The Digital Divide in Formal Educational Settings: The Past, Present, and Future Relevance

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Introduction

The Digital Divide has become an enduring fixture in our global society with educational opportunities (e.g., integrating information and communication technology in schools, classrooms, and libraries) often being perceived as the bridge to overcome this social inequity. Understanding the impact of the Digital Divide in formal educational settings has evolved over the past 20 years to not only examining equitable student *access* to computer devices (e.g., tablets, desktops, or smartphones) and the Internet (e.g., high-speed broadband) but also how information and communication technology (ICT)) resources are used for teaching and learning, its impact on students' learning outcomes, and ultimately how ICT is used by students for their own empowerment. The Digital Divide can be manifested by a variety of demographic characteristics (dividing factors): age (e.g., generations X versus baby boomers), gender (e.g., males versus females), culture (e.g., western versus eastern), location (e.g., rural versus urban), socioeconomic status (e.g., privileged versus underprivileged), race/ethnicity (e.g., white/Caucasian versus minority or Hispanic), education (e.g., college educated versus high school dropout), disability status (e.g., visually impaired versus nonvisually impaired), literacy (e.g., English versus not speaking English), and more. Further, the Digital Divide is a multidisciplinary issue which impacts a wide range of disciplines, such as economics (Antonelli, 2003), business (Srivastava & Shainesh, 2015), psychology

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(Jackson, Ervin, Gardner, & Schmitt, 2001), sociology (Drori & Jang, 2003), computer science (Payton, 2003), political science (Milner, 2006), and information and library science (Gyamfi, 2005). This chapter attempts to acknowledge the multidisciplinary nature of the Digital Divide while focusing attention on the phenomenon in formal educational settings. The purpose of this chapter is to provide a brief history of the Digital Divide, an operational definition of the Digital Divide, a conceptual framework of the Digital Divide for formal educational settings, and a review of recent research (past 5 years) and to provide solutions to bridge the Digital Divide through formal education.

Brief History of Digital Divide

Starting in 1995, the United States (US) Commerce Department's National Telecommunications and Information Administration (NTIA) released a series of reports titled *Falling Through the Net*, which analyzed computer and online access penetration rates throughout the USA and showed a number of dividing factors like education, location (e.g., rural versus urban), age (e.g., young versus old), or income (e.g., rich versus poor) (NTIA, 1995). By the 1999 report, *Falling Through the Net: Defining the Digital Divide* showed soaring access rates to personal computers and the Internet in the USA (NTIA, 1999). However, on many demographic characteristics (dividing factors), the NTIA found that there was still a significant, and in some cases widening, Digital Divide separating "haves" and "have nots" (NTIA, 1999). The original term – Digital Divide – referred to the social inequity between those who had access to computer devices and the Internet and those who did not. By the early 2000s, the term Digital Divide had become a common slogan among policy-makers, organizations, and educators in the USA and beyond (Singleton & Mast, 2000).

The boom of the dot-com industry in the USA resulted in the Internet economy with everyone trying to get connected to the Internet (Warschauer, 2004). Over time, the Internet economy became deeper and long-lasting with ICT playing a key role (Jarboe, 2001). This information economy set itself apart from the pre-information era by its increasing reliance on science, technology, information, and management (Castells, 1993). In several developed nations, there was a major shift from noninformation commerce (e.g., manufacturing) to information-based business (e.g., health care, banking, software). The Federal Communications Commission (FCC) strongly supported the availability of broadband access, computer access, and training and technical assistance to as many households as possible (Barton, 2016). In addition, the federal government promoted activities designed to reduce the adverse economic and social consequences of those who were left behind (Kruger & Gilroy, 2013). ICT was critical during this change process which fundamentally transformed the way we interact in society, especially in education.

Moreover, the information economy led to global economic stratification not only within but also across countries (Warschauer, 2004). There was a huge gap

between the richest and poorest countries in terms of wealth, exports, and Internet use (Wade, 2001). Even within developed countries, unequal distribution of ICT resulted in income inequality (Castells, 2000), while people in developing countries remained outside the global ICT revolution (Warschauer, 2004). ICT also had a huge influence on communication. Computer-mediated communication facilitated people's interaction across long distances, supporting new modes of teaching and learning. Millions of people around the world gained access to shared information (Warschauer, 2004). Therefore, ICT was critical not only for economic inclusion but also for "education, political participation, community affairs, cultural production, entertainment, and personal interaction" (Warschauer, 2004, p. 28).

Until the early to mid-2000s, access to the Internet remained highly stratified due to gaps in economics, infrastructure, politics, education, race, and culture (Warschauer, 2004). At that time, large-scale research studies reported strong correlations between Internet access with levels of economic development, education level, English popularity, and national wealth (Hargittai, 1999; Robison & Crenshaw, 2002). Countries with competitive telecommunication industries, open political policy, and high English proficiency were usually more "wired" than other countries (Hargittai, 1999). Developed countries associated socioeconomic status, culture, and race with disparities in Internet access (NTIA, 2000). In developing countries, the Internet use was largely concentrated among privileged class based in major urban areas. High rates of poverty, limited English proficiency, limited education, and rural underdevelopment limited broad use of ICT (Warschauer, 2004). Nevertheless, the unequal physical access to computers and the Internet remains a long-term concern for developed countries because (1) the development of the Internet will always leave out a small percentage of the population and (2) new forms of technological disparities will arise (Warschauer, 2004).

Operational Definition of Digital Divide

The term Digital Divide is polysemous in that it holds different meanings for individuals (Ritzhaupt, Liu, Dawson, & Barron, 2013). Parents, students, educators, administrators, legislators, and librarians account differently about how they have experienced or observed the Digital Divide in their personal and professional lives (Sparks, 2013). Researchers have used a wide array of definitions for the Digital Divide beginning with individual access to ICT and, more recently, the individual's ability to use and create knowledge and original artifacts with ICT (e.g., Warschauer, 2004). For this chapter, we will use the following definition: The Digital Divide is a social inequity due to disparate quantity and/or quality of students' access, use, and creation of original artifacts with information and communication technology (ICT) resources. There are important terms included in this definition that emphasize the perspective of this chapter. First, social inequity refers to unequal opportunities for engagement in society (e.g., social, economic, political, educational, or personal pursuits) based on different statuses or groups (e.g., culture, location, socioeconomic

status, race/ethnicity, age, disability, or education level). Second, the use of the words "access," "use," and "creation" are deliberately linked to the conceptual model (*Levels of the Digital Divide in Schools*) provided in the subsequent section of this chapter. Third, the quality and quantity of students interactions with ICT bring about the multilayered phenomenon of the Digital Divide with each layer associated with a variety of problems, research methods, and an assortment of solutions. Fourth, information and communication technology (ICT) resources include both physical (e.g., computer, tablet, smartphone) and digital (e.g., software, applications, information) resources that can be utilized to create original artifacts. Finally, by "original artifacts" we refer to the many types of objects that can be created by students with ICT resources, including original artwork, digital music, written publications, open-source software, animations, videos, games, blogs, web pages, visual presentations, spreadsheets, and much more.

