BRING YOUR OWN DEVICES CLASSROOM: ISSUES OF DIGITAL DIVIDES IN TEACHING AND LEARNING CONTEXTS

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Bring Your Own Devices Classroom: Issues of Digital Divides in Teaching and Learning Contexts

Abstract

Since the late 1990s, *digital divide* has gathered much attention from the research community and government organizations. The education sector has been an important area of inquiry for many researchers, as they strive to inform government initiatives on strategies to address digital divide issues prevalent here. This study reports on how existing and new digital divides have evolved with increased penetration of digital learning technologies into teaching and learning practices and the wide usage of enabling technologies by students across formal and informal learning spaces (i.e. both in- and out-of-school), within the context of a BYOD (bring your own device) classroom initiative. A five-year longitudinal investigation of a BYOD classroom initiative by a New Zealand school helped to gain insights into different nature of digital divides in the learning process. 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, the study 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 the most influential determinant of learning outcomes among students. In earlier phases of investigation of BYOD classrooms initiative, learner self-efficacy was found to be influenced by digital capability, in combination with 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. The study findings will inform policy makers and education government agencies, in their ongoing quest for bringing about inclusive digital transformation and overall improvement in learning outcomes.

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Chapter 1: Introduction

1.1 Introduction

Immersion with information and communication technologies (ICTs) in our lives has altered the way information literacy skills are being perceived among the general population. Media-rich collaboration tools having more visual effects such as animations, drag, drop and click events are being used to engage young and old. Essential sources of even the most basic services are increasingly becoming dependent on the digital communication mediums and technologies, thereby requiring people to acquire new skills to be able to avail these services in their everyday lives. Need for appropriate digital and information literacy skills are therefore on the rise and digital skills are now considered as the third most important life skill alongside numeracy and literacy (DfES, 2003; Johnson, Levine, Smith, & Stone, 2010). Hence, research studies which informs on the strategies for developing digital and information literacy skills among individuals in diverse societal and economic contexts are much needed, so that the opportunities offered by the digital revolution can be inclusive not exclusive.

The increased penetration of digital technologies into our daily life activities have led education agencies to emphasise on the integration of digital media (tools, technologies and services) into existing pedagogical practices to enable transformation in traditional teaching and learning methodologies (Anderson, 2009; Prestridge, 2007). In doing this, there is potential to add value to existing teaching methods by providing valuable resources so teachers can innovate with their classroom teaching

deliveries and design learning activities to improve the academic and social development of learners. Digital tools and technologies have changed how formal education is being delivered with design of novel learning activities and assessment models which are aligned with the current teaching curriculum (Demiraslan & Usluel, 2008; Mardis & Everhart, 2013). Teaching methods when assisted by appropriate technical tools, systems and services help to transform teaching and learning practices (Mardis & Everhart, 2013; Sampson, Ifenthaler, Isaías, & Spector, 2014). Individuals (in the context of teaching and learning, teachers) based on their defined profession (namely teaching) create their own context-adapted approaches (or teaching delivery styles) in their attempt to manage operations and reduce disruptions within their work domains (or classroom spaces), thereby making a more inclusive learning organization (Örtenblad, 2015). Or, in other words, teachers experiment with rich digital technologies as they integrate them into their existing teaching deliveries, thereby enabling innovative pedagogical practices in their classrooms. Further, with advances in digital tools and technologies, opportunities to search, retrieve and process information have improved immensely, especially among learners who can explore themselves. Furthermore, the penetration of mobile and handheld devices, 24/7 access to the internet, social media technologies, and other innovative tools have created more prospects for both educators and learners to collaborate on learning activities from anywhere (Newhouse, Lane, Cooper, & Twining, 2014).

Over the last two decades, technology has transformed the way we communicate and collaborate with people around us, and having an inclusive distribution of these technological opportunities would help individuals and society to take maximum benefit and achieve digital inclusion. Because of that, policies and initiatives to ensure

and maintain digital inclusion for the entire population has become a primary concern for governments, policy makers and researchers around the world.

Having said that, only the availability of technologies and ability to operate those digital tools and technologies are less than likely to improve the learning experience and outcomes within the educational context (Bailey, Schneider, & Ark, 2012). Information literacy skills to be able to understand the information and analyze it critically to apply into their learning are key for enabling learners to make meaningful use of available material resources to meet their learning requirements and realize their potential in future endeavors (Mardis & Everhart, 2013; Meyers, Erickson, & Small, 2013).

Furthermore, earlier studies about the integration of digital learning technology within the learning environment in New Zealand, called digital opportunities pilot projects (*DigiOps*[1]) indicated that mere integration of digital learning technologies into existing pedagogical practices might end up contributing nothing more than physical access to ICTs for individual learners (Rivers & Rivers, 2004). Literature suggests despite the unlimited potential of innovative digital learning technologies to improve learning outcomes, it could end up accentuating existing digital divides (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004b) within the teaching and learning environments. Supporting the earlier argument, Wei, Teo, Chan, and Tan (2011) too caution us that, as adoption stages of digital tools and technologies advance, there may arise more levels of digital divides based on the equity of digital capability and learning outcomes.

[1] The Digital Opportunities Pilot Projects 2001-2003, trialed the use of a variety of Information and Communications Technologies (ICTs) to enhance learning in four clusters of schools in New Zealand.

According to Pachler et al. (2010), the current situation of the world around us is fluid (always tending to change), provisional and unstable, where the responsibility for using technologies appropriately, meaning making and other risk taking is now transferred from institutions to individuals. Individuals make use of digital technologies and media more personally with more flexibility and mobility within their contexts in different worldly spaces. With these constant changes in the way the digital technologies are being used and appropriated, the meaning and the way we view the digital divide is also shifting (Van Dijk, 2017), requiring a shift in attention towards additional fields of enquiry into digital divide in learning research which are beyond just access and digital skills.

1.2 Digital divide phenomenon

During the late 1990s, innovations in the computing and communication technologies disrupted the traditional way of life introducing many opportunities and services people never imagined. The modern developments in digital tools and communication technologies referred as the digital revolution marked the beginning of the information age (Sterling, 1997). Revolution in technological advancement provided individuals with new opportunities to achieve great accomplishments by revolutionizing the working life in various professions, which included having better and instant access to information, ability to transfer information freely, and improving communication and collaboration between individuals (Greenstein, 2010; Tsatsou, 2014). This was the start of a shift in the economy from traditional industry to an economy based on the information, i.e., an information society. Despite the potential benefits offered by the information society and increased penetration of digital technologies into society, not everyone in the world around us has the privilege of

using the services offered by digital technologies, thereby restricting their opportunities in the information society. That includes the inability to access, operate and use the digital tools and technologies meaningfully to benefit from it. As a result, many individuals and some societal groups are still facing digital exclusion from the rest of the population.

However, there is no denial that, digital revolution has helped transform the global society positively with many technology-driven services and opportunities despite challenges around the equity (Van Dijk, 2017).

The phenomenon of the digital divide has been researched and defined in many different 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 not easy to understand the phenomenon within a single context and with a single definition (Van Dijk, 2017). Careful examination of the literature gives no clear evidence of the origin of the term '*digital divide*', and its meaning is still unclear. Many authors have described the digital divide phenomenon as the most pressing social, economic and academic issue of the information age, and therefore it is gaining more attention from the governments and policymakers in resolving the issue of divide, based on the digital opportunities (Dewan, Ganley, & Kraemer, 2005; Hilbert, 2011). Because of the complex nature of the digital divide phenomenon and the variety of economic, demographic, individual and social variables associated with this, the policies and initiatives to fight this issue has to be tailor-made to match certain conditions prevalent in the groups being targeted to get the desired impact.

The phenomenon of digital divide can be catagorised into three broad catagories, that includes digital access divide, digital capability divide and digital outcome divide. All of this three concepts of the digital divides are explained next.

The most basic understanding of the digital access divide is the gap between those who have access to ICTs and new digital media and those who do not (Cullen, 2001; Van Dijk, 2005; Zhong, 2011). There are several socio-economic factors like the differences in financial status, income, educational level, type of occupation and geographical location have been found to be the major determinants for division between the individuals and society in terms of the access to digital technologies. That is to say that individuals and societies with lower financial status and level of education may have limited or no material access to ICTs and digital media. This could play a vital role in pushing those disadvantaged individuals and societies onto the wrong side of the digital divide and create two different classes of haves and have-nots. The digital access divide is also known as the *first level* or *first order digital divide*.

Further study on the phenomenon of digital divide has found that merely offering access to digital tools and technologies 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 access to technologies should also have the skills to make meaningful use of the available technologies; otherwise, they may not be able to take even basic advantages of the available technology and its resources. Based on the study, Hargittai (2002b) has defined digital divide phenomenon in two different levels namely *first level* (access to ICTs) and *second level (*ability to use ICTs meaningfully) digital divide.

Digital outcome divide in addition to the divide in terms of access and skills, is a more recent analysis of the phenomenon and referred to as the *third level* digital divide. As the digital tools and technologies are integrating into more and more areas of our daily life, the attention has shifted from 'do people have adequate access to' and 'do people have adequate skills'. The recent attention in the study of digital divide is focused on the outcomes achieved by individuals through the opportunities leveraged by digital technologies. In determining the learning outcomes, the analysis has taken account of the individual attitude and motivation towards using technology, their nature of technology usage, and their ability of meaning making in appropriate contexts (Brandtzæg, Heim, & Karahasanović, 2011; Gunkel, 2003; Lenhart et al., 2003; Partridge, 2003; Wei et al., 2011; Zhong, 2011).

Every aspect of the world around us is continuously transforming as a result of the constant evolution of the digital media technologies surrounding our daily lives. As the penetration rate of the digital tools and technologies are improving in the society, it is allowing individuals to make use of it in a more personalised and flexible manner so as to meet their everyday technological needs. However, making meaningful usage of available digital tools and technologies to achieve maximum benefit is increasingly becoming the responsibility of the individual users (Pachler, Bachmair, Cook, et al., 2010). That is, individuals should be able to distinguish and decide between alternate opportunities offered by ICTs (Parycek, Sachs, & Schossböck, 2011). Therefore, with the change in dynamics around the way individuals access technologies and how it is being used also indicates towards the need of a shift in the direction of digital divide research in future studies (Deursen & Van Dijk, 2015; Van Dijk, 2006, 2012).

In this study, the focus and attention is on the ever-changing nature of digital divides within the educational environment, as the penetration and adoption of digital

technologies advance within the teaching and learning practices. The research study has investigated a technology-mediated pedagogical initiative in a secondary school in New Zealand, in the form of a BYOD (bring your own device) classrooms, that aims to improve the academic performances of the learners by integrating one-to-one digital learning technologies into the teaching and learning process.

Studies on earlier educational initiatives to integrate ICTs into teaching and learning suggested potential challenges related to aspects of equity within access and digital skills among individual learners, leading to digital divide in teaching and learning environments (Rivers & Rivers, 2004). Therefore, this initiative is an opportunity to report on how existing and new digital divides have evolved with increased integration of digital technologies into teaching and learning practices, and with the usage of technologies for learning activities by students across formal and informal learning spaces (i.e. both in- and out-of- school).

1.3 Bring your own devices (BYOD) classrooms

Bring your own devices (BYOD) is a relatively recent policy. This practice has been adopted mainly by schools across the world (especially in developed countries) to leverage the opportunities created by information and communication technologies into existing pedagogical practices and learning activities within classroom spaces. The term BYOD is also used in many other contexts like tertiary education, business settings and workplace for similar aims of maximizing of digital opportunities. However, it still predominantly refers to the initiatives taken by schools to introduce one-to-one digital learning technologies/devices into the teaching and learning activities.

There are some factors, which drives any school to introduce the BYOD policy. First, there is the sense of recognition that education must adapt to technological changes in wider society. As the everyday use of digital tools by school students grows, so does the need for schools to integrate digital technologies to remain relevant (Collis & Moonen, 2008; Engelhard & Kyeong-Ju Seo, 2012). Second, there is the drive towards making digital tools available as an integral part of education rather than just episodic interaction in a computer lab. The extent to which this influences the curriculum depends on the ambitions of the educators. Integration of digital tools may be the simple substitution of traditional textbooks to digitized textbooks (Mardis & Everhart, 2013) or could be a more fundamental redefinition of the curriculum delivery (Newhouse et al., 2014). Third, there is the financial pressure on schools that are unable to provide every student with a device. Thus the onus is increasingly being put on parents to provide such devices, though different funding models are required for different contexts (Bailey et al., 2012).

Along with potential benefits, such as improved learning outcomes in educational contexts (Cristol & Gimbert, 2013), come concerns such as a disruption in the classroom (Sharples, 2002a) and concerns about a lack of inclusivity and an increase in cyber-bullying (Sangani, 2013). There may also be digital divides in learning outcomes (Wei et al., 2011). Themes that have emerged from other research in a similar context (BYOD in New Zealand secondary education) have suggested that the main positive outcome has been a shift towards student-centred learning, while the main challenges are related to changing management structures and student supervison (Baker, 2014). Another New Zealand study, this time in primary education, highlighted the importance of collaboration between the key stakeholders of teachers, students and parents (Falloon, 2015). Ackerman and Krupp (2012) also stress the role

of collaborative stakeholders in a successful BYOD implementation, in particular, the forging of new partnerships between students and teachers in the classroom, emphasising the change brought about in classroom relationships by BYOD. Bruder (2014) highlights the need for certain structures to be put in place to promote equity, security and appropriate curricula, to ensure that BYOD programmes achieve their potential benefits rather than introduce risks.

It is important not to view BYOD in isolation and not to focus only on the device. We cannot ignore the additional technical requirements since BYOD integration into the learning environment can only take place within the context of certain enablers, such as having a suitable wireless broadband infrastructure with supporting policies and procedures for secure and appropriate use. These facilities could be as per those outlined by UNESCO (2013), and may be associated with other initiatives such as a move towards cloud-based resources (Lennon, 2012). The supporting technical infrastructure resources do not operate independently of the teaching and learning process, rather they drive changes in curriculum and pedagogy (Cochrane, Antonczak, Keegan, & Narayan, 2014). Therefore, schools have to be prepared and equip their classroom environments with up-to-date resources (like broadband speeds) to enable digital participation with one-to-one digital learning devices within BYOD classroom context.

1.4 The meaning of equity in teaching and learning

From the analysis of previous digital opportunities pilot projects, two major limitations of integration of digital learning mediums into existing pedagogy have been identified (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004a, 2004b). First, during the planning and implementation of the projects, the meaning of equity was

considered mainly as a matter of physical access to technologies and digital skills. However, the outcome of the projects indicated that equity in these two aspects might be a necessary first step, but is not sufficient by itself. To address the issue of digital divides, there must also be equity in learning outcomes beyond just access and skills (Wei et al., 2011). According to the research, equity of learning outcome is determined by the attitude and motivation of students towards technology, the nature of technology usage by students, and students' capability of meaning making (Jones & Issroff, 2007; Van Dijk, 2006; 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 (Ministry of Education, 2006). The goal of the ICT strategic framework is to develop a more learner-focused service culture where education agencies and organisations focus on the outcomes rather than on technology. This can be achieved through improved connectivity (access to ICT infrastructure for education), content (digital content from a variety of sources), and confidence and capability (skills needed to turn information into knowledge).

After the initial trial of the digital opportunities pilot projects (Far Net, Gen XP, Notebook valley and digitally boosted study support centers) during 2001-2003, a

number of ICT integration initiatives in schools continued with mixed rate of success in meeting the overall goals. Some of those projects include TELA laptops scheme, ICT Professional Development, National Education Network and continuation of Far Net, which aimed at three different areas identified in the ICT strategic framework objectives (i.e., better access to technologies, emphasis on digital courseware and improved confidence and capability).

TELA initiative aimed at providing teachers with better access to computers (particularly laptop) through a lease programme. The government funded up to two thirds of the total cost, while schools/individual teachers had to meet the balance. The initiative was designed to work together with a school-funded teacher professional development programme. Even though the findings from the digital opportunity pilot projects indicated that only focusing on access and skills is a narrow view, the goals of the TELA initiative repeated the same and focused solely on access and skills aspects. There was no clear direction on how this initiative would translate into better student learnings and other educational priorities. Therefore, the objective of the TELA initiative did not include benefits like improvement in learning outcomes for students (Ward & Parr, 2011).

Unlike TELA initiative, the ICTPD initiative focused on the development of teachers to help nurture innovative thinking in educational activities and provide quality-learning experience for students, using ICTs. However, the initiative did not speak about how the goals of innovations in learning activities and better learning experience can be furthered to meet the 21st century learning needs and pedagogical reforms needed for that reason. Therefore, how the objectives designed for the ICTPD initiative would invoke a change in practice which is geared towards the 21st century learning remained unclear (Ward & Parr, 2011).

In terms of the National Education Network (NEN initiative), the goal was set to reflect the objectives of the ICT strategic framework, which was to facilitate and support the potential transformation of teaching and learning practices. This was implemented through various sub-initiatives like ultrafast broadband to schools, infrastructure in school to support that, professional development and access to supporting digital technologies. The findings suggest that the initiative had a moderate impact on the schools that participated (Ward, 2013). The evaluation of the initiative further noted that the teaching staff were prioritized during the implementation of this initiative and the participating schools were "teacher-centric" (Ward, 2013, p. 8). Even though the schools eventually moved focus towards the student, the question of which one is more important was largely dependent on the participating schools. With this uncertainty of focus on students within the NEN initiative, it is important to note that benefits of digital technologies in schools will not be fully realized unless the technology also reaches the students (Halverson & Smith, 2009).

Far Net initiative was the continuation of the project under same name which was trialed as a part of the digital opportunities pilot projects. The aim of the initiative is to develop the online learning community for teachers and students. This was mainly based around the collaboration between schools and sharing of their resources. To run the initiative, better internet connectivity for schools, provision of required software resources and a website hub was setup. The project grew with more participating schools, which rose from 10 schools in 2011 to 26 in 2016. However, the findings suggest the initiative ended up improving the personal skills of teachers and increase of ICT in administrative usage. The main goal of integration of ICTs into the classroom was not realised too well, as only 11% of teachers reported considering teaching and learning aspect as a part of the project (Ward & Parr, 2011).

The overall objectives of the past and current digital opportunities projects are similar, improving the educational outcomes by bridging digital divides in learning, but focusing differently on material access and digital skills. The digital opportunities pilot projects aimed to address both physical 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 the student, since 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 framework has been designed to focus on digital skills and professional development. This shift in understanding of equity from physical access to digital skills can be interpreted as the evidence of the continuously advancing and changing nature of digital divides in learning.

1.5 Background to the research problem

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 can transform the classroom teaching and learning positively. A great deal of transformation is possible because of the opportunities for innovative education, facilitated by modern digital technologies. On one side, the digital learning technologies has opened up the unlimited possibility for access to information, ease of handling and processing information, and improved collaboration resulting in ever-improving academic activities and results. Whereas on the other side, as the penetration of technologies and adoption stages in teaching and learning advances, the new type of gap between the individual learners takes shape,

which has been conceptualised in a research paper with a three level digital divide framework (Wei et al., 2011).

The goal of the technology-mediated learning initiatives is to improve student-learning outcome, leveraging the opportunities provided by the digital learning technologies. Studies on what effect the technology-mediated teaching and learning will have on the existing digital divides, and how this may influence the digital outcomes of the learners is not currently present in the literature. With the increased penetration of digital technologies into the classroom teaching and learning practices, it is interesting to see how the existing and new digital divides will evolve in the context of BYOD classrooms initiative.

The preliminary study has identified some unanswered questions around how the digital access divide affects the digital capability divide, and if the capability divide leads to the outcome divide? Therefore, there is a need to investigate issues pertaining to the existing or new digital divides evolving in the context of the BYOD classroom initiative. Also, the best ways to do so is by extending the enquiry into digital divide research towards additional fields of enquiry beyond just access and digital skills.

1.6 Research questions

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 classrooms 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 teaching and learning changed over the years of BYOD classrooms?

The following subsidiary questions influence the above research question:

1. *How has the digital access divide evolved because of the BYOD classrooms?*
2. *How have the digital capabilities 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?*

1.7 Theoretical framework

This study has adopted the three level digital divide framework by Wei et al. (2011) for investigation of the BYOD classroom initiative to answer the above research question. The three level digital divide framework in Figure 1.1 outlines three stages of digital divides – digital access divide, digital capability divide and digital outcome divide – which can be applied to individuals (students), organizations (schools) and globally (countries) in the context of ICT interventions. The authors encourage use of their proposed framework as a theoretical platform for longitudinal studies which are conducted in school computing environments. With the increase in ICT-based teaching and learning efforts across institutions, there is a need to understand the long term impact of ICT interventions on different levels of digital divide among the people affected by it.

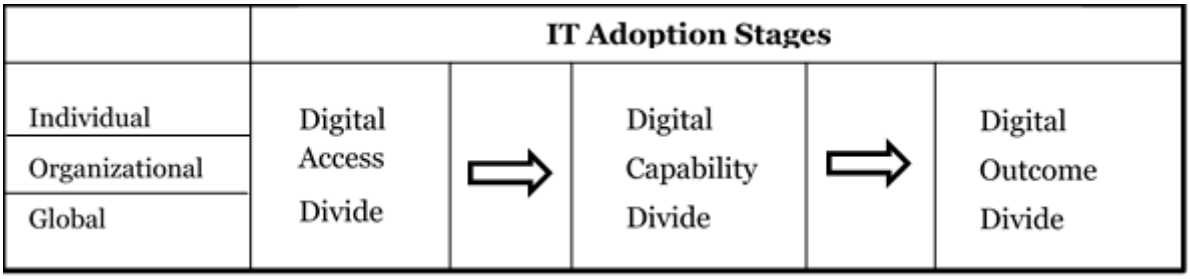

Figure 1.1 Three level digital divide framework (Wei et al., 2011)

The three level digital divide framework by Wei et al. (2011) has served as the theoretical foundation for the current investigation. The framework provided a comprehensive baseline and allowed this longitudinal inquiry to relate real-world pedagogical practices with various adoption stages of the one-to-one digital learning technologies within the BYOD classrooms initiative.

1.8 Contribution of the thesis

While the digital learning technologies has opened up unlimited possibilities, Wei et al. (2011) caution on the new type of gap which can emerge between individuals. As the adoption and acceptance of digital technologies increase, learning becomes more knowledge-intensive and individuals require skills to express themselves with the available technology. How students perceive technology and its use is reflected in their behavior, which in turn affects their overall learning outcomes. The investigation into the study has 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.

Existing literature have been used to extend the three level digital divide framework in the context of the technology-mediated learning, by mapping with factors pertaining to each phase of the digital divide in the learning process. With the increased

dissemination of digital technologies into the educational practice, this research study provides rich insights on how the existing and new digital divides might evolve from a BYOD initiative in a secondary school. The study reports on technology-enhanced learning practices in a real world context and increases our understanding on the wider usage of technology within education. The contribution of this research study to existing research related to the digital divide in learning can be summarized as follows:

1. Technology-mediated pedagogical initiatives like BYOD classrooms might not always accentuate the existing digital divides in the teaching and learning environment. The earlier studies on the integration of digital technologies to aid the teaching and learning practices within New Zealand (Rivers & Rivers, 2004), suggested any such initiatives might disrupt the teaching and learning process with the emergence of disparity in the access to learning technologies among learners. This research study itself indicated towards the digitally divided classroom during the early stage of investigation, supporting the results from the earlier study. However, as the teaching and learning evolved with the evolution in the teaching methodologies, findings suggested that the BYOD classroom initiative did not end up accentuating the existing gaps in the access to digital learning to cause the digitally divided classroom.
2. Ability of learning in individual learners in the technology-mediated learning context is not guided by their digital skills, but by adequate information literacy skills. The BYOD classroom initiative enabled teachers to experiment and apply different approaches to make their teaching and learning practices more innovative. Innovative teaching and learning methods made possible by the integration of digital learning technologies helped to attain greater student engagement and increased participation of learners into learning activities,

transforming the role of the teachers into facilitators. In addition, the increased participation of learners into learning activities allowed teachers to give even greater agency to learners, demanding more responsibility from students into their learning, making it student-led learning. On one side, this has enabled some students to take control of their learning, whereas on the other side this led to an increased frustration and motivational issues among the students with limited motivation, information literacy skills and critical thinking ability. As a result, the gap between the students at the two sides surfaced causing a potential disruption into the teachers attempt to transform the teaching methodology at one point of time during the research study. The analysis strongly indicated the presence of this gap between the two groups of students' mid-way through the research. This gap was eventually bridged at a later stage of the study with the evidence suggesting the greater acceptance of BYOD classrooms and associated teaching methodology by students, and increase in the digital and information literacy skills among learners.

