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Completed Research Paper

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Abstract

Over the last five years, we conducted a longitudinal study to investigate a 'bring your own device' (BYOD) initiative by a New Zealand School to integrate one to one digital learning devices into their learning process. Prior research from past projects has revealed adoption of ICTs give rise to three stages of digital divides in society, namely, digital access (i.e., equity in access/ownership of digital learning technologies among learners), digital capability (i.e., equity in digital/information literacy skills and usage) and digital outcome (i.e., equity in knowledge acquisition and progression). This study shares insights on how existing and new digital divides have evolved in BYOD classrooms with the increased penetration of digital technologies into teaching spaces and the wide usage of technologies by students both in and out of school by the BYOD initiative. Following the same path as the three level digital divide framework, we investigated issues pertaining to digital divide in the context of BYOD classrooms to make the following revelations. First, the BYOD classroom initiative did not end up accentuating existing gaps in access to digital devices and information, despite initial results indicating towards a potentially digitally divided classroom. Second, our analysis strongly indicated the presence of gaps in terms of information literacy and critical thinking ability, which was eventually bridged in the later stage, as students slowly adjusted to the classroom curricular structures in the BYOD classroom. Third, learner-self efficacy has been identified as a determinant of learning outcomes. In the earlier phase of ICT adoption, learner self-efficacy is influenced by a combination of information literacy, critical thinking ability, and positive motivation; however subsequently, self-efficacy influences affordances in various aspects of social cognitive abilities related to individual's learning activities affecting how learners engage and apply technology to shape their learning outcomes.

Keywords: BYOD, schools, digital access divide, digital capability divide, digital outcome divide

Introduction

The '*digital divide'* is a term that broadly represents just about any aspect of our daily life. It emerged from academic research to signify the gap between people or society who have access to digital technology and those who do not. Since the late 1990s, the term '*digital divide*' has gathered more attention from the academic research community and government organizations. The education sector has been an important area of inquiry for many digital divide researchers, as they strive to inform government initiatives on strategies to address issues prevalent here. When information and communication technologies (ICTs) are introduced into learning environments, they can give rise to innovative curricula changes, inform on novel learning activities and assessment methods, and provide valuable knowledge resources to enhance learners' academic and social development (Demiraslan & Usluel, 2008). Consequently, there have been a number of academic research emphasizing the integration of digital learning technologies into existing pedagogies to transform teaching and learning (Anderson, 2009; Prestridge, 2007). However, questions still remain unanswered on the issues of digital divides with the embedding of ICTs into learning environments.

There has been some evaluation studies in New Zealand on the projects initiated to tackle issues pertaining to digital divide (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004). The findings from the studies indicate that these projects have failed to contribute as were expected from them. In some cases, the initiative designed to fill the gap of digital divide potentially caused the gap to become even wider. The reasons for this gap ranged from not having up-to-date technology, not providing proper pedagogical support to teachers for integrating ICTs into their classrooms, a sense of isolation with lack of familiarity in using ICTs and overall lack of support to form learning communities having a sense of collective responsibility amongst others (Parr & Ward, 2005). Specifically, a number of digital opportunities projects[1] were launched in the early 2000s, with the aim to bridge the digital divide within the teaching and learning. However, results from the digital opportunities projects in New Zealand found that such an integration of digital learning technologies into teaching and learning might end up contributing nothing more than an effort to facilitate physical access to ICTs (Rivers & Rivers, 2004). While innovative technologies have the potential to improve the teaching and learning activities, the evaluation studies warn that digital transformation of educational environment is challenging and any such initiatives could even end up accentuating existing digital divides (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004).

We have used the results from the DigiOps as the base to start our research into the digital divide phenomenon within an educational context. We started our investigation into the issue within a secondary school in New Zealand, which made a decision to transform into technology-mediated teaching and learning, dubbed as the bring your own devices (BYOD) initiative. We focused the initial phase of our study to confirm the results from the digital opportunities projects. In the first year of our study (during 2012 and 2013), our inquiry revealed issues related to digital access (i.e., equity in terms of the access/ownership of digital learning technologies among learners) and competency of using technologies available for meaningful learning activities (i.e., digital skills). Our initial results also took account of public opinion, which had earlier shown strong resistance to the school's initiative. The initial results then provided us with a baseline to move the study forward. As the BYOD initiative gained momentum (leading up to the middle of 2014), there was much acceptance for technology-mediated teaching and learning among all the stakeholders, including students, teachers, and parents.

As the adoption and acceptance of digital learning technologies expanded, new levels of digital divides started to emerge. Therefore, we focused our investigation beyond digital access and skills in the next phase of the study, as the BYOD initiative progressed into mature stages. A relatively recent study on the digital divide phenomenon explains how IT adoption stages evolve to cause further levels of digital divides in teaching and learning (Wei, Teo, Chan, & Tan, 2011). Figure 1 illustrates the chain effect of digital divide from equity in access to ICTs to usage and skills (capability) divide, and then as learning becomes more knowledge-intensive, it further leads to learning outcomes divide (Wei et al., 2011).