Digital Divide Problem and Conceptual Model

Because education is often thought to be the vehicle to close the Digital Divide in society, it is important to examine the Digital Divide in structured formal educational settings. To characterize the Digital Divide in formal educational settings, we use the *Levels of the Digital Divide in Schools* presented by Hohlfeld et al. (2008). Figure 1 provides a modified visualization of the conceptual model of the Digital Divide in this context. Notably, there are three layers to the conceptual model starting with school infrastructure and access to ICT, moving to the classroom with teacher and student use of ICT, and finally, presenting the individual empowerment of the students using ICT as the highest layer. Activities, research, problems, and

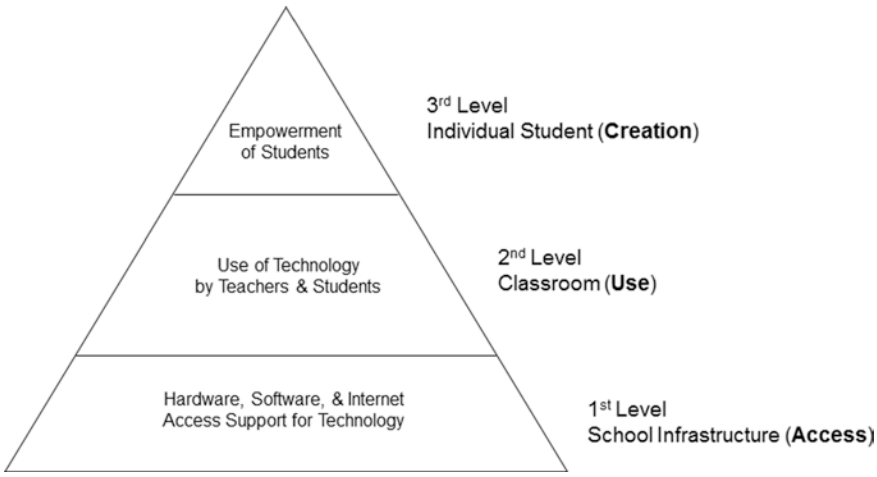

Fig. 1 Levels of the Digital Divide in Schools. (Hohlfeld et al., 2008)

solutions vary at each of these levels. From our operational definition, we use the terms "access" at level 1, "use" at level 2, and "creation" at level 3. The underlying assumption of this model is that student creation of meaningful and relevant artifacts using ICT and their ultimate empowerment with ICT is a desirable outcome for society.

Level 1: School Infrastructure and Access

The first layer of the *Levels of the Digital Divide in Schools* deals with the school infrastructure and access to appropriate ICT resources for students and teachers to integrate ICT into their daily routines. The first level is intentionally layered at the bottom of the conceptual model in that access to ICT resources is a prerequisite for teacher and student use and, ultimately, student empowerment with ICT. Further, a scan of the research literature shows that much of the early empirical research articles and reports conducted on the Digital Divide within formal educational settings has occurred at this level with researchers counting computers in schools and reporting the ratio of students to computer (e.g., Hess & Leal, 2001; Valadez & Duran, 2007). For instance, the reports published by the *National Center for Education Statistics* provide computer counts and the ratios of students to instructional computers with Internet access in formal educational settings (NCES, 2017).

There are several types of educational equity problems that occur at the first level of the Digital Divide. For example, students from lower-income homes, rural homes, ethnically diverse homes, and homes with parents with lower levels of educational attainment are less likely to have broadband Internet access (NCES, 2017). This creates a Digital Divide for these students, because they are unable to utilize online multimedia resources to complete and submit the digital homework assigned by their teachers and share their school activities with their families at home like their more advantaged peers. Although we have observed an overall decrease in the national ratio of students to instructional computers with Internet access in schools, we also have evidence that the computer devices may not have equitable software available for student and teacher use (Hohlfeld et al., 2008; Hohlfeld, Ritzhaupt, Dawson, & Wilson, 2017). In fact, providing equitable access to Internet-enabled machines at school has never guaranteed that these ICT resources would be used equitably by students and teachers (Cuban, 2009).

Level 2: Classrooms and Use

As educational researchers began to discover the limitations with "counting boxes" and attempted to answer deeper research questions about the evolving Digital Divide, some began to examine how the ICT resources were actually being used by students and teachers in their classroom environment across demographic groups

(e.g., rural versus urban or High-SES versus Low-SES) (e.g., Cuban, Kirkpatrick, & Peck, 2001). The literature base includes a wide range of qualitative and quantitative empirical studies on this level of the Digital Divide, often reporting at level 1 and level 2 in the same study (e.g., Hohlfeld et al., 2008; Hohlfeld et al., 2017; Judge, Puckett, & Bell, 2006). For instance, Judge et al. (2006) found differences with ICT use based on the SES in early childhood classrooms and schools, and Hohlfeld et al. (2008) discovered that teachers and students in High- and Low-SES schools used technology for different purposes. High-SES schools had significantly greater percentages of teachers using software for both delivery of instruction and administrative purposes. Students in Low-SES schools used software more for drill-and-practice or remedial tasks, whereas their High-SES counterparts used software more for creating things, like spreadsheets or word processing documents. While this trend is decreasing, some gaps in technology use between the Low- and High-SES- schools were still detected in the most recent school years (Hohlfeld et al., 2017).

Indeed, the second level of the Digital Divide presents different types of complications and research applications for consideration. While legislators and administrators might invest heavily to integrate the hardware and software resources into schools and classrooms, if the teachers are not prepared (e.g., sufficient professional development), do not have access to adequate technology support (e.g., technology specialist in a school), and do not support the mission of the ICT program (e.g., leadership), the Digital Divide may manifest as inequitable learning experiences with ICT resources for the students. These essential conditions are outlined by the International Society for Technology in Education (ISTE) and are perceived as necessary elements to effectively leverage ICT for teaching and learning (ISTE, 2017).

Level 3: Individual Students and Creation

Level 3 requires students to have the knowledge, skills, intent, and dispositions to create original artifacts with ICT resources. Historically, far fewer studies have explicitly examined the ICT literacy skills of students. Judge et al. (2006) demonstrated connections among computer proficiency, home computer use, poverty status, and academic achievement in reading and mathematics.. Ritzhaupt et al. (2013) examined the ICT literacy skills of middle school students ($N = 5990$ from 13 school districts across the state of Florida) using a performance assessment based on the ISTE student standards. Their results showed evidence of a Digital Divide between High-SES and Low-SES, white and nonwhite, and female and male students on all the performance measures in the study. That is, High-SES, white, and female students outperformed their counterparts. Level 3 of the model requires both quantitative and qualitative or mixed-method research methods examining the student as the unit of analysis with respect to their knowledge, skills, intent, and dispositions. Barron et al. (2010); Barron, Gomez, Pinkard, and Martin (2014) conducted a 3-year longitudinal mixed-method research study examining the development of

middle school students as creative producers within the context of the Digital Youth Network in Chicago public schools. During this research, case studies included observations of the activities and interviews with the students. They found the program successfully closed the Digital Divide at level 3. Students participating in this program in Low-SES schools were more engaged in empowering ICT activities than their counterparts in High-SES schools.