3. This study has led to the identification of one of the most important factor contributing to the level of digital outcomes. That is, learner self-efficacy has emerged as one of the most influential factor in shaping up the learning outcomes. The study cautions that the risk of learners ending up on the wrong side of the digital outcomes divide increases if they do not possess adequate self-efficacy. The reason is that the digital capability of the learner is partly dependent on the digital self-efficacy, along with other factors like information literacy skills and positive motivation. In addition to that, self-efficacy (also referred as computer self-efficacy) in learners further affects various sources of social cognitive abilities, affecting individual learner's knowledge acquisition, progression and changes in their attitude and behaviours, resulting into the digital outcomes divide.

1.9 Roadmap of study

Figure 1.2 below outlines the roadmap of this study undertaken to find the answers to the proposed research questions. Further details on various theoretical and conceptual frameworks underpinning this study's research design and data analysis are included in Chapters two and three of the thesis.

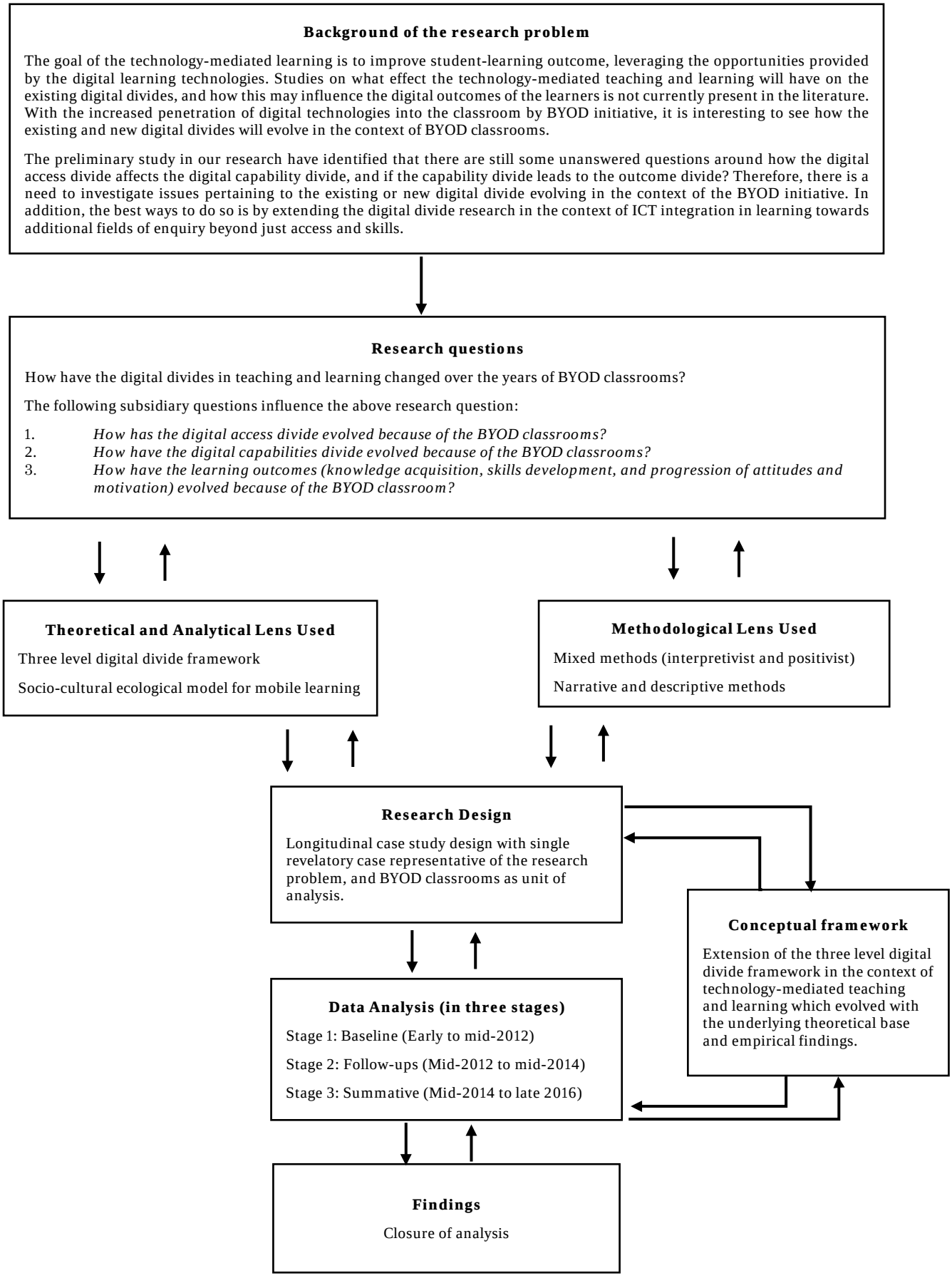

Figure 1.2 Roadmap of the research study

1.10 Thesis outline

Chapter ***one*** has laid the background of this study's inquiry. It starts with setting the foundation for the research study and explains the various aspects central to this study like digital divide phenomenon; bring your own devices (BYOD) classrooms, issues of digital divides in the teaching and learning, and the research problem. Subsequently, research question for this study have been introduced, along with the theoretical framework adopted for the study. The roadmap adopted for the study is presented in Figure 1.2.

Chapter ***two*** presents a detailed review of relevant literature published in the field of digital divide in teaching and learning practice. Review of academic literature has established the cross-disciplinary view on the digital divide phenomenon. In the context of teaching and learning, the most common determinants that affect digital divide issues are rooted at the individual, social and educational levels. Unequal diffusion of digital media in the daily lives of individuals, inequality in societal settings, unequal spread in digital literacy and skills are some issues in the current times which result in a deepening divide across our society. Specifically, this study has identified a gap in current digital divide research in the context of the teaching and learning which potentially affects digital inclusion to be in the form of inequity in learning outcomes.

Chapter ***three*** discusses the research methodology in detail. This study has followed a longitudinal case study design with the single revelatory case representative of the research problem, over a five-year period from 2011 to 2016. The case study is of a secondary school, an early adopter of one-to-one learning devices, having been one of the first schools to announce a BYOD initiative in 2011. This study has tracked the progress of the BYOD initiative starting from first time of inception (in early 2012)

onto the next five years of its gradual progression (until late 2016). Three data collection stages have been held over the five-year period including baseline, follow-ups, and summative.

Chapter ***four*** presents the analysis of the baseline data. This phase was focused in investigating the answers to the first research question related to the digital access divide (i.e. *How has the digital access divide evolved because of the BYOD classrooms?)*. Initially, the themes that emerged from the public debate surrounding the BYOD policy raised some concerns towards the digitally divided classroom. In a bid to find answers to those concerns raised, our initial investigation focused on affordability and availability issues of one-to-one digital learning devices for learning activities among students.

Chapter ***five*** presents the analysis of the follow-up data. The research activities in this stage were focused mostly on finding the answer to the second research question about digital capability divide (i.e. *How have the digital capabilities divide evolved because of the BYOD classrooms?)*. This stage of analysis also briefly revisits the access and competencies divide issue discussed in the earlier chapter *four*.

Chapter ***six*** presents the analysis of the summative data. Overall, the research activities in this stage were focused mostly on finding the answer to the third research question about digital capability divide, that is, *How have the learning outcomes (knowledge acquisition, skills development, and progression of attitudes and motivation) evolved because of the BYOD classroom?*

Chapter ***seven*** is discussion of the analysis of the data. This chapter summarizes the analysis of data in chapter four, five and six, and maps the analysis to the individual research questions to provide a clear answer to each of them. The five-year BYOD

journey is condensed to highlight key points during each stage of the study leading to contextualization of predicators for the three levels of digital divide – digital access divide, digital capability divide and digital outcome divide – in the learning process.

Chapter ***eight*** consolidates the findings over the five-year BYOD journey and discusses implications of the study findings to theory and practice. The study limitations are mentioned and directions for future research proposed.

Chapter 2: Literature Review

2.1 Introduction

The term '*digital divide*' is relevant to the social, cultural, economic and educational climate, which affects our daily lives. It has emerged from academic research to signify the gap between individuals and groups in terms of the varying level of access to digital technologies, as a result determining their social, economic and educational opportunities in the information society. Concerns around the equity of exposure and benefits of digital technologies have been raised since the very beginning of the information revolution. However, it took until the 1990s for the term '*digital divide*' to gather more attention from the academic research community, government organisations and policymakers.

Since the very beginning of the digital divide research, the issue of digital divide has been considered only in the context of the access to digital technologies. To be precise, the issue was commonly understood as the gap in terms of the access to digital technologies between individuals and groups in our society (Cullen, 2001; Van Dijk, 2012; Zhong, 2011). Some individuals and societal groups have better access to technologies putting them on the right side of the gap by providing them with all the opportunities offered by the digital media, whereas others having limited or no access have restricted opportunities. Early studies on the digital divide phenomenon therefore were mostly centered on segregations within society and based on the level of access to digital technologies. Nevertheless, this has established some grounds for

digital divide research by identifying various predicators like financial status, household income, educational level, type of occupation and geographical location responsible for the gaps between haves and have-nots. This gap in terms of the access to digital technologies have been termed as the '*digital access divide*' (also known as the *first level* or *first order digital divide*), making it one of the earliest interpretation of the digital divide phenomenon. Even though this is the oldest interpretation of the phenomenon, it still continues to be relevant in understanding the phenomenon in different social contexts (Araque et al., 2013).

Subsequent studies on the phenomenon have indicated that the division between individuals and groups in terms of the access to technologies may be just one aspect of the wider issue of the division. These studies have revealed that merely offering opportunities to access digital technologies may not be sufficient to bridge the gap of digital divide, as it does not guarantee that individuals will use the available technologies appropriately to take the benefits of the digital medium and meet their needs and expectations (Hargittai, 2002b). The study conducted by Hargittai (2002b) suggested that individuals given opportunity to access technologies should also possess adequate competencies (or have appropriate digital and information literacy skills) to make meaningful use of available medium (Bailey et al., 2012; Eynon, 2009). Further, into the investigation, it has been established that in the absence of the adequate digital and information literacy skills, individuals will not be able to make meaningful use of the technologies. That further limits them from taking even the basic advantages offered by the medium, as a result, the phenomenon of digital divide could persist as a gap in ability to responsibly use the available technologies, termed as the digital skills divide (Ghobadi & Ghobadi, 2015). This has led to the clasification of the digital divide phenomenon into two levels: *first level* (gap in access to digital

technologies) and *second level* (gap in the ability to leverage the ful potential of digital technologies).

As the penetration of digital technologies is increasing in society, the dynamics of accessing and using those technologies by individuals and society are rapidly changing. The responsibility of making meaningful usage of technologies and risk taking has shifted to individual users (Pachler, Bachmair, Cook, et al., 2010). However, it is worth noting that the change in the dynamics in terms of the level of access have benefited individuals by offering them greater flexibility and mobility. In addition to that, widespread diffusion of the internet and the digital tools has enabled individuals to develop digital skills through exploration and experimentation, trial-and-error or do-it-yourself approach in the safety of their homes (Matzat & Sadowski, 2012). Moreover, this immersion with technologies extends across a spectrum of age groups in areas related to education, social media, gaming environments and professional work practice amongst others. Societies today make conscious use of technology as they rely on them for their personal, professional, social, commercial and even political needs.

2.2 Digital divides in the education

The education sector has been an important area of digital divide inquiry since the beginning of the study into this phenomenon. When information and communication technologies (ICTs) are introduced into learning environments, they can give rise to innovations in teaching methodology, development of novel learning activities and assessment methods, and provide valuable knowledge resources to enhance learners' academic and social development (Demiraslan & Usluel, 2008). Consequently, there has been some academic research emphasising the integration of digital learning

technologies into existing pedagogies to transform teaching and learning (Anderson, 2009; Prestridge, 2007). This has provided motivation for the integration of digital technologies into formal education practice and helped in meeting the increased importance of professionalism with ICT use in our daily lives and workplaces.

During the early 2000s, integration of digital technologies into learning activities started with some small-scale initiatives around the world. One such example in New Zealand is the digital opportunities pilot projects (*DigiOps*) aiming to improve the educational outcomes by bridging the gap of access to technology and digital skills among the learners. This led to the increased use of computers and the internet into designing learning activities, development of interactive learning materials and setting up of relevant assessment tasks among the participant schools, thereby giving students a much-needed exposure to the digital tools (Rivers & Rivers, 2004).

With recent advances in technologies, opportunities for the learner have greatly improved. Learning environments are more accessible and flexible nowadays, which can enhance learner engagement to help them achieve better learning outcomes. In addition to that, the penetration of mobile, handheld devices and improved access to information over the internet have created more prospects for both educators and learners to collaborate on learning activities from anywhere (Newhouse et al., 2014). Despite the potential benefits offered by the current digital technologies to improve the learning opportunities and outcomes, there is a chance that it can cause an adverse effect in by accentuating existing gaps in terms of the access and skills among individuals, to create digitally divided learning environments (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004b). As the integration of digital learning technologies advances into the pedagogical practices, it might also trigger new levels

of digital divide in learning based on the gap of digital capability and learning outcomes (Wei et al., 2011), supporting the earlier argument.

The unprecedented developments in digital technologies referred as the '*digital revolution*' has 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, economy, commerce and education. With the fast adoption of digital technologies, we are now a society of digital citizens relying on the internet for information retrieval, online participation and even public deliberation (Parycek et al., 2011). Access to and use of digital technologies has many benefits to offer, though in the years after the digital revolution, the pattern of the distribution of ICTs still raises concern, since not everyone has access or adequate skills for making meaningful use of them. Many individuals, groups, and societies are still 'digitally excluded', from the rest of the society. For the educational sector, that means planning better ways of integrating digital media tools in learning environments. However, merely having a techno-deterministic approach where access to information is the main focus is not enough, education should be able to foster digital literacy (Maier-Rabler, 2002; Warschauer, 2003b) and enable learners to achieve better learning outcomes, without accentuating existing or creating new digital divides in the process.

2.3 Studies on digital initiatives in education

As the reach of new media, technologies and the internet improved across societies, pedagogical shifts in education started to emerge and the number of educational institutions embracing digital opportunities has increased. Some of the early technology intervention initiatives in the schools could not fully achieve the goal of improved learning results through their digital inclusion approach (Parr & Ward,

2005; Rivers & Rivers, 2004). This was partly because of the narrow focus on access to technologies and the lack of detailed forethought on aligning technology with pedagogical practice requirements.

Cotten, Hale, Moroney, O'Neal, and Borch (2011) share similar findings in their study about affordability of laptops in classrooms, that is, knowing how to implement technologies which are appropriate to learners is important, and also that not having an adequate support system might even adversely affect the overall effort of introducing the technology. Also, inadequate funding and lack of professional development activities can prove to be extremely limiting for successful implementation of the technology initiative (Petko, Egger, Cantieni, & Wespi, 2015). Moreover, the technology integration initiatives have led to the emergence of new classroom environments, which has created different learning needs among students, requiring increased professional development activities for teachers which may further cause challenges around workload for teachers (Wylie & Bonne, 2015).

Beyond the challenges discussed above, there might also be concerns around the attitudes and behavior towards the technology depending on the environment in which the students live in (Cotten et al., 2011). Therefore, it is important to improve understanding of various factors which affect attitudes and behaviors of students into accepting the technology and integration of any technology into the curricular activities (Ifenthaler & Schweinbenz, 2016). Ifenthaler and Schweinbenz (2016) in their findings argue that a longitudinal perspective on students' acceptance of digital technologies would be valuable in future to better understand how it might change over the different stages of the technology adoption.

2.4 Technology-mediated educational initiatives in New Zealand

Realising the importance of ICTs for better learning outcomes, in early 2000's an ambitious project aimed to provide students with regular access to modern digital technologies was started in New Zealand. This project was called '*digital opportunities pilot projects*' *(DigiOps)* and conceived as a three-way partnership between the ministry of education, participating schools, and supporting businesses to facilitate the best possible reach of modern digital technologies in schools. The *DigiOps model* was planned to be trialled through four different pilot projects called Generation XP, Far Net, Notebook Valley and Boosted Study Support centres. The model was based on the assumption that opportunity of technology usage and competent digital skills are the necessary components of a globally competitive 21st century '*knowledge economy*' (Bolstad, 2004; Boyd, 2002). The objective of the initiative was to leverage the opportunities offered by the use of ICT in schools, and to develop the digital and information literacy skills in students, which in turn would generate flow-on effects for improving technical proficiencies in the wider economy (Parr & Ward, 2005). Specific subject areas like mathematics, science and technology were selected as the target subjects because they are considered core subjects for a knowledge economy. Rivers and Rivers (2004) said the digital opportunity model was based on the understanding that introduction of ICTs has the scope to improve student learning and the model's overall objective was to increase student engagement and retain the interest of students in the target subjects.

According to Rivers and Rivers (2004), while each of the projects operated differently and had specific goals, they all had the common focus. That included lessening the

impact of the digital divide, improving student engagement and retention in science, mathematics and technology and providing an opportunity for trialling a government/industry/schools partnership model, aiming to bridge the digital divide through the introduction of an ICT initiative in schools. Boyd (2002) stated that the concept of the digital divide was assumed here, since it was presumed that a lack of access to technological resources would contribute to a social divide between those who were 'knowledge' and 'information' rich and those who were not. The digital opportunity model, therefore, focused on schools in remote areas or areas of lower socio-economic status, with the aim of reducing barriers to access, ability and attitude to ICTs by providing hardware, software, high-quality internet connection and providing training opportunities for teachers. The digital opportunities model assumed that ICTs can transform and improve teaching practices, over and above developing teachers' skills in the use of ICT and that this, in turn, would have a positive effect on student learning (Bolstad, 2004).

However, despite a good strategy and infrastructural support, the evaluation of the *DigiOps* model and its four projects showed that the expected goals were hardly achieved through the implementation of the pilot projects (Bolstad, 2004; Parr & Ward, 2005; Winter, 2004a, 2004b). The evaluation of the digital opportunities pilot projects revealed that there was a need to rethink the educational aims underpinning the concept of ICT initiatives and the process by which such concepts are translated into practice in schools (Rivers & Rivers, 2004). The results and experiences of the *DigiOps* raised several implications for future projects for ICT interventions and integration of ICTs in the learning process. These are

- Identify the need for starting of an initiative and then to ensure that the proposed project is the best means to meet the need.

- Establish clear and achievable goals. The focus should be on how innovative technologies can help to enhance academic results and help to achieve course or curriculum objectives, rather than merely on the provision of technologies as an end in itself.
- Identify in advance how outcomes of the project will be evaluated. The factors based on which outcomes will be evaluated should be clearly stated.
- Projects should include a strong pedagogical component; that is, focus on how to effectively use ICT to improve academic outcomes.
- All stakeholders should be involved early in the planning and need to have clear understanding of their responsibilities

Further, the evaluation of the digital opportunities pilot project model has been categorised into different groups, namely students, teachers, management, implementation, ICT infrastructure and sustainability. Table 2.1 shows the different group categories, their outcome measurement factors and brief analysis of the findings. As is evident from the table, *DigiOps* did not have a significant positive impact on students' attitudes towards mathematics, science and technology with ICTs and revealed a very small improvement with regard to teachers' attitudes. Teachers, who are the main facilitators for such initiatives were not consulted by management leading to their discontent. Moreover, management teams did not share information between schools where the *DigiOps* projects were rolled out leading to lack of collaboration and cooperation. The *DigiOps* project faced some infrastructure problems at the start, but these were eventually resolved. The project took a long time to roll out and eventually, the *DigiOps* project was not found to be sustainable without external funding support.

Table 2.1: Evaluation of categories, factors and analysis of findings in the digital opportunities pilot project.

Categories	Based on	Findings
Student	Achievements, retention, use of and attitude to ICT, access to computers	*Evaluation of the projects indicated that none of the digital opportunities pilot projects were successful on either retention of students in the target subject area of mathematics, science and technology or contribute to lower the school dropout rates (Rivers & Rivers, 2004).*
Teacher	Professional development, attitudes to ICT, teacher's use of ICT	*Based on the evaluation of projects, considerable variation has been found in the attitude to ICT and teacher's usage of ICT within and across different projects, and only minimal improvement has been found.*
Management and Implementation	Roll out, collaboration and cooperation, wider school and community use of ICT, staffing, partnership, external factors	*The roll out of the projects delayed and could not start on time. The most important stakeholders into such projects, i.e. teachers were often not consulted or included in the planning phase (Rivers & Rivers, 2004). There was also very little collaboration between schools within projects.*
ICT infrastructure	Hardware, Internet connections, and the integration of the ICT with existing networks	*According to (Rivers & Rivers, 2004), all projects were having ICT infrastructure problems with hardware, internet connections, and the integration of the ICT with existing networks, but were resolved.*
Sustainability	Financially and technically	*Initially there was a sense that projects are financially and technically sustainable, but actually, sustainability was dependent on the external support from the government and businesses.*

One of the lessons learned from the evaluation of the digital opportunities pilot projects is the understanding that the challenge of this information age is not just the material integration of ICTs. The bigger challenge is to integrate ICTs into teaching and learning to harness the opportunities offered by those ICTs to improve the academic outcomes of the learner, as well as to accelerate the rate at which knowledge is distributed so that positive changes in learning activities and learning outcomes are equalised through society.

2.5 Methodology

The phenomenon of the digital divide is complex due to the variety of economic, demographic, individual and social variables associated with it. Therefore, grounded theory as a method have been followed to review 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. All of the major databases (like Scopus, Science Direct, and Web of Science, EBSCO) have been chosen to access relevant journal and conference articles for reference material. Due to the nature of the issue under investigation, relevant government articles and reports to reflect on the current practices have also been searched. The table below details the search terms used in the database searches.

Table 2.2: 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 OR BYOD	Find the literature on any form of integration of technology in education.

Stage *two* involved a 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 backwards and then forward analysis was performed to establish the quality of the article. This process resulted in a final set of 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.

2.6 Analysis of digital divide literature

The phenomenon of digital divide is prevalent in almost every aspect of our lives and is also present in the form of challenges and inequality at different levels, like personal, social and economic. These inequalities might be present in the state of absolute or relative depending on the nature of available digital opportunities and on various other determining variables (e.g., income, age, education), and therefore, digital divide is a complex and dynamic phenomenon (Van Dijk & Hacker, 2003).

The diffusion of digital technologies and the internet in societies can be considered as the most important aspect that determines the phenomenon of digital divide at the

most basic level of analysis. Further to that, family income and affordability, plays an important role in determining the divide at least at the individual and social levels (Martin & Robinson, 2007). This is because limited or no access to technologies is based on financial and affordability constraints. However, studies indicate that despite the widespread diffusion of technologies and related resources, there are some sections of society where the use of the technologies like the internet is minimum (Agarwal, Animesh, & Prasad, 2009). The literature further suggest that, variations across geographic, ethnic and racial lines are responsible for this disparity at the individual and social levels (Van Dijk & Hacker, 2003). In a different analysis of the digital divide phenomenon, gap in the household income has more influence in determining the digital divide followed by geographical location (Vicente & López, 2011). However, both play an equally influential role when it comes to the broader analysis of the phenomenon.

