, this method was chosen for the following reasons: First, it permits us to use data from different sources to synthesize the importance of technology skills, and the possible risk of TSD from the rapid innovations in technology from the perspective of digital divide. Second, it provides scientific validity to studies that identify, and re-use data generated from a previous study. This has helped to resolve major questions raised to demean this methodology, which centered on "combining statistical data." However, given the "explosion in scientific publications, the field of research synthesis has formalized approaches to combining data from published studies" (Mosteller & Colditz, 1996, p. 1).

The science policy on open data and data sharing encourages researchers to reuse data for the purposes of producing research (Pasquetto, Randles, & Borgman, 2017). Research syntheses have shown that open access to data and data sharing promote innovation in research and collaboration between researchers; it also increases the visibility of research organizations and researchers, and gives wider coverage to scientific data (FSSDA, 2017). The method involves a rigorous process of data selection for reuse; it was chosen because it supports the investigators' intentions of using open data to address this topic beyond those in previous studies.
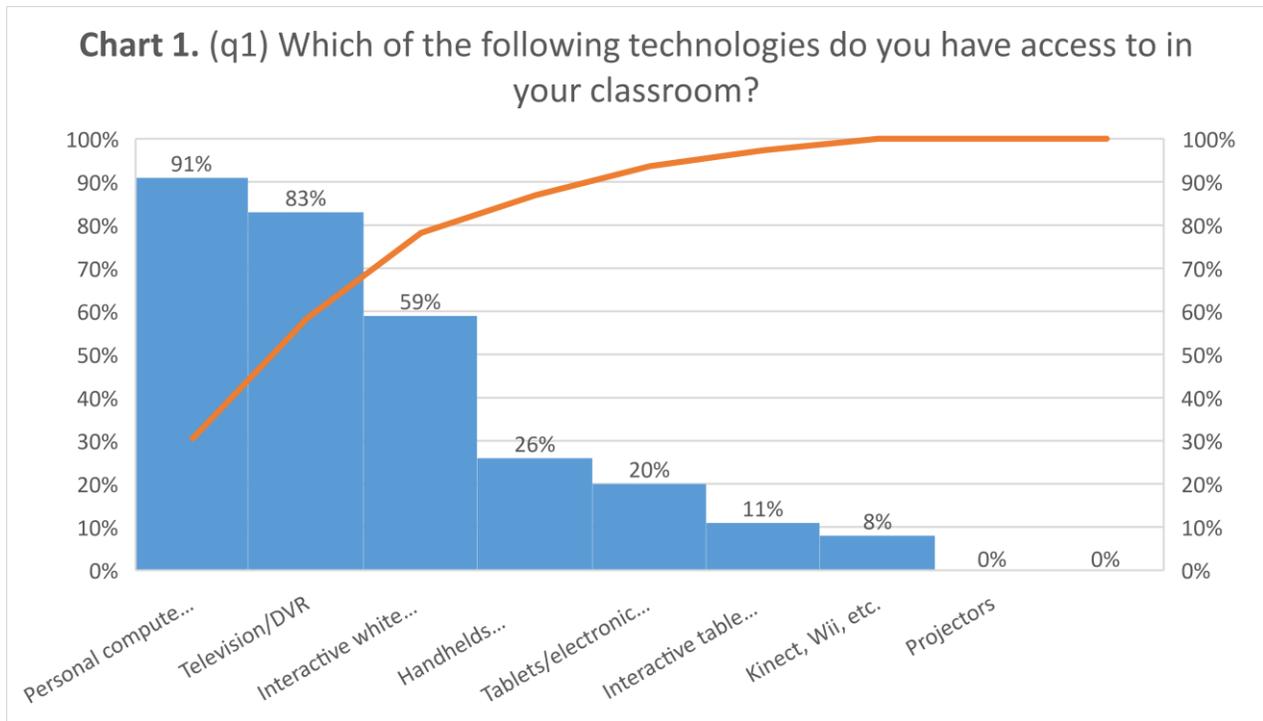
Research Design and Data Sources

Since the standing policy of science on open data and data sharing encourages researchers

pursuing new research to reuse data for the sole purposes of producing new research (Pasquetto,

Randles, & Borgman, 2017). The policy explains that data reuse increases the visibility of research findings

and enables reusability of data among researchers from different fields of science (FSSDA, 2017). This

point is important, considering all data reused in this study comes from original works that have been

peer-reviewed before publication.