The ultimate goal of meaningfully integrating ICT resources into schools and classrooms is to prepare students to participate in an increasingly digital society. ICT has the potential to support, advance, and enrich opportunities and outcomes for all students. Furthermore, ICT literacy and the ability to leverage ICT for learning are essential to the future empowerment of all students across demographic conditions (dividing factors). Students with ICT literacy are at a distinct advantage in terms of learning in increasingly digital classrooms (NETP, 2010), competing in a progressively digital job market (Koenig, 2011), and participating in a digital democracy (Jenkins, 2006; p. 21, 2011). Further, students with ICT literacy have a particular advantage within the science, technology, engineering, and mathematics (STEM) disciplines, because ICT literacy is embedded within core STEM competencies (Carnevale, Smith, & Melton, 2011; NETP, 2010) and components of ICT literacy have been empirically linked to success in STEM areas (Antonenko, Toy, & Niederhauser, 2012; Kumsaikaew, Jackman, & Dark, 2006; Sonnentag & Lange, 2002). However, neither ICT literacy nor leveraging ICT for teaching and learning happens unless teachers make the decision to use ICT in their educational practice with their students (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Thus, level 2 of the *Levels of the Digital Divide in Schools* model is a prerequisite for level 3 – the empowerment of students to use ICT resources for the betterment of their quality of lives. In the next section, we review the previous 5 years of research published about the Digital Divide in relation to formal educational settings.

Review of Recent Empirical Research

To examine the previous 5 years of research, we searched with two major peer-reviewed literature search engines, EBSCOhost and ProQuest, with all the databases in them being selected, including ERIC, Dissertations & Thesis Global, Academic Search Premier, etc. The search terms included “digital divide” or “digital equity,” in combination with “education.” We searched “digital divide” or “digital equity” in titles and abstracts and “education” in any field or in all text. We included the literature that is scholarly peer-reviewed, in English, from the year of 2010 to 2017, and with full text available. A total of 152 articles were extracted with these criteria. We subsequently removed the articles that were published before 2012 and that had not provided empirical data (either quantitative or qualitative) and ended up with $k = 27$ articles to carefully examine. The articles were coded in terms of a set of relevant attributes, including the location, dividing factors, education

level, level of the Digital Divide addressed, educational need and problem, educational technologies and interventions employed, period of study, sample size, research methods, empirical data results, and findings.

We acknowledge a major limitation to the search strategy we used to retrieve the relevant articles for this analysis. Many studies have been published in the past 5 years that may or may not have been framed by the Digital Divide (or related term Digital Equity) terminology. For example, there have been many studies published on the topic of gender in relation to various ICT measurements from 2012 to 2017 (e.g., Aesaert & van Braak, 2015; Hohlfeld, Ritzhaupt, & Barron, 2013; Punter, Meelissen, & Glas, 2017). If these articles were not framed by the Digital Divide in relation to gender, they would not have been included in our examination. This decision was made to incorporate the literature base in which the researchers explicitly attempted to address the Digital Divide in their research context. Future research, especially meta-analytic studies of the Digital Divide, should seek to incorporate a wider net of search terms and a broader strategy to ensure all the related literature is examined. In light of this limitation to our search terms and procedures, this analysis resulted in several important findings.

Notably, only 19% of the articles examined were within the USA. The countries examined are found in all continents with the exception of Antarctica, including Albania, China, Colombia, India, New Zeeland, Norway, Romania, South Africa, Spain, Turkey, Uruguay, and the United Arab Emirates. This finding suggests that the Digital Divide may be an issue of increasing concern outside of the USA. The methodologies employed within the studies include quantitative, qualitative, and mixed-method designs with more than half of the articles making use of survey results and quantitative comparisons. We also note the disparate quality of the research procedures reported in the articles. Some studies had major methodological flaws (e.g., limited sample size, poor measures, violations of statistical assumptions, etc.). Other articles did not provide enough information to understand how the research was conducted. We present the remainder of our analysis in relation to the three layers of the *Levels of the Digital Divide in Schools* model. Table 1 provides a review of the research by dividing factors and the levels of the Digital Divide. As can be gleaned, the research on the Digital Divide in education has examined a wide range of dividing factors across the three levels. Details are reviewed in the following sections.

Level 1 Concerns

Of the 27 articles that met our criteria for inclusion, 10 studies (approximately 37%) examined issues at the first layer of the model (e.g., access to ICT resources), with a range of dividing factors, including SES, culture, geographic location, and gender (see Table 1). Some studies were executed in the context of educational programs, such as 1:1 device initiatives in formal educational settings (Pittaluga & Rivoir, 2012) or by deploying ICT resources in student homes (Lei & Zhou, 2012). There

Table 1 Research by dividing factors and levels of the Digital Divide

Dividing factor	Level 1	Level 2	Level 3
Age	–	Ballano, Uribe, & Munté-Ramos, (2014); Dornisch, (2013)	Ballano et al., (2014); Firat, (2017); Dornisch, (2013); Peral-Peral, Arenas-Gaitán, & Villarejo-Ramos, (2015); Ramalingam & Kar, (2014)
Culture	Lei & Zhou, (2012); Yuen, Park, Chen, & Cheng, (2017)	Berrío-Zapata, (2014); Hatlevik & Gudmundsdottir, 2013)	Yuen, Lau, Park, Lau, & Chan, (2016)
Education	–	Berrío-Zapata, (2014); Hatlevik & Gudmundsdottir, (2013); Naidoo & Raju, (2012)	Firat, (2017); Muresan & Gogu, (2014); Park & Lee, (2015); Ricoy, Feliz, & Couto, (2013)
Ethnicity	–	–	Ritzhaupt et al., (2013); Vigdor, Ladd, & Martinez, (2014)
Gender	Yuen et al., (2017)	Doiron, (2012); Dornisch, (2013); Eyo, (2014)	Doiron, (2012); Firat, (2017); Park & Lee, (2015); Ramalingam & Kar, (2014); Ritzhaupt et al., (2013); Yuen et al., (2016)
Geography	Pittaluga & Rivoir, (2012); Sampath, Basavaraja, & Gagendra, (2014)	–	Pittaluga & Rivoir, (2012); Ramalingam & Kar, (2014); Sampath et al., (2014)
Socioeconomic status	Hartnett, (2017); Hohlfeld et al., (2017); Pittaluga & Rivoir, (2012); Sampath et al., (2014); Starkey, Sylvester, & Johnstone, (2017)	Hatlevik & Gudmundsdottir, (2013); Hohlfeld et al., (2017); Naidoo & Raju, (2012); Starkey et al., (2017)	Firat, (2017); Mirazchiyski, (2016); Muresan & Gogu, (2014); Park & Lee, (2015); Peral-Peral et al., (2015); Pittaluga & Rivoir, (2012); Ramalingam & Kar, (2014); Ricoy et al., (2013); Ritzhaupt et al., (2013); Sampath et al., (2014); Vigdor et al., (2014); Yuen et al., (2016); Zilka, (2016)

was a wide range of outcome measures employed in the research studies, ranging from broad access to ICT resources in educational or home settings, access to various software types, access to hardware devices, Internet access, and broad ICT infrastructure measures.

