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Bring Your Own Devices Classroom: Exploring the issue of digital divide in the teaching and learning contexts

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Bring Your Own Devices Classroom: Exploring the issue of digital divide in the teaching and learning contexts

1. Introduction

With the increased ubiquity of digital technologies into almost every aspect of our lives, the need for appropriate digital and information literacy skills are on the rise. In this changing technological world, digital skills are now considered as the third most important life skill alongside numeracy and literacy (DfES, 2003; Johnson, Levine, Smith, & Stone, 2010).

Recent trends in formal education emphasize the integration of digital learning media into existing pedagogies to transform teaching and learning (Anderson, 2009; Prestridge, 2007). Introducing ICT provides valuable resources for learners' academic and social development as they present new learning activities, extend collaboration mediums, provide novel assessment models and demonstrate curricula content using visual stimulants, all of which was lacking in traditional learning environments (Demiraslan & Usluel, 2008; Meyer, 2015). Proper integration of appropriate tools, systems and technology supported services assist in the transformation of traditional teaching and learning environments with new practice methods to 'learn' and 'assess learning' (Sampson, Ifenthaler, Isaías, & Spector, 2014). The results from early digital opportunities projects[1] in New Zealand indicated that integration of ICTs into learning might end up contributing nothing more than an effort to facilitate material access to ICTs (Rivers & Rivers, 2004). Despite the potential of innovative ICTs to improve the learning outcomes for every learner, evaluation of the projects indicate that integration of ICTs into the learning process is challenging and any such initiatives may even end up accentuating existing digital divides (Parr & Ward, 2004; Rivers & Rivers, 2004; Winter, 2004).

In response to this evaluation report, an ICT strategic framework for education has been developed in 2006 by taking account of the lessons learned from previous projects. The goal of this framework was to develop a more learner-centred service culture where education agencies and organizations focus on the outcomes rather than the technology through improved connectivity (access to ICT infrastructure for education), content (digital content from variety of sources), and capability (skills needed to turn information into knowledge) (Ministry of Education, 2006).

Therefore, to understand the phenomenon of digital divide in the current learning context, we have undertaken a longitudinal case study of the BYOD (bring your own devices) policy in one of the secondary schools in New Zealand. The school made recommendations for each student to bring one-to-one digital learning devices in classrooms. The school, at first, advised iPads as a preferred device, but this has since been extended to other types of tablets and computing devices. Our research study employed a number of methods, including surveys, interviews, and classroom observations. While our initial findings revealed that equity of access and skills are not major issues, other findings strengthened the need to extend the digital divide research in learning towards additional fields of enquiry (i.e. learning outcomes divide). In this paper, we present the findings, which gave us insights into the digital divide issues in the context of technology-mediated learning. Some of our earlier research on this topic (Adhikari, Parsons, & Mathrani, 2012; Parsons & Adhikari, 2015) have explored how the BYOD policy has influenced existing divides within the learning process across three levels, namely digital access, digital capability and digital outcome. The research is on-going and our subsequent study will investigate teaching practices initiated through BYOD to engage learners and maximize student learning to help bridge divides in skills and knowledge acquisition. The research project ends in June 2017.

2. Digital Divide Literature

The phenomenon of the digital divide has been studied and understood in different ways across various contexts, which has caused more confusion than clarification. The most common perspective in regard to digital divide research is the inequality of access to technologies, while some other research extends this further to inequality in digital skills and even on how it is being used (Dijk, 2012). However, the common understanding behind most of the research is that the digital divide is a

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[1] The Digital Opportunities (DigiOps) projects are joint partnerships between schools, organisations involved in ICT and the Ministry of Education in New Zealand.

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).

Phenomenon of the digital divide is complex due to the variety of economic, demographic, individual and social variables associated with it. Table 1 categorises the literature discussing the digital divide into three different types based on the nature, and type of factors associated.

Table 1: Classification of Digital Divide Literature

Type of digital divides	Factors	Reference in literature
Digital Access Divide	financial condition, income, educational level, occupation, geographical location	*(Cai, 2008; Cullen, 2001; De Haan, 2003; Dijk, 2012; James, 2001, 2007a, 2007b, 2008, 2009; Morakanyane, 2010; Parker, 2001; Van Dijk, 2005; Zhong, 2011)*
Digital Capability Divide	digital skill, educational level, control over available technology	*(Cole, 2001; Deursen & Dijk, 2009; Dijk, 2006, 2012; Gaziano, 2010; Ghobadi & Ghobadi, 2015; Hargittai, 2002b; Park, 2002; van Dijk & Hacker, 2003; Wei, Teo, Chan, & Tan, 2011; Yoori & Se-Hoon, 2009)*
Digital Outcome Divide	attitude and motivation, behaviour and willingness, nature of technology usage, and the ability of meaning making	*(Brandtzæg, Heim, & Karahasanović, 2011; Brosnan, 1998; Gunkel, 2003; Lenhart et al., 2003; Partridge, 2003; Wei et al., 2011; Zhong, 2011)*

The digital access divide is the divide between those who have access to ICTs and various forms of digital technologies and those who don't (Cullen, 2001; Dijk, 2012; Van Dijk, 2005; Zhong, 2011). For many years during the initial study on digital divide, it was considered the only definition, and hence the meaning of digital divide has been interpreted mainly in the context of access to digital technologies. Prior studies on the field established some determinants for gaps between haves and have-nots, financial status, household income, educational level, type of occupation and geographical location as being the most common factors. This indicates that individuals and societies with lower financial status and educational level might have limited or no material access to ICTs and digital media. As a flow-on effect, it can push disadvantaged individuals and societies further onto the wrong side of the digital divide, as a result creating two different classes; haves and have-nots. The digital access divide is also known as the *first level* or *first order digital divide*. Even though, digital access divide is considered one of the earliest concepts of digital divide, research around this area is relevant and will continue to remain so in understanding the digital divide in different social contexts (Araque et al., 2013).

