Factors affecting access to digital technologies and the resulting impact for students in a P-12 context

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This article investigates the complexities influencing students' access to ICT in order to affect a positive academic outcome. The digital divide metaphor (van Dijk, 2002) has re-entered common parlance in the wake of students being required to learn at home (Duffy, 2020; Nash & Eynon, 2020; Thomson, 2020). Exploration of the digital divide through the interrelated domains of capital (Bourdieu, 2002; Ragnedda et al., 2019; Selwyn, 2004) reveals insights into the resultant success or failure of various ICT initiatives. Research identifies a positive impact on academic achievement for disadvantaged students afforded ubiquitous access to appropriate digital technology at home over a period of time. In contrast, advantaged students who already have access to digital technology at home demonstrate a negligible or even negative impact on academic achievement when provided with additional access to digital technology. In the Covid-19 context, access to ICT has been crucial to enabling student participation in learning at home. In the wake of that period, continuing remote learning teaching strategies will impact disadvantaged students.

Introduction

Until the Covid-19 pandemic response forced students to engage in remote learning, there was widespread perception students' access to digital technologies, and the internet was ubiquitous. A perception substantiated by the United Nations, who reported global mobile cellular subscriptions were almost equivalent to the population (Resta & Laferrière, 2015). A mobile cellular subscription implies the internet connection is likely delivered via a smartphone or mobile phone. Charities, contemporary media and online news journals have published articles highlighting significant disadvantage that serves to contradict the perception of ubiquity (Duffy, 2020; Nash & Eynon, 2020; Thomson, 2020). Supporting the media reports, only 86% of households in Australia had access to the internet in 2016-17, with 99% of those indicating mobile phone ownership (Australian Bureau of Statistics, 2018). Suitability of device form factor has been the focus of studies with mobile phones as the primary device for internet access identified as less favourable than laptops or desktop computers (Reisdorf et al., 2020). Device selection and ability to maintain access in order to affect a desirable outcome are subject to the complexity of interrelated domains of economic, social and personal capital (Bourdieu, 2002; Ragnedda et al., 2019; Selwyn, 2004). The socio-economic impact of the Covid-19 pandemic is anticipated to exacerbate existing digital inequality (Nash & Eynon, 2020).

It is within and post the Covid-19 context that schools will be required to make decisions about student access to digital technologies. Knowledge of the complexities of the digital divide in conjunction with the influence of the domains of capital is imperative to support informed decision making. This paper will investigate the digital divide and the domains of capital (Bourdieu, 2002) and discuss how these contribute to impact student access to and use of ICT.

Digital Divide

Access to digital technologies and the internet address the base layer of the first level of the digital divide (van Dijk, 2002). The notion of access within digital divide research has many nuances. Van Dijk (2002) presented an early conceptualisation of a framework to structure research related to the digital divide metaphor. Four steps of access were identified; mental, material, skills and usage and essentially proposed a dichotomy of have or have not. The framework was presented as cyclical in nature, reflecting the continual presence of new innovation. The initial concept has subsequently become known as the first level digital divide with second and third levels since identified and widely acknowledged in research (Hargittai, 2002; van Deursen et al., 2017; van Deursen & van Dijk, 2010; van Deursen & van Dijk, 2019). They have or have not dichotomy remains somewhat present although blurred in these second and third levels.

The Digital Education Advisory Group (2012) (DEAG) in Australia presented the notion of smartphones as the device of choice in enabling sufficient access to the internet. With imminent ubiquitous access to the internet and mobile devices, DEAG posit the digital divide will have effectively been addressed within Australian schools within a few years of the release of the report. As previously identified the Australian Bureau of Statistics (2018) data indicates there is still 14% of the Australian population who do not have access to the internet five years later.