Lei and Zhou (2012) found that students with parental support with ICT resources at home engaged in a wider range of online activities in school than those without parental support, showing another dividing factor – parental involvement. Starkey et al. (2017) found that the focus in schooling in New Zealand was on the access divide (level 1) for students with variation across SES conditions. From India, Sampath et al. (2014) found that infrastructural facilities varied among rural and

urban schools and that the majority of urban students had access to ICT resources in their homes when compared to their rural equivalents. Yildiz and Seferoglu (2014) showed in a Turkish context that almost 50% of their $N = 979$ students from 28 cities who attended seventh and eighth grades had access to a computer at home, but far less had access to the Internet. Hohlfeld et al. (2017) reported that students within Florida schools had equitable access to both modern desktops and laptops in the most recent school years when comparing High- and Low-SES schools. These findings demonstrate that many parts of the USA may have mitigated level 1 issues of the Digital Divide, while many other developing countries continue addressing concerns at this layer of the model.

Level 2 Concerns

Analogous to the first layer, ten studies (approximately 37%) addressed concerns at the second level of the Digital Divide: student and teacher use of technology. Again, a wide range of demographic conditions operationalizing the Digital Divide were in these papers, including SES, gender, education level, culture, and age (see Table 1). Again, a wide range of outcome measures were employed at this level of the Digital Divide: barrier to the use of ICT in teaching and learning, difficulties with using ICT, use of various types of software, frequency of technology use, and frequency of Internet use.

In the context of New Zealand, Hartnett (2017) discovered that regardless of dividing factors, young people reported that the digital technology used at their schools was limited and lagging behind their educational needs, suggesting that teachers and the education system were not keeping up with the pace of ICT. Yuen et al. (2017) emphasized that the overreliance on schools by some Hong Kong parents resulted in neglecting their role in guiding their children's ethical and educational use of ICT at home. These are crucial aspects of digital equity and digital citizenship (Hollandsworth, Dowdy, & Donovan, 2011). From the United Arab Emirates, Doiron (2012) found gender differences in the types of software used by males and females. He concluded that men needed increased opportunities to practice and strengthen the use of basic applications such as word processing and presentation software, whereas females needed more learning activities that involved creating concept maps, computer programs, micro-worlds, and simulations. Meanwhile, Eyo (2014) found no differences between genders and ICT use in the context of Nigeria. From Spain, Ballano et al. (2014) examined generational divides between older and younger populations. One of their primary conclusions was that "there is no single profile of a digital native, because having been born in a digital context in no way determines a single model of appropriation and use" (Ballano et al., 2014, p. 153). This study supports previous research debunking the notion of the digital native versus immigrant debate (Bennett, Maton, & Kervin, 2008). From the US context, Hohlfeld et al. (2017) described significant differences moderated by school level (e.g., elementary, middle, and high) and SES on teacher and student

use of different software types. Across the findings of these studies, we demonstrated that the Digital Divide at level 2 can be manifested on a number of dividing factors and associated outcome measures.

Level 3 Concerns

A surprising finding is that the majority ($k = 16$) or approximately 60% of the articles identified in this time period addressed to some extent the third layer of the model, which focuses on student outcomes. This is an important and inspiring finding in that it shows more interest in student outcomes or the empowerment of the student in relation to using ICT resources for creating original artifacts. We see a wide range of dividing factors studied to manifest the Digital Divide, including SES, gender, culture, geographic location, age, education level, and ethnicity (see Table 1). Both SES and gender appear to be studied most often in these level 3 articles. The student outcome measures included both perceptions and performance assessments related to ICT, such as ICT awareness, ICT literacy or mastery, ICT skills and competencies, perceived ICT competency, attitudes toward computers and the Internet, academic achievement in mathematics and reading, recognition of ICT resources, technology anxiety, and technology self-efficacy.

In Hong Kong, Yuen et al. (2016) identified differences in students' learning-related use of technology by their SES and gender. In a follow-up study, Yuen et al. (2017) found that both the culture of parent-child relationships and parents' ICT-related child-rearing practices were associated with students' effective ICT skills. That is, both parental involvement and cultural context can be dividing factors in students' effective ICT skills. Firat (2017) explained that, in Turkey, elementary school students' level of concept formation about technological artifacts was moderated by both parents' education level and the school SES. In Israel, Zilka (2016) found that although positive changes occurred in all students' computer literacy after they received a computer device (e.g., laptop or desktop), there were some differences between groups.

When explaining a generational Digital Divide in the ways that ICT resources can empower students, Ballano et al. (2014) concluded:

> Those who learned to use the tools later and have a need or an interest in including them in all aspects of their day-to-day life will no doubt use the tools in a more complex way than those who, despite facing no instrumental barriers, do not have the motivation or the necessary resources to make any significant contribution in the digital environment. (p. 152)

Using the context of online social networks, Peral-Peral et al. (2015) confirmed these findings. They examined a range of demographic and psychological variables, like technology anxiety and technology self-confidence of elderly students enrolled in a university course. This study had two major findings: (1) the researchers did not detect any differences on the "traditional" dividing factors like gender or education level, and 2) the authors reported "high heterogeneity among the elderly" (p. 62) in relation to ICT outcome measures (e.g., technology anxiety or technology

self-confidence). They suggested that individual attributes are more important in producing the Digital Divide at level 3 than traditional dividing factors such as age or gender. These findings reiterate the importance for researchers to examine students' knowledge, skills, intent, and dispositions along with how they use ICT resources in complex ways for creation.

Although the number of studies that examined level 3 of the Digital Divide has been increasing (as evidenced in this chapter), few of the studies investigated the connections among the integration of ICT resources by teachers in the classroom, the influence of a supportive learning environment outside of formal school (e.g., parental guidance and support, community or after-school linkages), and the training or scaffolding techniques which support students with creating artifacts and improving their educational outcomes. An exception is the Digital Youth Network, a one-to-one laptop program examined by Barron et al. (2014), which included not only in-school but also after-school and at home components. The researchers examined the effectiveness of this program using a comprehensive set of research methods and found that students in this program were more engaged in using ICT than their counterparts in a High-SES middle school.

More research examining the dividing characteristics across a wide range of ICT-related outcome measures is warranted across both developed and developing nations. Certainly, the use of longitudinal studies would also assist in characterizing the improvements made in the Digital Divide (e.g., widening, narrowing, or no change) over time. In this next section, we provide some practical solutions to bridge the Digital Divide by use of formal educational enactments.

Bridging the Three Levels of Digital Divide

Policy-makers, administrators, researchers, and educators have sustained their efforts to address the three levels of Digital Divide by increasing access to ICT resources, providing rich and job-embedded professional development for teachers about best practices for ICT integration, and empowering individual students with ICT experiences that enhance their learning. As the educational environment and the stakeholders involved are from complex systems, we contextualize our solutions at the three system levels: (1) micro (e.g., schools, classrooms, and educational organizations such as libraries); (2) macro (e.g., state, municipal government, and school district structures), and (3) mega (e.g., national and international government and multinational organizational structures) (Richey, Klein, & Tracey, 2010).