The rising innovations in computer and internet technologies has changed the way we live and how economy develops across the globe (or what is widely known as the information society in academic and governance terms). This has resulted in segregation of who can or cannot derive benefits from this information society, having implications on social development within society, at regional and at state levels (Wong, Law, Chu Fung, & Ping Lee, 2010). It has also been noted that the ratio of distribution of digital technologies is highly unequal within countries that are underdeveloped and developing, contributing to greater disparity in terms of benefits from information society among these population groups (James, 2008). Whereas in the case of the developed nations, access to and the ratio of technology distribution among general population is not an immediate issue, as the government is capable of providing infrastructure and facilities required to kick start the digital journey (Dewan

& Riggins, 2005). However even with the relative advantage in terms of necessary digital access, there is still a possibility for emergence of digital divide based on the meaningful usage of available technologies to generate desired productivity and outcomes, as the adoption of the technology evolves (Wei et al., 2011).

2.7 Relevant literature on digital divide in learning

During the review of the literature, various aspects and concepts of the digital divide have been analyzed before grouping the related concepts together under a category. The following categories are the results of the review of the literature under the broad area of digital divide, education, and BYOD/technology-mediated pedagogical practices.

2.7.1 Access to digital technologies

The issue of digital access is the oldest and most widely researched aspect of the digital divide, is characterised at both the individual and the social level, and has always been the easy determinants for defining the digital divides in any of these contexts. In fact, one of the earliest understanding of the digital divide phenomenon was entirely based on the level of access to the digital technologies in everyday life. According to Van Dijk (2005, 2017), Zhong (2011), and Cullen (2001) the digital access divide is the divide between those who have access to ICTs and those who do not. A large number of studies have been conducted to explore this issue of access and the impact it is causing to individuals and the society in general. When we try to identify the most important background characteristics of the digital access divide; it appears that highly correlated variables of *income, socioeconomic status, educational level, occupation, and gender* are the main determinants (Martin & Rader, 2002; Parker, 2001; Parycek

et al., 2011; Van Dijk, 2006). 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.

Recent trends in formal education emphasise the integration of digital learning media into existing pedagogies to transform teaching and learning (Anderson, 2009; Prestridge, 2007). Introducing ICT provides potentially valuable resources for learners' academic and social development, such as new learning activities, improved collaboration mediums, innovative assessment models, and curriculum changes which introduce more visual stimulants in the learning environment (Demiraslan & Usluel, 2008; Mardis & Everhart, 2013). However, to realise that outcome, it is essential that every learner in the class or school be equipped with personal digital learning devices as a starting point, to enable learners to participate in teaching and learning activities. Financial sources for that are usually the parents in most cases, and it is observed from a previous study that income is a vital factor when it comes to ensuring appropriate digital access. The world today is suffering from various economic crises, and in the current situation, not every parent will be able to afford the expensive digital devices for their children. This can put both the parent and children in a disadvantaged situation with two consequences. One, the learners or children probably will go to school without the digital device, and that would make them feel less involved compared to their peers who have these devices, leading to a poorer learning experience. Second, the parents can feel embarrassed for not being able to afford any form of digital devices for their children, while other parents in the same school have been able to afford. This situation again has potential to lead to the feeling of disparity in society leading to a social gap.

As a result, some initiatives have been taken by communities and governments around the world to tackle this issue of growing gap of digital access. One such initiative was the digital opportunities project in New Zealand discussed earlier in the chapter, which facilitated access to digital technologies to students and teachers as a part of the educational initiative aiming to bridge the digital access divide. Despite the opportunities of digital access evaluation of the projects indicate that integration of ICTs into the learning process is challenging. Moreover, any such initiatives might end up contributing nothing more than access to ICTs, and may even end up accentuating existing digital divides (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004b).

2.7.2 Digital/information literacy

The knowledge gap hypothesis theory by Donohue, Tichenor, and Olien (1975) suggests that each new medium or technology increases the gap between the information rich and information poor. The differences in access to the medium, technology and control over its use in turn affects the ability or skills of the users (Gaziano, 2010). However, with the infusion of new media or technologies into our multi-segmented social system, the segments of population having higher socioeconomic status tend to acquire this technology at a faster rate than the lower status segments (Yoori & Se-Hoon, 2009). As a result, the gap in knowledge between these segments increases further.

An earlier study study on digital divide 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 the digital divide, it is not sufficient to overcome the issue (Hargittai, 2002b). It is equally

important to have digital/information literacy 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 different perspectives on the interpretation of digital divide to include the digital capability as one of the aspect (Hargittai, 2002a, 2002b), several other authors have also discussed the digital media literacy (Warschauer, 2003b) and digital skills (Van Dijk, 2006) in relation to the digital divide phenomenon. This new interpretations of the digital divide phenomenon has been collectively termed as the *second level* or *second order* digital divide. Van Deursen and Van Dijk (2009), have further categorized the digital capability into four different types:

- *Operational Capability:* This is derived from concepts that indicate a set of basic skills in using the available technology. When a person has learned to operate and understand the technology, only then the final goal of appropriating the technology will be realised.
- *Formal Capability*: This relates to the hypermedia structure of the technology, which requires the skills of navigation and orientation. This involves aspects of having medium-related and content-related skills like finding, communicating, acting upon and creating information.
- *Information Capability*: This is derived from studies that adopt a staged approach to explaining the actions via which users try to fulfil their information needs. This deals with actual levels of skills possessed by people to achieve online tasks adequately.
- *Strategic Capability:* This is the awareness and capacity to use the technology as a means of improving one's position in society by achieving certain goals. This deals

with usage, when digital media merges into a person's daily life and is measured by overall usage time, frequency of usage, diversity of usage applications, and with more or less active or creative use.

The concept of the second level digital divide is very much relevant in the context of education. First, because this is already proven that the issue of access is a reality in the current educational landscape and with the help of the knowledge gap hypothesis it can be assumed that the gap in the digital and information literacy might follow soon after. Secondly, as mentioned in the earlier section, recent trends in formal education emphasise the integration of digital learning technologies into existing pedagogies. Digital opportunities project referred earlier in the section concluded that the initiative could even accentuate the existing digital divide. The reason for coming to that conclusion from the analysis of the digital opportunities pilot projects is that these initiatives are focused on treating the symptoms of the digital divide phenomenon, not the cause. During the planning and implementation of the digital opportunities projects, the meaning of ***equity*** was understood only as a matter of material access and digital skills. Instead, the initiatives around the technology-mediated or digital teaching and learning should focus on the various ways to create opportunities for learners to gain sufficient digital and information literacy skills so that they are able to participate in learning activities in technology-mediated pedagogical context.

To realize this, a more learner-centered culture is essential where education agencies and organisations focus on enriching the ability of the learners rather than the technology/medium itself. Moreover, it can be done through the combined focus on improved connectivity (or, access to ICT infrastructure for education), content (such as digital content extracted from a variety of sources), and with confidence and

capability (or use of skills for converting information into knowledge) (Ministry of Education, 2006).

2.7.3 Learner self-efficacy

Findings from prior literature on the digital divide phenomenon and outcomes from various digital opportunity projects show that equitable material access to digital learning technologies at home and school and having appropriate digital skills are necessary first steps, however, this alone is not sufficient for achieving digital inclusion for every learner.

When it comes to the digital access divide, main predicators include personal attributes like gender, educational level, interest, and social attributes like affordability and socio-economic status. Lack of adequate access to digital technologies then limits the individual's digital/information literacy levels. This can further affect the learning activities of learners, restricting their ability to meet the learning objectives (Ersanlı, 2015; Wei et al., 2011; Yusuf, 2011). When the digital access divide leads to the divide in terms of their capability to learn in the context of teaching and learning, this can soon start influencing the various sources of the social cognitive abilities related to the individuals learning, usually referred as the self-efficacy of the individual/learner. This self-efficacy among learners is very important to translate the opportunities offered by the technology-mediated teaching and learning practices. Eventually, the limited self-efficacy levels among learners can potentially cause a life-long impact on the individual's learning tendencies and abilities which can restrict them in acquiring new skills and knowledge in using the available technologies thereby reducing their opportunities (Garipagaoglu, 2013). Therefore, there is a need to extend the digital divide research in the context of

technology-mediated pedagogical practices, towards additional fields of enquiry beyond just access and skills.

2.7.4 Nature of the technology usage by learners

As discussed in the earlier sections in this chapter, a broader definition of equity reaches beyond level of physical access to technologies and skills to make use of those technologies. Having adequate access and individual's ability to utilise the available technologies are necessary first steps towards consuming information. To achieve wider digital inclusion in the context of technology-mediated pedagogical practices, engagement has moved beyond consumption to participation and creation. Faced with rich variety of digital tools, learners can engage with digital media and exchange information with each other, for example via posting messages to chat rooms, newsgroup and forums, or use peer-to-peer file sharing sites all of which can lead to building up of social capital (Brake, 2014) and achieving better learning outcomes. However, some communication tools can often be used for pursuing entertainment and leisure activities such as downloading music, streaming videos, surfing for fun, playing online games and cheering up each other to pass time (Van Deursen & Van Dijk, 2014). However, such forms of entertainment and leisure motives can interfere with classroom teaching and learning activities. Hence, behavioural aspects of the individual learner is equally important to realise the equity in terms of the learning outcomes among learners. The way individual learners make use of the available technologies can have a huge impact on student achievement, as the usage of digital technologies can be done meaningfully or not (Jones & Issroff, 2007; Wei et al., 2011). In addition to that, since the learners will be having access to all kinds of games and other resources available on the internet at their fingertips, the classroom might

experience some disruptive behavior from the students (Bru, 2006). This remains one of the challenges for teachers to keep the learners on task and guide them to make meaningful usage of available technologies during the learning activities. Therefore, the nature of technology usage by learners is a very important aspect when investigating the issue of the digital divide, as the nature of the technology usage determines the productivity of the learning activities.

2.7.5 Motivation/belief

Introduction of the technology-mediated teaching and learning requires a big shift in the way teachers teach the classroom and students engage with the learning activities. Redefinitions of the learning activities and change in the expectations levels means the students often have to come out of their comfort zone and embrace the new way of learning. Some might appreciate it and others not. Therefore, the shift in the way of learning in the technology-mediated learning environment requires a careful transition through which the learners can be kept motivated.

Constructivist learning theory by Jean Piaget holds that learners learn more effectively through the active design and development of projects meaningful to them and the community around them (Piaget, 1937, 1952). Through this process of learning, they actively construct new knowledge and become more deeply involved in their learning process. When learners are novices, they need to be guided and supported to construct knowledge and then integrate this knowledge to create further knowledge. However, without instructional guidance that informs learners on how to add to existing knowledge in their learning process, their belief in themselves could waiver and thereby affect their motivation to learn. For that reason, it is one of the most important

to area to investigate to find how motivational issues can affect the learning outcomes of the learners.

2.8 Contextualization of literature

As the adoption of digital tools and technologies are advancing, the applications of and impact it may cause to the society are continually evolving. Whereas on one side this brings up new opportunities for individuals, on the other side this also has the potential to disrupt the socio-cultural balance. Despite that risk of disruptions, in the context of the education, there is a common consensus that digital tools and technologies have a lot to offer to get better learning outcomes for the learners. Key stakeholders in this whole process of transforming education are the teachers who act as the agents of change, through engaging learning activities and innovative teaching methodologies.

As we know that the integration of digital learning technologies into the pedagogical practices can bring a great deal of transformations through the benefits it brings like fast access to information, ease in information processing, and collaboration opportunities. This comes with a possible side effect where the same transformation into pedagogical practices can become barrier for some, because of the potential gap among the learners in terms of the access, skills or some other factor. This gap has been conceptualised in a research paper with a three level digital divide framework (Wei et al., 2011).

This study follows 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. The three level digital divide framework has been explained next.

2.8.1 Three level digital divide framework

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 literacy 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 et al., 2011; Brosnan, 1998). As explained in the three level digital divide by Wei et al. (2011), the literature shows a clear shift in digital divide research around acceptance and adaptation of digital technologies, the nature of technology use, changes in attitude and behavior, ability of meaning making, skill development, and knowledge acquisition 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).

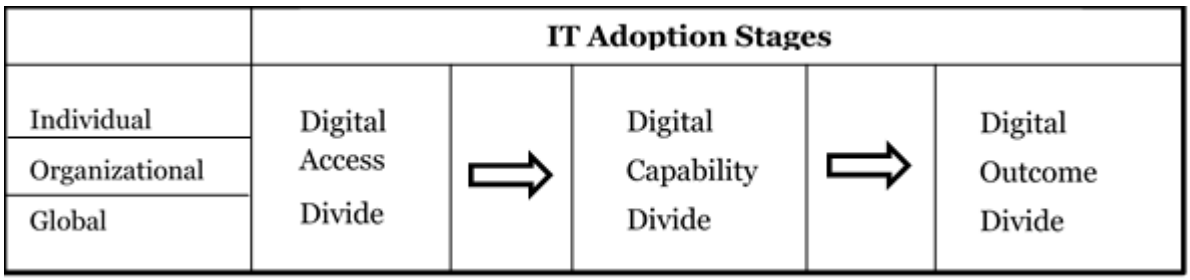

Figure 2.1: Three level digital divide framework (Wei et al., 2011)

The figure 2.1 depicts the adoption of information technologies across three stages, having access to ICTs (digital access divide) developing usage capability (digital capability divide) and achieving outcomes (digital outcome divide) (Wei et al., 2011). The importance of computing environments is growing and so is the penetration of digital tools and technologies within every aspect of our daily lives. With the ever increasing adoption of digital technologies in study and leisure activities, it is important to find how that affects the ability to use and the level of outcomes gained through the adequate apropriation of the technologies. There is also an area to understand in this context that, if the digital access divide in anyway contributes to the following levels of the digital divides. This extends the area of enquiry to investigate the effects of the digital access divide on the subsequent two levels of divides.

It is therefore evident that, there are still some unanswered questions around whether one level of divide leads to another in the context of technology-mediated teaching and learning process. It is especially unclear how digital access divide will affect the digital capabilities divide and the learning outcomes divide in turn. Therefore, there is a need to extend the digital divide research towards additional fields of enquiry beyond just access and digital skills to understand the evolution of the digital divide phenomenon within the context of technology-mediated teaching and learning environments.

Specifically, with the increased penetration of digital technologies into the teaching methodologies and learning activities by the BYOD classroom initiative, this framework guides the study on how the existing and new digital divides will evolve within the BYOD classrooms.

2.8.2 Analysis of the three level digital divide framework

2.8.2.1 Antecedents of the three level digital divide framework

The three level digital divide framework from Wei et al. (2011) is grounded on social and educational issues surrounding the phenomenon of digital divide. The research conducted on digital divide prior to the formulation of three level digital divide phenomenon lacked the explanation for "chain of effects", i.e., how one divide might lead to another and have impact on successive levels of divides as the adoption for ICT evolves (Wei et al., 2011). This "chain of effects" explicates how digital divide transitions through various levels, in particular for the study of technology-mediated teaching and learning, where access to technology, developing usage capability and achieving outcomes are important sources of influence.

The authors of the three level digital divide framework used two major support from the literature to reach the purposed framework.

Firstly, study by Dewan and Riggins (2005) explores the current and future research directions on the digital divide phenomenon. Specifically, it discusses the two distinct orders of digital divide (first order and second order, also known as first level and second level), and examines the issue of digital divide in the broader sense of community, commerce and learning. This study uses three levels of analysis, at the individual, organisational and global levels to understand and suggest a series of research questions at each level to guide future research on digital divide. Further, the two categories of digital divide concept from Dewan and Riggins (2005) study is drawn from extant literature on digital divide, and is mostly based on some of the early research on technology diffusion and adoption. This consists of understanding digital divide based on the inequality of access to digital technologies (Cullen, 2001; Joan

Sidney, 1998; Rachel, Jock, & Otto, 2000; Van Dijk, 2005), and the inequality in abilities to use the technology (Hargittai, 2002b; Van Dijk & Hacker, 2003; Warschauer, 2003a). Majority of the earliest literature on the digital divide research falls into either of these categories.

Second is the social cognitive theory by (Bandura, 1997, 2001), which has helped the authors to extend the analysis of digital divide beyond pre-existing research in access and skills to include outcomes. Social cognitive theory builds on the view that every individual has a self-belief that guides them to stay focused to control their behavior changes (even when they are facing "obstacles and aversive experiences") (Bandura, 1997, p. 191), and this has been termed as 'self-efficacy'. The enhancement of self-efficacy among individuals can be achieved through their persistence in activities (like learning) and reduction in defensive behavior (Bandura, 1997), which "facilitates human accomplishments" (Wei et al., 2011, p. 172).

The three level digital divide framework uses the social cognitive theory and the concept of self-efficacy and contextualizes them into a technology-mediated teaching and learning context. Wei et al. (2011) have taken the model of triadic reciprocity involving personal, behavioral and environmental factors from social cognitive theory (Bandura, 1997, 2001) to establish the social cognitive influence with the computer self-efficacy of learners in a technology-mediated learning context. Self-efficacy in turn inculcates a positive attitude towards technology adoption which relates to the digital capability divide among individuals or learners (Dewan & Riggins, 2005).

2.8.2.2 Propriety of the three-level digital divide framework for study of digital divide in learning

The social cognitive theory by Bandura (1997, 2001) is important for this study, as it cautions that there is an increased risk of learners ending up on the wrong side of the digital outcomes divide, if they do not possess adequate self-efficacy. The reason is that the digital capability of the learner is partly dependent on digital self-efficacy, along with other factors like information literacy skills and positive motivation. Self-efficacy (also referred as computer self-efficacy) in learners impacts their social cognitive abilities affecting the individual learner's knowledge acquisition, progression and changes in their attitude and behaviors, resulting in the digital outcomes divide. As an example, this can be around confidence in conducting web searches, installing/configuring/personalizing settings, resolving academic and technical issues, posting reviews or asking/answering questions on blog posts.

Further, three level digital divide framework from Wei et al. (2011) is a prominent recent theory purposed to address the much needed exploration on issues of digital divide beyond the notion of access and capability. This framework by Wei et al. (2011) has been used as a reliable base theory by prominent researchers studying the digital divide and technology supported learning to better understand the phenomenon based on the perceived benefits in regards to the outcomes followed by the better access and capability (Parsons, 2014; Wang, Myers, & Sundaram, 2013; Yixiang, Yulin, Kwok-Kee, & Zhaohua, 2012; Zhao, Lu, Wang, & Huang, 2011).

Wei et al. (2011) framework have helped researchers establish relationships across digital access divide, digital capability divide and digital outcomes divide. However, Srivastava and Shainesh (2015) have criticized Wei et al.'s framework, stating it to have

a narrow scope and mostly applicable to developed economies since it takes a goods-centric view. The ICT investments in developed countries are prioritized and driven by government policies, which in turn leads to relative ease in availability of digital goods to the societies living there. Hence, it can be argued that this model has limited applicability in developing countries where majority of the population are still struggling over healthcare and basic education issues. Nonetheless, Srivastava and Shainesh (2015, p. 246) affirm that conceptualization of the digital divide framework can be "valuable in scenarios where (1) governments have sufficient resources to provide the necessary digital goods, and (2) the society in general is capable enough to transform the digital goods into desired outcomes". New Zealand is a developed economy, where the government is making significant investments in digital infrastructure to realize the transformational power of ICTs across schools and society in general (e.g., *DigiOps* projects, ultrafast broadband connection to schools' initiatives). Hence, the three-level digital divide framework is not limited by the critics' observations and is a suitable model to investigate the digital divide phenomenon within this study's BYOD classroom context.

Any approach to learning design that involves integration of technology may have an impact on the digital divides at varying levels, like access, skills, and ability of meaning making (Parsons, 2014), adversely affecting the individual's ability to learn successfully. And importantly, the various levels of digital divides within technological integration situation further influence the "successive" stages of divide (Van Dijk, 2005, p. 22). The three level digital divide framework by Wei et al. (2011) encapsulates concepts related to varying levels of digital divide and conceptualizes the relationships between different levels of digital divides within the context of teaching and learning.

The framework captures the constantly evolving nature of digital divides and the relationships between them within a technology-mediated teaching and learning context. Further, it helps to establish divide boundaries, thereby enabling researchers to classify the determining factors at each level. Within an ICT-driven educational context, these include access to hardware and software (Wang et al., 2013), digital/information literacy skills, ability of meaning making (Zhao et al., 2011), motivation, competence and self-efficacy (Yixiang et al., 2012) for learning activities. This study utilizes the framework to provide an empirical account on the determining factors affecting BYOD classrooms within a New Zealand secondary school context.

2.8.3 Contextualization of three level digital divide framework into the study

Because of the reasons discussed above, three level digital divide framework by (Wei et al., 2011) has been adopted and applied to this study's context. Next, themes emerging from the analysis of the literature have been contextualised into the three level digital divide framework (refer figure 2.2). Themes 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 can further impact how individuals develop information literacy skills, computer self-efficacy, and motivation to learn, affecting the equity in terms of the digital capability of the learners. The divide in terms of the access and capability at the earlier stages can then have a follow on effect to disrupt how new skills and knowledge are honed, to have further implications on the equity of the learning outcomes, potentially causing digital outcome divide.

While adapting the three level digital divide framework for our study, the three levels

of IT adoption stages have been mapped to the three levels of digital divides in the learning process. Specifically, ICT adoption stages include access, capability and outcome divide stages, which match with the digital access divide, and digital capability divide and digital/learning outcome divide in our framework.

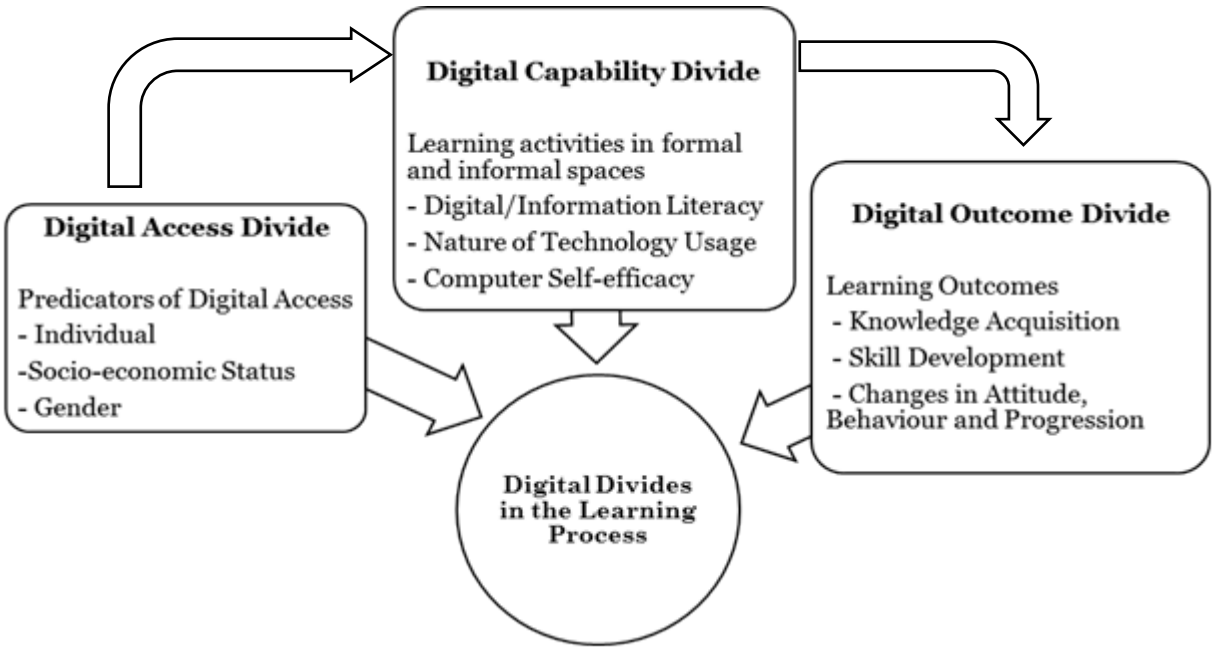

Figure 2.2: Three levels of the digital divide in learning (three level digital divide framework applied to the context of our study).