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[1] The Digital Opportunities (DigiOps) projects are partnerships between schools, organizations involved in ICT and the Ministry of Education in New Zealand.
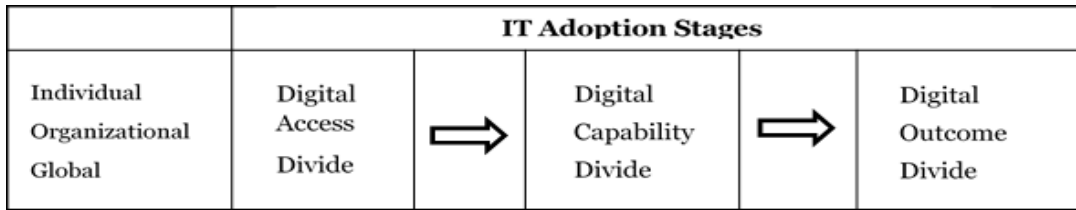
Figure 1: Three level digital divide framework (Wei et al., 2011)

In the subsequent phase, as the ability of meaning-making and critical thinking among students matured, we carried out a deeper investigation on factors pertaining to learning outcomes. During this stage of study, that is from the middle of 2014 to 2016, the progression of agency among students across different learning spaces has been analyzed using the socio-cultural ecological model (SCEM) for mobile learning (Cook, Pachler, & Bachmair, 2011; Pachler, Bachmair, Cook, & Kress, 2010). The SCEM explains the interrelationships between enablers (technology, curriculum), actors (student's ability to act) and cultural practices (social interactions in everyday life enabled by technology). This framework underpins our case study analysis to inform on the relationships between different aspects of the BYOD initiative.

Digital Divides in the BYOD Context

The unprecedented developments in digital technologies generally referred as the '*digital revolution*' created the opportunity for better access to information and services for everyone. This marked the start of a shift towards an information society, and changed our view of society, business, and education. Generally, access to and use of digital technologies has many benefits to offer. However, in the years after the digital revolution, the pattern of the distribution of ICTs still raises concern, since not everyone has proper access to them or has adequate skills for making meaningful use of them. Many individuals, groups, and societies are still excluded digitally, from the rest of the population. Therefore, initiatives for equal distribution of ICTs to achieve digital inclusion for everyone through better policy has come up as a primary concern for governments, policy makers, and researchers.

The phenomenon of the digital divide has been researched and defined in many contexts, which has caused more confusion than clarification. However, the common understanding behind most of the research is that the digital divide is a complex issue and it is hard to understand the phenomenon within a single context and with a single definition. Careful examination of the literature gives no clear evidence of the origin of the term '*digital divide*' and its meaning is still unclear. The *digital divide* phenomenon has been described by many authors as the most pressing social, economic, and academic issue of the *information age* and is now receiving increased attention from researchers and policymakers around the world (Dewan, Ganley, & Kraemer, 2005). The phenomenon of the digital divide is complex due to the variety of economic, demographic, individual and social variables associated with it. Therefore, we have followed the grounded theory as a method for reviewing the literature in the research area as identified by the Wolfswinkel, Furtmueller, and Wilderom (2013) in three stages.

Stage *one* defined the scope of the review, search terms and criteria to be considered while scoping the literature review. We have chosen all of the major databases (like Scopus, Science Direct, and Web of Science, EBSCO) to access journal and conference article for our source material. Due to the nature of the issue we were investigating, we have also searched for relevant government articles and reports to reflect on the current practices. Following table below details the search terms used in the database searches.

Table 1: Criteria for the search of relevant literature

Concept	Search Terms	Justification
Digital Divide	digital divide OR digital access divide OR levels of digital divide OR nature of digital divide	To cover the width and depth of the literature on the digital divide phenomenon
Education	digital divide in education OR digital divide in teaching and learning OR digital divide in learning OR digital divide in school	Capturing the literature on the digital divide in education
BYOD	technology enhanced learning OR technology-mediated learning OR technology mediated learning	Find the literature on any form of integration of technology in

	OR BYOD	education.

Stage *two* involved combination of search terms with the inclusion criteria and querying on the relevant article databases.

Stage *three* involved the task of filtering articles relevant to our study. That included removing any duplicate articles retrieved from across the databases, reading abstracts to find the suitability of the article for inclusion in the review. A backward and then forward analysis was performed to establish the quality of the article. This process resulted in a final set of 29 articles for inclusion. The final list of articles that are reviewed is representative of the existing body of knowledge on the issue of digital divide in the teaching and learning in the context of integration of technology in education.