Data was pulled from a study conducted by PBS on "teachers technology use" for statistical

illustration and clarifications (Learning Media, 2013, pgs. 9 & 11). The survey was conducted January 15-

20, 2013, by VeraQuest, Inc., with a margin of error of +/- 4.4% at a 95% confidence level from a total of

"503 web-based interviews with US pre-K-12 teachers" (PBS Learning Media, 2013). The above results

were adapted for reuse in ways relevant to both the research questions and goal of this synthesis.
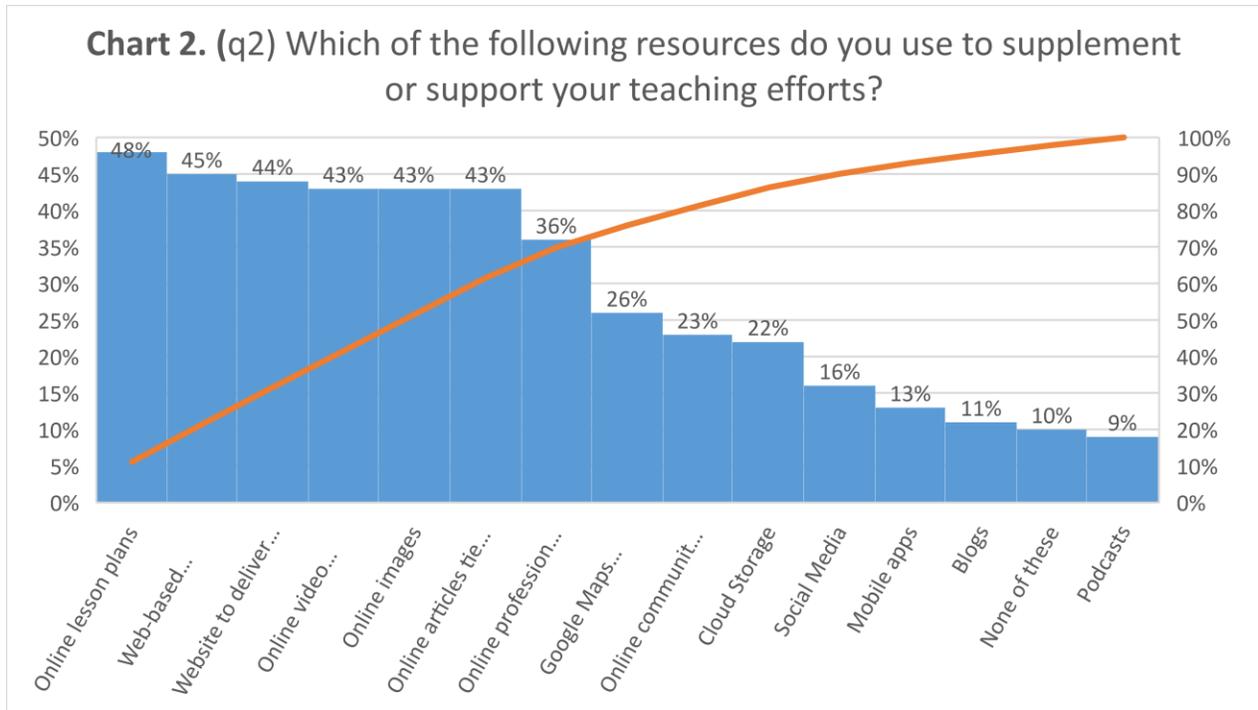
Analysis

In this section, the datasets reused from the named previous study were analyzed to answer two

research questions posed in the beginning of this paper.

1. How can we model technology skills for high school teachers in an era of exponential growth,

   innovations, and rapid changes in ICT?