Level 1 Solutions

To enable equitable access to ICT resources in schools, a major initiative has been the continuing development and expansion of one-to-one technology programs in K-12 schools, including urban schools (e.g., Kaufman, 2016), rural school districts

(e.g., Dickinson, 2016), and schools with a high population of students from Low-SES households (e.g., Persinger, 2016). One-to-one programs have been initiated by all levels of the system (mega, macro, and micro). One-to-one technology programs address the Digital Divide by providing each student with a physical device, such as a laptop, an iPad, or other mobile devices. For instance, at the mega level, the international one laptop per child program provides a rugged, low-cost, low-power, connected laptop with access to quality educational resources to individual children within some of the poorest regions of the world (One Laptop, 2017). In some one-to-one programs, students can use the devices for all their courses and bring the devices home for learning and personal use (Penuel, 2006; Warschauer & Ames, 2010). Other programs such as the "i Learn at home" program (macro level – Hong Kong, China) (Yuen et al., 2016) assist students from low-income families, and the "Computer for Every Child project" (mega level – Israel) (Zilka, 2016) provides increased access to ICT resources. One-to-one programs, initiated at the macro level (Texas), have helped economically disadvantaged students reach the same proficiency in ICT skills as advantaged students after 3 years of participation in a laptop program (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011). Zheng, Warschauer, Hwang, and Collins (2014) found that a one-to-one laptop program, an EETT program initiated at macro level (California), significantly improved at-risk students' science test scores. When evaluating an EETT program initiated at the macro level (Florida), Dawson, Cavanaugh, and Ritzhaupt (2008) showed how a one-to-one laptop program and effective teacher professional development transformed the teaching and learning environment with increased student-centered teaching, increased tool-based teaching, and increased meaningful use of technology. Further, a recent meta-analysis on one-to-one learning environments showed positive effect sizes in a wide range of subject areas (Zheng, Warschauer, Lin, & Chang, 2016).

Providing access to computing devices is only one aspect of the complex problem of the Digital Divide at this level. Students will still need broadband Internet connectivity to exploit the access to an ICT device, complete digital online homework, and fully utilize the Internet to improve their lives and academic achievement. Government programs (e.g., E-Rate program) for providing discounts for telecommunications and Internet access costs for schools and libraries to ensure equitable access across demographic characteristics is also a requirement. These programs can be initiated at the mega and macro level of the system. Some evaluations of the E-Rate programs within the USA concluded that the program had failed to close the Digital Divide (Park, Sinha, & Chong, 2007). Even with these evaluations, by Fall of 2001, 99% of public schools in the USA had access to the Internet (NCES, 2017). Now schools are working to integrate broadband wireless network access for both students and teachers in the schools. Some schools, at the micro level, and school districts, at the macro level, have even adopted BYOD ("Bring Your Own Device") programs (Raths, 2012) where students bring their own device to connect to the school's network. Further at the mega level, partnerships between multinational public and private entities are also supporting promising ventures into addressing the Digital Divide at level 1. For instance, Google has partnered with the US government to provide Google Fiber, high-speed Internet access to low-income families, allowing children to get online and complete their digital homework (Newcomb, 2015).

Open Educational Resources (OER)) is envisioned as another important dimension for bridging the Digital Divide by increasing access to rigorous, relevant educational content and learning opportunities both inside and outside of the classroom (Olcott, 2012; Wright & Reju, 2012). OER are generally described as freely accessible, openly licensed digital assets that are useful for teaching, learning, and assessing. Educators can use OER in their classrooms and depending on the open licensing; they can reuse and remix the materials for different educational contexts. As a result of OER initiatives implemented at micro, macro, and mega levels, teachers in economically disadvantaged school districts can provide their students with high-quality educational resources without having to spend limited instructional funds on expensive traditional textbooks. For example, the Khan Academy, a global nonprofit organization (mega level), has provided free academic resources, which many K-12 students and teachers have been using to enhance their teaching and learning. WikiEducator's Learning4Content (L4C) project, funded and supported at the mega level, connects educators globally and provides training for wiki technology, which also results in the creation of new free OER (Schlicht, 2013).

Level 2 Solutions

Both ICT programs and OER initiatives may address the first level of Digital Divide by decreasing the inequity of access to ICT and quality educational resources that are associated with the dividing factors; however, these programs and initiatives do not necessarily close the second and third level of the Digital Divide. It is possible that technology integration could broaden Digital Divide (Ritzhaupt et al., 2013). It is not mere access to ICT per se that narrows Digital Divide but how ICT resources are used by students and teachers. We have years of evidence that shows merely placing ICT resources in schools does not lead to meaningful changes in important teacher or student outcomes (Cuban, 1986; Cuban, 2009). Although students had access to ICT resources, Kassam, Iding, and Hogenbirk (2013) noted that students with Low-SES primarily used technology for entertainment rather than academics. Hohlfeld et al. (2017) reported that the percent of teachers in Low-SES schools who regularly used ICT software for instructional purposes (e.g., video conferencing, web publishing, podcasting, e-mailing families and students) was significantly lower than that in High-SES schools. Teachers' perceptions toward ICT, their knowledge and skills in ICT integration, and how ICT is actually being integrated are critical factors that impact Digital Divide, which constitutes the second level of the model.

To address the second level of Digital Divide, it is imperative to provide rich job-embedded professional development opportunities for pre-service teachers and in-service teachers which help them develop their ICT skills and improve their ICT integration knowledge, skills, and dispositions (Ritzhaupt et al., 2013). In addition, schools and universities typically include instructional technologists who can provide essential instructional technology support and mentoring for teachers and

professors. Students require appropriate modeling of ICT and project-based ICT learning experiences that require teachers to be effective in their ICT integration strategies. At the mega level, several professional associations (e.g., ISTE) provide ongoing professional development through conferences, workshops, webinars, and more. Further, ISTE develops technology standards for administrators, teachers, coaches, and students, which have been widely adopted in the USA and beyond. Policy-makers and administrators, at the macro and micro level, must understand that ICT is an ongoing expenditure – not a one-time investment (Ritzhaupt, Hohlfeld, Barron, & Kemker, 2008).

Evidence shows that training in the integration of ICT resources into classroom activities can be effective. For instance, pre-service teachers who received professional development for using ICT, from an initiative sponsored at the mega level (Canada), had a higher probability of using those ICT resources in their future roles as in-service teachers (Larose, Grenon, Morin, & Hasni, 2009). In the study by Kazan and ELDaou (2016), it was revealed that teachers' attitudes toward ICT and their ICT self-efficacy had significant effects on their intent to use technology in the classroom as well as on the students' performance. In this study, the researchers found that teachers who were trained were able to better define and apply ICT in their science classrooms better when compared to their peers who were not trained (Kazan & ELDaou, 2016). As part of an EETT evaluation study initiated at the macro level (Florida), Ritzhaupt, Dawson, and Cavanaugh (2012) examined 732 teachers in 17 school districts across the state of Florida and found that the frequency of teacher use of technology, classroom integration strategies, and teaching experience with technology all significantly contributed to student use of technology. We advocate for the essential conditions outlined by ISTE for preparing the teaching and learning environment for meaningful ICT use by both students and teachers (ISTE, 2017).

At the macro level, state governments and school districts determine the broad educational goals and provide directions and model plans for the implementation. In the USA, the state legislature sets the educational standards for student outcomes and requirements for teacher certification. Together, the state governments with municipal governments raise the revenue to accomplish these outcomes. The local school boards are charged with approving the educational curriculum, adopting policies for achieving the goals, and paying for the implementation. The state government, municipal government, and local school board can earmark specific revenue for special ICT programs, which are designed to overcome the Digital Divide in their communities. In the USA, state governments (macro) also control the teacher certification requirements. State governments set the course requirements, specify the curriculum for pre-service teacher education in collaboration with institutions of higher education, and administer certification assessments to assess the content knowledge of the teachers. States also set the continuing education requirements for teachers to maintain their professional certification. As a result, states have a major impact on the curriculum and teacher preparedness, which addresses the second and third levels of the Digital Divide. Recent research showed that less than 50% of the US state departments of education offered educational technology certifications for

teachers (Ritzhaupt, Levene, & Dawson, 2017). At the micro and macro level, schools (micro) and school districts (macro) can support and require their teachers to participate in job-embedded and ongoing professional development to improve ICT integration strategies and practices. Also at the macro level, programs can be administered to address specific community needs (e.g., technology magnet school programs or public-private partnerships). While the use of ICT resources in classrooms is the focus of level 2, the primary focus of closing the Digital Divide is to positively impact student outcomes.