Themes emerging from the review and analysis of the literature have been grouped into the following subsections and analyzed accordingly.

Digital Access

The issue of digital access is the oldest and most widely researched aspect of the digital divide and is characterized at both the individual and the social level. According to Van Dijk (2005), Zhong (2011), and Cullen (2001) the digital access divide is the divide between those who have access to ICTs and those who don't. According to the literature found under this category; financial status, income, educational level, type of occupation and geographical location were found to be the major determinants which could affect access to technology and ownership of technology in a number of different contexts (Cai, 2008; De Haan, 2003; James, 2009; Parker, 2001). This is an indication that individuals and societies with lower financial status and educational level may have poor or no access to ICTs putting them into the wrong side of the digital divide. The digital access divide is also known as the *first level* digital divide.

Digital Capability

A study on digital divide in 2002 found that merely offering individuals access to technology is not sufficient to ensure that they can use the medium appropriately to meet their needs, or be on the right side of the digital divide. While equitable material access to technology can be a necessary first step to address the phenomenon of digital divide, it is not sufficient to overcome the issue (Hargittai, 2002). It is equally important to have proper digital/information skills to use the available technologies appropriately and meaningfully (Cole, 2001; Ghobadi & Ghobadi, 2015; Yoori & Se-Hoon, 2009); otherwise, individuals may not be able to take even basic advantage of the technology and resources available.

After Hargittai's definition of the digital divide from the different prospect of digital capability, several other authors have also discussed the digital media literacy (Warschauer, 2003) and digital skills (Dijk, 2006) in relation to the phenomenon of the digital divide. This is also considered as the *second level* digital divide.

Digital Outcome

The world around us is transforming and changing every day, and therefore understanding the phenomenon of digital divide only from the notion of material access (haves and have nots) and adequate digital/information skill (can and cannot) may not be sufficient. Apart from those aspects, studies on how individuals engage with and make use of the available technologies, as an expressive tool, in and across different contexts to achieve set goals are very important (Brandtzæg, Heim, & Karahasanović, 2011; Brosnan, 1998). As explained by the three level digital divide (Wei et al., 2011), the literature shows a clear shift in digital divide research around the nature of technology use, attitude and motivation, and the ability of meaning making in recent years. It has been collectively termed as the *digital outcome divide* or *third level divide* and is a more recent analysis of the digital divide phenomenon (Brandtzæg et al., 2011; Gunkel, 2003; Lenhart et al., 2003; Partridge, 2003; Wei et al., 2011; Zhong, 2011).

Contextualizing literature review into three level digital divide framework

The themes emerging from the review of the literature have been contextualized into the three level digital divide framework. Factors pertaining to the digital access divide include access to and use of

ICT in homes and at schools, personal attributes like gender and academic ability, and environmental conditions of homes and schools. This further influences affordances in various sources of social cognitive abilities related to individual's learning activities and computer self-efficacy levels, demonstrating digital capability divide among individuals (Wei et al., 2011). These will, in turn, affect how new skills and knowledge are honed; having further implications on the individuals learning outcomes leading to digital outcome divide.

For that reason, we have adopted three level digital divide framework and applied it to the context of our study. While adapting the three level digital divide framework for our study, we mapped the three levels of IT adoption stages to the three levels of digital divides in the learning process. Specifically, ICT adoption stages includes access, capability and outcome divide stages, which matches with the digital access divide, digital capability divide and digital/learning outcome divide.
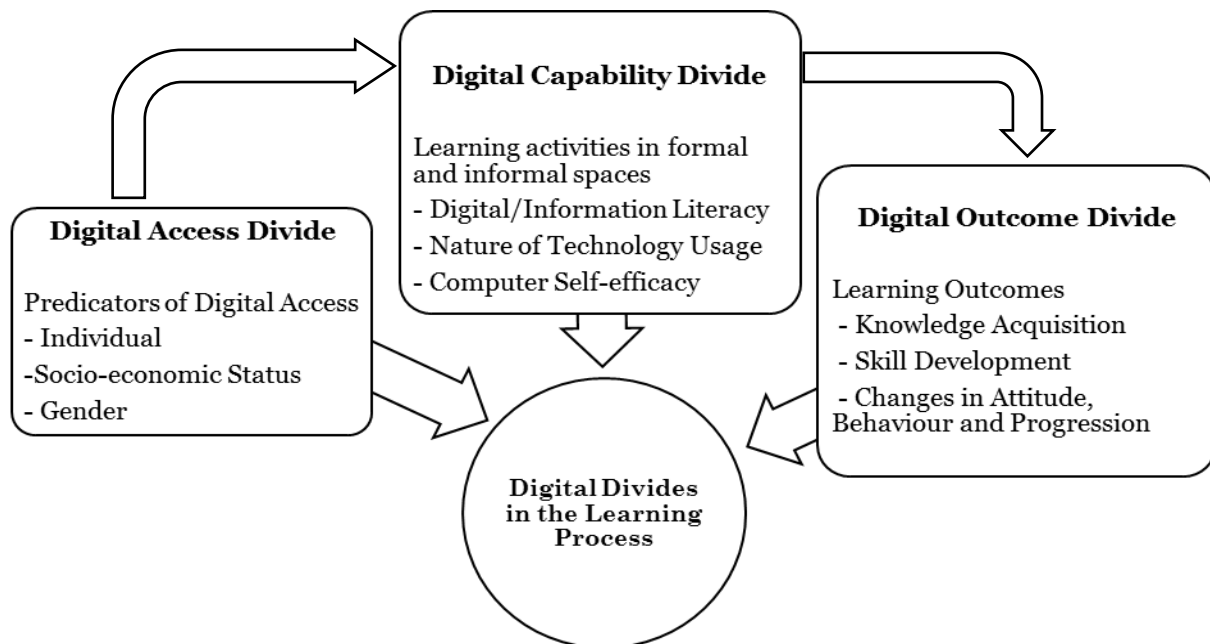