The promise of mobile device capability has been refuted by research into the effectiveness of smartphones in enabling users to achieve the outcomes offered by the internet (Reisdorf et al., 2020; van Deursen & Helsper, 2015). It is contended the digital divide has been ever-present, superficially masked by the availability of mobile internet. The widespread adoption of mobile phone technology with associated internet subscription has presented a scenario of extensive and comprehensive internet access; however, those whose access to the internet is solely via a mobile phone or smartphone have been identified as falling into a digital or mobile underclass category of disadvantage (Helsper & Reisdorf, 2017; Napoli & Obar, 2014; Wang & Liu, 2017). Device type presents varied affordances. Desktops and laptops present a limited opportunity for continuous social engagement; however, mobile or tablet access provides a restricted opportunity for deeper immersion in online activities. Access to a range of devices, however, takes advantage of the affordances of each device and reduces the impact of education and economic factors on the diversity of internet opportunities (Reisdorf et al., 2020; van Deursen & van Dijk, 2019).

The rapid development of new technologies enables leapfrogging wherein a new technology emerges with affordances superseding previous technologies. Leapfrogging is somewhat counter to diffusion theory wherein the laggards, or the disadvantaged will rarely catch the innovators as they progress to the new (Rogers, 2003). The laggards will likely be excluded from realising the benefits of the new technology affordances and be at risk of falling further behind. Mobile phones, or smartphones, present an example of leapfrogging. Smartphone sophistication and affordances increase with every new iteration. Mobile leapfrogging, a term initially employed to describe the shift by vendors or government agencies to the provision of a mobile data service instead of a fixed home service (Reisdorf et al., 2020), is an apt description of the increasing trend towards users with mobile-only access. However, to paraphrase Orwell, 'all internet access is equal, but some access is more equal than others' (Orwell, 1945). The inequity of mode and purpose of internet access is brought to the fore through the second and third levels of the digital divide (van Deursen et al., 2017). Inappropriate device type will impact the ability to effectively engage with the internet to realise outcomes. Research around citizens in disadvantaged, inner-city neighbourhoods of Detroit found the provision of internet access was predominantly via mobile data service rather than broadband infrastructure (Reisdorf et al., 2020). Mobile data provision determines use confined to mobile phones resulting in a restriction of online activities. Detroit city enabled access to fixed broadband service through community spaces. Although autonomy of use (DiMaggio et al., 2004) remains a restriction in a public location, it serves to provide access through an alternative mode. The research conducted by Reisdorf et al. (2020) identified citizens who accessed the internet through a range of different modes, i.e. home, work, library, school, or mobile phones, were able to engage

in a wider variety of online activities. In short, the opportunity for breadth of access is a determinant of the breadth of activities. Socio-economic variables were not found to be a significant factor; however, it is contended social and cultural capital will impact the breadth of access as a result of unemployment or lack of engagement with community services (Bourdieu, 2002).

The acuity of digital divide research emerges within the second and third levels wherein the focus is on the skills, purposes and outcomes of the use of the internet (van Deursen & Helsper, 2015). The second and third levels extend the notion of access to include a broader range of skills and achievement of outcomes as a result of engagement with the internet. Critical to the nestedness and sequentiality of the levels is the compound effect of no access at any one level, on all subsequent levels (van Deursen et al., 2017). In addition, the recursive nature of the framework is integral to the three levels of the digital divide, having particular relevance within the context of rapid emergence and adoption of new technologies. The effect of compoundness is essential for schools and education systems to acknowledge. Inhibiting student access reinforces the risk of perpetuating digital, social and economic exclusion (Resta et al., 2018).

Despite the evolution of knowledge of the digital divide complexities, it is the first level digital divide, and specifically access to devices and the internet, that is most consistently referred to in contemporary media (Duffy, 2020; Nash & Eynon, 2020), possibly because access may be perceived to be easily addressed through the application of attention and finance, revisiting the dichotomous nature of access within the first level, i.e. increased opportunities for affordable internet and devices accompanied by classes teaching basic skills for connection will ensure the 'have nots' become the 'haves'. Citizens of Hong Kong experience near-ubiquitous access to the internet as a result of government strategies, however, digital inequity persists and is evident in the way internet is used by students (Yuen et al., 2018). Cultural capital was found to impact the way in which a student will engage with technology outside the school context. The student will develop skills to use the technology at school, however, parents' capacity to further engender those skills or mediate access to technology at home impacts the students' effective or meaningful use of technology. The first level digital divide factors have effectively been addressed in Hong Kong, yet a divide continues to exist between those with greater cultural capital and those without.