Another study on the phenomenon of digital divide has found that merely offering access to ICT to individuals may not be sufficient to ensure that they will use the medium appropriately to meet their needs and expectations (Hargittai, 2002a, 2002b). This study suggests that people who have been provided with the access to technologies should also have the digital skills to make meaningful use of the available technologies., Otherwise, in the absence of even basic digital skills, digital divide will still be there in the form of the digital skills divide (Ghobadi & Ghobadi, 2015);. This is in line with an

earlier study conducted by Hargittai (2002b), where, digital divide has been classified in two different levels namely *first level* (access to ICTs)and *second level (*ability to use ICTs properly) digital divide.

Digital outcome divide is a more recent analysis of the phenomenon and is also referred to as the *third level* digital divide. It is defined as the inequality of outcomes achieved by users of ICTs and digital media based on factors like individual's attitude and motivation towards technology, nature of technology usage, and ability of meaning making (Brandtzæg et al., 2011; Gunkel, 2003; Lenhart et al., 2003; Partridge, 2003; Wei et al., 2011; Zhong, 2011). A recent study conducted on primary school students also establishes that motivational related factors have a significant impact on how the digital divide is shaped in educational context (Ghobadi & Ghobadi, 2015). However, motivational related factors are themselves shaped by complex interactions of events, such as access to computers and internet at home, active use of ICT by parents, overall good experience from using ICT and the school's computing environment.

Every aspect of the world around us like society, technologies, and mass media are continuously transforming and because of this socio-cultural and technological transformation, a shift in attention has been observed in digital divide research (Dijk, 2006, 2012). According to Pachler et al. (2010), the current situation of the world around us may be characterised as fluid (always tending to change), provisional, and unstable, where the responsibility for using technologies appropriately, meaning making and other risk taking have been transferred from institutions to the individuals. This has also facilitated individuals to make use of technologies and media more personally with more flexibility and mobility within different spaces and contexts of their daily.

Our study investigates one school in New Zealand with a BYOD (bring your own devices) policy aiming for better academic outcomes. In this paper, we focus our attention on the ever-changing nature of digital divide along with its challenges into an educational context.

3. The Meaning of Equity in Learning

From the analysis of previous digital opportunities projects, two major limitations of integration of digital learning mediums into existing pedagogy have been identified. First, during the planning and implementation of the projects, the meaning of equity is considered mainly as a matter of material access and digital skills. However, the outcome of the projects indicated that equity in these two aspects may be a necessary first step, but is not sufficient. To address the issue of digital divides in learning, there must also be equity in learning outcomes beyond just access and skills (Wei et al., 2011). According to different researchers in this field, equity of students' learning outcomes depends on factors such as (a) the attitude and motivation of students towards technology, (b) the nature of technology usage by students and (c) students' capability of meaning making (Dijk, 2006, 2012; Jones & Issroff, 2007; Wei et al., 2011). A second limitation was the lack of detailed forethought by planners in understanding how learning activities and environments are affected by the introduction of ICTs. According to Salomon (1993, p. 189), *"Introduction of ICTs redefines the whole activities and interpersonal relationships inside and outside of the classroom"*. Therefore, both formal (classrooms and wider school environment) and informal (home and outside school) learning spaces should be equally taken into consideration while investigating technology-mediated learning.

In response to previous project outcomes, the Ministry of Education, New Zealand, have developed an ICT strategic framework for education (cite Ministry of Education, 2006). The goal of the ICT strategic framework is to develop a more learner-centred service culture where education agencies and organizations focus on the outcomes rather than on technology through improved connectivity (access to ICT infrastructure for education), content (digital content from variety of sources), and confidence and capability (skills needed to turn information into knowledge). Based on the objectives of the ICT strategic framework, currently, eleven different digital opportunities projects aiming to contribute towards bridging digital divides are on-going. However, these current digital opportunities projects have not been successful in fully embracing the vision and goals of the ICT strategic framework for education and have failed to take account of lessons learned from the previous initiatives. Despite the

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experience from past projects, all of the current projects are still focusing either on material access or digital capability aspects, as was done in the previous digital opportunities pilot projects.

The overall objectives of the past and current digital opportunities projects are similar, bridging digital divides in learning, but focusing differently on material access and digital skills. The digital opportunities pilot projects aimed to address both material access and digital skills aspects, but did not extensively address digital skills. Current projects have been more focused on the digital skills of the teacher and student because they have been designed and deployed according to the ICT strategic framework which is based on the outcomes of past pilot projects. Initial projects put material access at the centre of the ICT implementation while the strategic framework has been designed to focus on digital skills and professional development. We can interpret this change in focus of equity from material access to digital skills in ICT implementation strategy to reflect the continuously advancing and changing nature of digital divides in learning.

4. Preliminary Investigation

In 2011, a New Zealand school decided to fully integrate ICT 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 for 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) provided devices through schools.