Figure 2: Three levels of the digital divide in learning applied to the context of our study.

As illustrated in Figure 2 above, the digital capability divide is influenced by learning activities, which occur in both formal and informal spaces. These activities can be contextualized based on digital/information literacy of learners in performing different types of computing tasks, nature of technology usage by learners ranging from familiarity to addiction, and computer self-efficacy measurements of their capabilities. Finally, digital/information literacy, computer self-efficacy, and nature of technology usage are the focal constructs through which personal, behavioral and environmental factors further influence learning outcomes resulting in digital outcome divide. Accordingly, as shown in the framework, the nature of digital divide may change from one form to another over the different stages of technology adoption. Therefore, to examine digital outcome divide, various factors in first two levels has to be investigated to find their effect on the extent of knowledge acquisition, skills development and changes in attitudes, behaviors, and progression in learning.

Case Narrative and Research Questions

In 2011, a New Zealand school decided to fully integrate digital learning technologies into the learning process in the form of one-to-one portable digital devices for all students in a cohort. The school informed all parents and students that they were expected to bring a one-to-one digital learning device (preferably an iPad2) into the classroom in year 9 (students aged 13-14) for the 2012 academic year. The most controversial and unique aspect, which makes this initiative different from most others, is that the parents were told they must cover the full cost of the required digital learning devices for their children, whereas similar projects in the past (like the digital opportunities projects) had provided devices and resources through the schools. The school's decision resulted in a high profile news story in the New Zealand Herald, a national newspaper, triggered by a complaint from a parent about being

asked to buy a digital device for their child. This set off a significant public and media response, leading to news stories on TV, radio, and online debates on various news sites and forums.

Drawing on from the initial evaluation of the literature review, the purpose of this research study is (a) to investigate whether and, if so, how, the introduction of BYOD initiative has changed digital divides and affected teaching and learning process, in both formal and informal learning spaces; (b) and, to evaluate the effectiveness of BYOD initiative on students' learning outcomes. Therefore, the main research question posed in this paper is:

How the digital divides in teaching and learning have changed over the years of BYOD classrooms?

This research question is influenced by the following subsidiary questions:

1. *How has the digital access divide evolved because of the BYOD classrooms?*
2. *How have the digital skills divide evolved because of the BYOD classrooms?*
3. *How have the learning outcomes (knowledge acquisition, skills development, and progression of attitudes and motivation) evolved because of the BYOD classroom?*

Socio-cultural ecological model to analyze the BYOD

Drawing on further from our previous research (Adhikari, Mathrani, & Scogings, 2016; Adhikari, Parsons, & Mathrani, 2012), we have focused our investigation next on the influences of digital/information literacy, computer self-efficacy and nature of technology usage with the aim to increase understanding of how personal, behavioral and environmental factors influence learning outcomes which are known to result in digital outcomes divide. These focal constructs identified for further investigation has potential to disrupt learning activities not only on formal spaces like classrooms but also in informal spaces, such as home/out of school. Our analysis framework (Figure 3 below) adapted from socio-cultural ecological model by Pachler, Bachmair, et al. (2010) has been used to analyze the interrelationships between three components, namely structures, agency and cultural practices, within formal and informal learning spaces mediated by one-to-one ICTs. The idea behind this framework is that teaching and learning practices using one-to-one devices in and around different learning spaces is influenced by a triangular relationship spread across structures (imposed by curricula, communication, technology), agency (such as self and other users/actors) and cultural practices (or social interactions in everyday life) (Pachler, Bachmair, et al., 2010; Pachler, Cook, & Bachmair, 2010).
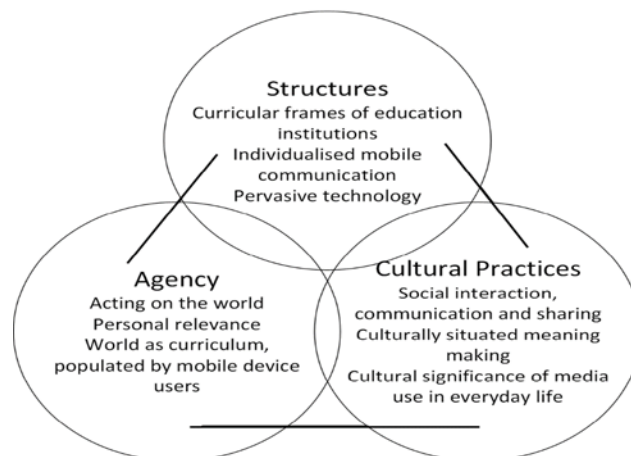