Key indicators for those at risk of being subject to the negative impact of a digital divide include; socio-economic status, geographic location, education level and duration of use (Hargittai, 2002; van Deursen & Helsper, 2015). Digital inequalities are evident across all of these indicators, individually and collectively. (Selwyn & Facer, 2014). The key indicators, as contributors to second-level digital divide factors, determine the types of technologies used, how they are used and the resultant outcomes. Socio-economic status and education levels impacting the type and purpose of the technologies used are key indicators in the research studies identified previously. Citizens of disadvantaged, inner-city neighbourhoods in Detroit were constrained to the use of mobile phones for internet access (Reisdorf et al., 2020). Students in Hong Kong have reduced opportunity to maximise effective and meaningful access to technologies as a result of limited parental capacity to mediate use (Yuen et al., 2018).

A limitation of Digital divide research is the primary focus on adults as homogenous groups defined by indicators of disadvantage. Attributes of the individual or family as an interdependent group must be considered when looking to factors influencing student digital equity (Yuen et al., 2018). A further limitation of digital divide research is the absence of underpinning theory to understand the deeper causes of inequality of access (van Dijk, 2006).

Domains of Capital

An individual's ability to engage with and use ICT to effect a positive outcome is significantly influenced by the interrelated domains of capital (Bourdieu, 2002; Gomez, 2019; OECD, 2010; Ragnedda & Mutsvairo, 2018; Ragnedda et al., 2019; Selwyn, 2004; van Deursen & van Dijk, 2019). Selwyn (2004) draws attention to the need to shift focus from the technological onto social, economic and cultural issues of the digital divide.

When viewed through a technological capital frame, all three domains of capital are evident in the procurement of a device; economic capacity to effect the purchase, technological cultural knowledge to select a fit-for-purpose device, and a technical social network to initiate and maintain the device and connection (Selwyn, 2004). It is through Bourdieu's (2002) domains of capital the focus turns to the individual within the context of the family wherein economic, social and cultural capital is appropriated from the context in which the student was raised and, as evidenced by the digital divide indicators, has a significant impact on their ability to engage with digital technologies to effect a positive outcome. The introduction of technological capital as a subset of economic, social and cultural capital contributes to developing a greater understanding of the individual (Selwyn, 2004). The notion of technological capital adds a further dimension to the digital divide indicators. The first level issue of material access is not restricted to economic status as predisposition as well as skills are pre-requisites to obtaining access (van Dijk, 2002). Cultural and social capital are determinants of predisposition and skill. Contributing further to the concept of technological capital is a proposal by Gomez (2019) to position it as a subset of cultural capital within the frame of digital inequalities and the reproduction of digital and social stratification (Gomez, 2018). In doing so, ICT is more explicitly situated within the domain of cultural capital as a specific indicator.

Tondeur et al. (2010) support Selwyn's (2004) proposed shift in focus from the technology but proposed ICT as an indicator of cultural capital wherein ICT is the contemporary means of gaining access to information, skills and competencies. The role of economic capital in ensuring the means for the procurement of a device is acknowledged. ICT as cultural capital addresses the predisposition or mental access element of the first level of the digital divide framework (van Dijk, 2002). The second and third levels are where it is most applicable, as evident in the disparities in how and why children use the internet in conjunction with the resultant outcomes (Hargittai, 2002; van Deursen & Helsper, 2015; van Deursen & van Dijk, 2019; Yuen et al., 2018). Despite having ubiquitous access to technology, and the requisite skills, students in

Hong Kong experience digital inequity in the ability to capitalise on this access as a consequence of cultural capital dependency (Yuen et al., 2018).