Chart 1. (q1) Which of the following technologies do you have access to in your classroom?

Personal compute… 91%, Television/DVR 83%, Interactive white… 59%, Handhelds… 26%, Tablets/electronic… 20%, Interactive table… 11%, Kinect, Wii, etc. 8%, Projectors 0%, 0%

Presently in the U.S. educational system, technology use in high schools has become standard instructional design. Unfortunately, the rapid growth and innovations in ICT is creating a gap in technology skills for teachers. Part of the arguments in the study rest on the notion that teachers cannot function effectively without appropriate technology skills. To make matters worse, the technology skills are on the increase due to changing ICT relevant to classroom instructional design, which requires teachers to constantly update their technology skills because of these innovations. Addressing the first research question on the required technology skills for teachers considering the rapid innovations in ICT, the survey findings on chart 1 list the technology resources accessible to teachers, while the resources currently in use to supplement/support teaching-learning activities are listed on chart 2. The charts enable a virtual illustration of the idea of a technology skill divide.

2. Could innovations, rapid changes and exponential growth in ICT cause technology skills divide to high school teachers in the United States?

Chart 2. (q2) Which of the following resources do you use to supplement or support your teaching efforts?

Bar values (left axis): Online lesson plans 48%, Web-based... 45%, Website to deliver... 44%, Online video... 43%, Online images 43%, Online articles tte... 43%, Online profession... 36%, Google Maps... 26%, Online communit... 23%, Cloud Storage 22%, Social Media 16%, Mobile apps 13%, Blogs 11%, None of these 10%, Podcasts 9%

Left axis: 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%
Right axis: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%

Juxtaposing the two charts above (1 & 2) shows evidence of a technology skill divide based on the increase in technology available to supplement teaching-learning activities, with the actual technology that teachers have access to in classrooms. In that case, one may rightly fear that a re-emergence of digital divide may likely occur, if it hasn't already, since a great disparity exists in the technology skills required of teachers, and the technologies available and accessible in classrooms. The survey findings presented in Charts 1 and 2 contain (1) findings on technology resources currently used to supplement/support teaching, and (2) the types of technology teachers have access to in the classroom. When combined, the data uncovers gaps in available and accessible technology when compared with teachers' technology-skills. This explains areas of digital divide targeting technology-skills.

Conclusion

TSD can be viewed as an entropy in technology skills of teachers created by the rapid changes and exponential growth in ICT. For instance, when innovations in classroom technology become sporadic,