The school's decision resulted in a high profile news story in a leading national newspaper, triggered by a complaint laid by a parent about being asked to buy a digital learning device for their child. This set off a significant public and media response, leading to news stories on TV and radio, and online debate. The series of public media coverage on the school initiative led us to focus our initial research on the public debate, in an effort to identify important themes and concepts emerging from it about the initiative. Public debate data was collected from as many relevant public forums (as we could identify), then qualitatively coded and analysed using NVivo. Although many of the contributions to the debate were not considered because of the very general nature of the comments or, in many cases, because the comments were simply offensive, we have been able to analyse more than 500 responses. Analysis of the debate highlighted some of the possible challenges for the BYOD project as shown by the themes summarized in Fig. 1.
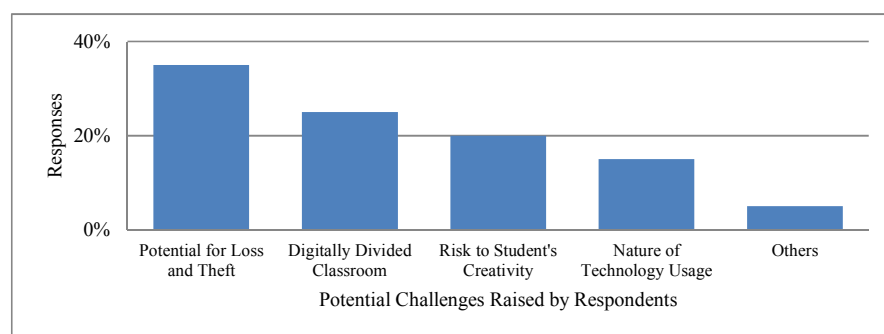

Figure 1: Analysis of the Public Debate over BYOD Project

Around 40% of the responses were concerns regarding the potential for loss, theft and damage of the device; however, our interests were not focused on physical security but on aspects of learning. Moreover, few years into the trial, there are very few incidents of damage to the device and none had been lost or stolen. Another widely expressed view in the public debate was related to inequality in terms of device ownership. More relevant to our research was that more than 20% of the contributors expressed their concerns that the classroom may become digitally divided. The general feeling was the classroom could become divisive in terms of the ownership of digital learning devices. Participants to the debate feared that some may regard it as a status symbol within the classroom, and others who do not have the device, could possibly feel disadvantaged. Further to the issue of access to devices, about 20% of the contributors expressed concerns about the meaningful use of the technology by the

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students. Some self-reported parent contributors expressed their concern about the unsupervised access to online resources by their children via the internet, as some of the resources might not be useful or may even be harmful.

5. Theoretical framework

According to recent research, as the adoption stages of ICTs advance there arise further levels of digital divides in terms of equity of information literacy and learning outcomes (Wei et al., 2011) as shown in Figure 1.
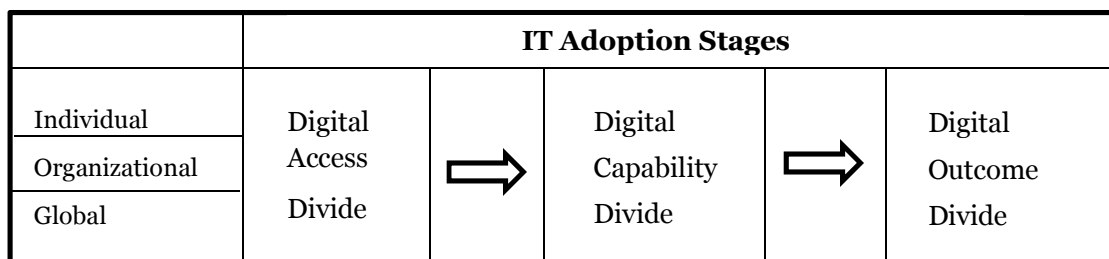
	IT Adoption Stages				
Individual Organizational Global	Digital Access Divide	⇨	Digital Capability Divide	⇨	Digital Outcome Divide

Figure 2: Three level digital divide framework (Wei et al., 2011)

Findings from the past and current digital opportunity projects show that equitable material access to ICTs at home and school and having appropriate digital skills are necessary first steps, however, this alone is not sufficient for achieving equalised learning outcomes for every learner. There are still some unanswered questions around whether capability divide leads to outcome divide? And it is especially unclear how access to and use of technology at home may influence interactions within the school's ICT environment and vice versa, that is, how digital access divide will impact the digital capability divide and learning outcomes or the digital outcome divide. Therefore, there is a need to extend the digital divide research in the context of ICT integration in learning towards additional fields of enquiry beyond just access and skills.

The three level digital divide framework describes factors pertaining to the digital access divide to 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 gained having further implications on an individual's 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 have access, capability and outcome divide stages, which match with the digital access divide, digital capability divide, and digital/learning outcome divide.
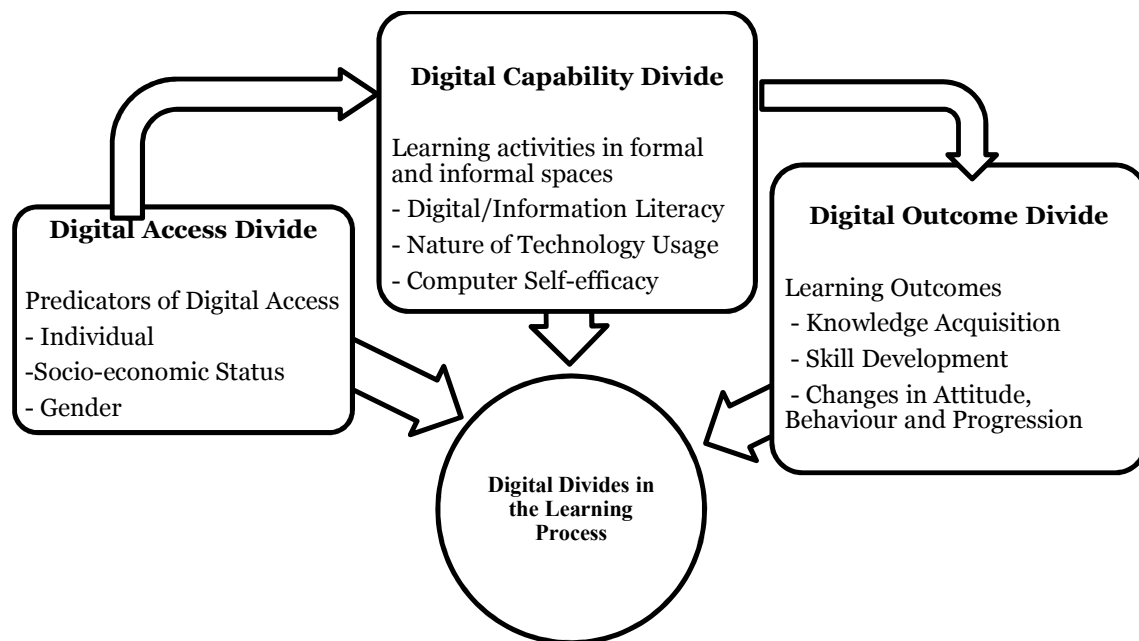
Digital Capability Divide