Digital Capital, as an independent and specific domain of capital, is posited by (Ragnedda, 2018) as 'the accumulation of digital competencies … and digital technology' (p. 2367). A subsequent empirical study to test the veracity of digital capital as an independent domain identified positive relationships between digital capital and the indicators of digital divide. (Ragnedda et al., 2019). Of note is the underpinning premise of achievement of first level divide factors. Acknowledged is the relatively advantaged cohort, i.e. access already enabled, and the necessity to repeat the study with less advantaged or culturally diverse cohorts. Applicability of digital capital as a reference or point of consideration for Australian schools will be dependent upon replication and further verification of the study.

Inattention to students' capital is likely to result in the unrealised potential of both the school's technology program and the student's life choices. Irrespective of various representations of digital technology within the domains of capital, it is through consideration of the interrelatedness of social, economic and cultural capital, recognition of the student and family circumstance can be used to inform any program of technology implementation at the school level. Those lacking long term socialisation in the use of a range of technologies have been identified as being more prone to resort to mobile-oriented use (Gomez, 2018), a consequence previously identified as leading to membership of a digital underclass (Helsper & Reisdorf, 2017; Reisdorf et al., 2020; Wang & Liu, 2017). Students who were already digitally excluded may become socially excluded as well (Helsper, 2012). Those afforded access without mediation are constrained in the ability to effectively and meaningfully capitalise on opportunities (Yuen et al., 2018). Design and implementation of any program to increase access to technology must incorporate consideration of economic, cultural and social capital (Bourdieu, 2002).

One-to-one models

A one-to-one initiative is typified by enabling all students to have individual access to a computing device (Penuel, 2006). Device type, location or extent of access are not specified, and it is these aspects that result in a diverse range of one-to-one programs and outcomes in schools. BYOD is just one strategy to achieve a one-to-one ratio. As an exit strategy from the national secondary school computer fund (NSSCF), the Digital Education Advisory Group paper presented BYOD wherein the D is a mobile internet-enabled device such as a smartphone (Digital Education Advisory Group, 2012). Some schools elected to maintain the standard set through the NSSCF and specified the type of device, generally a laptop or tablet, while others were more permissive and invited students to bring whatever they owned (Janssen & Phillipson, 2015; Selwyn et al., 2017). Smartphones or mobile phones are banned in many schools; consequently, those schools would be unlikely to accept smart phones as the D in BYOD (Janssen & Phillipson, 2015; Selwyn, 2019).

One-to-one laptop initiatives began to proliferate in the 1990s in the US with the intent of addressing the emerging understanding of the digital divide in addition to an expectation of improved student academic achievement, all with varying degrees of success (Argueta et al., 2011). Australia also had a number of schools starting to develop 1:1 programs at that time widespread (Fluck, 2011). 1:1 student to computer initiatives are now prevalent in a significant number of secondary schools and are beginning to become more frequent in primary schools. It is likely this situation is replicated across Australia in the wake of the Digital Education Revolution (Digital Education Advisory Group, 2012) as schools endeavoured to maintain the momentum, or meet the perceived community expectation, of a 1:1 program (Janssen & Phillipson, 2015). Many resultant education technology initiatives were manifest as Bring Your Own Device (BYOD) programs (2015). The movement towards BYOD was posited as a positive outcome of the DER National Secondary School Computer Fund and a potential cost saver for schools (Digital Education Advisory Group, 2012) irrespective of the economic capacity of parents to accommodate this cost-shifting proposal (Selwyn, 2019).

As previously identified in the digital divide research, device type has an impact on the access enabled (Reisdorf et al., 2020). Autonomy of use is identified as a significant factor in enabling student skill development, specifically where access is ubiquitous and mobile (DiMaggio et al., 2004; Helsper, 2012). Smartphones enable access to the internet however the type and extent of use is not comparable to that afforded by a laptop or desktop computer, thus impacting skill development and achievement of outcomes identified through the second and third levels of the digital divide (Gomez, 2018; Hargittai, 2002; van Deursen & van Dijk, 2019). Much of the research on one-to-one initiatives identify laptops as the device most prevalent (Crook et al., 2015; Kposowa & Valdez, 2013; Lowther et al., 2012; Shapley et al., 2011; Warschauer et al., 2014; Zheng et al., 2016). Laptops were identified as the preferred device as they facilitate access to a range of internet activities and enable autonomy of use as a result of being mobile (Zilka, 2016).