it requires teachers to constantly update their technology skills. If unchecked, it then becomes logical to assume that these innovations could trigger a nonlinear problem of TSD equal to the digital divide. When curriculum lacks integration of technology skills development, TSD may likely emerge and target teachers. To have knowledge of emerging technology requires an educational pedagogy that supports technology skills development for teachers (Alexander, Knezek, Christensen, Tyler-Wood, & Bull, 2014).
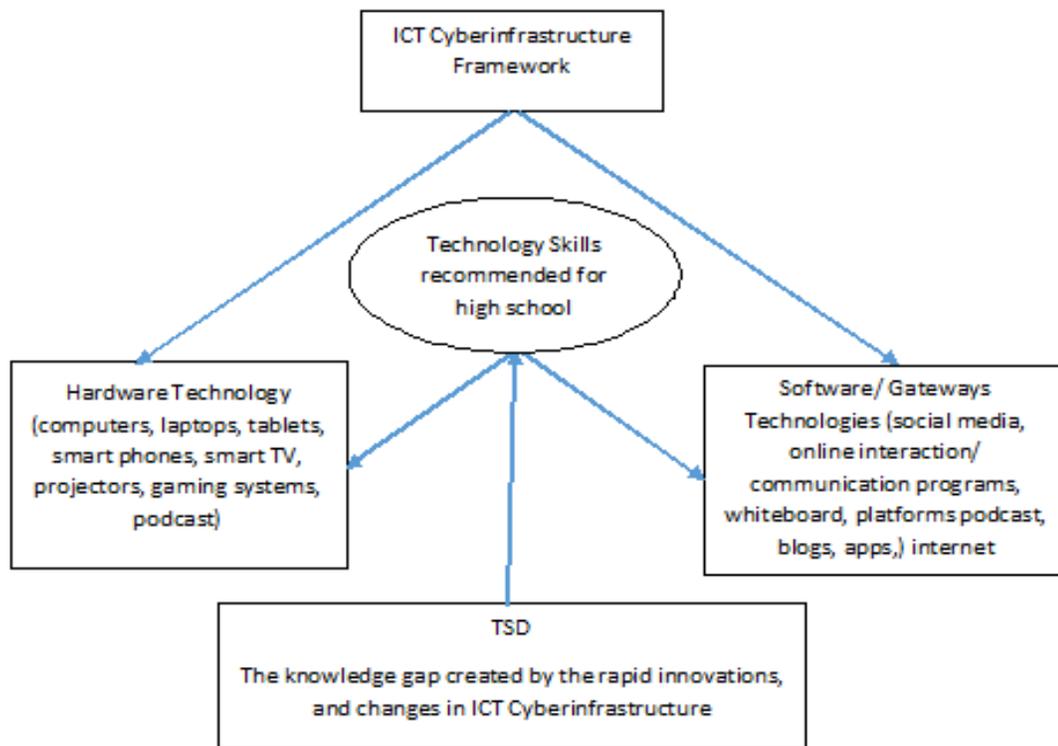
With most emerging technology requiring digital technology skills, teachers face numerous challenges to keep abreast with the innovations taking place in classrooms throughout the United States. The above image is a representation of the data from both charts; it depicts the stunning evolution in ICT advancement that requires teacher technology skills above basic technology knowledge. The evolution of cyberinfrastructure is one of the innovations in technology described as cutting age (Ellisman, 2005), and represents a paradigm change from the ordinary skill to manipulate technology. Teachers need to be experts of the cyberinfrastructure of today's technologically advanced classrooms to command students' respect as well as effectively transmit knowledge. In their article, Portowitz, Peppler, and Downton (2014)

stress the imperative of present music teachers possessing certain technology skills to mediate learning experiences for students. But, as technology keeps innovating rapidly, teachers encounter daunting challenges to keep abreast with the changes. While TSD persists, chances of a digital divide re-emerging become imminent and unavoidable, especially if unidentified and unchecked appropriately in a timely manner.

Considering the spate of innovations in ICT, especially those occurring in the classroom, it becomes obvious that teachers need technology skills that surpass the basic knowledge to operate network, files, and applications for the sake of transforming education with innovation. Students with different learning challenges and disabilities will most likely benefit from teachers with advanced technology skills than teachers whose technology skills are made obsolete with changes in technology. Making technology available in schools without appropriately giving teachers the necessary skills to operate the technology will hinder instructional design, and the entire teaching-learning process. Technology skills are a necessary tool for teachers and require constant updates to be compliant with emerging trends in ICT.

With the emergence of technology compliant classrooms in high schools in the United States, the technology skills of teachers should be considered along with the various innovations that schools are adopting. This is important considering the possible emergence of TSD from the unchecked innovations in technology that are adopted and integrated in the classroom.

To achieve technology skills integration for teachers, it is necessary to highlight technology tools in pedagogy and educational program content (Polly, 2015). This includes the zeal in teachers to pursue self-instruction whenever the opportunity arises, and to put into practice the pedagogy of using technology. Teachers must change their attitudes and beliefs toward technology that demands new skills. Finally, unlike digital divide, which Shapiro (2014) described as a social environmental problem, the

researchers herein explain TSD as a "cognitive functioning problem" that burdens one's conscious mental activity within the social space-environment. Part of the innovations in schools come with the integration of new technology in classrooms. However, this could hinder the technology skills of teachers as they are needed to master rapidly changing technology. TSD is then a reminder of the burden that teachers face due to innovations rendering their skills obsolete as new technologies emerge and are adopted in schools. Therefore, if the changes and innovations in digital technology become exponentially rapid, then the technology skills divide becomes the new digital divide challenge for tomorrow's digital environment.

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