Learning activities in formal and informal spaces
- Digital/Information Literacy
- Nature of Technology Usage
- Computer Self-efficacy

Digital Access Divide

Predicators of Digital Access
- Individual
-Socio-economic Status
- Gender

Digital Outcome Divide

Learning Outcomes
 - Knowledge Acquisition
 - Skill Development
 - Changes in Attitude, Behaviour and Progression

Digital Divides in the Learning Process

Figure 3: Three levels of the digital divide in learning applied to the context of our study.

As illustrated in Figure 3, the digital capability divide is influenced by the opportunity of access to digital technologies among individuals based on various predictors from the first level (i.e. digital access divide) and learning activities which occur in both formal and informal spaces in the second level. 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, behavioural and environmental factors further influence learning outcomes resulting in digital outcome divide in the third level. 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, we have to analyse the phenomenon of the digital divide in all levels of it. Various factors in first two levels of digital divides have an effect on the extent of knowledge acquisition, skills development and changes in attitudes, behaviours and progression in learning.

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6. Research Objectives and Questions

Drawing on the three digital divides influencing the learning process, 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 have the digital divides in the learning process evolved over the years of bringing your own devices policy into secondary school?

This research question is influenced by the following subsidiary questions:

1. *How does the integration of one-to-one digital learning devices change existing digital divides in learning?*
2. *How has the digital access divide evolved as a result of the BYOD initiative?*
3. *How have the digital skills divide evolved as a result of the BYOD initiative?*
4. *What are the main contributing factors to the digital outcomes divide in the context of the BYOD initiative?*

7. Research Methods

Different approaches can be used to investigate the integration of digital learning technologies in formal education/classrooms. However, surveys, interviews and observations are more suitable when studying BYOD or similar initiatives (Cheung & Hew, 2009). The case study method is particularly suited to learning in detail through an in-depth study (Dubé & Paré, 2003). Case studies are defined in various ways and a standard template does not exist, however, in general, a case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or more entities. The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used (Benbasat, Goldstein, & Mead, 1987; Dubé & Paré, 2003; Yin, 2003).

Given the nature of our study, a descriptive case study method has been employed for the study of the longitudinal case of a secondary school implementing BYOD policy. According to Yin (2003), a single case design is appropriate when it represents a unique, revelatory or critical case. Our study follows an in-depth single case study research design with continued investigation over a period of time. The case chosen is also a representative of the research problem and field of enquiry we are investigating since the said case is one of the early adopters of BYOD in New Zealand.

Research instruments such as surveys, interviews and observations methods have been used to collect data from various stakeholders in the BYOD initiative (i.e. students, teachers and parents). Participants have been selected randomly from few focus subject areas (i.e. Mathematics, Science and Physical Education) after taking their consent to participate in this research study. 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. A low risk notification has been obtained to conduct the study from the university human ethics committee well before starting the data collection.

7.1 Data Collection

Because of the nature of our investigation, we have conducted data collection in regular intervals over three years (starting from 2012 until 2014). Up until now, three rounds of data collection including interviews, online surveys, and classroom observations have been carried out. The online surveys and interviews with students, teachers and parents have been designed to understand and investigate equity in terms of the level of access, digital skills and learning outcomes.

Table 2: Numbers of respondents to each survey

Respondents	2012	2013	2014
Teachers	14	40	63
Parents	4	71	50
Students	56	98	41

It may be noted that online surveys are limited to access of participants to one-to-one devices. To address this limitation, the school encouraged students to complete their surveys during school hours, since the school had provision for one-to-one internet-enabled devices for all students.

Apart from surveys, a total of 26 one-to-one interviews have been conducted (10 students, 9 teachers, and 7 parents). Also, 9 classroom observations have been conducted for target subject areas (Mathematics, Science, and Physical Education).

7.2 Data Analysis

Survey results were mostly quantitative in nature including some text responses. Further to quantitative analysis of the survey results across the different factors included in the three level digital divide framework (Figure 2), qualitative data has also been analysed. Interviews, classroom observations, and text responses data from surveys have been coded into various categories to gain an in-depth understanding of each of the themes emerging from the data. Following table 2 shows the major themes emerging from the coding of interviews, classroom observations, and text responses data.

Table 3: Coding categories and their respective number of coding references in an interview, classroom observation and text responses data related to digital divide aspect of the study.

Code No.	Coding Themes	Number Coding References
C1	Students' level of access to ICTs	16
C2	Level of digital skills and information literacy in teachers and students	22
C3	Students' ICT usage patterns and their activities	18
C4	Students' attitude and motivation towards ICT mediated learning	32
C5	Challenges and issues experienced by students	26
C6	Challenges and issues experienced by teachers	21

Among the themes emerging from the coding of the qualitative data, almost all of them relate to the factors we are considering for the three level digital divide framework (Figure 3). Code C1 (students' level of access to ICTs) relates to access to ICT divide, C2 and C3 (level of digital skills and information literacy in teachers and students and ICT usage patterns) relates to learning capability divide, and rest of the themes (C4, C5 and C6) which emerged relate to the learning outcome divide. Therefore, the results are presented in the same order as the framework has described the digital divides in learning process shown in Figure 3.