The purpose of implementing a one-to-one program varies considerably between, schools, systems and countries. A frequently stated intention is; to enhance learning in general as well as contribute to the development of 21st-century skills (Digital Education Advisory Group, 2012). Somewhat counterintuitively however is the volume of research focussed on attainment of traditional academic achievements or behaviours as opposed to 21st-century skills (Adhikari et al., 2017; Crook et al., 2015; Digital Education Advisory Group, 2012; DiMaggio et al., 2004; Dunleavy & Heinecke, 2007; Fraillon et al., 2019; Fraillon et al., 2018; Harper & Milman, 2016; Islam & Grönlund, 2016; Kposowa & Valdez, 2013; Moon & Hofferth, 2018; Warschauer et al., 2014; Zheng et al., 2016; Zilka, 2016). Research findings in relation to academic achievement are somewhat mixed. There is evidence of improved academic achievement in maths, science, reading and writing; however, it appears to have a dependency on the amount of access enabled and the user experience of the student. There is evidence of a positive relationship between ubiquitous access to a mobile computer over time and indicators of the digital divide when reviewing the impact on academic achievement or internet outcomes (DiMaggio et al., 2004; Dunleavy & Heinecke, 2007; Kposowa & Valdez, 2013; Moon & Hofferth, 2018; OECD, 2010; Zheng et al., 2016; Zilka, 2016). One-to-

one programs where student access was only available at school demonstrated negligible impact on academic achievement (Lowther et al., 2012; Warschauer et al., 2014).

It is necessary for schools to acknowledge the compoundness of effect, also noting the impact of length of experience and the potential to positively affect this factor. Cohorts of students who are disadvantaged against the indicators of the digital divide may experience the most benefit from access to technology and the internet at an early age (Moon & Hofferth, 2018). Children of immigrants afforded home access to internet-enabled computers during their kindergarten years demonstrated improved academic results, catching their peers, within two years. Young students, 8-12, of low socio-economic status, provided with internet-enabled computers, demonstrated improved academic results and technology skills over time (Zilka, 2016). Increasing access to computers at school through a one-to-one program is unlikely to result in a gain in academic achievement. Enabling students to also use those devices at home is more likely to result in a gain in academic achievement over time. Enabling home use in conjunction with a concerted effort to develop the parental capacity to mediate use, is likely to result in a gain in academic achievement and a move to reducing the digital divide.

Conclusion

Selwyn (2019) reports general support for the continued use of digital technologies in Australian public schools, supported by government funding. BYO or one-to-one programs appear to be an accepted mode of enabling access to those digital technologies; however, there is some dissonance surrounding financial responsibility for the provision of the devices. The predicted negative financial impact of the Covid-19 pandemic and associated issues with employment are likely to exacerbate the existing socio-economic status of many disadvantaged students. It is within this context that schools will be required to progress digital technology programs, possibly with a view to supporting extended periods of learning at home. Schools wishing to capitalise on the resurgence in enthusiasm for online learning, and create a pandemic-proof learning environment, through the introduction of a one-to-one or BYO program must account for social, economic and cultural capital impacted by an ongoing and unprecedented global pandemic.

Mobility, ubiquity and quality of access are three components to consider when planning to facilitate access to digital technologies (Helsper, 2012). The interrelated domains of capital, within a technology frame, have the most significant impact on the student's ability to participate in a school's technology program (Bourdieu, 2002; Gomez, 2019; Ragnedda, 2018; Selwyn, 2004). It is these domains of capital, overlaying the three levels of the digital divide framework, with specific attention to the compoundness, sequentiality and recursiveness of the framework, that must inform the operational elements of any educational technology program (van Deursen et al., 2017; van Deursen & van Dijk, 2019).

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