As illustrated in Figure 2.2 above, the main predicators for the digital access divide are individual (like educational level), socio-economic (like affordability) and gender, which has potential to contribute to the digital divide in learning directly or indirectly through its effect to the digital capability divide. Further to that, the digital capability divide is influenced by various factors during the learning process as the learning activities can occur in formal or in informal learning spaces. In this context, the formal learning space constitutes classrooms and informal space constitutes anywhere outside of the school/classroom. Specifically, the factors determining the digital

capability divide are digital/information literacy of learners in performing different types of computing tasks, nature of technology usage by learners (motivation to learn), and computer self-efficacy measurements of their capabilities. We can consider these factors as the focal constructs for this study through which personal, behavioural and environmental factors further influence the knowledge acquisition, skill development, and progress in attitude and behavioral aspects in learner, resulting in digital outcome divide. 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, behaviours, and progression in learning.

2.8.4 Socio cultural ecological frame for mobile learning as an analytical framework

As we know, any kind of integration of the digital tools and technologies within the context of technology-mediated teaching and learning has potential to disrupt learning activities not only at formal learning spaces like classrooms, but also at informal learning spaces, such as home/out of school. Therefore, an analytical lens that can help to frame the analysis across both learning spaces is needed. The socio-cultural ecological frame for mobile learning by Pachler, Bachmair, Cook, et al. (2010) analyses 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, Cook, et al., 2010; Pachler, Cook, & Bachmair, 2010).

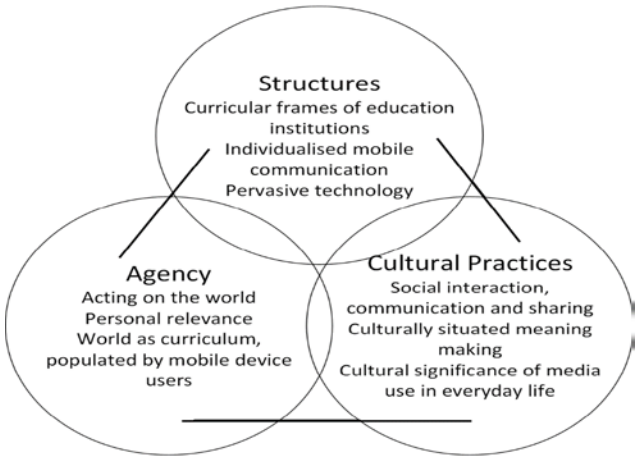

Figure 2.3: The sociocultural framework used in our analysis (adapted from Pachler et al, 2010)

Each of the three components of the socio-cultural framework actually relates to the BYOD case study being investigated and helps to scaffold the interrelationships between key stakeholders, practices, and structures governing the teaching and learning. For that reason, the sociocultural ecological framework for mobile learning by have been adapted for this study, as this provides much needed analytical lens for the analysis of data. Figure 2.3 above shows the various points of references within each component that relates it to our study.

One of the components, the *agency*, is all about the ability of actions made by individuals within their worlds. It includes the capacity to construct one's own learning responsibly and to build information literacy skills and self-efficacy around media use. In the context of our study, the agency is having adequate digital/information literacy skills for using digital tools, thinking critically to process the information and

personalizing that information knowledgeably. In this manner, a habitus of learning emerges from individualized expertise which can then be applied to formal learning practice (Pachler, Bachmair, Cook, et al., 2010). *Cultural practices* on the other side emphasize the areas that can benefit learning, as they relate to collaboration, social interaction, 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. Episodes from everyday life can be captured and shared to create cultural artefacts. Once captured and in tangible form, they provide a context and can then be used for further discussion, reflection and analysis. 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. For example, the educational experience is structured around projects, assignments, and presentations where the media can be used to generate and express relevant content for assessment purposes.

2.9 Conclusion

The importance of ICTs as influential technological tools for bridging the divide between information poor and information-rich is now widely recognised by governments around the world (Mutula & van Brakel, 2006). Hence governments around the world are articulating a broad vision of information society development where access to ICTs can nurture human capital, support economic growth, and improve government services (WorldBank, 2010). Different kinds of initiatives have been conducted by many governments around the world as a part of the larger goal to bridge the digital divides. Integration of ICTs into the teaching and learning process in formal education is one of the many initiatives. Because of the premise that ICT is

important for transforming educational outcomes positively, educational systems around the world are under increasing pressure to integrate the digital learning technologies into their pedagogical practices (Nwosu & Ogbomo, 2011). Creative and innovative usages of ICTs in teaching and learning have been considered as the potential tool to equip learners with appropriate digital skills. This could enable them to participate in the future information society by overcoming the barriers of digital capability and outcomes.

Within the context of the technology-mediated teaching and learning, we might experience a range of the digital divide issues depending on the socio-economic background of the learner, and the stage of technology adoption. Literature suggests that one level of divide might lead to another divide during the various stages of technology adoption (Wei et al., 2011). However, there is very little evidence around one divide leading to another and if it does, then how does it really happen needs to be explained. Therefore, any of the study into the digital divides into technology-mediated educational practices has to be investigated from the beginning. There are still some unanswered questions around how one level of divide leads to another? In addition, it is especially unclear how access to and use of technology at formal and informal learning spaces influence their learning activities across both areas. Within the context of the technology-mediated teaching and learning, it will be very important to find how gap in access affects the learners' ability to learn and self-efficacy levels to case the digital capability divide. Further studies are needed to find how digital capability, in turn, affects how new skills and knowledge are gained which has further implications on an individual's learning outcomes leading to digital outcome divide.

This chapter has provided a theoretical account on current issues of digital divides in education and laid out the areas where further research is warranted. The next chapter

discusses the methods, which will be utilized to investigate these issues in a real-world secondary school context.

Chapter 3: Research Methodology

3.1 Introduction

Review of academic literature in the previous chapter has established the cross-disciplinary nature of the digital divide phenomenon. In the context of teaching and learning, the most common determinants which impact digital divide issues are rooted at the individual, social and educational levels. Unequal diffusion of digital media in the daily lives of individuals, inequality in societal settings, unequal spread in digital skills and information literacy are some issues we are facing in the current times which is resulting in a deepening divide across our society. Specifically, this study has identified a gap in the digital divide research in the context of the teaching and learning, which potentially affects digital inclusion to be in the form of inequity in learning outcomes.

To study the digital divide phenomenon, this research investigated a technology-mediated teaching and learning initiative called Bring your own devices (BYOD) in a secondary school context. The phenomenon has been studied in its natural setting with no intervention into the process of BYOD for over five years to capture ongoing transitions occurring in the digital divide phenomenon over different stages of the BYOD classroom initiative. This helped gain a deep understanding of the progression of digital divide issues and how this impacts overall learning activities, shapes the acquisition of skills and knowledge, and causes improvement in attitudes and behaviors of learners. At the very first stage, the school informed all parents and

students that they were expected to bring a one-to-one digital learning device (preferably an iPad2 as the recommended device) 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 of the similler nature, is that the parents have been asked to cover the full cost of the required digital learning devices for their children, whereas similar projects in the past (like the digital opportunities pilot projects) had provided all the digital tools and resources to student at the expense of the project through participating schools. As a result, 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 learning device for their child (NZHerald, 2011a, 2011b). 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. The concern surrounding the introduction of one-to-one learning devices gave an excellent opportunity to study digital divide antecedants in a real-world technology-mediated pedagogical settings, and provided the motivation for this study.

3.2 Research questions

Review of the literature helped identify possible research directions and set the scope of the research study into mainly two areas. These are, (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. Given the broad and long-term scope of the study, that is, to provide a deep understanding

of the evolution of the whole BYOD classroom initiative, the main research question posed is:

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

The following subsidiary questions influence the above research question:

1. *How has the digital access divide evolved because of the BYOD classrooms?*
2. *How have the digital capabilities 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?*

3.3 Researchers role

The selected case study provided a platform for the researcher to be an observer of the unique initiative of technology-mediated pedagogical practices that was re-defining some of the earlier norms about the integration of digital tools and technologies in the formal educational environment. At the same time, this initiative provided a platform for teachers and practitioners of educational technology to re-define their teaching and learning practices to meet the educational requirements for the future. The researcher too can be thought of as a research instrument that is guided by theoretical foundations in their enquiry; however in doing so they also have to develop habits of observation, interviewing, self-reflection and communicating in ordinary language as a part of undertaking a qualitative research activity (Janesick, 2016). The researcher in this study therefore has maintained the neutral view on the otherwise very controversial initiative, avoiding the trap of being an advocate of any specific

stakeholder or the aspect of the study itself. Accordingly Janesick (2016) suggests researchers to conduct a pilot study (or a mini-study) to get an understanding of their roles and familiarize with the various aspects of the research setting. Mini studies are useful as the practice exercises to help understand different research methods for collecting data including observation, surveys, and interviews. As a part of their data collection, researchers can work with publications and analyse various documents related to media such as newspapers, government statistics, policy reports, project evaluations and others.

A pilot study was conducted in February 2012. This practice exercise prepared researcher's entry into the field of qualitative research and helped in forming an objective view about the case being used for investigation. As an outside observer of the initiative, the initial focus was on the public debate surrounding various aspects of much anticipated digital divide within the classroom based on many arguments. Some of the arguments that have been looked at closely from that public debate amongst others provided a holistic picture of public concerns. That includes expenses incurred by parents in purchasing devices, issues related to household expenses to create the supportive environment for technology-mediated learning (like internet connection at home), risk of negative impact on children due to unsupervised access of online content, and issues related to the potential loss and theft of devices. To gain deeper insights into issues raised by media (i.e., radio, newspapers and television) and public debate, it was decided that primary data would be collected through surveys and questionnaires with parents and teachers of the school. Prior ethics approval was sought before conducting surveys and questionnaires from Massey University Human Ethics Committee. The study was approved and certified as low risk by the committee as the investigation did not require access to sensitive or confidential data.

As identified by Walsham (1995), while an outside observer does not have the same privilege as an involved (or internal) researcher like access to inside information, the outside observer is often more accepting by the respondents. The respondents are less wary of expressing their opinions to outside researchers than they are to internal researchers. Moreover, in the case of this research, being an outside observer gave the researcher an objective view of how participants think of the school's initiative and provided rich insights on how they were affected in the whole process, which complemented the data collected from other secondary sources. During the collection of primary data, the emphasis has been given not just to the interviews, surveys, and observations, but also to the informal meetings, workshops, and conferences held to discuss about the proposed initiative. The case setting helped to capture the real vibe around implementation of the BYOD classroom initiative.

3.4 Research philosophy

A research philosophy is the thinking behind how data about a phenomenon should be collected, analysed and used to answer the research questions posed. Two major research philosophies which have been identified are positivist and interpretivist (Galliers, 1992). Positivists believe that reality is stable and can be understood from a single objective viewpoint (Hudson & Ozanne, 1988), regardless of what the researcher thinks about the phenomenon under the study. Interpretivist argue that reality can only be fully understood through a subjective lens since situations are contextual and reality is relative (Carson, 2001, p. 5), hence they believe that knowledge has to be constructed through socially situated human interaction. Therefore, the study of a phenomena in its natural environment is key to the interpretive philosophy. Benbasat, Goldstein, and Mead (1987) inform that no single research methodology can be

identified to be intrinsically better than another methodology, and qualitative researchers are advised to use a combination of research methods to improve the quality of their research (Kaplan & Duchon, 1988). Halfpenny (1984) discussed how positivist research differs from interpretivist, as shown in Table 3.1.

Table 3.1: Comparisons between Interpretivist and Positivist

Positivist Philosophy	**Interpretivist Philosophy**
Positivism looks at the institutions in the society.	Interpretivist looks at the individual in the society.
Positivism look for what has caused a particular relationship and what are the effects of this relationship.	Interpretivist looks for meanings and motives behind people's actions like behaviour or interaction with others.
Favors quantitative data are employing structured interviews and questionnaires with close-ended questions.	Favors qualitative data to analyse human's behaviour in depth employing unstructured interviews, and participant observation.

Whatever research viewpoint is undertaken, it should be relevant to the research environment and the questions that are posed in the research study. Concisely, interpretivist philosophy is suitable for those situations where the aim is to understanding relationship between individuals and is therefore appropriate (1) to gain an understanding of how students adopt and adapt to the technology-mediated pedagogical practice into their learning activities and (2) to understand how one-to-one integration of digital learning technologies into formal and informal learning impacts on the learning outcomes among learners. This research aims to gauge the influence of technology integration on learners' learning activities in formal as well as informal learning spaces to learn whether this will further have a positive or negative impact on their learning outcome.

Reviews of literature have affirmed a mixed approach, and recognized that the researcher will adopt both an interpretivist stance as well as a positivist stance during the conduct of this study.

Caldwell (1994, p. 244) asks researchers to adopt "methodological pluralism" and not confine to one philosophy to bring the entire discourse into the scope of phenomenological research, or, adopt a "post-positivist" stance. Therefore, mixed method approaches (using both positivist and interpretivist stance) are suitable to address the importance of subjectivity in the phenomenological society. Methodologists refer to mixed approaches by terms like logical positivism, post-positivism, logical empiricism or realism (Miles & Huberman, 1994; Schwandt, 2001; Yin, 2003). Patton (2002, pp. 94-95) has used the term "reality-oriented qualitative inquiry" instead of post-positivism to describe a phenomenological inquiry which aims to understand perspectives and experiences of people in a particular situation (or social phenomenon). This research has conducted phenomenological inquiry into the digital divide phenomenon to provide an empirical account on perspectives of students, parents and teachers in a BYOD classroom context. Prior literature, e.g. (Pachler, Bachmair, Cook, et al., 2010; Wei et al., 2011) has provided a theoretical foundation upon which the study will be built on.

3.5 Rationale for case study method

The study investigates a technology-mediated learning initiative called BYOD classrooms to find how individual, societal, and educational factors influence the digital divide phenomenon within the educational landscape at various stages of technology adaptation as the initiative advances. A five-year longitudinal investigation was conducted to answer the question: How have the digital divides in teaching and

learning changed over the years of BYOD classrooms? Yin (2003, p. 9) considers case study research to be appropriate for answering, "how and why questions being asked about a contemporary set of events, over which the investigator has little or no control". Further, case study research can be applied with whatever philosophical bearing – positivist, interpretivist, or critical – which has been adopted by the researcher (Dubé & Paré, 2003).

This study employed the case study research methods using case design with both positivist and interpretivist stance to investigate the digital divide phenomenon within natural settings of a teaching and learning environment. The researcher wanted to analyse the whole initiative of technology-mediated learning (i.e. BYOD classrooms) within a school and document how the phenomenon of digital divide within teaching and learning evolves as it goes through the various stages of the technology adaptation within the teaching methodologies and learning activities. Further, real-world experiences of respondents (including students, teachers and parents) have been analyzed in the context of a research framework (section 3.7 discussed later in the chapter), thereby using an interpretivist and positivist stance.

A number of approaches can be used to investigate the integration of digital learning technologies and strategies in classrooms. Some of the approaches include social constructivist perspective (Khalid, Jurisic, Kristensen, & Ørngreen, 2014) and experimental approach using pre- and post- tests (Martin & Ertzberger, 2013). Cheung and Hew (2009) suggest research designs to include surveys, interviews or observations, especially when investigating technology-mediated teaching and learning, and similar initiatives.

The case study method is appropriate when the objective is to learn about some environment in more detail (Dubé & Paré, 2003). A case study explores a phenomenon in its natural environment by using multiple data collection methods to gather information from variety of sources associated with the phenomenon under study (Baxter & Jack, 2008). The boundaries of the phenomenon are not apparent at the initial stages of the research, and no intervention or manipulation tactic is to be used (Benbasat et al., 1987; Dubé & Paré, 2003; Yin, 2003). Case studies are common research designs for exploratory (theory building), explanatory (theory testing) and descriptive (description of the context) in social science research (Yin, 2003). In this study, a descriptive case study design has been used to present a longitudinal case of a secondary school implementing technology-mediated pedagogical practices in the form of the BYOD classrooms. The case selected for conducting the study is co-educational secondary school, which is state funded and is ranked at the decile[2] 9 in the New Zealand school ranking system based on the socio-economic status of the area surrounding the school.

According to Yin (2003), case study research design with a single case is suitable when the study represents a unique, revelatory or critical case. The case chosen is unique, revelatory and representative of the research problem and field of enquiry being investigated, since the said case is one of the earliest adopters of BYOD classroom or similar initiative in New Zealand. In an analysis of the literature on various research design, Dubé and Paré (2003) revealed 60% of case study research in information system (IS) studies to comprise single cases, and stated that of those single case studies at least 15% were either unique, revelatory or both. Although, Dubé and Paré (2003)

[2] Deciles are a measure of the socio-economic position of a school's student community relative to other schools throughout the country. Decile 1 being the lowest end of socio-economic community and decile 10 the highest end.

further reported that the proportion of the longitudinal case study design were relatively low in IS literature. However, they affirm that longitudinal studies are important in IS research for investigating phenomena like technology implementation, since issues related to the impact of technology evolve over time, and therefore have to be empirically observed over a longer periods of time (Benbasat et al., 1987). In this research, the impact of BYOD classroom implementation has been investigated over a 5-year period to determine its effect on digital access, digital capability and eventually on learning outcomes.

One of the most essential methodological requirements for the single case study research design is the repeated assessment and evaluation of the dependent variable across various phases of the study, tracking how the phenomenon evolves during the longitudinal period of investigation (McKay, 2008). This study follows an in-depth single case study research design with the continued investigation over a longitudinal period (of five years) to explore how digital divides in learning evolve within BYOD classrooms and with associated changes in teaching and learning methods.

In addition, the study was not intended to be comparative to any other initiative or school. Hence, to evaluate the different levels of digital divides evolving in the context of technology-mediated teaching and learning, the use of decile 9 school does not affect the outcomes and findings from the study. There could well be no digital divide based on the haves and have-nots of the access to technologies (first level), but this case study provided the foundation to explore higher levels of divides that may evolve. The research study therefore uses the data at various stages within a five-year period from a range of sources like classroom observations and surveys at the earlier phase, interviews and surveys at the follow-up phase, and teacher interviews at the summative phase.

3.6 Relevance and rigour

Relevance and rigour are two very essential traits to be considered while conducting a research study. The relevance of any academic research depends on the level of real-life experiences, interactions, and relationships being considered while the study aims to address a significant problem applicable to multiple audiences. Moreover, the *digital divide* phenomenon has been considered a significant issue affecting almost every aspects of the society, including societal, economic, and educational outcomes of the *information age,* and therefore receiving increased attention from researchers and policymakers around the world (Dewan et al., 2005; Hilbert, 2011). This study is aiming to explore the issue of digital divide in the context of teaching and learning, investigating the evolution of the teaching methodology and learning practices to find answers to gaps in learning outcomes resulted from the gaps in various other forms of the divides in the first place. The initiative on technology-mediated pedagogical practices is relevant to both academia and practice around educational technology led interventions in teaching and learning environment. The case study method in the context of our study can inform us about how digital divide in teaching and learning practices evolves over various stages of the technology adoptions in the natural settings of the BYOD classroom initiative (Benbasat et al., 1987; Dubé & Paré, 2003; Yin, 2003).

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. Most of the literature in this areas of study focuses on the technological intervention, in response to the issue of digital divides in the teaching and learning through improved access and opportunity to develop skills to digital technologies. However, the objectives of any intervention

to address the issue should equip learners with also the motivation to make meaningful use of the digital technologies into their learning activities and ability to think critically towards the creation of new knowledge which is responsive to the solution of professional and social needs (Ghobadi & Ghobadi, 2015; Richey, 1998). Ensuring inclusive digital access and digital skills are necessary measures towards bridging the digital divides in the teaching and learning, but further divides still exist (Van Dijk, 2012). As the way forward, various researchers in the field of digital divide argue that better access to digital technology and improved digital skills as a result of that gives any individual an increased chance of achieving improved information literacy skills, which in turn potentially supporting better learning outcomes (Deursen & Van Dijk, 2015). Therefore, it can be argued that increased access to digital technologies will equip learners to gain better digital and information literacy skills supporting learners in their quest for knowledge acquisition and critical thinking thereby bringing about positive changes in attitudes and behaviours, ensuring inclusive learning outcomes.

Academic rigour is maintained by clearly defining research questions with use of appropriate research methods to answer these questions However, instruments used in the study depends on the philosophical bearing of the study. Researchers should provide some evidence on methodological aspects in the conduct of their study to ensure that all checks of scientific rigour have been addressed (Dubé & Paré, 2003).

Further, Dubé and Paré (2003), identify three main areas to establish rigour for any case study research. These areas are as follows. (1) Research design refers to attributes associated with the design of the inquiry, including posing of research questions, application of theoretical framework, and selection criteria of the cases. (2) Data collection refers to the quality and process of the data collection methodology used and

how the methodology has been applied to enhance reliability and validity (3) Data analysis refers to the use of primary exploration techniques (e.g., observations made, field notes, and coding of the data collected).

3.7 Research framework used in this study

This study is guided by theoretical underpinnings from exiting literature on digital divide in the context of teaching and learning. Theoretical framework which has been applied in the context of the selected case used for this study is adopted from the three level digital divide framework by Wei et al. (2011). Themes emerging from the analysis of the literature have been contextualised into attributes across the three levels of the digital divide framework. The three level digital divide framework describes factors pertaining to the digital access divide include access to and use of digital learning technologies for learning activities accross formal learning space (school) and informal learning spaces (homes/outside school), personal attributes like gender and educational level, 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, determining digital capability divide among individuals (Wei et al., 2011). These will, in turn, affect acquisition of knowledge and various skills necessary for better learning outcomes; potentially leading to digital outcomes divide.

While adapting the three level digital divide framework for our study, three stages of IT adoption have been mapped into three levels of digital divides in learning process, accompained by all of the potential predicators suggested by the literature along with the some identified at the earlier stage of the investigation of the case. Also, the framework adopted for the purpose of our study also taken the potential

transformation/evolution of the digital divides and the impact of one level of divide to other during that process.

As illustrated in Figure 2.2 in chapter 2, the phenomenon of digital divide is changeable from one level to another, and is also directly/indirectly dependent on the factors pertaining to the earlier divide. Therefore, various factors pertaining to the digital access and digital capability divide has to be investigated, to find an answer to how digital divide evolves during the various stages of technology adoption.

3.8 Research design

The research design is the rationale that links the empirical data that has to be collected to answer the research questions which have been posed. Yin (2003) classifies five components within a research design, which form the two phases of the research plan. Phase 1 includes consideration of what data has to be collected, and is guided by (i) the research questions posed, (ii) intentions and scope of the study, and (iii) proposed units of analysis. Phase 2 specifies next steps after the data collection period, that is, (iv) rationally linking the data to the propositions and (v) criteria for deducing answers to the questions.

Phase 2 comprises of (ix) the data collection phase, which links to elements of Phase 1, that is, (iii) units of data analysis, and to Phase 2 (iv) analysis of data. Over here, the researcher considers manner in which the data have been collected, the number of phases of data collection, and what was the length of each data collection phase (which is especially relevant in the case of longitudinal case study design).