8. Results

This section describes the key findings based on this three level digital divide model (digital access divide, digital skills divide and learning outcomes divide). This includes how the learning process has changed over the years since the BYOD initiative was rolled out. Specifically, we are focusing on the digital divide aspect of our study for the purpose of this paper and therefore results in this paper covers data that relates to the digital divide aspect of our longitudinal study, including surveys and interviews with students, teachers and parents.

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8.1   Digital access divide

One of the major issues that emerged in the preliminary analysis was potentially the large division in the classroom in terms of access to digital learning devices. However, the baseline data shows 100% access to digital learning devices and the internet (with few exceptions where students had to borrow school computers for their learning needs). Despite the survey results indicating 100% access, interview responses provided in-depth insight into this issue and revealed that some students have limited access to digital technologies (at least access to the internet) for their everyday learning activities. 2 out of 9 students interviewed at the beginning of BYOD initiative, had no internet access at home although they had access to a digital learning device, and therefore expressed an inability to continue learning activities while being at home. One student stated:

> "*I usually do not spend much time with the tablet at home because I don't have 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 dialup so I only use my tablet for the project I have downloaded. I don't have internet at home.*"

In-depth analysis of data has indicated that majority of limited access issues reported relates to informal learning spaces (home and outside school). Further to that, socio-economic status and geographical locations have emerged as main reasons for limited access to digital learning devices and the internet. Interviews with parents' also backs up the student responses. When we asked, did they think of providing one-to-one learning devices for their child; one parent says:

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

Another parent said asking the government to provide financial support is an unrealistic expectation. However, tax breaks similar to school donations would help families in economic difficulty. One parent explained how difficult it was for some families, and this financial hardship had influenced their decision to go for the cheaper non-recommended device.

> "*It wasn't something that was in our budget, we had to use other means to purchase this device for our daughter, it wasn't ideal as we've had to put it onto HP and with one income it has proven difficult to pay this off in the required "no interest" time frame*".

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 compatibility issues. On the other hand, responses from teachers confirm 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. Also, the access to the internet at homes has improved in the subsequent years, which contributed to narrow down the gap in access to digital technologies and resources for students. Looking into the positive change in digital access divide, bring your own device (BYOD) can be considered an enabler in this context.

8.2   Digital capability divide

According to that three level digital divide framework in Figure 3, digital/information literacy, nature of technology usage and computer self-efficacy are some of the factors that could affect the digital capability of learners. However, findings do not provide any evidence of a widening gap in digital/information literacy skills for both students and teachers. Some level of skills issues had been reported initially, but that seem to have improved in the second set of survey data.

8.2.1   Digital / Information literacy

In the latest survey, overall skill levels of staff appeared to be slightly lower in the 2014 survey than in 2012 (Figure 3). However, it should be noted that the 2012 staff were early adopters who volunteered to take part in the first year of the BYOD initiative. The figures for 2014 represent a larger cohort of teachers across the school. This suggests that we cannot expect the digital skills of staff overall to reach its maximum potential until the BYOD policy has been fully rolled out across all school years so that all the staff has had the opportunity to fully develop their digital skills. Moreover, a reason for reporting lower skills by staff could be that having been introduced to ICT enabled teaching over the last 2 to 3 years the staff became more judgemental of their own skill levels. This is also related to their perception of computer self-efficacy, as having engaged with one-to-one devices in teaching and learning practices, teachers have gained more knowledge on instructional delivery practice methods and so had become more sceptical of their own skills.
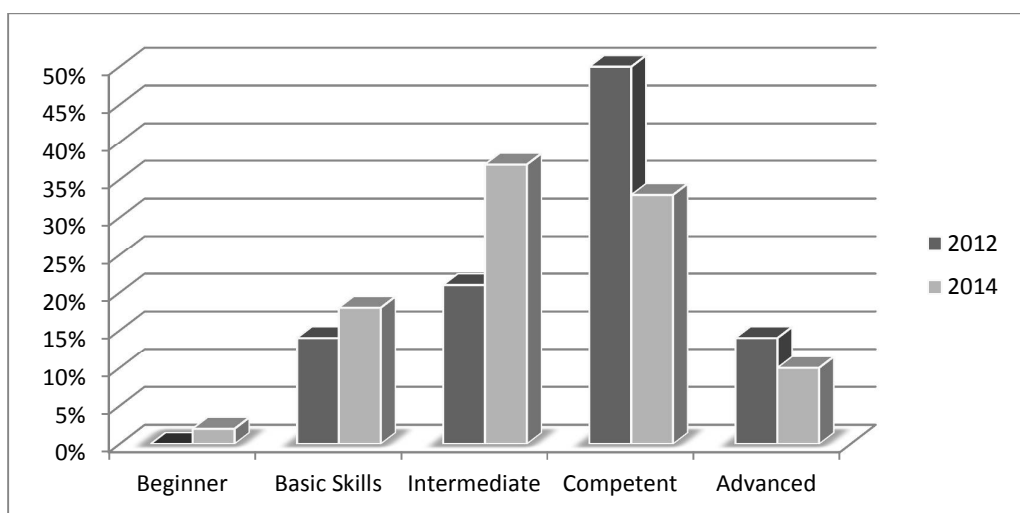