Figure 3: The sociocultural framework used in our analysis (adapted from Pachler et al, 2010)

We have further extended the socio-cultural ecological model to explain the interrelationships in a technology-mediated teaching and learning environment. Figure 3 above shows the sub-contexts within each component that help to scaffold the interrelationship between key stakeholders, practices and structures that relates to the BYOD case study we are investigating. One of the components, the *agency*, is all about the ability of actions on the world. In the context of our study, the agency is having adequate digital/information literacy skills for using digital tools, thinking critically to process and apply available information knowledgeably. *Cultural practices* in the other side emphasize the areas that can benefit learning, as they relate to collaboration, meaning making and media use. Cultural practices in the context of BYOD is enabled by a digital communications medium and is transforming how individuals interact and use media in everyday life. At the end, *structures* relate to immersion in

digital learning technologies, prevalent school infrastructure to facilitate BYOD classrooms, and the curriculum within which they are applied.

Research Methodology

Different approaches can be used to investigate the technology-mediated teaching and learning, but surveys, interviews, and observations are the most appropriate methods (Cheung & Hew, 2009). The case study method is particularly suited to learn/explore an issue through an in-depth study (Dubé & Paré, 2003). Case studies are defined in a number of ways, employing multiple methods of data collection to gather information from one or more entities. The boundaries of the phenomenon are not evident at the outset of the research and no experimental control or manipulation is used (Benbasat, Goldstein, & Mead, 1987; Dubé & Paré, 2003; Yin, 2003). Because of the longitudinal nature of the study, a descriptive case study method has been employed. According to Yin (2003), a single case design is appropriate when it represents a unique, revelatory or critical case. Our study follows a single case, representative of the research problem and field of inquiry with the continued investigation over a period. It is also one of the early adopters of BYOD initiative in New Zealand.

Research instruments and timeline of data collection

Research instruments such as surveys, interviews, and observations have been used to collect data from students, teachers and parents. A low-risk notification has been obtained to conduct the study from the university human ethics committee well before starting the data collection. For the students below 16 years, parents have been informed of the research being conducted through school newsletter and given plenty of time to allow them if they want to withdraw their child from the study. Data have been gathered using different methods at various rounds as outlined in the following table.

Table 2: Timeline of data collection

Timeline	Data collection methods
Early 2012	Baseline data collection (surveys with students, teachers, and parents)
2012 – mid-2014	Interviews with a randomly selected sample of students, teachers, and parents. Follow-up surveys with students, teachers, and parents
Mid-2014 – 2016	Two rounds of interviews with teachers

In early 2012, we investigated the answers to the research question 1 related to the digital access divide. Initially, the themes that emerged from the public debate on the BYOD policy raised some concerns towards the classroom being digitally divided. In an effort to find answers to those concerns raised, our initial investigation focused on affordability and availability issues of digital devices for learning activities among learners. The results from this round of investigation then informed the nature of subsequent research questions to be posed for the remainder of the study. During this time, we conducted surveys with students, teachers and parents.

Between 2013 and mid-2014, the research was focused on finding the answer to the 2nd research question about digital capability divide. The previous phase of study along with the review of the literature helped us to identify a number of factors that have potential to influence digital capability. We next conducted semi-structured interviews with student, teachers, and parents, all of whom were selected randomly. We analyzed two sets of data from the baseline surveys and the interviews with students, teachers, and parents to learn how certain factors influenced the capability of an individual learner. The factors that have been included as a part of the investigation are digital/information literacy, nature of technology usage and self-efficacy.

During the last phase of our study (that is, between mid-2014 to 2016), we combined findings from the first two stages of research to investigate how digital outcome divide evolved during the last 4 years of BYOD classrooms. At this stage of investigation, we conducted further semi-structured interviews with teachers who had participated over the whole BYOD initiative. This helped to gain more insights on changes in learners' attitudes and self-efficacy over the five year long journey with the BYOD policy. Interview data from teachers has been analyzed to answer the 3rd research question about progression in knowledge acquisition, skills development, attitude and motivation.