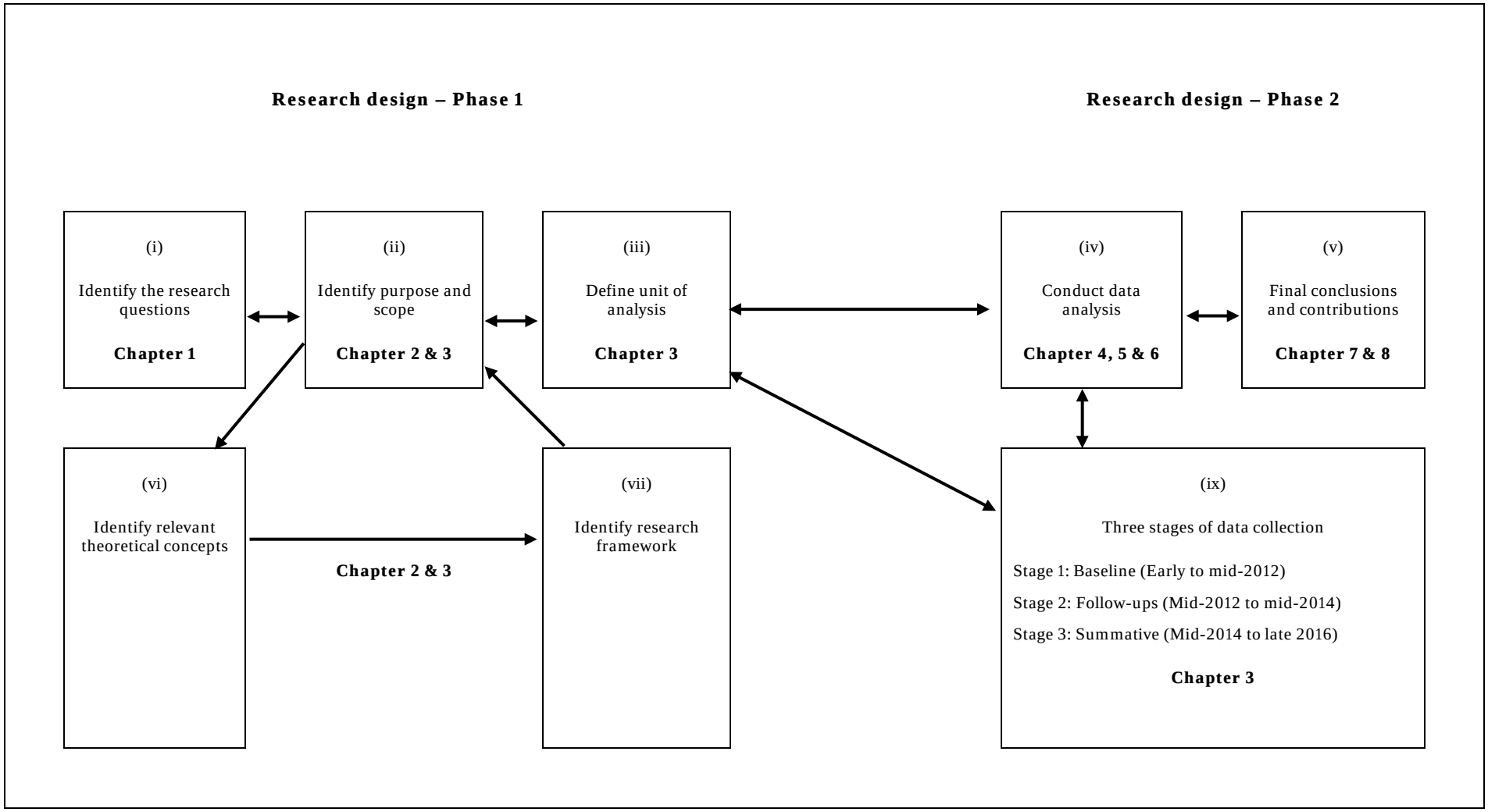

Figure 3.1: Five components in research design. Adapted from (Yin, 2003)

The first component of the Phase 1 (i.e., identify the research questions) of the research design is addressed through elucidation of the research problem background in chapter one and articulation of research questions described in chapter one and in section 2 of this chapter. The second component (i.e. identify purpose, and scope) has been addressed with the development of research framework through in-depth reviews of literature related to the research problem (refer chapters two and three). Moreover, since the study is exploratory and pertaining to a school which was one of the earliest adopters of the BYOD classroom or similar initiative, the third component (i.e. define units of analysis) is informed by BYOD classrooms within the single case study. The single case study is representative of the research problem. The first component of Phase 2 (i.e. data analysis) is discussed later in this chapter. Finally, the last component (i.e. conclusions and contributions) refers to a reporting of overall findings and study contributions discussed in chapter 7 and 8.

3.8.1 Unit of analysis

A clear explanation of the unit of analysis helps define the boundaries of theory in the context of the exploratory case study and states the limitations on how the theory has been applied (Dubé & Paré, 2003). As Trochim (2001) has suggested, the unit of analysis for any study is the actual individual or the group that is being analyzed as a part of the investigation. There is no challenge in deriving the unit of analysis once there is a clarity in what the research wants to analyze (Miles & Huberman, 1994). This study investigates the evolution of the digital divides in the educational context by analyzing the teaching methodologies and learning activities within the BYOD classrooms over the five-year period. Therefore, the unit of analysis for this research study is the BYOD classrooms.

A pilot study has been considered a best practice as an opportunity to try and test the research exercise designed and establish the relevant unit of analysis for the phenomenon under study (Pratt & Loizos, 1992). However, there is always a chance that new units of analysis emerge during the investigation of the phenomenon (Patton, 2002), depending on the nature and requirements of the study but there is no guarantee that those will be mutually exclusive to each other. Therefore, as Patton (2002) advises, the researcher must have a clear purpose on what they want to discuss at the culmination of their study to be able to identify an appropriate unit of analysis. The research study has conducted the preliminary study of the case under the study to confirm the identification of the unit of analysis.

3.8.2 Quality of research design

Empirical social research requires four tests to ascertain quality of the research design. These include construct validity, internal validity, external validity, and reliability (Yin, 2003).

3.8.2.1 Construct validity

Construct validity refers to the correct operational measures for identifying constructs relevant to the study (Yin, 2003). Yin recommends two ways to establish construct validity in the study. First is purposeful selection of relevant study objects and connecting them to the study objectives. Second, by providing evidence that the selected study objects are a reflection of the research problem being investigated. This can be done by getting feedback from multiple research participants, or using different sources to substantiate the study findings to establish a chain of evidence (Dubé & Paré, 2003; Miles & Huberman, 1994; Yin, 2003). To maintain the validity, this study

conducted interviews and surveys through (1) purposeful sampling; (2) use multiple data collection methods (e.g., interviews, surveys, classroom observations, and relevant media documents) ; (3) conducting follow-up interviews and surveys and (4) sharing of findings with the participants.

By following a data collection protocol, many stages of data collections were held over a five-year long period. This helped to establish a chain of evidence linking the initial research questions to draw the final conclusions; thereby improving the reliability and validity of the case study (Yin, 2003). The use of the phenomenological analysis of the qualitative data collected helped to identify relevant themes and make sense of how to establish evidence while reporting the findings.

3.8.2.2 Internal validity

Internal validity informs on how the correct interpretations can be made from a phenomenon such as interviews and surveys. Yin (2003) suggested that the meanings made should be questioned to confirm 'if the inference made is correct'. Including rival explanations in the discussions help to strengthen the analysis, and ensures that the story connects together to form the conclusion. Researchers should self-reflect to remove possible biases in the data collected and look for multiple reasoning for a sequence of events (Klein & Myers, 1999) This can be done by pattern matching to identify themes, explanation building to inform their reasoning, and using appropriate logical models (Yin, 2003). The internal validity of this study has been established during both data collection and analysis, which were concurrent. Interviews and surveys complemented each other and follow-up interviews and surveys were held with respondents (teachers, students, parents) for "plausibility, sturdiness and validity" (Miles & Huberman, 1994). The data collected during the various stages of

the BYOD classroom investigation were then analysed for similar patterns, as themes evolved iteratively.

3.8.2.3 External validity

External validity ensures that the findings can be generalised beyond the current case study (Yin, 2003). A thorough description of the study's context helps to gauge the integrity and determine its generalizability (Dubé & Paré, 2003; Yin, 2003). In this manner, the reader can get an informed view and ensure that findings from this study can be extended to other studies. Selection of a sampling strategy which suitably fits the study's scope, time constraints, and available resources increases likelihood of an information rich and relevant case(Patton, 2002). This in turn helps to make further extensions to the phenomenon under inquiry to some other contexts.

3.8.2.4 Reliability

Reliability refers to consistency of operations used in the case under study, and ensuring that repetition of data collection under similar conditions will yield similar results (Yin, 2003). Patton (2002) suggests triangulation of relevant data sources and maintaining an analytical and questioning perspective helps to increase the accuracy and trustworthiness of the study's findings.

Data collection in this study has been conducted in an ever-changing state of the BYOD classroom initiative in a real-time school environment. Therefore, there was a challenge in replicating the same methods of data collection procedure in each of the phases. Also, the data collection for the following phase was guided and informed by the earlier stage of the data analysis outcomes. Moreover, in this study, approaches and methods used for data collection often varied throughout the case study duration.

The study focused on year nine students during 2012 (i.e. at the start of the study), and then followed the same cohort of students which progressed to year ten. Subsequently in the later stage of the data collection, the focus moved to only one stakeholder (i.e., teachers involved with students across a range of subjects) and the data collection method mainly involved semi-structured interviews to help gain in-depth insights into the continuously changing nature of the teaching and learning practices and the evolving digital divide situations. Therefore, the reliability in this study is maintained through use of systematic operational steps. These involve (1) use of the case study protocol including observation, open-ended surveys and semi-structured interviews, (2) detailed record keeping of the data collected, (3) use of a conceptual model as a lens to analyse data, and (4) maintenance of structured case study database.

3.8.3 Selection of case

Case study research is well suited when the study investigates the current phenomenon with no clear boundaries, and over which there is no experimental control of the researcher, and is exploratory in nature (Benbasat et al., 1987; Darke, Shanks, & Broadbent, 1998). Furthermore, a case study is suitable where there are circumstantial conditions that are relevant to the phenomenon under study (Yin, 2003). Also, the qualitative case study approach provides an opportunity to the researcher to explore the phenomenon under study within its natural environment using multiple data sources (Baxter & Jack, 2008). As all of the conditions defined for the qualitative case study research applies to the case study environment, this makes the case study approach fit for this research. A single case study approach has been undertaken to provide an in-depth understanding of the constantly evolving nature of the digital divide in teaching and learning environment. While the significance of single case

research is methodologically viable, particularly when the case depicts some extreme or critical scenario, there seems to be some confusion in generalizability of this approach. However, since this research is driven by events surrounding this particular case study of the unique in nature and representative of research problem, the study is well placed to be able to follow the single case study approach. For single case selection, Yin (2003) has proposed four strategies, namely critical case referring to testing a theory, extreme or unique case referring to documenting an unusual case, revelatory case referring to observing and analysing a phenomenon, and the prelude case referring to exploring a case as shown in the table 3.2.

Table 3.2: Selection criteria for single case designs (Yin, 2003)

Nature of case	***Matching purpose***
Critical	Testing a well-formulated theory
Extreme or Unique	Documentation and analysis of a rare case
Revelatory	Observation and analysis of a phenomenon
Prelude	Exploratory

According to Yin (2003), a single case design is appropriate when it represents a unique, revelatory or critical case. This study follows only a single case, representative of the research problem, and the case selected is one of the early adopters of BYOD classroom or similar initiative in New Zealand (Mass, 2011; Moore & Tasman-Jones, 2011; Tasman-Jones, 2012), validating the researchers' choice of single case. Because of the longitudinal nature of the study to investigate the evolution of the BYOD classroom and the digital divides within the teaching and learning practices, a descriptive case study method has been employed (Yin, 2003).

3.8.4 Triangulation

Triangulation is the process of producing convincing evidence to support the research investigation to ensure its validity, such as by using data collected from multiple

sources (Denzin & Lincoln, 2005; Patton, 2002). In the qualitative case study research context, there is often a need to analyze a complex web of interactions, relationships and behaviors among the various stakeholders related to a phenomenon, therefore the inquiry has to be looked at from multiple perspectives. Therefore, using multiple sources to uncover the findings is reassuring for both the validity and the credibility of the data (Patton, 2002; Yin, 2003).

The findings of a study also become more valid by employing triangulation in the research methods, as no single method can capture every aspect of the study. Denzin and Lincoln (1994) suggests, “Because each method reveals different aspects of empirical reality, multiple methods of observations must be employed”. However, the consideration for the triangulation in research also depends on the various considerations like practicality, budget, and time constraints (Patton, 2002). Hence, it is argued that a qualitative research design should be adequately open and flexible to permit the exploration of contextual needs and requirements of the phenomenon under study.

Use of the triangulation will increase validity as the various methods can complement one another strengthening the validity of the outcome (Marshall & Rossman, 1999). This is imperative for a good qualitative research, as each type and source of data have some strengths and weaknesses (Patton, 2002).

In our study, triangulation of data sources, research methods, and respondent responses have been applied. Regarding the data sources and methods, classroom observations, online surveys, and semi-structured interviews within the BYOD classroom settings have been used. This also included three different stakeholders (e.g.

learners, teachers, and parents) for the collection of data stating their point of view. More aspects of data collection methods used are discussed in section 9 of this chapter.

3.8.5 A priori specification of constructs

Review of relevant literature based on the identified research problem helps in identification of a priori specification of constructs, which are still provisional. These provisional constructs are measured and validated through the study protocol and questionnaires to formulate more accurate constructs for the study (Eisenhardt, 1989). Moreover, if the identified constructs match with the initial constructs, they provide strong triangulated measures for underpinning the emergent theory; although some constructs could be discarded during the research process (Dubé & Paré, 2003; Eisenhardt, 1989). However, having some prior knowledge of tentative constructs will help in theory building from the case study research design.

For this research, several constructs have been identified as relevant to the issue of digital divides in learning within educational context, based on the review of the literature on the field of study. These constructs served as predictors which have the potential to affect the digital inclusion of learners at the various levels of digital divides. The constructs have been further categorised based on the various stages of the technology adoption within the context of BYOD classrooms initiative. That includes, digital access divide (individual, access and ownership to technology including one-to-one devices, socio-economic status, educational level, gender), digital capability divide (level of digital/information literacy, nature of technology usage, attitude and behaviour of students), and digital outcomes divide (knowledge acquisition, skills development, motivational and behavioral progression).

An initial exploration of theoretical constructs identified during the review of the literature was conducted during the preliminary study of the case under investigation in its natural setting. Some of the priori constructs under the category of digital access divide did not match the empirical constructs, and therefore have been discounted for the purpose of the further investigation. However, majority of the constructs identified matched with the empirical ones either as a whole or in some combination. Because of that, the research constructs for further investigation have been revised, after the first stage of the study (especially in digital capability divide and digital outcome divide categories). One such example is the introduction of the computer self-efficacy in the digital capability divide.

3.8.6 Context of the case study

To assess the trustworthiness and generalizability of the study findings, an adequate description of the research context and the case study under investigation is necessary (Benbasat et al., 1987; Yin, 2003). The context of the case study refers to the research environment, period of total investigation, phases of collecting data, the opportunity for the researcher to build a better understanding of the phenomenon under study, and if the data were collected during the progression of the research (Dubé & Paré, 2003). The case study context is described next.

In 2011, a New Zealand school decided to implement technology-mediated teaching and learning practices in the form of one-to-one portable digital learning devices for all students in a cohort dubbed as the BYOD classrooms initiative. The strategy was to develop the teaching methodologies and learning activities to make maximum use of the available technology in the everyday learning. Therefore, school informed this plan to parents of all the students, and communicated that students are expected to bring a

one-to-one digital learning device (preferably an iPad2) into the classroom. Initially, this initiative was only rolled to students in year 9 (students aged 13-14) for the 2012 academic year. The expectation that the parents of the students should cover all the cost associated in buying the required one-to-one learning devices was the most controversial aspect of this initiative. Projects of similar nature and aims in the past (like the digital opportunities pilot projects) had provided required tools and technologies to students through the schools. Therefore, the school's decision resulted in to a fierce public debate raging from local and national newspapers, TV, and radios requiring school to defend their dicission (Mass, 2011; Moore & Tasman-Jones, 2011; Tasman-Jones, 2012). It is pertinent to mention here that the school in this study is co-educational, state funded and ranked at the decile[3] 9 in the New Zealand school system. The school has progressed with the implementation of the BYOD classrooms initiative as planned, at the starting of the school year in 2012.

An adequate level of confidentiality has been maintained for the purpose of research; hence, this study did not disclose the identity of the school in any of the interim reports and publications. Further a constant feedback loop was maintained with the school management to share any new insights from this study in case it is useful for their initiative.

The study was conducted in three stages, starting early 2012. Research instruments such as surveys, interviews, and observations have been used to collect data from students, teachers and parents. Data in the study have been gathered using different methods at various stages as outlined in the following table.

[3] Deciles are a measure of the socio-economic position of a school's student community relative to other schools throughout the country. A higher decile implies a higher socio-economic region.

Table 3.3: Timeline of data collections

Stages	***Data collection timeline***	***Data collection methods***
Stage 1: Baseline	Early to mid-2012	• Open-ended surveys with students, teachers, and parents • Classroom observations on targeted subject areas
Stage 2: Follow-ups	Mid-2012 to mid-2014	• Semi-structured interviews with a randomly selected sample of students, teachers, and parents • Two rounds of open-ended follow-up surveys with students, teachers, and parents
Stage 3: Summative	Mid-2014 to late-2016	• Two rounds of semi-structured interviews with teachers

3.8.7 Research design checklist

Dubé and Paré (2003) have defined a template of attributes for helping researchers ensure their research design is rigorous and study is reported by using a chain of evidence. The following table (Table 3.4) details a checklist, which shows the steps to be undertaken in the design of a research study. The table also explains how the steps have been applied in the context of this study.

Table 3.4: Attributes used to assess research design in positivist case studies (Dubé & Paré, 2003)

Research Design	Authors	Exploratory	This study
Clear research questions	(Benbasat et al., 1987) (Yin, 2003) (Eisenhardt, 1989)	✓	✓ How questions were identified for the study.
A priori specification of constructs	(Yin, 2003)	✓	✓ A number of constructs have been identified for the study based on the review of the literature and the preliminary baseline analysis of the case study.
Clean theoretical slate	(Yin, 2003)	✓	✓ The researcher adopted an objective/neutral view and no hypothesis were formed
Multiple –case design	(Benbasat et al., 1987) (Yin, 2003) (Lee, 1991)	✓	Not applicable
Nature of single-case design	(Yin, 2003)	✓	✓ A single case study design has been determined based on the uniqueness of the case, since it is one of the earliest adopter of BYOD classroom or similar initiative.
Replication of logic in multiple-case design	(Eisenhardt, 1989) (Lee, 1991)	✓	Not applicable

Unit of analysis	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ Technology-mediated learning environment of the BYOD classrooms
Pilot case	(Yin, 2003)	✓	Not applicable
Context of the case study	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ A technology-mediated learning initiative in the forms of the BYOD classroom initiative in a secondary school in New Zealand
Team-based research	(Benbasat et al., 1987) (Eisenhardt, 1989)	✓	Not applicable
Different roles for multiple investigators	(Benbasat et al., 1987) (Eisenhardt, 1989)	✓	Not applicable

3.9 Data collection process

The research design should appropriately describe the details of the data recording methods used and also the number of stages of data collection (Dubé & Paré, 2003). "A clear description of data sources and the way they contribute to the findings of the research is an important aspect of the reliability and validity of the findings" (Benbasat et al., 1987, p. 381). A research protocol helps in anticipating potential problems in recording and collecting information to build a better understanding of the phenomenon under study. Data collected from multiple sources like observations, surveys, and interviews can give a wider perspective of the research context. This can then be used to build an informative and logical chain of evidence, which is grounded in real-world settings. This section expands on the data collection process undertaken during the three phases of this study, namely during the baseline, follow-ups and summative phases.

3.9.1 Ethical issues in data collection

Ethical considerations are an important part of any research study. Researchers have an obligation to protect the privacy, confidentiality and rights of the research participants during the process of recording data. A checklist of general ethical issues such as mutual benefit, possibilities of risk to privacy and confidentiality, informed consent and access to data is important from ethical point of view (Patton, 2002).

An outline of the study's objectives, data collection methods to be used, assurance of protection of participants' rights, their consent for recording of interviews and a pre-designed questionnaire for conducting surveys and interviews was submitted to the

Human Ethics Committee of Massey University. The school authorities were kept in the loop during the process of the ethics application.

After attaining low risk approval, this study moved forward to the data collection stage. Asking for permissions to start collection of data from the relevant institution is important to ensure cooperation from the research participants. Also, taking permission acknowledges that all the participants know about the purpose of the study and allows the researcher an opportunity to think on how ethical aspects will be maintained (Creswell, 2007). A copy of the ethics approval letter was submitted to the school. All research participants were given a written description of the purpose of the research study, along with the list of University officials to be contacted if the participants felt the ethical consideration was not correctly adhered. Participant provided either consent through online consent form (for an online survey) or signing the paper consent form (for interviews) before researcher started recording data.

Parental consent for conducting interviews with students involved in the BYOD classrooms was sought by the school (through a newsletter) and during parent meetings conducted by them. The school reviewed all data collection instruments (survey questions, classroom observation protocol, classroom observation forms, interview questions, and information sheets and consent forms). Further, the school provided access to classrooms, teachers, students and parents for this study. The researcher did not recruit the participants directly. For instance, the request for completing online surveys went via school email to teachers, students and parents. Again permission for conducting few classroom observations was granted by the school, where the researcher sat quietly in one corner and made no communication with teachers or students during the time of the observations. Further, the school provided the researcher access to year 9 students (who had opted-in with parental

consent) and with the parents for conducting interviews. Each interview was conducted in an open executive office area of the school where people were moving freely. Each interview lasted for approximately 15-20 minutes. It was agreed that all participants and the school could access the recordings or the transcripts if they wanted and that all published findings resulted from the study will be shared with the school. The ethics approval lasted for 3 years, subsequently a second round of ethics approval was sought and a similar process was followed again.

3.9.2 Case study protocol

The case study protocol refers to the set of rules that has to be followed in a study while using research instruments (survey forms, interview questions, and observation guidelines). The research protocols are useful tools in maintaining the consistency during the collecting of the data and avoid any biases in the study. (Creswell, 2007).

Observation protocol involves setting up a favorable place for making observations and defining a list of activities or events of interest for making notes. Researchers should record the observation setting, the sequence of events, activities of the participants, selective conversations and other non-verbal nuances (Creswell, 2007). Recording these experiences helps the researcher to reflect on the data collected during the later stage of the study (Benbasat et al., 1987; Dubé & Paré, 2003; Yin, 2003). Surveys protocol refers to aspects related to the target participants, sampling mechanism, time of the survey administrations, properly defined follow-up timelines, revision of questions based on the earlier stages of the study, and the information and consent process. Similarly, interview protocol helps to determine the nature of questions for the interviews, target participants, any sampling mechanism, time of the interview, and information and consent process. Designing an interview protocol for

the use of voice/video recording helps in providing a detailed picture of the interview (Creswell, 2007).

3.9.3 Case study database

Case study database contains all of the data that belongs to the case study, including unprocessed or processed data at any stage of research. It normally contains raw data collected from the field (observation notes, any documents collected to support the collected data, survey responses, and interview recording and transcripts), data coding structures, coded data, and any written notes produced during the analysis of the data (Dubé & Paré, 2003). This helps to link the questions with the raw data, apply reasoning throughout the life of the project (Maxwell, 2005). This study employed a software tool (NVivo) to organise and make sense of the different forms of data collected during various stages of the study.

NVivo helped to organise the observation, survey responses, and interview recordings and transcript data from the various stages of the study. During the transcription of the interview data, NVivo was helpful as the audio and transcript could be managed in the same tool/screen. It also provided the platform to organise the data into various categories and cross-categories by creating folders and subfolders. This facility of the NVivo eased the process of interpretive coding as it helped to bring various data sources in one place. Bazeley and Jackson (2013) encourage the use of qualitative research tools like NVivo to manage the complex structure of the multiple types of data so that it do not affect the interpretive capacity of the researcher.