Figure 4: Staff skill levels in digital devices and computer technology
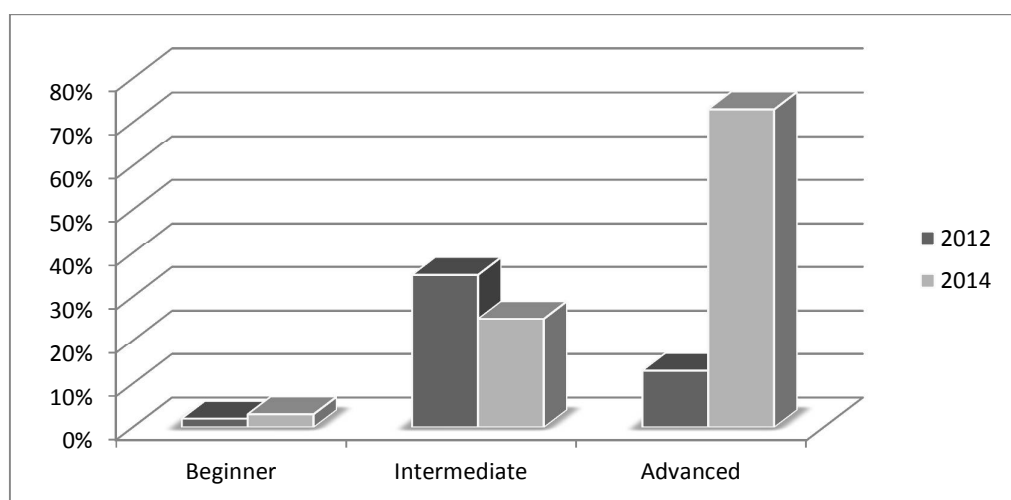

Figure 5: Student skill levels in making meaningful use of digital devices in learning activities

From the survey responses of students shown in Figure 4, it should be noted that we asked a somewhat different question about their levels of skill in making meaningful use of digital devices in learning. Further, the 2014 survey only had three options instead of five. Nevertheless, there is a marked increase in the perceived level of digital skills, thus, we see the potential for the agency has increased over time.

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Learning is constantly evolving in the context of technology-mediated learning environment and that started to appear in the second set of the survey responses. In recent years since the BYOD classroom, we have seen teaching and learning practices focused more on processing available information and applying that knowledge into their learning, rather than relying on the raw information as it is. Many students have expressed appreciation for the way they are learning and reported that BYOD classroom is clearly much more relevant and useful in today's modern society. In fact, there have been some responses that indicate this change in focus to be one of the reasons why one-to-one devices have been well received by the majority of students.

Because of this shift in learning from merely consuming information to processing information and applying it into their learning, we have to extend our attention from digital skills to information literacy. The reason is, digital skills may not be the only key factor that determines the learning outcome of the students anymore. Students may have very good digital skills to operate one-to-one devices but if they don't have enough skills to process and apply the information given to them, they might still struggle in achieving desired learning outcomes. Survey and interview data suggests that a significant proportion of students clearly struggle to find, process and apply information into their learning activities. Therefore, to attain the equity of learning outcomes in the changing nature of teaching and learning practices, 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.

8.2.2   Nature of technology usage by learners

Findings suggest that there is diversity in students' usage of one-to-one devices in school as well as in their everyday life. Overall their usage patterns haven't changed across the surveys. However, there is a small increase in device usage for educational purposes and that indicates the positive trend in student motivation for BYOD classrooms. But interestingly, there remains a large number (around 50%) of students reportedly spending most of their times around non-educational activities like social media/communication, games and other forms of entertainment (as shown in Figure 5).

When asked what have been their major challenges, 17% of teachers responded that, keeping an eye on students during classes to prevent them from going off task has remained a challenge. Some of the students too confirmed their peers going off task and classroom being disrupted because of that. Although the school has taken some measures to discourage students going off a task, that seems to have little or no effect. Therefore, it remains one of the challenges for teachers to keep learners on task. Parents in their responses, also clearly voiced their concerns regarding the unsupervised usage of devices by their child. What came out from the survey results is that, parents worry about the nature of their child's device usage and potential harm because of the exposure to inappropriate and damaging internet contents. One parent worried for change in their children's behaviour and social interactions says:

> "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".

However, since the initial introduction of one-to-one learning devices, there appears to be different levels of digital literacy between students and parents. Particularly, the digital divide between the students and parents appears to be an issue in the context of technology-enabled learning where students are exposed to the different forms of digital technologies as an integral part of their learning. In a different study, Yu, Yuen, and Park (2012) reported similar findings in a learning environment using web 2.0 technologies. Because of this, parents fear for the safety of their children as a result of unsupervised access to virtually unrestricted online resources. In the latest surveys, some of the parents responded as:

> "A negative effect on our family is that as everything is digital we cannot discuss what is being learnt as easily as it is not in a book to be shared but on a web site."

> "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."

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"Yes definite negative impact I have seen in our community and at home. 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."
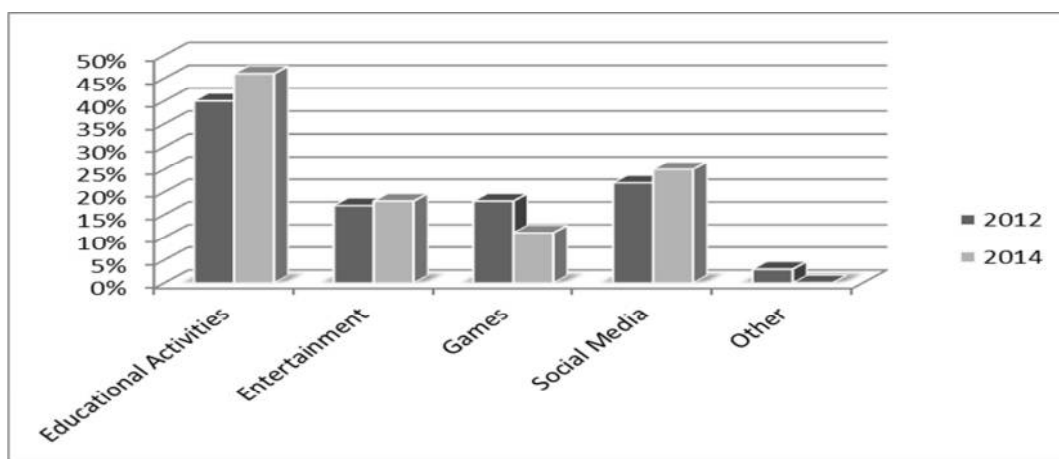

Figure 6: Student's nature of technology usage in school and at home (self-reported)

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.