Level 3 Solutions

The third level of Digital Divide is the most challenging to tackle as it first requires the foundational levels (levels 1 and 2) of Digital Divide to be addressed. As noted, teachers play a significant role in developing a student's expertise in the use of ICT to improve the quality of their lives (Ritzhaupt et al., 2012). Teachers are the catalyst for bridging the second level of the Digital Divide to the third level by delivering educational activities that expand students' modes of using ICT for interacting with the content, their teachers, fellow students, their families, and the community (Hohlfeld, Ritzhaupt, & Barron, 2010). For example, at the second level, students can read an assignment in an OER textbook and then complete digital online homework exercises with immediate feedback. Students can research a topic online, and then they can create a digital presentation, which they can post on the class website for their peers to review and provide constructive criticism. Students can support researchers in the university setting by collecting data (e.g., take digital pictures or record interviews) in their community and uploading the data to an online database. At the final step, students perform in the third level of the Digital Divide in schools by seamlessly utilizing ICT resources and the Internet to improve their academic achievement and pursue their personal and professional interests. Although the empowerment of students has to be achieved at the micro level of the system, support and direction for programs designed for closing the Digital Divide at the third level can occur at all system levels: micro, macro, and mega.

To address the third level of Digital Divide, a well-designed program does not just provide ICT devices and resources and professional development for teachers on ICT integration in the classroom, but also it ensures adequate support and guidance for students to develop and engage in nurturing learning environments both at school and at home. Students need meaningful and relevant learning experiences that seamlessly integrate ICT into their daily lives to reach the full benefits of ICT and student empowerment. Teachers, parents, administrators, and interested community members are at the front line of these educational initiatives and are ultimately the individuals responsible for narrowing the third-level Digital Divide. Nevertheless, researchers and evaluators are necessary for documenting the effectiveness of these initiatives and disseminating best practices to the wider educational community.

Key, at the mega level, is supporting large-scale research projects, which can be used to investigate the *Levels of the Digital Divide in Schools* by the many dividing factors, and disseminating the research results [e.g., the Programme for International Student Assessment (PISA) sponsored by the Organisation for Economic Co-operation and Development (OEDC), the Trends in International Mathematics and Science Study (TIMSS) sponsored by the International Association for the Evaluation of Educational Achievement (IEA), the National Assessment of Educational Progress (NAEP) by National Center for Education Statistics (NCES), International Computer and Information Literacy Study (ICILS) by the International Association for the Evaluation of Educational Achievement (IEA)]. Another important research activity at the mega level is archiving the educational data for future Digital Divide research and making it publically accessible to educational researchers for secondary data analysis, discovery, and dissemination. Accomplishing huge research projects like these requires the coordination of many stakeholders, who are often located in different regions of the world. Closing the third level of the Digital Divide requires proactive leadership and dedication from all the stakeholders.

Closing Remarks

This chapter has provided a brief history of the Digital Divide, an operational definition of the Digital Divide, a conceptual framework of the Digital Divide for formal educational settings, a review of recent research (past 5 years), and potential solutions to bridge the Digital Divide through formal education. The terminal goal of any solution to the Digital Divide must address the third level – student empowerment of ICT. Programs and resources must create environments (ISTE essential conditions) that support both teachers and students in the meaningful use of ICT in the classroom. This chapter has shown that the research literature has mixed results across the many dividing factors associated with the Digital Divide (e.g., SES, gender, age, etc.) on a range of ICT-focused measurements that examine access, teacher and student use, and student empowerment via ICT knowledge, skills, intent, and dispositions. As noted in this chapter, there are dramatic differences between developed and developing nations on these outcome measures with many developing nations still struggling with level 1 issues (Fuchs & Horak, 2008). Future research should seek to conduct both primary data collection in virtually every country at all three levels of the Digital Divide and meta-analytic studies to examine the overall effects of each of the dividing factors on the ICT outcome measures. Further, more longitudinal studies need to examine the trends and effects of the Digital Divide, as most studies reviewed in this research were cross-sectional and only represented a single point in time with a few exceptions (e.g., Hohlfeld et al., 2008; Hohlfeld et al., 2017; Pittaluga & Rivoir, 2012; Vigdor et al., 2014). The Digital Divide remains an important and evolving social inequity that requires the careful attention of legislators, administrators, librarians, educators, students, and parents. While initiatives from all levels (mega, macro, and micro) for formal education and

programming can assist in diminishing the adverse effects of the Digital Divide, the key to empowering students is to provide meaningful ICT learning experiences in classrooms. We hope this chapter has provided a useful framework for thinking about the Digital Divide and that future educational researchers can use this work to address the Digital Divide in their contexts (e.g., developing nation).

References

Aesaert, K., & van Braak, J. (2015). Gender and socioeconomic related differences in performance based ICT competences. *Computers & Education, 84*, 8–25.

Antonelli, C. (2003). The digital divide: Understanding the economics of new information and communication technology in the global economy. *Information Economics and Policy, 15*(2), 173–199.

Antonenko, P. D., Toy, S., & Niederhauser, D. S. (2012). Using cluster analysis for data mining in educational technology research. *Educational Technology Research and Development, 60*(3), 383–398.

Ballano, S., Uribe, A. C., & Munté-Ramos, R. A. (2014). Young users and the digital divide: Readers, participants or creators on Internet? *Communications Society, 27*(4), 147–155.

Barron, B., Gomez, K., Pinkard, N., & Martin, C. K. (2014). *The digital Youth Network: Cultivating new media citizenship in urban communities*. Boston: MIT Press.

Barron, B., Levinson, A., Martin, C. K., Mertl, V., Stringer, D., Rogers, M., et al. (2010, June). Supporting young new media producers across learning spaces: A longitudinal study of the Digital Youth Network. In *Proceedings of the 9th International Conference of the Learning Sciences* (Vol. 2, pp. 203–210). International Society of the Learning Sciences, Chicago, Illinois.

Barton, J. (2016). *Closing the digital divide: A framework for meeting CRA obligations*. Dallas, TX: Federal Reserve Bank of Dallas.

Bennett, S., Maton, K., & Kervin, L. (2008). The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology, 39*(5), 775–786.

Berrío-Zapata, C. (2014). The digital divide in the university: The appropriation of ICT in higher education students from Bogota, Colombia. *Comunicar, 22*(43), 133–142.

Castells, M. (1993). The informational economy and the new international division of labor. In *The new global economy in the information age* (pp. 15–43). Macmillan Education UK: London, UK.

Castells, M. (2000). *The information age: End of millennium*. Blackwell Publishing: London, UK.