The qualitative coding of the case data was based on the constructs identified for the study during the earlier stages of the research and the unit of analysis as the broad area of investigation. This is explained in detail in the later chapters.

3.9.4 Stage 1: Baseline study

The baseline data in this study have been collected during early to mid-2012. The data have been collected using open-ended online surveys including students, teachers and parents. The questionnaires were mostly designed to be open-ended, giving respondents an opportunity to write about the recent implementation of the BYOD classrooms initiative by the school.

Initially, themes that emerged from the public debate on the BYOD policy raised some concerns towards the classroom being digitally divided. Therefore, in this phase, the study aimed to explore the answer the first research question related to the digital access divides. To find answers to those concerns raised from the public debate, our initial investigation focused on affordability and availability issues of digital devices among learners to be able to participate into the learning activities across the formal (classroom) and informal (home) learning spaces. The results from this round of investigation then informed the nature of subsequent research questions to be posed for the remainder of the study.

3.9.5 Stage 2: Follow-up study

Following the outcomes from the baseline investigation, the follow-up stage of study between mid-2012 and mid-2014 focused on finding the answer to the second research question about digital capabilities divide. The data have been collected using, the semi-structured interviews with a randomly selected sample of students, teachers, and

parents, and two rounds of open-ended follow-up surveys with students, teachers, and parents. The baseline stage of study along with the review of the literature helped identify and confirm some factors that can influence digital capability, potentially leading to variations in the capability among learners. Two sets of data were analyzed to learn how certain factors influenced the digital 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.

In addition, this stage of the study was also tracking the evolution of the digital divides in learning and the transformation of the teaching methodology and learning activities because of the BYOD classrooms.

3.9.6 Stage 3: Summative study

The study has gained a lot of understanding of the BYOD classroom initiative and how digital divides in learning are shaping within the context of technology-mediated teaching and learning practices. Therefore, the summative stage of study between mid-2014 to late 2016 combined the findings from the first two stages of research to investigate how digital outcome divide evolved during the last five years of BYOD classrooms. Two rounds of interviews were conducted further with those teachers who had participated in the BYOD classroom initiative since the beginning of the 2012. This helped to gain a more accurate vision of changes in learners' attitudes and self-efficacy within the teaching and learning environment over the five-year long journey with the BYOD policy. Interview data from these teachers has been analysed to answer the third research question about knowledge acquisition, skills development, motivational and behavioral progression in learners.

3.9.7 Data collection checklist

It is essential to check for the legitimacy and trustworthiness of the data collected before it is analysed. Dubé and Paré (2003) have defined the attribute checklist for data collection for case studies based on the works of the other authors in research methods.

Table 3.5: Attributes used to assess data collection in exploratory case study (Dubé & Paré, 2003)

Data Collection	Authors	Exploratory	This study
Elucidation of data collection process	(Benbasat et al., 1987)	✓	✓ A school was selected for the research study based on the critical case sampling. The confirmation of using the case for the study was determined after the preliminary investigation of the BYOD classroom initiative introduced by the school.
Multiple data collection methods	(Benbasat et al., 1987) (Yin, 2003) (Eisenhardt, 1989) (Lee, 1991)	✓	✓ Classroom observations, online surveys, and semi-structured interviews
Mix of qualitative and quantitative data	(Benbasat et al., 1987) (Eisenhardt, 1989)	✓	✓ This study investigated the progression and changes in the BYOD classroom initiative over a 5-year period in its natural settings using qualitative data. However, some quantitative data was collected through surveys at the initial stage of the study.
Data Triangulation	(Benbasat et al., 1987) (Yin, 2003) (Eisenhardt, 1989) (Lee, 1991)	✓	✓ Data have been collected from multiple sources to gather evidence including classroom observation, online surveys, and semi-structured interviews.
Case study protocol	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ A data collection protocol has been followed in each of the methods used.
Case study database	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ Observation notes, survey records, interview recording and transcripts.

3.10 Data analysis

A well-defined data analysis strategy is important for exploratory studies since the goal of the research study is to develop a theory (Dubé & Paré, 2003). Having adequate description of the context of the case and extracts of data underlying the analysis helps to establish a chain of evidence to support the study's findings (Benbasat et al., 1987). Data collection and data analysis happen concurrently in qualitative research as emerging results and insights from previous analysis informs the next stage of data collection (Eisenhardt, 1989; Miles & Huberman, 1994; Patton, 2002). This brings about internal validity since both data collection and data analysis processes occur in close proximity to each other, thus validating the final evidence (Dubé & Paré, 2003).

The first step in the analysis stage is organization of the data collected. All data, such as observation notes, online survey responses and interview transcripts are to be categorised and cross-categorized based on the data collection method and data collection stage. The observation notes and survey responses were already in text format, so could be easily transferred in NVivo. However, each interview had to be first transcribed individually by the researcher to the closest possible accuracy. The researcher applied bits of rewording and paraphrasing to the interview conversations so that the transcript could be contextualised to the research context and reduce content with irrelevant conversations during the interview period.

Data have been collected in different stages using various data collection methods, starting with the baseline data in 2012. The baseline data have been analysed using the NVivo to track the themes emerging from the survey responses from student, teachers and parents. The survey responses were analysed across multiple areas of investigation, including various constructs in access, capability and outcomes divide

identified earlier. This stage of data analysis helped to re-think and structure the constructs under the three categories of the digital divide framework adapted for the study. Much of the analysis is directly supported by quotations from participants to reveal “the undigested complexity of reality” (Patton, 2002, p. 463). Apart from the baseline data, two further rounds of data have been collected using one follow-up surveys and interviews/follow-up interviews.

Analytical descriptions have been used (Yin, 2003), to explain the lessons learned from the baseline data analysis so that it could then be applied in a broader context during subsequent investigations (Stake, 1995). Once all the data from surveys and interviews was organised and transcribed, NVivo was used to code the plain data into themes giving deeper understanding of the phenomenon under investigation. Insights from data from each phase of the study have been reported through research publications, presentations and summary reports that have been shared with the case study institution. The qualitative nature of the data, such as interview quotes have helped bring about richness in the reporting of the data analysis. Direct quotes in qualitative reports helps to capture the participant views regarding the phenomenon under study without the researcher in the middle (Creswell, 2007).

Creswell (2007) suggests finding a connection between the emerging themes for maintaining the rigour in the analysis of the data. That also includes combining or merging relevant themes at the different levels of the inquiry so that a theoretical and conceptual model can be generated. Janesick (2016) suggests using the quotes from the participants as they are expressed, to guide the reader to the analytical discourse. Therefore, quotes from the interview data have been widely used as evidence and back up the conclusions reached.

3.10.1 Data analysis checklist

A researcher has to be flexible with the themes emerging from the analysis as the themes mapped based on the predicted data and the themes emerging from the empirical data may not match. This section utilises the checklist identified by Dubé and Paré (2003) for the steps taken as the themes emerge during the analysis of empirical data. As suggested by (Dubé & Paré, 2003), the following table lists the steps to establish the rigour in the exploratory case study research design.

Table 3.6: Attributes to assess data analysis in case study research (Dubé & Paré, 2003)

Data Analysis	Authors	Exploratory	This study
Elucidation of data collection process	(Benbasat et al., 1987) (Yin, 2003) (Eisenhardt, 1989)	✓	✓ Combining and merging themes from data
Field notes	(Yin, 2003) (Eisenhardt, 1989)	✓	✓ Field notes were made during the visits to the school for the meetings and events like staff training sessions and annual conference. This was never used directly into the analysis, but was used as input to prepare for subsequent round of data collections.
Coding and reliability check	(Yin, 2003)	✓	✓ Purposeful sampling of the critical case. Baseline and follow-up surveys and interviews.
Data displays	(Yin, 2003)	✓	✓ Folder structures to organise the data collected through various stages of the study. Visual mapping of themes and codes in NVivo.
Flexible and opportunistic data collection process	(Benbasat et al., 1987) (Yin, 2003) (Eisenhardt, 1989)	✓	✓ As the themes, emerging from the analysis of baseline data required revisiting of the ideas and the themes anticipated before the data collection and analysis. Therefore, the flexibility was maintained throughout the various stages of data collection and analysis.
Logical chain of evidence	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ Emphasised in the context of the case and the richness of the data retrieved from the case to establish the clear chain of evidence up to the results.

Explanation building	(Yin, 2003)	✓	✓ Followed the descriptive analysis of the qualitative data.
Searching for cross-case patterns	(Eisenhardt, 1989) (Lee, 1991)	✓	Not applicable
Quotes (evidence)	(Benbasat et al., 1987) (Yin, 2003)	✓	✓ Exact quotes from the participants have been used in the write-up as evidence.
Reviews of data analysis and results	(Yin, 2003)	✓	✓ Repeated the analysis exercise to spot any difference in the results. Reporting the outcomes through presentations, peer-reviewed conferences and journals.
Comparison with extant literature	(Eisenhardt, 1989)	✓	✓ Analysing the similar studies through their published literature

3.11 Case study report

Yin (2003) suggests a classic single case narrative based on the emerging storyline to report findings. This study too uses a classic single case narrative format. Initially, a brief description of the case under the study and its natural setting is presented to inform the reader about the context of the study. That was followed by the textual descriptions of the different stages of the case under study, and focus of each stage is linked to the issue under investigation. In this manner, a storyline unfolds of the five-year BYOD classroom journey.

Data analysis has been performed by mapping the empirical data with a priori constructs identified from the literature review. The researcher has to be very careful and not be entirely guided by the priori constructs, as data should tell its own story as it leads to important themes emerging in the study. Also, creating new categories or themes at each phase of analysis guides the way forward for further investigation. Patton (2002) advises researchers to question each category and reflect on its relevance before coding it. Each of the identified categories can then be matched with the priori constructs to make a decision on accepting or rejecting it. This study is exploratory case study research, using observation, open-ended surveys, and semi-structured interviews. Hence, the data collected within the case selected for the study is subject to socio-economical and educational settings, where participants responded based on their conditions. The responses based on their conditions, experiences, and environment of the technology-mediated learning can give many insights into current issues.

3.12 Methodological model for the study

Mapping of various research component and activities that occurred during the time of the research can help the reader of the case study report make sense of the result and follow the researcher's arguments (Janesick, 2016). The figure below represents the methodological model of this study and captures the various research activities across three stages that have been followed to reach a conclusion.

Table 3.7: Methodological model of this research study

Stage of Study	Inputs to Research	Research Process
Stage 1: Baseline study Early to mid-2012	- Media Reports (e.g., newspapers, radio, television) - Government reports - Reports from previous digital divide projects - Published academic literature on ✓ Digital divide phenomenon ✓ Technology integration in education/learning ✓ BYOD classrooms	- Analysis of relevant literature - Analyse media reports - Establish protocols for conducting single case research design - Get ethics approval - Conduct surveys (students, parents and teachers) - Conduct observations of classroom learning activities.
Outcomes from stage one		
1. Research design for the study 2. Formulation of research questions 3. Refinement of priori specification of constructs pertaining to digital access and digital capability divide (Figure 2.2) 4. Have a plan for next stage of study 5. Define theoretical framework for based on three level digital divide framework (Wei et al., 2011) 6. Have an analytical framework for the study as a lens to the analysis of the data (Pachler, Bachmair, Cook, et al., 2010) 7. Case study protocol		
Stage of Study	**Inputs to Research**	**Research Process**
Stage 2: Follow-up study Mid-2012 to mid-2014	- Findings from stage one - Plan for the data collection - Case study protocol	- Establish protocols for conducting single case research design (ongoing) - Conduct interviews (students, parents, and teachers) - Conduct online surveys (students, parents, and teachers)
Outcomes from stage two		
8. Recapitulation of priori specification of constructs pertaining to digital capability and digital outcome divide (Figure 2.2) 9. Refine the research design for study 10. Have a plan for next stage of study		
Stage of Study	**Inputs to Research**	**Research Process**
Stage 3: Summative study Mid-2014 to late-2016	- Findings from stage one and two	- Conduct interviews (teachers) - Analysis of the data - comparison of data from various stages
Outcomes from stage three		
11. Case study report (Longitudinal journey with BYOD classrooms: Issues of access, capability and outcome divides)		

The study begins in the stage one with the review and analysis of the relevant literature related to the research problem. The researcher also collected as much information as possible on the current and past technology-mediated or similar teaching and learning interventions. In regards to the case under study, researcher gathered all the public debate data on the BYOD classroom initiative planned for the case (school).

As an outcome of the stage one, the research design for the study has been determined. This has been done with input from the review and analysis of the literature to identify the research problem, questions, priori specification of constructs, conceptual framework, and analytical framework into a single case study research design. The outcomes of this stage of the study includes, refinement of the theoretical framework, formulation of research questions, defining of theoretical and analytical frameworks, case study protocol, and identification of data collection methods. Also, the availability of the information about the case study selected for the study and its setting at this stage was helpful in determining the ethical considerations for the study.

At stage two of the study, many of the outcomes from the stage one was accepted as the input. The follow-up data collection has been done at this stage, which helped to refine the already established priori specification of constructs and inform the research design to fit with the requirements of the ever changing and evolving BYOD classrooms, digital divides within learning process and the emerging pedagogical practices.

At the stage three of study, the focus was in understanding the evolution of the key investigation points for the study like BYOD classroom practices, digital divides within learning process, teaching methodologies. The findings from first two stages have been combined along with the data from the third stage to gain a clear picture from the

beginning of the BYOD classroom initiative. A major part of this stage was to sum up the analysis over the data from five-year long journey and prepare a case report to present the findings from the whole study period. A detailed and descriptive case study report has been prepared based on the analysis of the data from the case study database, with the help of the qualitative data analysis tool NVivo. In the end, findings have been reported to answer the questions posed at different stages of the study.

3.13 Conclusions

This chapter has outlined the research design used in this study. A single case research design has been determined appropriate for conducting this study. The said case is unique and revelatory of the phenomenon under study. It is representative of the research problem since the case (school) is one of the earliest adopters of the BYOD classroom or similar initiative in New Zealand. The case study research design includes considerations for ensuring (1) ethical obligations are met in this study, (2) data collection methodology is followed, (3) triangulation methods are suitably applied to bring credibility to study findings, (4) correct data collection protocols are established, (5) case study database is maintained, (6) data analysis strategies are trustworthy so as to establish a logical chain of evidence, and (7) an appropriate case study reporting mechanism is outlined.

Chapter 4: Baseline Data Analysis

4.1 Introduction

This study has followed a longitudinal case study design over a five-year period from 2011 to 2016. The case study is of a secondary school in New Zealand, an early adopter of technology-mediated teaching and learning practices, having been one of the first schools to announce a BYOD classrooms initiative in 2011. This study has followed the progress of the BYOD classrooms initiative starting from first time of inception (in early 2012) onto the next five years of its gradual progression (until late 2016). Three data collection stages have been held over the five-year period as described in table 4.1.

Table 4.1: Stages of data collection (1st stage)

Stages	***Data collection timeline***	***Data collection methods***
Stage 1: Baseline	Early-2012 to mid-2012	• Open-ended surveys with students, teachers, and parents • Classroom observations in targeted subject areas
Stage 2: Follow-ups	Mid-2012 to mid-2014	• Semi-structured interviews with a randomly selected sample of students, teachers, and parents • Two rounds of open-ended follow-up surveys with students, teachers, and parents
Stage 3: Summative	Mid-2014 to late-2016	• Two rounds of semi-structured interviews with teachers

Each stage of the data collection and analysis focused on different research questions which were posed, as the initiative advanced over the years to capture evolutions in digital divides (from access to capability to learning outcomes). This chapter analyses the data collected over the stage one of the study, based on the baseline data collected

from early-2012 to mid-2012. Baseline stage of investigation can be categorised into two parts. First, analysis of the public responses data about the BYOD classroom initiative when the project was launched (i.e. preliminary analysis of case study). Second, analysis of online surveys with three important stakeholders, namely students, teachers and parents, once the initiative came in practice within classrooms. The questionnaires for the online surveys were mostly open-ended giving respondents an opportunity to write about their views and experiences of the BYOD classrooms initiative introduced by the school.

During this phase, answers to the first research question related to the digital access divide (i.e. *how has the digital access divide evolved because of the BYOD classrooms?)* have been investigated. Initially, themes that emerged from the public debate surrounding the BYOD classroom initiative raised some concerns towards the potentially digitally divided classroom. In a bid to find answers to those concerns raised, our initial investigation into the study focused on affordability and availability issues of one-to-one digital learning devices among the students. Results from this stage of investigation then informed the nature of subsequent research questions to be posed for the remainder of the study.

4.2 Preliminary analysis of the case study

As already described in the earlier chapter (refer to chapter 3, section 8.6), the school made a decision to implement the technology-mediated teaching and learning in the form of the BYOD classrooms. Every single student was expected to bring their own one-to-one digital learning devices for classroom learning, which resulted in a fierce public debate on a national level. This led the researcher to focus the initial investigation into analysis of the public debate data to identify important themes and

concepts, that would inform in the formation of the research questions relevant for the next stage of the study. Researcher therefore, collected data from as many relevant public forums and media sources as possible, specifically from the comments and discussion sections of the online news articles published into several newspapers. Sources of the public response data that was collected and the number of responses in each of the source are listed as follows in table 4.2:

Table 4.2: Information about the sources of information collected for initial analysis.

Source of Public Response Data	**Number of Posts in Source**
http://www.stuff.co.nz	News + 49 Comments
http://www2.everybody.co.nz	17 Comments
http://www.e-bls.com	News Only
http://edorigami.edublogs.org	News + 5 Comments
http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10739485	News Only
http://www.macobserver.com/tmo/article/nz_school_adds_ipad_2_to_compulosry_list_for_students	News + 3 Comments
http://nz.news.yahoo.com/a/-/top-stories/9872475/opposition-to-ipads-in-schools/	News + 104 Comments
http://www.3news.co.nz/Orewa-College-leads-iPad-introduction/tabid/817/articleID/219329/Default.aspx	News + 11 Comments
http://www.3news.co.nz/Orewa-College-leads-iPad-introduction/tabid/817/articleID/219329/Default.aspx	News + 18 Comments
http://www.3news.co.nz/Principals-Assn-weighs-into-iPad-debate/tabid/423/articleID/219385/Default.aspx	News + 10 Comments
http://www.odt.co.nz/news/national/169840/school-ipads-tough-parents-budget-advisors	News + 3 Comments
http://ipadeducators.ning.com/forum/topics/school-s-controversial-decisio	News + 2 Comments
http://www.stuff.co.nz/national/education/5304084/Schools-iPad-requirement-divisive	News + 183 Comments
http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10739428#cmnts_Start	News + 45 Comments

The public responses data was then added into the case study database and then qualitatively coded using NVivo. The analysis of the public debate showed potentially

digitally divided classroom as the most notable concern relevant to the study. People expressed their views anticipating the gap in terms of the affordability of the recommended digital learning device and were concerned that students may turn up in the school without any devices to support their learning, potentially disadvantaging their learning opportunity. About 20% of the contributions to the public debate were not considered because of the very general nature of the comments, or, in many cases, because the comments simply used offensive language. Analysis of debate expressed some of the potential challenges ahead for the BYOD classrooms initiative. The themes emerged from the analysis of the public debate data indicating challenges facing BYOD classrooms are shown in the figure. 4.1.

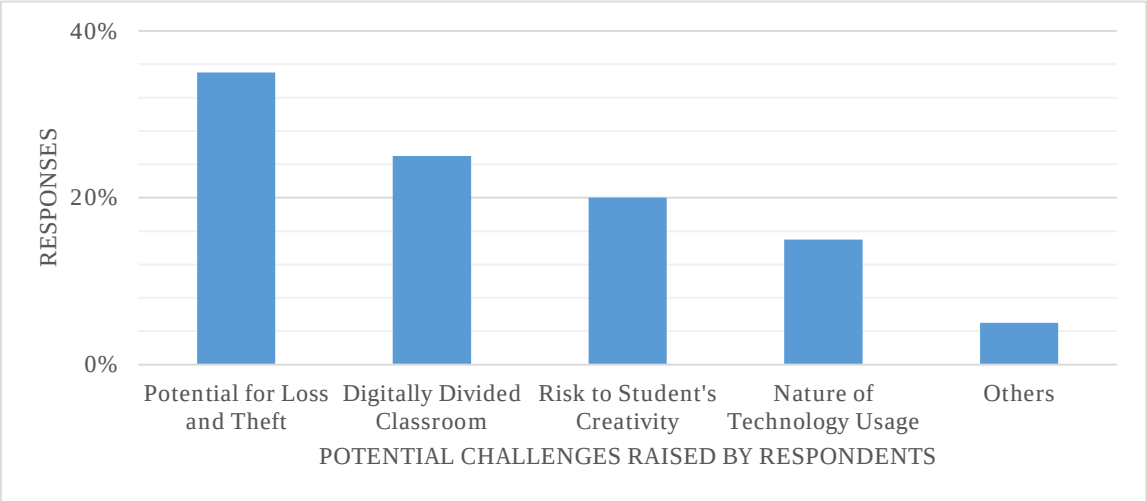

Figure 4.1: Notable concerns raised by the decision of BYOD classroom

As shown in the figure 4.1, the highest percentage (around 40%) of responses were related to the potential for loss, theft and damage to the device. The most common reason behind this concern was the young age of the student and their ability to handle the expensive devices carefully, while unsupervised. Despite being the biggest concern which emerged from the public debate; this is not relevant for the purpose of the study.

In fact, further into the trail, only two devices have been found damaged, and none had been lost or stolen.

Another widely expressed view was related to inequality within classroom based on the ownership of the digital learning devices. Nearly 25% of the respondents expressed their concerns that the classroom may become digitally divided. This was a genuine concern and in case if it did eventually realise, then those who did not have the recommended device or any device at all, would be disadvantaged, potentially restricting their learning opportunities within the BYOD classroom context. Following that, about 20% of the contributors expressed concerns around the meaningful use of the technology by the students. Some contributors who introduced themselves as parents said that even if they could afford the device, they were more concerned about the unsupervised access to internet content. Parents were worried on potential exposure to digital content and resources which may not be suitable for their young children or could even be harmful to them.

4.3 Collection of baseline data

The baseline data collection has been conducted as a part of the stage one of the study, during early to mid-2012. Data collection methods included online surveys with students, teachers and parents, and classroom observations. All online surveys for baseline stage are provided in appendix D. Each survey question was checked by the school authorities for relevance and suitability in the context of the proposed BYOD initiative.

The online surveys with students focused on their level of access to tools and technologies, overall attitude and motivation towards participation with BYOD

classroom learning practices and the nature of their technology usage across formal and informal spaces. Online surveys with teachers and parents were intended to assess their attitudes towards technology-mediated teaching and learning practices, level of their digital skills and the ways they can contribute to students' learning processes.

Online surveys received a mixed rate of participation from different stakeholders. The student and teacher participation rate was significantly higher than that of the parents as shown in the table 4.3.

Table 4.3: Survey responses in baseline data collection

Respondents	Response received
Student	56
Teachers	14
Parents	5

A total of 200 students in year 9 were invited to participate in the online survey via an invitation email with a link to the online survey link, forwarded through the school. A total of 56 students participated, and 46 completed the survey. All the teachers in the year group participated and completed the survey. The participation rate of parents was unfortunately very low with only five responses to the online survey. However, it helped provide some understanding on how different stakeholders perceive the changes occurring in traditional teaching spaces.