Data analysis

The data to analyze the research questions came pre-dominantly from the surveys and semi-structured interviews conducted with the students, teachers, and parents over the past 5 years. Qualitative data provided personal narratives involving classroom interactions with technology, thereby revealing rich insights during the different implementation phases of the BYOD policy. Interviews and text response data from surveys have been coded and categorized under three research questions to be analyzed. Thematic analysis was then performed on each of the category resulted from the qualitative coding using NVivo, a qualitative data analysis software.

Findings

This section details the key findings based on the three level digital divide model (Figure 2). We describe how the learning process has changed over the last 5 years since the BYOD initiative to answer the three research questions. The findings in this paper are categorized into three aspects of digital divide, namely, digital access divide, digital skills divide and learning outcomes divide, in the order of the 3 research questions posed.

How has the digital access divide evolved because of the BYOD classrooms?

Initially, survey showed that almost every student in that cohort has access to computers and internet connection at home. Despite the online survey indicating 100% of material access, the interviews with students informed about differences in the level of access to ICTs. Our findings showed that majority of the learners had full access to ICTs at home and at school, but few students lacked this privilege. Initially, few students arrived at school without any kind of one-to-one device. The school tried to resolve this issue of potential gap in device ownership by providing notebook computers to those who did not have any learning devices to use during school time. However, these students could not take those devices to home. Despite the school's efforts to facilitate learning devices during school hours, a significant number of students still did not have full access to ICTs in their everyday life. Regardless of the fact that the school area is ranked decile nine (representing a region where citizens belong to a relatively higher socioeconomic status), our data shows that some students did not have access to computers and/or the internet at home or only have very limited access. One student stated in the survey:

> "*I usually do not spend much time with the tablet at home because I don't have the internet at home. Sometimes I can't complete my work at home because of the internet*".

Similarly, another student too had responded:

> "*Well in my house we don't have dial-up so I only use my tablet for the project I have downloaded. I don't have the internet at home.*"

Teachers also confirm the issue of internet access at home:

> "*Something that is a problem is internet access at home or broadband access. Because children are saying honestly that, 'I cannot do this at home'. I have one bright student in my class who said she doesn't have the internet in her home or the device either*".

Many of the parents also expressed their concerns about not being able to make the recommended device available to the students. Some of them said:

> "*One-to-one devices are great for education but there needs to be equity for families that cannot afford devices*".

Another issue that came up regarding digital access was the compatibility issues between different types of one-to-one devices. Interview responses from student indicate that some students have been unable to carry out their usual learning activities during classroom because of device compatibility issues. Responses from teachers confirmed that most of the learning activities are designed keeping iPads in mind, and these activities may be difficult to perform using a laptop and android devices. Regarding compatibility issue, one student says:

> "*I felt disadvantaged sometimes because I have a laptop and all the teachers talk about is apps for iPads*".

However, students and teachers were keen to find alternative ways for these situations. Also, the overall survey responses do not reflect incompatibility issues to be prevalent on a larger scale in everyday learning.

Despite some degree of access, compatibility and technology issues, BYOD initiative certainly provided a greater degree of access to digital learning technologies to learners and it is improving gradually. In addition, the access to the internet at homes has improved in the subsequent years, which contributed to narrowing down of the gap in access to digital technologies and resources for students. Looking into the positive change in terms of access/reach, BYOD initiative can be considered an enabler in this context.

How have the digital skills divide evolved because of the BYOD classrooms?

The baseline and follow-up survey data between 2013 and mid-2014 helped in laying the foundation of the study. Teaching and learning are constantly evolving in the context of BYOD classrooms and it started to appear in the second set of the survey responses. The teaching and learning practices during this period seemed to concentrate more on critical thinking and analysis of available information rather than consuming as it is. Many students found BYOD classroom much more relevant and useful.

Because of this shift in teaching and learning practices/activities from consumption to analyzing critically before applying it into their learning, the area of inquiry of our investigation has shifted from just digital skills to much broader information literacy. Survey and interview from this phase suggests that a significant proportion of students lack critical analysis of information to apply to their learning activities. Therefore, to attain the equity of learning outcomes in the ever-changing landscape of teaching and learning, it is necessary that we consider information literacy as the key factor to raise computer self-efficacy among students, which is one of the focal constructs in our framework. From these results, we might assume that digital/information literacy skills will increase over time once BYOD is consistently applied across all year levels. For those who are already actively engaged in using one-to-one devices, there is certainly skill development going on. However, information literacy, on the other hand, is evolving as an aspect that needs more in-depth investigation in the technology-mediated learning context. Overall, the technology usage patterns among students have not changed a lot across the baseline and follow-up surveys. However, there continues to be a positive trend in student motivation for BYOD classrooms.