Carnevale, A. P., Smith, N., & Melton, M. (2011). *STEM: Science technology engineering mathematics*. Georgetown University Center on Education and the Workforce, Washington D.C.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. Teachers College Press: New York, NY.

Cuban, L. (2009). *Oversold and underused*. Harvard University Press: Cambridge, MA.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813–834.

Dawson, K., Cavanaugh, C., & Ritzhaupt, A. D. (2008). Florida's EETT leveraging laptops initiative and its impact on teaching practices. *Journal of Research on Technology in Education, 41*(2), 143–159.

Dickinson, B. D. (2016). *One-to-one mobile devices in rural school districts: A mixed methods study investigating the impact of khan academy on mathematics achievement and teacher pedagogy*. ProQuest Dissertations Publishing: Northwest Nazarene University.

Doiron, G. (2012). The digital divide and single-gender undergraduate education in the UAE. *Learning and Teaching in Higher Education: Gulf Perspectives, 9*(2), 1–10.
Dornisch, M. (2013). The digital divide in classrooms: Teacher technology comfort and evaluations. *Computers in the Schools, 30*(3), 210–228.
Drori, G. S., & Jang, Y. S. (2003). The global digital divide a sociological assessment of trends and causes. *Social Science Computer Review, 21*(2), 144–161.
Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423–435.
Eyo, M. (2014). Digital divide in the utilization of Information and Communication Technology (ICT) in counsellor education in Nigerian Universities. *Africa Education Review, 11*(2), 91–102.
Firat, M. (2017). Growing misconception of technology: Investigation of elementary students' recognition of and reasoning about technological artifacts. *International Journal of Technology and Design Education, 27*(2), 183–199.
Fuchs, C., & Horak, E. (2008). Africa and the digital divide. *Telematics and Informatics, 25*(2), 99–116.
Gyamfi, A. (2005). Closing the Digital Divide in Sub-Saharan Africa: Meeting the challenges of the information age. *Information Development, 21*(1), 22–30.
Hollandsworth, R., Dowdy, L., & Donovan, J. (2011). Digital citizenship in K-12: It takes a village. *TechTrends, 55*(4), 37–47.
Hartnett, M. (2017). Differences in the digital home lives of young people in New Zealand. *British Journal of Educational Technology, 48*(2), 642–652.
Hargittai, E. (1999). Weaving the Western Web: Explaining differences in Internet connectivity among OECD countries. *Telecommunications Policy, 23*(10), 701–718.
Hatlevik, O. E., & Gudmundsdottir, G. B. (2013). An emerging digital divide in urban school children's information literacy: Challenging equity in the Norwegian school system. *First Monday, 18*(4).
Hess, F. M., & Leal, D. L. (2001). A shrinking "digital divide"? The provision of classroom computers across urban school systems. *Social Science Quarterly, 82*(4), 765–778.
Hohlfeld, T. H., Ritzhaupt, A. D., Barron, A. E., & Kemker, K. (2008). Examining the Digital Divide in K-12 public schools: Four-year trends for supporting ICT literacy in Florida. *Computers & Education, 51*(4), 1648–1663.
Hohlfeld, T. N., Ritzhaupt, A. D., & Barron, A. E. (2010). Connecting schools, community, and family with ICT: Four-year trends related to school level and SES of public schools in Florida. *Computers & Education, 55*(1), 391–405.
Hohlfeld, T. N., Ritzhaupt, A. D., & Barron, A. E. (2013). Are gender differences in perceived and demonstrated technology literacy significant? It depends on the model. *Educational Technology Research and Development, 61*(4), 639–663.
Hohlfeld, T. N., Ritzhaupt, A. D., Dawson, K., & Wilson, M. L. (2017). An examination of seven years of technology integration in Florida schools: Through the lens of the levels of digital divide in schools. *Computers & Education, 113*, 135–161.
ISTE. (2017). *Essential conditions*. International Society for Technology in Education. Retrieved from https://www.iste.org/standards/tools-resources/essential-conditions
Jackson, L. A., Ervin, K. S., Gardner, P. D., & Schmitt, N. (2001). The racial Digital Divide: Motivational, affective, and cognitive correlates of Internet Use. *Journal of Applied Social Psychology, 31*(10), 2019–2046.
Jarboe, K. P. (2001). *Inclusion in the information age: Reframing the debate*. Athena Alliance.
Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. NYU Press: New York, NY.
Judge, S., Puckett, K., & Bell, S. M. (2006). Closing the digital divide: Update from the early childhood longitudinal study. *The Journal of Educational Research, 100*(1), 52–60.

Kassam, A., Iding, M., & Hogenbirk, P. (2013). Unraveling the digital divide: Time well spent or "wasted"? *Education and Information Technologies, 18*(2), 215–221. https://doi.org/10.1007/s10639-012-9233-9

Kaufman, D. (2016). *The implementation of a one-to-one iPad program in an urban high school*. ProQuest Dissertations Publishing: Boston University.

Kazan, S., & ELDaou, B. (2016). The relationship between teachers' self -efficacy, attitudes towards ICT usefulness and students' science performance in the Lebanese inclusive schools 2015. *World Journal on Educational Technology, 8*(3), 277–293.

Koenig, J. A. (Ed.). (2011). *Assessing 21st century skills: Summary of a workshop*. National Academies Press.

Kruger, L. G., & Gilroy, A. A. (2013). Broadband internet access and the digital divide: Federal assistance programs. In *Broadband internet: Access, regulation and policy* (p. 51). New York: Nova Science Publishers.

Kumsaikaew, P., Jackman, J., & Dark, V. J. (2006). Task relevant information in engineering problem solving. *Journal of Engineering Education, 95*(3), 227–239.

Laptop One (2017). *One laptop per child*. Retrieved from: http://one.laptop.org

Larose, F., Grenon, V., Morin, M., & Hasni, A. (2009). The impact of pre-service field training sessions on the probability of future teachers using ICT in school. *European Journal of Teacher Education, 32*(3), 289–303. https://doi.org/10.1080/02619760903006144

Lei, J., & Zhou, J. (2012). Digital divide: How do home internet access and parental support affect student outcomes? *Education, 2*(1), 45–53.

Milner, H. V. (2006). The digital divide: The role of political institutions in technology diffusion. *Comparative Political Studies, 39*(2), 176–199.

Mirazchiyski, P. (2016). The digital divide: The role of socioeconomic status across countries. *Solsko Polje, 27*(3–4), 23–52.

Muresan, M., & Gogu, E. (2014, July). Overcoming the digital divide for facilitating the elearning process. In *The International Scientific Conference eLearning and Software for Education*. 3, 310–315, National Defence University.

Naidoo, S., & Raju, J. (2012). Impact of the digital divide on information literacy training in a higher education context. *South African Journal of Libraries and Information Science, 78*(1), 34–44.

National Educational Technology Plan Technical Working Group. (2010). *Transforming American education: Learning powered by technology*.

NCES. (2017). *Digest of Educational Statistics*. Retrieved from: https://nces.ed.gov/programs/digest/2015menu_tables.asp

Newcomb, A. (2015). Google Fiber helping to close the Digital Divide. *ABC News*. Retrieved from: http://abcnews.go.com/Technology/google-fiber-helping-close-digital-divide/story?id=32492506

NTIA. (1995). *Falling through the net: A survey of the "have nots" in rural and urban America*. Washington, DC: National Telecommunications and Information Administration, US Department of Commerce.