Nine classroom observations were performed during this stage to gain understanding of evolving teaching practices where various teaching and learning transformations were gradually shaping up with the BYOD classrooms initiative. Each classroom observations lasted for the period of the lesson, that is, approximately 50 minutes. As mentioned in the section 3.9.1 (i.e., ethical issues in data collection section in chapter 3), the researcher did not interact or talk with either the teacher or the students during

the classroom observation. Classroom observations were carried out in few subject areas (such as Mathematics, Science and Physical Education), and have been documented in the form of observation notes for recording strategies employed by teachers to engage and encourage student participation, and also for other classroom interactions between the teacher and the students. Apart from that, some data about the teaching and learning facilities (like classroom PC, data projector, and device with teacher), types of devices used by students in classrooms and the status/functionality of the internet connection inside the classroom have also been recorded in the observation notes.

With the introduction of one-to-one devices in classroom learning, some opportunities and challenges were evident during the classroom observation. In a bid to leverage opportunities such as increase the level of engagement amongst learners in the BYOD classrooms, some teachers went to great lengths and put much effort to integrate devices with learning activities and make good utilization of technological resources (e.g., one-to-one devices, the internet, and classroom learning equipment). Although it was also observed that a few teachers used devices mainly as a typing and storage medium.

One example of the utilization of one-to-one devices in a science class is described next. The science class had gone for a field trip to gather information about native plants. Using their devices, students took photographs, videos and measured/recorded the height of various plants. The next day of the trip, the researcher was permitted to conduct classroom observation. During this session, the students were tasked to find one other place in the world where these plants could also be found and to make note of plant differences from the New Zealand samples. Students searched the internet by using the name of the plant, its scientific name and

even used the 'Google search by image' feature (using image of plant leaf) to track plants in other places. This classroom observation revealed lively participation scenarios where students were thinking critically to retrieve, synthesize and authenticate their information.

In another example, observation of one Physical Education classroom demonstrated the use of an iPad as a means to make students analyze their long jump performance and improve their jump in the subsequent rounds. Students made video recordings of the long jump act, which were then discussed with the teacher to identify further improvement tactics. In this manner, each student viewed their own jumping act which added a personal meaning to their analysis of the jump performance. The students also used different apps to calculate the jump trajectory and kept records of their performance to track their progress over time. Since this activity was being done in a group, the students were also collaborating with each other to decide on different jumping strategies.

While in other cases, some of the pressing issues became evident from the classroom teaching and learning practices. One issue observed during the classroom observations was the increased distraction among learners with their device usage, which posed challenges for teachers in managing and controlling the class. Students were often tempted to go off task since they had access to their personal digital devices and unsupervised exposure to the internet. Therefore, they could easily access gaming and social media apps with just a touch of a button leading to some amount of disengagement with the topic currently being discussed in the classroom.

4.4 Results and findings

This section summarizes findings which emerged from the baseline data and classroom observations to provide insights on some aspects of digital divide research within a technology-mediated teaching and learning context. The findings have been categorised into three separate groups. The first two groups of findings relate to the issue of material access to digital learning technologies (including levels of access) and digital skills to be able to utilize the available devices into learning process. The third group of findings are related to the additional field of enquiry identified for further research.

4.4.1 Variations in the level of access

During the initial investigation, survey data showed that almost every student in that cohort has access to required tools and technologies like one-to-one learning devices and the internet. Despite the online survey indicating 100% of access to one-to-one learning devices and the internet, further investigations during classroom observations indicated differences in the level of access to digital media among students at home and at school. It is worth noting that few students arrived at school without any one-to-one device during the early days of the initiative. Therefore, the school took a proactive decision by making it their responsibility to bridge the gap in terms of the access to learning devices inside the school. The school started to provide notebook computers to those who did not have any devices to use during the classroom learning. However, the students were not allowed to take these computers home, and had to deposit the computers at the library before leaving school. Regardless of the fact that the school area is ranked decile 9 (so is in an area of high socio-economic status),

deeper look at the access concerns showed some students in year nine did not have access to required one-to-one devices and/or the internet at home, or in some cases only had very limited access. These findings show that the issue of adequate access to digital tools and technologies required for students to support their technology-mediated learning was still an issue, as shown in figure 4.2.

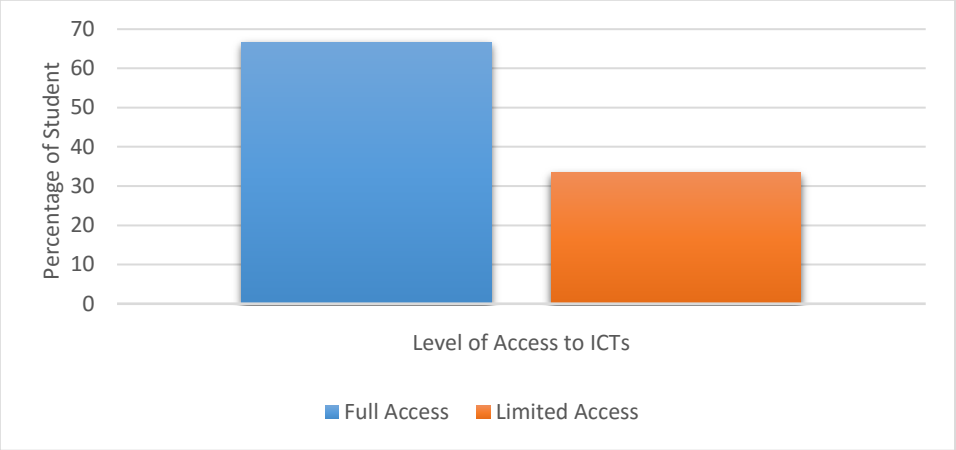

Figure 4.2: Variations in the level of access to ICTs among students

The survey response rate was only around 30% for students, and therefore, it cannot be stated with any certainty that the level of limited access to digital tools and technologies revealed in baseline data applies across the whole year group (class). However, in the context of a technology-mediated learning environment, any level of limitation, in terms of access has a risk to create unequal learning opportunities for learners. In addition to loaning computers to students during school hours to minimize the impact of the gap in terms of the access, the school also provided assistance on easy payment options for parents to help them purchase one-to-one devices for their children. Moreover, the school continued to raise awareness about the benefits of digital learning technologies among the parents. Because of these measures, the issue of material access to digital learning devices was found to be decreasing gradually. Six months into the BYOD classroom initiative, the number of

students borrowing school notebook reduced from six to three. It is worth noting that the original estimate made by the school was for 16 school netbooks to be made available for borrowing by students.

4.4.2 Variations in the level of digital skills

Digital skills in the context of the digital divides in teaching and learning environment is important since it defines whether or not the learners can make use of the one-to-one digital learning devices, and if yes, then to what extent. Some of the earlier studies in the area of digital divide have concluded that it is not enough for an individual or group to have just access to the digital technologies to be on the right side of the divide (Hargittai, 2002b). If they do not have skills to make use of the device, they will still find themselves in a situation as if they do not have access to technologies. Therefore, exploring potential issues related to the digital skills is imperative to the study of digital divides in learning.

The responses from the online surveys indicated various levels of digital skills among learners, indicating not all of them being equally capable of making use of the one-to-one learning devices into their learning activities. Only 13% of the students reported having advanced levels in digital skill when it came to their learning activities. The data further showed that 39% to be competent, 35% to be intermediate, and 10% to have only the basic skills. There were also some students (nominal) reporting themselves as beginners in digital skills (as shown in figure 4.3). This variation of digital skills among students is not a good prospect for the BYOD classrooms, where what students learn is largely dependent on what level of digital skills they have. For those sitting at the lowest levels of the digital skills, the very one-to-one learning devices aimed at enhancing their learning can become a barrier instead.

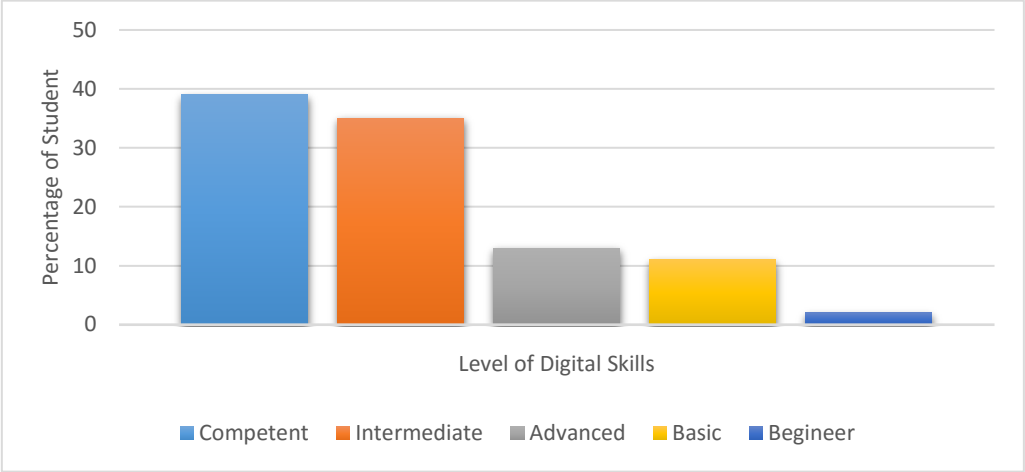

Figure 4.3: Variations in the level of digital skills among students

The achievement of the goals of the BYOD classrooms initiative largely depends on adequate and comparable digital skills among the students, so that they are all able to utilize the opportunity of digital learning. The lack of digital skills among learners therefore could affect the students' ability to learn, and potentially lead to the lack of motivation towards technology-mediated learning in the long term.

The data showed that the issues of digital skills to be not just limited to the learners; teachers on the other hand seemed to have variations in digital skills especially when it came to the application of digital learning technologies into their teaching and learning activities. Only around 65% of the teachers reported having competent digital skills, while the rest reported either intermediate or basic level. This correlates with the classroom observation findings where it was observed that a few teachers barely integrated devices into the learning activities; devices were used merely as a medium to type some text. These teachers preferred to use the white board just as the traditional classroom teaching to write and explain subject topics. In some cases, this led to uncoordinated classroom situations where the teacher did not have specific

instructions for students on how technology could be effectively aligned with their learning activities to complete certain subject tasks.

In the technology-mediated teaching and learning environment, teachers have greater responsibility in fulfilling the aims of the initiative. They are required to re-design the teaching methodology and learning activities to immerse the available digital technologies into the process of teaching and learning. Therefore, having different levels of digital skills that is not comparable to the digital skills required to make meaningful implementation of the technology-mediated instructional activities is a major barrier. Within the context of the case, around 15% of teachers reported having lack of sufficient digital skills. Although 15% is not being a big proportion, this could easily become a barrier for the whole BYOD classroom initiative.

The baseline data showed the presence of issues related to the adequate access to digital technology and lack of adequate and comparable digital skills among learners and teachers. However, it is important to acknowledge that, achieving full digital access for and comparable digital skills in every individual is well-nigh impossible. Moreover, these variations in access and digital skills are gradually improving within the context of BYOD classroom and are on the upward progression path.

4.4.3 Analysis towards aspects beyond access and digital skills

Issues related to the access and digital skills have been analysed in the context of the BYOD classroom initiative as one part of the investigation at this stage of study. Whereas access to digital technologies and digital skills are still relevant, the focus of this study is to extend the field of enquiry in digital divides in learning beyond access to technologies and digital skills, and to explore various aspects affecting learning

outcomes. For this purpose, an analysis scheme that allows the investigation to open up useful lines of enquiry for further research has been used next.

The socio-cultural ecological approach to mobile learning framework by Pachler, Bachmair, Cook, et al. (2010) recognizes technology-mediated or similar teaching and learning practices as an educational response to an on-going socio-cultural transformation. This has an emphasis on the assimilation of cultural practices and practices of media use in everyday life into schools and their curricular practices of teaching and learning. Therefore, this analysis scheme has been chosen to analyze the baseline data to open up the area of enquiry into digital divide in learning beyond the current understanding. This analysis scheme contains a set of four didactic parameters defined by Pachler, Bachmair, and Cook (2010) as shown in table 4.4 below. Each of the four parameters in this analysis scheme has two poles, which represent the students' practices of media (digital learning technologies) use within formal and informal learning spaces. The analysis then attempts to link opposing ends of the learning and media practices. One side being the current condition in the BYOD classroom context, and other an ideal condition for the successful assimilation of the technology-mediated learning practices

Table 4.4: Didactic parameters for systematic analysis of learning with mobile devices (Pachler, Bachmair, & Cook, 2010)

Parameter A: Learning Sets	
Pole: practices of school	*Pole: practices of mobile media*
Parameter B: Relationship to the object of learning	
Pole: mimetic reproduction	*Pole: personal reconstruction*
Parameter C: Institutional emphasis on expertise	
Pole: school curriculum	*Pole: personal expertise*
Parameter D: Modes of Representation	
Pole: discrete (mono media, mono modal)	*Pole: convergent*

These parameters are intended as a tool and to identify points of contact between the cultural practices of using digital learning technologies for learning in school and everyday life, and the agency of the learner to bring them into a meaningful relationship conceptualized as assimilation. This analysis scheme provides us with well-defined parameters along with two separate poles for each of them, which are suitable for us to frame our data analysis.

The analysis of the data provides insights into the differences between school's approach to technology-mediated learning and the classroom teaching and learning methodologies within the classroom. Furthermore, some limitations have been identified in the classroom teaching and learning practices that were not in line with the technology-mediated learning methodologies. These limitations could affect the learning outcomes of students and bring about further digital divides in learning. Key findings from the analysis of data using the systematic analysis scheme using four parameters in table 4.4 are as follows:

4.4.3.1 Differences in the learning practices between classroom and everyday life

The first parameter A: *learning sets,* includes all attendant practices and activities as well as every constituent part of the learning process such as learner, teacher, one-to-one devices, and learning environment (Pachler, Bachmair, & Cook, 2010). In the context of technology-mediated learning, the process of learning can take place across formal learning spaces (inside school or classroom) or informal learning spaces (home or outside school). Therefore, learning may span across the established school practices, and practices pertaining to everyday life. Learning that takes place in either, a formal or an informal learning space is both equally important for that reason.

Analysis of the data shows that, activities other than learning dominate learner's usage of one-to-one devices in school and everyday life. According to the responses to the online survey, around 41% of students reported having spent most of their time on practices related to teaching and learning activities. However, the majority of students reported to have spent their time on activities other than learning; like social media, games, entertainment, and many other activities as shown in figure 4.4.

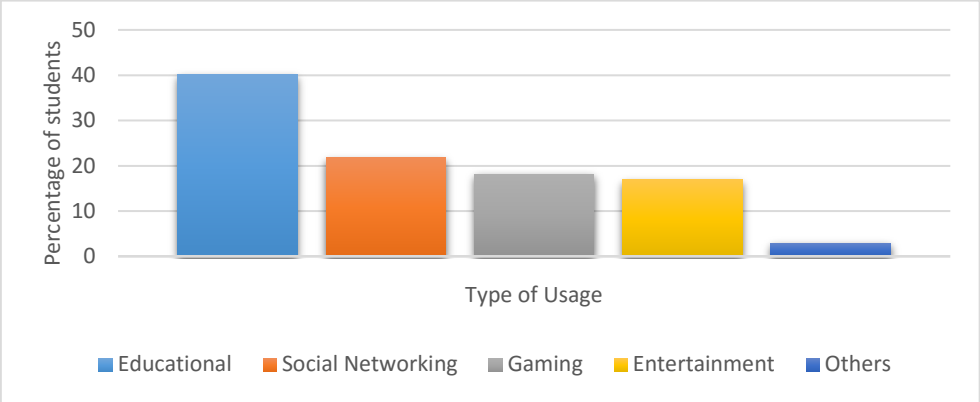

Figure 4.4: Students nature of digital technology usage

Digital habits prevalent in the convergent media world which are known to engage students in their everyday lives were not matched with the practices of using digital learning technology in classroom learning activities. This has probably generated a gap between the teachers and the students regarding their usage of one-to-one devices for the learning activities. In some cases, students became unmotivated towards the teaching methodologies and learning activities designed by teachers, creating a potential tension in the classroom teaching and learning environment. Situations of tensions between the teachers and students were also evident during some classroom observations. However, in some cases where teachers faced classroom management issues, these challenges were related to the level of device integration brought into the learning activities. More the students were required to use their devices for completing subject related tasks, the less classroom tension and management issues were

observed. With students busy carrying out learning activities using their devices they had less time to go off-task or be distracted.

In the first instance, teachers and the whole school approach treated this conflict as the students' unwillingness to participate into the classroom learning activities, and prepared a strategy to deal with the situation by applying certain rules and regulation around the usage of devices within classrooms. Despite the rules in the place, one teacher shares experience on the issue about this as:

> "*They all now have got command over their devices, and sometimes it is very difficult to say 'this is not what you meant to be doing, turn that off*".

One of the students from year 9 confirmed this and said:

> "*The real difficulty I suppose is the fact that a lot of people play games during classroom learning, I think the fact is that the games are so easy to get and so easy to swap between your work when teachers come around*".

Sharples (2002b) says the introduction of such one-to-one devices in learning could be a means for both opportunities and challenges for classroom education. He says, "*Learners can command an increasing range of mobile technologies that have the potential to support learning anytime anywhere, but also to disrupt the carefully managed environment of the classroom" (Sharples, 2002b, p. 1).* As the unruly digital behaviours of the students within classrooms were already evident, the observation of the classroom indicated that this has grown over the school year as students are becoming more and more digitally capable. One teacher said,

> "*Even if we know they are doing other activities or playing games, they can quit the games very quickly before we catch them".*

This implies as the students are becoming more and more digital savvy, they are quick at hiding their non-educational activities from the teachers. Inappropriate usage of one-to-one devices inside the classroom by students was a major concern for both the school and the teachers in seeking to develop positive attitudes and motivation of students towards learning activities in the classroom. This kind of situation in a classroom in the context of the technology-mediated learning process can be a worrying concern for teachers and school. Moving forward, the study found that the teaching methodologies and learning activities designed and practiced by teachers were unable to recognize the patterns and interests of technology usage in learning activities by students. This possible tension and disruption in classroom environment therefore could have been avoided by carefully designing pedagogical practices that can catch the attention and motivation of the young learners. Therefore, study has found a gap in terms of how technology is perceived for learning activities between teachers and students.

It has already been established that assimilation of formal and informal practices of mobile media is an important step to enhance the educational environment (Pachler, Bachmair, Cook, et al., 2010). However, school curricular practices are currently detached from how students use one-to-one devices in their everyday life. Few teachers in the BYOD classroom initiative have made their own attempt to include the practices and tools from students' technology usage in everyday life into the classroom learning activities. During the classroom observation, two very innovative attempts by teachers was observed. One teacher in Mathematics experimented with 'Google Drive' by designing several classroom activities based on that. Google drive is an evolving web 2.0 tools which combine different tools that allow teachers' and students' an opportunity to collaborate, create, and publish information on a cloud-based

environment. It also provides free storage space up to 5 GB, which allows students to access their information and materials from any device and any location. Another teacher in Digital Design had created a group in Facebook aiming to share small videos and brief information on different topics. The teacher invited students to join the group and encouraged them to communicate with each other on the social media platform, not only inside the classroom and inside school, but also outside school. These are the only few initiatives which have been found in BYOD classroom during the early days of the initiative, but it certainly indicates that teachers have been trying to identify appropriate teaching and learning methodologies and tools to motivate students in participating more and they are keen to embrace new methods into their classroom learning activities and instructional practices.

Nevertheless, data indicates the requirements of further effort to bring together the practices of digital technologies from the everyday lives of students into school practices to improve the participation of students with the learning activities. Engelhard and Kyeong-Ju Seo (2012) suggest that technology-mediated learning process should always embody the principle of openness and collaboration to enhance the educational environment. One of the ways to do that is to extend the formal learning practices by including informal digital media practices from students' everyday life into school curricular practices. Doing this could help to improve the attitude and motivation of students into teaching and learning activities using digital technologies, and pedagogic agents (i.e. teachers) certainly has an extra responsibility in doing so.

4.4.3.2 Traditional vs technology-mediated teaching methodology

The objective of the BYOD classroom initiative is to transform the way students learn by developing the information literacy and critical thinking ability, rather than requiring learners to repeat and memorize objectified knowledge passively. It aims to facilitate active and collaborative learning opportunities for every learner to enhance those skills and ultimately the learning outcomes. The socio-cultural ecological approach by Pachler, Bachmair, Cook, et al. (2010) adopted as an analysis framework for this study supports these curricular aims and argues that learning mediated by digital learning technologies should not just apply the functionality of digital technologies to current instructional practices. Instead, a central concern must be to understand how learners meaningfully engage with available tools and technologies within formal and informal learning environments to create spontaneous sites of learning (Sharples, 2007). In the context of the technology-mediated learning process, collaborative knowledge building is one of the effective ways to achieve user generated context, and support active 'passion-based' learning (Brown & Adler, 2008; Wunsch-Vincent & Vickery, 2007).

Before the roll out of the BYOD classroom initiative, every teacher had been provided with opportunities to attend professional development courses to facilitate applying of teaching and learning methodologies that matched the objectives of the initiative. That comprised a range of professional development activities conducted by the school, including peer-support workshops, training workshops conducted by academic and professional experts, attendance at conferences related to BYOD and other external training programmes, which supported the BYOD initiative. The school invested appropriately on training sessions with experts on the technology-mediated learning designs into the classrooms. Teachers were encouraged to consult with the experts and

discuss their plans to build an appropriate strategy to integrate one-to-one devices into their classroom instructional process. Despite the school's efforts in the professional development of teachers, classroom observations revealed that some teachers were not making efficient and innovative integration of devices into the classroom to maximise the use of one-to-one devices into teaching methods and learning activities. As an example, a teacher in one of the observation used the white board during the whole classroom session. The device was being used as just another medium to replace pen and paper. However, a few other representative cases revealed teachers utilizing devices to bring about innovative learning activities into classrooms. For instance, devices were being used for the discovery of relevant information through extensive internet searches from multiple sources, for cross checking the sources for correctness of the information, synthesizing all the captured information and presenting information highlights in graphical, audio and visual forms.

However, compared to the initial stage, the trend of teachers including different tools and methods into their instructional methods are now increasing over time. One of the major reasons for that is the availability of the peer-support group within the school, since the teachers who are on the forefront of innovative instructional practices are guiding other teachers. Peer-support groups are occurring through setting up of weekly meetings in which sessions are organized for everyone to share his/her experience and educate others about their accomplishments. One teacher's views regarding the peer-support is:

> "*Tuesday night we are basically expected to be there for sort of more formal gathering for learn and share things that you know. So, yes there is a lot of support there*".

While recognising the efforts made by the school in the professional development of teachers, it is important to mention that some teachers seemed to be making very little or superficial use of the one-to-one devices during their classroom teaching. Classroom observation sessions revealed that some teachers continued with their old methods of teaching and used one-to-one devices mainly as a medium to store and transfer the learning contents. One student says

> *"A lot of teachers still do teacher to classroom learning rather than one-to-one device learning. The teacher still will teach as they would otherwise other than with the one-to-one devices".*

This comment from a student too indicates that some teachers with low digital skills have less motivation to use devices; hence they continue to teach the same way as they used earlier and have limited the use of devices in their classrooms as a mere replacement for pen and paper.

Applying parameter B: *relationship to the objective of learning* to the BYOD classroom initiative in the wake of the findings above, continuation of traditional teaching and learning methodology, even by the very few teachers might hinder the transformation aimed from the initiative to develop the information literacy and critical thinking ability among students. For the students to be able to reconstruct the knowledge in the learning process, the method of instruction should enable the learners to participate in anytime anywhere learning with the ability to create, collaborate, share, and publish with teachers and students irrespective of the learning spaces they are in (Crow, 2010). The collaborative learning environment could only be created by using a wide range of convergent digital media tools and applications in the

instructional activities. That could improve their learning outcomes as well as experience among learners.

The results of the survey data have shown the variations in the level of digital skills among teachers to provide a possible explanation for the continuation of traditional methods of instructional practice by teachers in the context of the BYOD classrooms. Even though majority of the teachers has advanced or competent levels of digital skills, a significant number of teachers reported having an intermediate or basic level of digital skills as shown in figure 4.5.