When asked what have been their major challenges, 17% of teachers indicated classroom management in the BYOD context. This was mainly because of the extra effort teachers had to put in their classroom to prevent students going off task. A number of measures have been taken caution students, but this has had little or no effect. Therefore, the issue remains one of the challenges for teachers. Parents in their responses, also clearly voiced their concerns regarding the unsupervised usage of devices by their child. A number of parents worried about the unsupervised nature of their child's device usage and the potential harm it may cause. One parent worried for change in their children's behavior and social interactions say:

> "*Yes I constantly have to take the device off my child she seems to be constantly on it and it is a constant battle, she has lost interest in a lot of other activities*".

The unsupervised access of students to the device and the internet could also be a concern because of the widening digital skills gap between the students and parents. On one hand, students are exposed to the different forms of digital technologies as an integral part of their learning, whereas in the other their parents severely lack an ability to monitor their digital activities. In a different study, Newhouse, Lane, Cooper, and Twining (2014) reported similar findings in a learning environment using web 2.0 technologies. Because of this, parents have a growing concern about the safety of their children. In the latest surveys, some of the parents responded as:

> "*Negative impact: they spend a huge amount of time at home on their devices. It is often very difficult for us to know whether it is school related or not. As it is a condition of them attending school we are bound to allow them access to their devices.*"

> "*Yes, the definite negative impact I have seen in our community and at home. A huge amount of social bullying and inappropriate use of the device to take photos, and send images, messages to others about others etc. Children as young as Year 7 and 8 being given complete access to the internet and everything on it getting into pornography (written and visual) and chat rooms talking to older men and women.*"

Lately, there have been reports of students using some of the applications and sites that are used for internet bullying in New Zealand schools. There is no report of that from the school where our research is based on, but this is clearly an alarm bell for school and parents involved in the BYOD classrooms. Therefore, there is a mixed result from the analysis in this context. Therefore, while the results show improvement in the digital/information literacy, they also raise concerns caused by the digital practices/habits of the students.

How have the learning outcomes evolved because of the BYOD classroom?

Certainly, addressing and bridging of access and digital/information skills are important aspects in the context of the BYOD classrooms. At the same time, having reasonable access and adequate skills will not guarantee overall digital inclusion. Even with the innovative technologies and best digital skills, students may still struggle in their learning activities. Therefore, our analysis in this category focuses on some of the factors contributing to the learning outcomes divide.

One of the factors that closely affect the learning outcomes is *knowledge acquisition*. In the recent years since the introduction of BYOD classrooms, we have seen a shift in the teaching and learning practices and activities. The learning activities are now designed in such a way that it needs students to gather information, synthesize it and analyze critically before applying into their learning. Many students have appreciated the way they are currently learning. Whereas earlier a small proportion of students expressed concerns regarding not being able to meet that standard. However, recent interviews with teachers indicated that there is huge progress among students in critical thinking abilities, such as gathering, analyzing and applying information into their learning.

> *"The results that we are getting since having BYOD are improved. I definitely would be very surprised if results go down."*

Another factor that affects the learning outcomes is the *attitude, behavior, and motivation*. Apart from few exceptions, majority of learners find BYOD classrooms a great idea. Interestingly, despite the potential opportunities offered by the BYOD classroom, some students earlier expressed some apprehensions with the initiative. However, the latest data from the teacher interviews shows a very different picture on the issue indicating positive changes in attitude, behavior and motivation.

> *"There far more engagement and there is far more openness with their work. I remember years ago students sort of covering their work and not showing it to teachers when they were writing, if their handwriting was bad or spelling was bad. Whereas now the kids are lining up to show their work, whether it's the video, report or presentation."*

Learner self-efficacy is another factor that can affect the learning outcomes. It has its root in the three level digital divide framework (Figure 2), adapted for our research. The framework describes self-efficacy as one of the major predicators of the digital capability divide, which in turn leads to digital outcome divide in combination with some other factors. Therefore, exploring self-efficacy is very important for understanding its effects on student learning outcomes. Recently, a number of teaching and learning strategies implemented have been designed to promote self-learning and maximize student engagement. All of that have been done with emphasis on student led learning which does not just maximize student engagement, but also gives them more freedom, responsibility and ownership of their learning. The following comments from different teachers show the change in students' attitude in the new environment.

> *"On a good day, you come here and you will see students outside. They are still on task but they are choosing different learning environment for them."*

> *"Very first thing is, let the students be and trust that they are going to take ownership of their learning."*

As a result, the changes that are appearing now indicate that students are developing into independent learners. One comment states it simply:

> *"For majority of students, they have improved on critical thinking ability."*

At the same time, concerns about every student not being on the same page and not having same level of information literacy skills were also raised.