NTIA. (1999). *Falling through the Net: Defining the digital divide. A Report on the Telecommunications and Information Technology Gap in America*. Washington, DC: National Telecommunications and Information Administration, US Department of Commerce.

NTIA. (2000). *Falling through the net: Toward digital inclusion*. Washington, DC: National Telecommunications and Information Administration, US Department of Commerce.

Olcott, D. (2012). OER perspectives: Emerging issues for universities. *Distance Education, 33*(2), 283–290.

Park, E. A., & Lee, S. (2015). Multidimensionality: Redefining the digital divide in the smartphone era. *Info, 17*(2), 80–96.

Park, E., Sinha, H., & Chong, J. (2007). Beyond access: An analysis of the influence of the E-rate program in bridging the digital divide in American schools. *Journal of Information Technology Education, 6*(1), 6387–6406.

Payton, F. C. (2003). Rethinking the digital divide. *Communications of the ACM, 46*(6), 89–91.

Penuel, W. R. (2006). Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education, 38*(3), 329–348.
Peral-Peral, B., Arenas-Gaitán, J., & Villarejo-Ramos, A. F. (2015). From digital divide to psycho-digital divide: Elders and online social networks. *Comunicar, 23*(45), 57–64.
Persinger, R. J. (2016). *The effects of one-to-one technology on students in schools with a high population of students from low-socioeconomic households*. ProQuest Dissertations Publishing.
Pittaluga, L., & Rivoir, A. (2012). One laptop per child and bridging the digital divide: The case of plan CEIBAL in Uruguay. *Information Technologies & International Development, 8*(4), 145.
Punter, R. A., Meelissen, M. R., & Glas, C. A. (2017). Gender differences in computer and information literacy: An exploration of the performances of girls and boys in ICILS 2013. *European Educational Research Journal, 16*(6), 762–780.
Ramalingam, A., & Kar, S. S. (2014). Is there a digital divide among school students? An exploratory study from Puducherry. *Journal of Education and Health Promotion, 3*(30). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4089106/
Raths, D. (2012). Are you ready for BYOD: Advice from the trenches on how to prepare your wireless network for the Bring-Your-Own-Device movement. *The Journal (Technological Horizons in Education), 39*(4), 28.
Richey, R. C., Klein, J. D., & Tracey, M. W. (2010). *The instructional design knowledge base: Theory, research, and practice*. New York: Routledge.
Ricoy, C., Feliz, T., & Couto, J. (2013). The digital divide among university freshmen. *The Turkish Online Journal of Educational Technology, 12*(2), 262–268.
Ritzhaupt, A. D., Dawson, K., & Cavanaugh, C. (2012). An investigation of factors influencing student use of technology in K-12 classrooms using path analysis. *Journal of Educational Computing Research, 46*(3), 229–254.
Ritzhaupt, A. D., Liu, F., Dawson, K., & Barron, A. E. (2013). Differences in student information and communication technology literacy based on socio-economic status, ethnicity, and gender: Evidence of a digital divide in Florida schools. *Journal of Research on Technology in Education, 45*(4), 291–307.
Ritzhaupt, A. D., Levene, J. & Dawson, K. (2017, April). *Where are we as a certifiable body of knowledge? Technology certificates and endorsements offered by state departments of education in the United States*. Paper presented at the American Educational Research Association, San Antonio, TX.
Ritzhaupt, A. D., Hohlfeld, T. N., Barron, A. E., & Kemker, K. (2008). Trends in technology planning and funding in Florida K-12 public schools. *International Journal of Education Policy and Leadership, 3*(8), 1–17.
Robison, K. K., & Crenshaw, E. M. (2002). Post-industrial transformations and cyber-space: A cross-national analysis of Internet development. *Social Science Research, 31*(3), 334–363.
Sampath, B. T., Basavaraja, M. T., & Gagendra, R. (2014). Computer literacy competencies among Indian students: The digital divide. *Asian Education and Development Studies, 3*(3), 267–281.
Schlicht, P. (2013). Turning the digital divide into digital dividends through free content and open networks: Wikieducator Learning4content (L4c) initiative. *Journal of Asynchronous Learning Networks, 17*(2), 87–99.
Shapley, K., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2011). Effects of technology immersion on middle school students' learning opportunities and achievement. *Journal of Educational Research, 104*, 299–315.
Singleton, S., & Mast, L. (2000). How does the empty glass fill? A modern philosophy of the Digital Divide. *Educause Review, 35*(6), 29–36.
Sonnentag, S., & Lange, I. (2002). The relationship between high performance and knowledge about how to master cooperation situations. *Applied Cognitive Psychology, 16*(5), 491–508.
Sparks, C. (2013). What is the "Digital Divide" and why is it important? *Javnost-The Public, 20*(2), 27–46.
Srivastava, S. C., & Shainesh, G. (2015). Bridging the service divide through digitally enabled service innovations: Evidence from Indian healthcare service providers. *MIS Quarterly, 39*(1), 245–267.

Starkey, L., Sylvester, A., & Johnstone, D. (2017). Negotiating digital divides: Perspectives from the New Zealand schooling system. *Journal of Research on Technology in Education, 49*(1–2), 31.

Valadez, J. R., & Duran, R. (2007). Redefining the digital divide: Beyond access to computers and the Internet. *The High School Journal, 90*(3), 31–44.

Vigdor, J. L., Ladd, H. F., & Martinez, E. (2014). Scaling the digital divide: Home computer technology and student achievement. *Economic Inquiry, 52*(3), 1103–1119.

Wade, R. H. (2001). Making the world development report 2000: Attacking poverty. *World Development, 29*(8), 1435–1441.

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, MA: MIT Press.

Warschauer, M., & Ames, M. (2010). Can One Laptop Per Child save the world's poor? *Journal of International Affairs, 64*(1), 33–51.

Wright, C., & Reju, S. (2012). Developing and deploying OERs in sub-Saharan Africa: Building on the present. *International Review of Research in Open and Distance Learning, 13*(2), 181–220.

Yildiz, H., & Seferoglu, S. S. (2014). Overview of digital divide and democracy awareness: Primary school students' opinions. *Education & Science/Egitim Ve Bilim, 39*(171), 86–98.

Yuen, A., Lau, W., Park, J., Lau, G., & Chan, A. (2016). Digital equity and students' home computing: A HongKong study. *Asia-Pacific Education Researcher, 25*(4), 509–518.

Yuen, A., Park, J., Chen, L., & Cheng, M. (2017). Digital equity in cultural context: Exploring the influence of Confucian heritage culture on HongKong families. *Educational Technology Research and Development, 65*(2), 481–501.

Zheng, B., Warschauer, M., Hwang, J., & Collins, P. (2014). Laptop use, interactive science software, and science learning among at-risk students. *Journal of Science Education and Technology, 23*(4), 1–13.

Zheng, B., Warschauer, M., Lin, C. H., & Chang, C. (2016). Learning in one-to-one laptop environments: A meta-analysis and research synthesis. *Review of Educational Research, 86*(4), 1052–1084.

Zilka, G. C. (2016). Reducing the digital divide among children who received desktop or hybrid computers for the home. *Journal of Information Technology Education: Research, 15*, 233–251.