8.3   Learning outcomes divide

Having proper digital access or skills may not be the only key factor that determines the learning outcomes of the learner anymore. Students may have very good access to technologies and digital skills to operate one-to-one devices but if they don't have enough skills to process and apply the information given to them, they are still going to struggle in their learning. Therefore, our analysis in this category focuses on some of the potential factors that might have an impact on students learning outcomes:

8.3.1   Knowledge acquisition and skill development

Teaching and learning practices are constantly evolving in the context of technology-mediated learning environment and that started to appear in the data in later stages. In recent years since the BYOD classroom, we have seen the teaching and learning practices focused more on processing and synthesizing available information into learning activities and tasks, rather than absorbing the content from the teachers. Many students have identified and appreciated the way they are learning and reported that BYOD classroom is clearly much more relevant and useful since it supports them in learning through critical analysis. In fact, there have been some responses that indicate this change in focus being one of the reasons why one-to-one devices have been well received by the majority of students.

In the surveys, students expressed positive comments in support of BYOD initiative and how it has made a positive change into their learning. A larger proportion of students found themselves to be more productive as devices enable them to communicate with their teachers and peers easily. It gives them the opportunity to collaborate on a task in the real time, leading to improved success rate. One student comment sums up the benefits of BYOD policy to the students:

"We are able to access information from the internet much easier. Our learning has advanced because of this. We can record and present our projects in a creative way. We are able to communicate with our teachers through email, iMessage and other apps. We can hand in work faster and not have to waste printing ink or even be at school to hand in work."

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There are, however, a small proportion of students who expressed their concerns over BYOD policy and the teaching/learning methods used. Most of the concerns were, not being able to identify facts, process evidence and apply appropriate information into their learning activities, drop in handwriting skills, and physical issues like headaches. These were sometimes reflected by parents in their interviews as:

> "My daughter feels due to no longer writing out her work she often does not retain information as well as she used to."

> "My daughter just gave up and went back to pen and paper and refused to present work on the tablet."

Certainly, BYOD initiative is transforming the traditional form of teaching and learning students are getting exposure to variety of learning opportunities which otherwise would have been impossible to have. However, a small proportion of students find themselves not being able to reap the benefits of this change. With a closer look into the responses from the later group, it all comes down to the limited information literacy skills to identify, process and apply information into their learning activities. And therefore, it is much more relevant for us to investigate information literacy instead of digital skills after the change in dynamics of the classroom due to BYOD initiative.

8.3.2 Attitudes and motivation of learners

As expected, the majority of learners find BYOD initiative a great idea and seemed to be happy with the changes in everyday teaching and learning as a result of that. However, some of the students expressed their unwillingness towards the use of one-to-one digital learning devices for teaching and learning activities as shown in Figure 7 below. Issues that has been raised were the compatibility between the different types of learning devices within classroom, quality of internet connection at school, concerns regarding the assessment method of NCEA[2] exam and overall, the lack of relevant information literacy skills (not being able to find, process and apply appropriate information) for their learning needs.
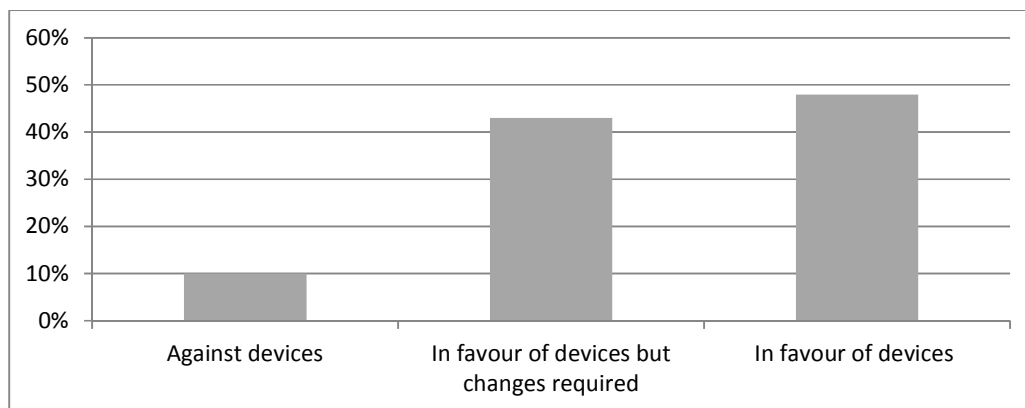

Figure 7: Student support for digital devices in learning measured by self-reported percentages

Students reported to have some degree of concerns regarding the loss in handwriting and spelling skills, since the introduction of BYOD. However, the number appeared to have increased in the latest survey. Around 50% responded that they are worried about their loss in handwriting skills., As the current method of assessing students in the school involves one-to-one learning devices, which is different than the way NCEA exams are conducted., Therefore, there is a growing concern among students about their ability to perform well enough in the NCEA exams because they feel they have not been trained accordingly. Around 30% responded that they are not sure what to expect until they sit in the exams. Only 9% of students responded saying they are confident and prepared for the exam. By looking into the responses, we can conclude that a large number of students are worried about their performance in NCEA exams and this can potentially be one of the reasons behind motivational issues identified during the later stage of BYOD project.