> *"Some students are lot more confident in finding, processing and applying information they come across and others don't. I think that's what separates your achieved students with excellent ones, because quite often your excellent students have higher level of information literacy."*

Interestingly there were no conflicting views about improvement in student learning outcomes over the years of BYOD policy. There was a strong feeling among teachers that BYOD has definitely contributed in improving learning outcomes.

> *"The results that we are getting since having BYOD are improved. I definitely would be very surprised if results go down."*

> *"I think the critical thinking ability in majority of students have improved because I find their essays lot more detailed and with in-depth information. They have lot more insightful comments."*

Overall, the latest round of data shows improvements on many aspects, including school curricular practices, giving students' agency and ability of meaning making all of which contribute to build students self-efficacy in the context of BYOD policy. This in turn has a positive effect in achieving better learning outcomes among students.

Contributions

There is a common consensus among educators and policy makers that the technology-mediated pedagogical practices have a lot to offer to improve the quality of education. Technology-mediated teaching and learning may not deliver 100% on the promises, but it certainly has the ability to transform the classroom teaching and learning positively. A great deal of transformation is possible because of the opportunities for innovative teaching and learning, facilitated by modern digital technologies. On one side, the digital learning technologies opened up the unlimited possibility for access to information, ease of handling and processing information, and improved collaboration resulting into ever improving academic activities and results. Whereas on the other side, as the penetration of technologies and adoption stages in society advances, the new type of gap between the individuals takes shape, which has been conceptualized in a research paper with a three level digital divide framework (Wei et al., 2011). We have followed the same path as the three level digital divide framework to investigate the leveraging of digital learning technologies to improve student-learning outcome in the context of BYOD classrooms. With the increased penetration of digital technologies into the teaching practice by the BYOD initiative, we shared rich insights on how the existing and new digital divides have evolved within the BYOD classrooms and in the wider usage of technology in and out of the school by students.

One of the *first outcomes* of the study is there is no evidence of a widening gap in terms of the digital access. The positive results in the digital access in itself do not seem a significant finding in the context of New Zealand. However, our study has investigated the issue of access to technologies based on the findings presented from a series of technology enhanced pedagogical initiatives within New Zealand (Rivers & Rivers, 2004). What was important in this finding is that the BYOD classroom initiative did not end up accentuating the existing gaps in the access to digital technologies and information literacy, despite the initial results indicating towards potentially digitally divided classroom.

The *second outcome* of the study is the ability of learning in individual learners in the BYOD context is not guided by their digital skills, but the adequate information literacy skills. The introduction of technology-mediated pedagogical practices like BYOD classroom enabled teachers to introduce innovative teaching and learning activities and methods. These innovative methods are designed for greater student engagement, turning teachers into facilitators. In addition, the students have been given even greater agency into their learning activities, demanding more effort from students, making it student led learning. This led to an increased frustration and motivational issues among the students with limited information literacy skills and critical thinking ability. As a result, the gap between the students with or without the information literacy and critical thinking ability increased. The analysis strongly indicated the presence of this gap during the mid-way through the research (around late 2013-2014), which were bridged in the later stages of the study. Reason for that is it took some time for students to accept the teaching and learning practices in the BYOD classroom, with the huge change in the classroom curricular structure.

The *third outcome* of the study is the identification of one of the most important factor contributing to the level of digital outcomes students' achieve. From the analysis of the data, learner self-efficacy has emerged as the factor with influence in shaping up the learning outcomes. In fact, when students lack adequate self-efficacy, it poses risk for learners potentially ending up on the wrong side of the digital capability divide. Therefore, the most important driver to cause the issue of digital capability is the learner self-efficacy, and is largely influenced by the factors pertaining to the digital capability divide in itself. In the next stage, the level of self-efficacy further influences affordances in various sources of

social cognitive abilities, affecting individual learner's knowledge acquisition, progression, and changes in their attitude and behaviors. When this happens, this influences how learners engage and apply technology to attain their learning outcomes, and hence results into digital outcome divide.

Conclusions and limitations

As a part of the five-year study of the technology-mediated teaching and learning, we have been able to explain some of the unanswered questions around the issue of digital divide in the learning process. Starting from the preliminary study, new factors started to unravel as we progressed through the individual stage of data analysis, informing the focal contracts contributing towards the higher levels of digital divide investigations. Rich insights have been shared in the context of technology-mediated pedagogies and specifically BYOD classroom, as to how digital divides moved beyond access and skills to ensure inclusive learning outcomes. Further, teachers who had been involved in the BYOD initiative over the complete five year period gave a holistic perspective on how teaching and learning transformations occurred. While this study is limited to a single case, it takes account of a five-year longitudinal period to reveal a comprehensive understanding about technology-mediated transformations in teaching and learning spaces. It is hoped that the study findings will provide value to policy makers and education government agencies in their ongoing quest for bringing about an inclusive digital transformation.

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