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[2] The National Certificate of Educational Achievement (NCEA) is the official secondary school qualification in New Zealand.

9. Discussion

The integration of one-to-one learning devices has the ability to transform the teaching and learning process. Results so far show that access to ICTs has improved at a phenomenal rate as a result of the BYOD policy, and access to digital learning devices is not an issue in general. Findings do not provide any evidence of a widening gap in digital skills for both students and teachers. Some issues in skills levels were reported initially, but that seem to be improving gradually. As students interact with digital media and resources for learning in classrooms, they become more aware of skills which in turn are reflected in their perception of self-efficacy measurements (Deursen & Dijk, 2015). Pedagogical practices are constantly evolving within the context of BYOD classrooms and as a result the teaching and learning practices are focused more on critical thinking. Because of this shift in the way students learn from consumption of information to processing and applying information through critical analysis, we have to extend our attention into our study from digital skills to information literacy; allowing us to further investigate what effects it has on the learning outcome divide.

In the current context of BYOD initiative, students' usage of one-to-one devices includes more and more use of online social media, and web 2.0 tools for everyday life as well as learning activities in formal and informal spaces. This has provided students an extra layer of opportunity and ability to collaborate with peers and teachers, and has been reflected highly in student responses. Collis & Moonen (2008) affirm the use of web 2.0 internet tools to enhance collaboration, communication, and distribution of information among its users regardless of their physical locations. By using web 2.0 social media technologies, learners can have the same level of ability to carry on their learning activities from either formal or informal spaces. While this is empowering students regarding easier access to learning content and in making choices regarding preferred learning venues that suits their needs, requirements and interests, this also brings forth new avenues of divides. Parents have concerns over unsupervised access to the internet by their child while pursuing learning activities in schools and homes. Mainly parents have been concerned about the safety of their children as a result of the prevalence of digital bullying in schools lately. Also, there have been feelings among parents that they are not as good as their children in using computers and various internet applications as they voiced doubts on their own abilities to supervise their children's learning at home.

Our study has articulated the contextual factors affecting the three levels of digital divide identified by Wei et al. (2011) within a learning context. As specified by Wei et al. (2011), the first level or digital access divide predictors are individual specific and based on their environmental settings such as socio-economic status. This will include factors such as one-to-one access to a device (e.g., do students have access to a computer at home? is it shared with the whole family?) and internet access (e.g., do they have proper internet connectivity at home?). This leads to the second level or digital capability divide. In this level, we identified factors related to learning activities in formal and informal spaces (e.g., what is the ability or digital literacy level of students in the meaningful use of technology? how much of the available technology, the internet and other resources are used for self-learning in school or at homes? is the level of computer self-efficacy high?). These two levels, in turn, lead to the achievement of learning outcomes through knowledge acquisition, skill development, and changes in attitude, behaviour and progression among students. Positive outcomes will help to reinforce the meaningful use of technology and lead to confidence and raise self-efficacy in the learner, which will again feed into improving the learning outcome.

Technologically supported pedagogical practices must be able to address the divider levels as we continue to move from traditional education to smart education in the current teaching and learning context. However, for education to be really smart and lead to improved learning outcomes, the delivery of content has to be inclusive across formal and informal boundaries to help students engage in critical thinking as they acquire new skills and knowledge in their learning process. The three level digital divide (shown in Figure 3) demonstrates causal relationships amongst the identified three divider themes. That is, how predicators of digital access (e.g. at individual level) influence differentiators in learning activities being pursued in formal and informal spaces (e.g., technology usage, self-efficacy), which has a further effect on knowledge acquisition, skills development and overall motivation. The interaction amongst these three digital divide levels forms the basis of how learning technologies establish a pathway towards learners' academic and social development.

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10. Conclusion and Future Direction

Despite progress in dealing with the changing nature of digital divides over the years, not every aspect of it has yet been taken into account. Ensuring equalised digital access and digital skills/literacy are necessary measures towards bridging the digital divides in the learning, but further divides still exist (Dijk, 2012). In order to achieve the complete digital inclusion, objectives should be to equip learners with not only the improved access and skills to digital technologies but the motivation and ability to think critically and the creation of new knowledge which is responsive to the solution of professional and social needs (Ghobadi & Ghobadi, 2015; Richey, 1998). Various researches in the field of digital divide shows that, better access to digital technology and skills gives any individual an increased chance of performing and achieving better outcomes (Deursen & Dijk, 2015). Therefore, increased access to digital technologies to better digital and information literacy to think critically can support learners in their quest for knowledge acquisition, skill development and bring about positive changes in attitude and behaviour, ensuring inclusive learning outcomes.

This study has offered insights on the various aspects of digital divides in teaching and learning environment and how it has been transformed since the BYOD initiative. When learners are comfortable within their own personalized space – formal and informal – and technology is embedded in one-to-one learning, trust and confidence of their abilities are established. Learners will be motivated by their own levels of digital literacy to explore new knowledge on their own, rather than be instructed to do so. However, data indicates more dividers which are spread across different aspects and stakeholders in BYOD policy; specifically, between parents and their children and between different teachers. Moving forward, further studies will be conducted to investigate the changes in pedagogical approaches as technology becomes more inclusive and more pervasive in classroom teaching. More research on understanding the impact of ICT for maximizing student knowledge acquisition and skill development and overcoming digital divide is crucial. While this study is limited to a single case which limits generalization to other contexts, it takes a longitudinal approach to understanding the dynamics of how technology-mediated learning environments are transforming formal and informal learning spaces over time.

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