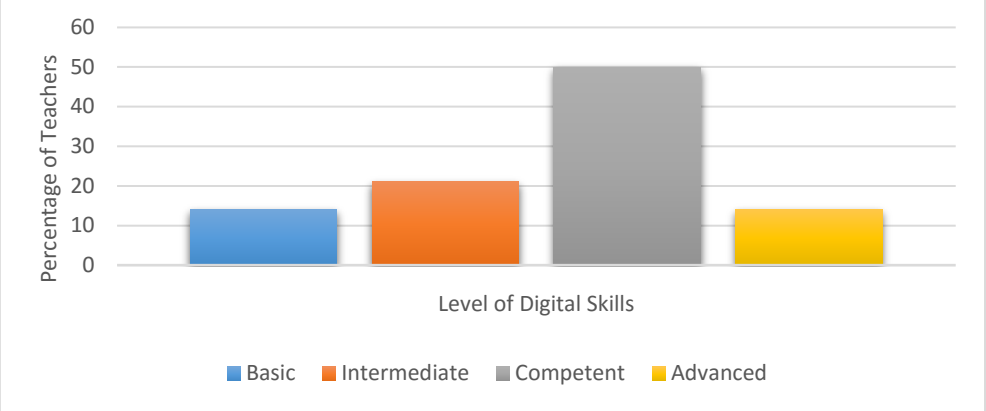

Figure 4.5: Variations of digital skills among teachers

Given the intermediate or basic digital skills among some teachers, finding innovative ways to integrate one-to-one devices into their classroom learning practices remains a challenge. In addition to that, the results also indicate towards the increase in workload for teachers as one of the major challenges, as the planning, preparation, design and development of learning contents and activities for the new teaching methodology and learning activities demanded more time and effort.

However, there is no alternative to bridge the gap between mimetic reproduction and personal reconstruction of the knowledge. Teachers could encourage learners to participate in learning activities by allowing them to bring their everyday life practices

of using digital technologies into classroom learning. This can be done by carefully considering the use of online social media and web 2.0 tools for instructional practices to create a participatory and collaborative learning environment. This strategy of designing classroom learning activities may motivate students to actively participate into learning process. This may gradually reduce the teacher's role in the learning process and increase the ability of learners to lead their learning by creating their learning context and contents.

4.4.3.3 Convergent digital media applications within the method of instruction

Literature shows that learners are quick to embrace and are making more and more use of available tools and technologies in their learning and everyday activities (Engelhard & Kyeong-Ju Seo, 2012). This matches with the observations from the BYOD classrooms where young learners are very creative in terms of using one-to-one devices in different activities and they can learn new things very quickly. With the carefully designed lesson plans and learning activities by few teachers, students had to be given very little input and support to carry out the learning activities. For example, students were eager to go and find relevant information from the carefully selected internet sources provided by the teacher, then combine all that information in a coherent form and prepare various presentation modes via blog posts. Some classes where teachers were more technology savvy were raising the bar of technology integration into the curriculum and learning activities. However, the digital skills and readiness of the students played an important part in making this happen. The data in figure 4.4 shows that learners' usage of one-to-one devices includes more and more use of online social media and web 2.0 tools for the everyday as well as learning

activities. By using these applications and tools, they get opportunities to create, collaborate, share, and publish the contents in a matter of minutes, leaving them feeling accomplished and empowered. Therefore it is an important question though that, if schools and teachers are keeping up with the usage of digital technologies (Collis & Moonen, 2008; Engelhard & Kyeong-Ju Seo, 2012) to match that of the students. Use of convergent digital media and web 2.0 tools are growing exponentially in the everyday life of the young learners, but whenever they come to the classroom, the possibility of being able to use those skills into their learning activities are slim. This shows that, teaching methodologies practiced in schools and educational institutions are lagging behind in embracing the opportunities offered by those technologies.

Applying parameter C: *Institutional emphasis on expertise* in the BYOD classroom, there is a scope for school in recognizing personal expertise of learners' and including those into the school curricular practices. One of the ways to do that is to include a teaching and learning platform into the curricular practices that can enhance the educational experience of the learners and empower teachers to facilitate technology-mediated learning practices in their everyday teaching. Specifically, a learning management system that allows teachers and students to communicate, collaborate, create, share and publish their learning activities in a real time would contribute a lot to the objectives of the BYOD classrooms initiative.

The school in the context of BYOD classroom is using an online learning platform called Ultranet[4], which provides a wide range of features and functionality, which is helpful for teachers, students and for parents. Broadly, Ultranet's functionality can be

[4] **Ultranet** is a New Zealand-based learning platform for schools.

described as covering three distinct areas, or what they like to call the 'three spaces' (Ultranet, 2012):

- **ClassSpace:** This is essentially the heart of the system, providing individual virtual classroom spaces for students and teachers to interact - like the physical classroom, but made available online. Here is where anyone can find collaborative learning, resource sharing, online task and activity management.
- **uSpace:** This is the personal learning area of Ultranet, where students will find the social learning network with ePortfolios integrated. They can also share any media and create their blog.
- **WebSpace:** This is the public aspect of Ultranet, and schools set up their main website pages to publish information about themselves and news to the public.

During their implementation of the Ultranet's learning platform, the school decided to disable some of its features and functionality. While these policy decisions have been made for good reason, they nevertheless pose a limitation for students and teachers on collaboration and communication on the learning platform.

One of the major parts of Ultranet's - uSpace - has been purposefully built to improve and encourage the students' participation in learning activities by providing tools and applications to collaborate and communicate. The uSpace provides a personal learning area for every student that contains safe social networking, blogs, media sharing and ePortfolios. This can enable every student to collaborate with teachers and peers, since it has been designed in such a way that this could utilize practices of digital technologies from students' everyday life for learning. Unfortunately, this module has been made unavailable in the school's implementation of Ultranet.

Although, the teachers who are innovative in learning design are making use of the external tools and media like Facebook and Google to accomplish the task. However, it is very important to acknowledge here that those capabilities could have been accomplished by uSpace in Ultranet. Some of the other features have also been disabled from Ultranet including features like online homework submission, causing majority (in fact all) of the teachers to use either email or some third party cloud-based services (e.g. drop box) for the purpose. Only very basic features like resource sharing and media publishing are currently included in the online learning platform and that too from only from the teachers' perspective.

Given the school's decision to integrate one-to-one devices into learning process, earlier policies about the implementation of Ultranet may need to be reappraised. On one hand, the school is adopting technology-mediated learning to promote collaborative and active learning, whereas on the other hand, the reduced features in Ultranet might be limiting the learning opportunities of the students. By bringing the functionality of different digital media applications and web 2.0 tools within the realm of the school curriculum and instructional practices, digital media expertise of the learners may be better utilised into formal learning activities.

4.5 Conclusion

When digital technologies and tools are integrated into the teaching and learning practices, various factors dependent on learners like adequate level of access to technologies, motivation and attitude towards learning activities, nature of their technology usage for learning and learners' capability of meaning making could affect learning activities of learners in both formal and informal learning spaces. At this stage, only the findings of the baseline data have been presented. Studies on how

learners use digital learning technologies in different learning spaces and what could affect their learning activities in formal as well as informal learning spaces in the context of technology-mediated teaching and learning are very limited. However, the BYOD classroom initiative and the theoretical framework adopted for the study helped to generate a comprehensive research agenda for further investigation by following additional lines of enquiry of digital divides in the learning environment for the next stage of the study.

The next focus of the investigation moves to curricular practices adopted and how these practices can help in addressing the issues identified during the analysis of the baseline data.

NOTE: Chapter 4 is a partial re-print of two articles:

- Adhikari, J. & Parsons, D. (2012). Bridging digital divides in the learning process: Challenges of integrating ICTs in learning. In M. Brown, M. Hartnett & T. Stewart (Eds.), *Future challenges, sustainable futures. Proceedings ascilite Wellington 2012*. (pp. 2-4).
- Adhikari, J., Parsons, D., & Mathrani, A. (2012) Bridging digital divides in the learning process: Challenges and implications of integrating ICTs. In M. Specht, M. Sharples & J. Multisilta (Eds.), *Proceedings of the 11th International Conference on Mobile and Contextual Learning 2012* (pp. 224-227).

The thesis author was the primary investigator of these articles.

Chapter 5: Follow-up Data Analysis

5.1 Introduction

This chapter analyses the BYOD classrooms implementation as the adoption stage moved in the period from mid-2012 to mid-2014 (refer Table 5.1). During this time, the initiative had moved from initial controversy in the local press over the proposals, through a pilot year, to an ongoing process of staged implementation to other year groups in school. This project had also gained national interest, with the school too having run two conferences to share their teaching and learning experiences with other schools and interested parties. During this stage of research, a number of methods including surveys, interviews, classroom observations and workshops were employed. Some of the previous work relating to the early stages of the BYOD project has been published (Adhikari, Parsons, & Mathrani, 2012).

Table 5.1: Stages of data collection (2nd stage)

Stages	***Data collection timeline***	***Data collection methods***
Stage 1: Baseline	Early to mid-2012	• Open-ended surveys with students, teachers, and parents • Classroom observations in targeted subject areas
Stage 2: Follow-ups	Mid-2012 to mid-2014	• Semi-structured interviews with a randomly selected sample of students, teachers, and parents • Two rounds of open-ended follow-up surveys with students, teachers, and parents
Stage 3: Summative	Mid-2014 to late-2016	• Two rounds of semi-structured interviews with teachers

Overall, the research activities in this stage were focused mostly on finding the answer to the second research question about digital capability divide (i.e. *How have the digital capabilities divide evolved because of the BYOD classrooms?).* This stage of

analysis also briefly revisits the access and competencies divide issue discussed in the earlier chapter, and touches on how digital capability might influence the next level of digital divides in learning (i.e. learning outcomes divide) before investigating at the next stage of study. Therefore, analysis at this stage bridges digital access and learning outcome divides.

5.2 Data Collection and analysis

The source data for this stage of analysis comes from multiple sets of evidence, including interviews, surveys and classroom observations. A total of 26 one-to-one semi-structured interviews has been conducted (with 10 students, 9 teachers, and 7 parents). Nine classroom observations carried out for the baseline data in target subject areas (Mathematics, Science, Physical Education, and Digital Design) have also been used in combined analysis later.

In addition, online surveys have been administered in three rounds from early 2012 to mid-2014 (including one from the baseline round). There were three separate sets of questions administered in each of these years, to teachers, parents and students at the school. There were no sampling criteria to include or exclude any members of these groups. Study did not record any demographic data, but the students concerned were primarily from year 9 (first two surveys) and some from year 10 (third survey), so would be aged around 13-14. The gender balance at the school is approximately equal. As part of the low-risk ethics process under which the research was undertaken, the surveys were all anonymous and voluntary and publicised through the usual school communication channels (e.g. school newsletters). The researcher designed the surveys which were reviewed by the school authorities. The questions were not identical in each survey because the surveys aimed to address a range of issues over

time. The survey in all instances were conducted online via Qualtrics (an online surveying tool). The numbers of fully completed responses to each of the surveys are shown in Table 5.2. The school roll is approximately 2,000, but only one year group was involved in the pilot year (2012), and the programme has only slowly expanded through other year groups . Despite limitations of the lower response rate among students and parents, the amount of data gathered in these surveys is substantial and combines both quantitative (multi choice, ordering, Likert scale) and qualitative (free text) data.

Table 5.2: Numbers of respondents to each survey

Respondents	**2012 (Baseline)**	**2013**	**2014**
Teachers	14	40	63
Parents	5	71	50
Students	56	98	41

Follow-up stage of investigation can be categorised into two parts. Firstly, understanding and uncovering deeper insights about the evolution of digital divides in learning (focused more on digital capability divide). Secondly, gaining an understanding on the changes occurring within curricular practices and the evolution of the BYOD classrooms over the years.

5.3 Evolution of digital divides issues

This part of the analysis is focused to gain the deeper insights about the digital access, digital capability, and outcome divide issues in the context of the BYOD classroom initiative. 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 5.3 shows the major themes that

emerged from the coding of interviews, classroom observations, and survey text responses data.

Table 5.3: Coding of the interview, classroom observation and online surveys.

Code No.	Coding Themes	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 which emerged from the coding of the qualitative data, almost all of them relate to the factors being considered for the three level digital divide in learning framework (Figure 5.1). Code C1 (students' level of access to ICTs) relates to digital access divide, C2 and C3 (level of digital skills and information literacy in teachers and students and ICT usage patterns) refers to digital capability divide, and rest of the themes (C4, C5 and C6) which emerged relate to the digital outcome divide. Therefore, the results are organised in the structure of the three level digital divide model (digital access divide, digital skills divide and digital outcomes divide) in Figure 2.2.

5.3.1 Digital access divide

Baseline stage of analysis identified a potential gap among students in terms of the level of access to digital learning tools and technologies across both formal and informal learning spaces. Moving forward, interview data at this stage provided in-depth insight into this issue and confirmed 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 held with parents' also backs up the student responses. When asked, did they think of providing one-to-one learning devices for their child; one parent said:

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

Another parent in interview 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".*

The above response represents the situation of the many parents, who decided to go for cheaper, non-recommended options in a bid to make something available to their children. This has however resulted into other concerns like compatibility and comparison with the recommended device. Interview responses from student

indicated that some students have been unable to carry out usual learning activities because of compatibility of the teaching methodology, learning activities, tasks and procedure defined by keeping recommended device in mind. Regarding compatibility issue, one student voiced:

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

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

Despite some limited degrees in access to digital tools and technologies, or compatibility issues which limit ability to participate in learning activities or technological issues like quality of internet access in school, the BYOD classroom initiative has certainly provided greater access levels with digital learning technologies for learners. This has been found to be improving gradually. In addition, connectivity to internet at homes has improved in the subsequent years, which has also contributed to narrowing down of the gap in access to digital technologies and resources for students. Looking into the positive change in digital access divide, BYOD classroom initiative can be considered an enabler in this context.

5.3.2 Digital capabilities divide

According to three level digital divide in learning framework (refer to Figure 2.2), 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 capability for both

students and the teachers. Some level of capability issues had been reported initially, but that seem to have improved in the second set of survey data.

5.3.2.1 Digital/Information literacy

In the latest survey, overall digital skill levels of staff appeared to be slightly lower in the 2014 survey than in 2012 (Figure 5.1). 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 digital skills of overall staff cannot be expected 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 technology-mediated teaching and learning over the last 2 to 3 years the staff became more judgmental 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 skeptical of their own skills.

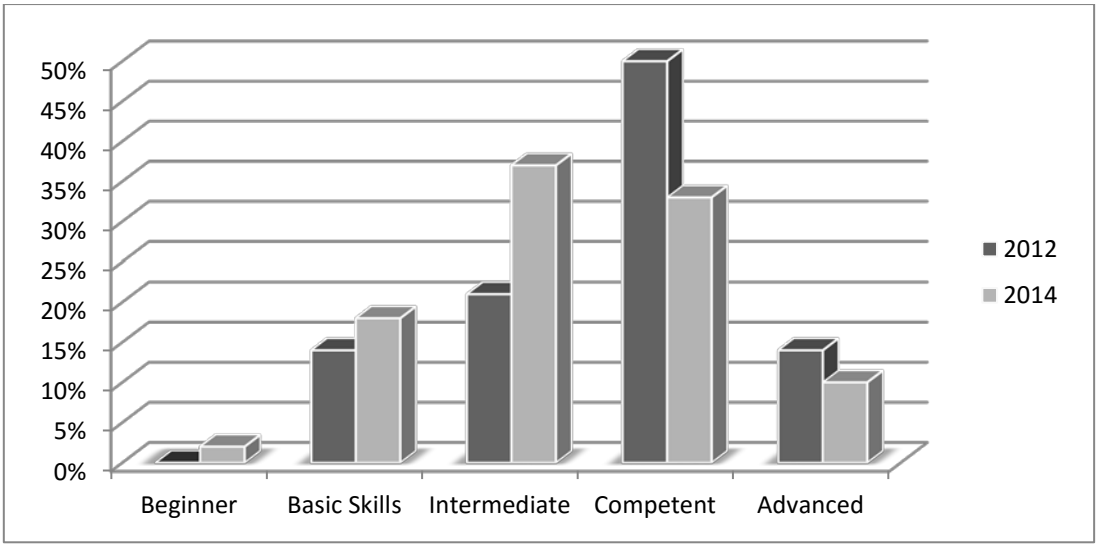

Figure 5.1: Staff skill levels in digital technologies

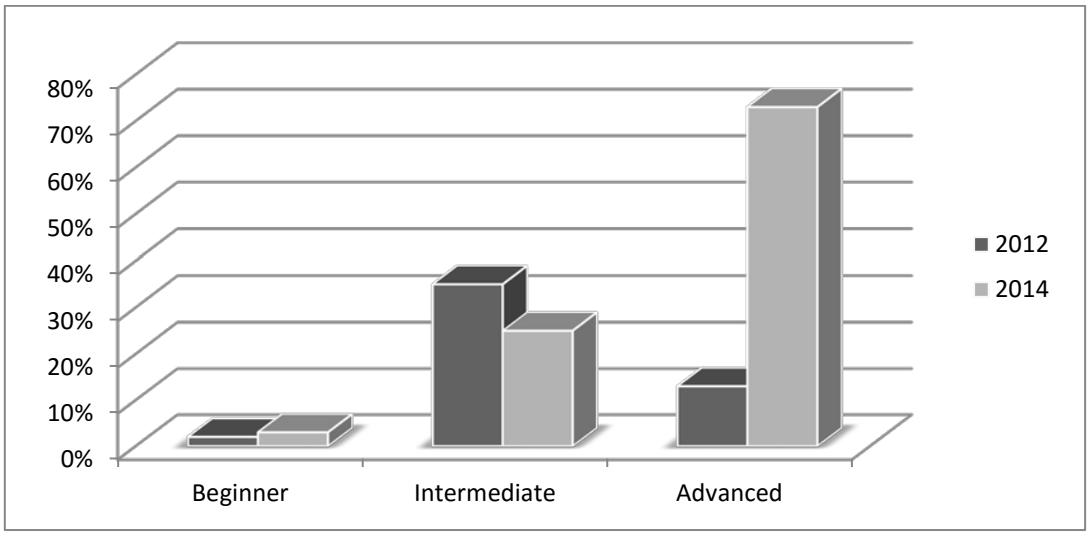

Figure 5.2: Student skill levels in making meaningful use of digital devices in learning activities

From the survey responses of students shown in Figure 5.2, it should be noted that somewhat different questions about their levels of skill in making meaningful use of digital devices in learning were asked. 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, the potential for the learner agency has increased over time.

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, 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 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, the attention has been extended from digital skills to information literacy. The reason is, digital skills may not be the only key factor that determines the learning outcomes of the students anymore. Students may have very good digital skills to operate one-to-one devices but if they do not have enough skills to process and apply the information given to them, and have a lack of critical thinking ability to recreate knowledge, they might still struggle in achieving desired learning outcomes. Data suggests that a significant proportion of students clearly struggle to find process, apply information, and make meaning out of the information available into their learning activities. Therefore, to achieve better learning outcomes in the technology-mediated teaching and learning practices, it is necessary to consider information literacy skills (ability to think critically to re-create knowledge from available information) and computer self-efficacy (competitive use of available technology) among students, which is some of the focal constructs in our framework.

These results indicate that information literacy skills and computer self-efficacy 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 and computer self-efficacy, on the other hand, is evolving as an aspect that needs more in-depth investigation in the technology-mediated learning context.

5.3.2.2 Nature of technology usage by learners

Data indicates diversity in students' nature of using one-to-one devices in school as well as in their everyday life. Overall, their usage patterns have not changed across the surveys. However, there is a small increase in device usage for learning activity related purposes and that indicates the positive trend in student motivation for BYOD classrooms. Nevertheless, interestingly, there remains a large number (around 50%) of students reportedly spending most of their times around non-learning activity related activities like social media/communication, games and other forms of entertainment (as shown in Figure 5.3).

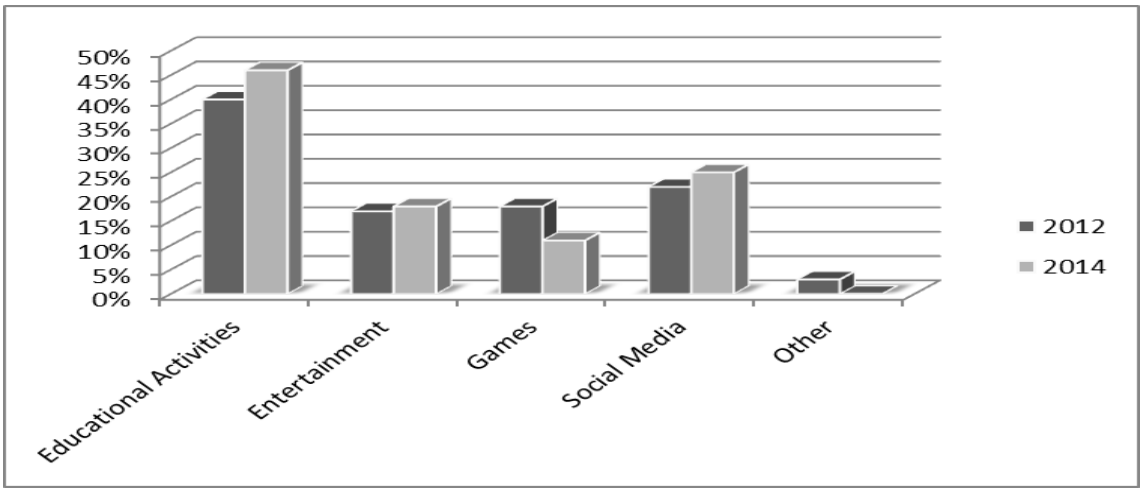

Figure 5.3: Student's nature of technology usage in school and at home (self-reported)

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 having some disruptions because of that. Although the school has taken a few 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 behavior 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".*

One of the other finding related to the digital capability is that, 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-mediated learning, limiting parents' ability to monitor digital activities and support learning of their children. In a different study, Newhouse et al. (2014) 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."

"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."

While 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 such behavior from the school where this research is based on. Having said this, it is still an alarm bell for schools and parents involved in the BYOD classrooms or similar technology-mediated learning initiatives.

5.3.3 Learning outcomes divide

Having 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 possess digital skills to operate one-to-one devices but if they do not have enough information literacy and computer self-efficacy 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:

5.3.3.1 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, it was observed that 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 identified aspects of learning tasks, which has been designed and appreciated the new way of learning. They reported BYOD classrooms to be clearly much more relevant and useful since it supported them in learning and through critical analysis.

In the surveys, students expressed positive comments in support of the BYOD classroom initiative, and explained how it brought positive changes 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. With devices, students are provided with an opportunity to collaborate on a task in real time, leading to more online interactions, as they become more technology savvy. One student comment sums up the benefits of BYOD classrooms initiative 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."*

There were, 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. Parents too in their interviews as sometimes reflected these concerns:

> *"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."*

Overall, the BYOD initiative led to transforming of the traditional form of teaching and learning, with students 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 a latter group, it all came down to limited information literacy skills to think critically, and computer self-efficacy to identify, process and apply information into their learning activities. Therefore, after the change in dynamics of the classroom due to BYOD classroom initiative, it became more relevant to investigate aspects of information literacy and computer self-efficacy instead of digital skills.

5.3.3.2 Attitude and motivation of students

As expected, the majority of learners find BYOD classroom initiative a great idea and seemed to be happy with the changes in everyday 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 5.4 below. Issues that were raised related to the incompatibility between different types of learning devices used within classrooms, quality of internet connection at school, concerns regarding the assessment method of NCEA exam. Despite these issues presented as the barriers and cause of the lack of motivation, overall deeper look at the issue shows the lack of relevant information literacy skills (not being able to find, process and apply appropriate information) for their learning needs as the root cause.

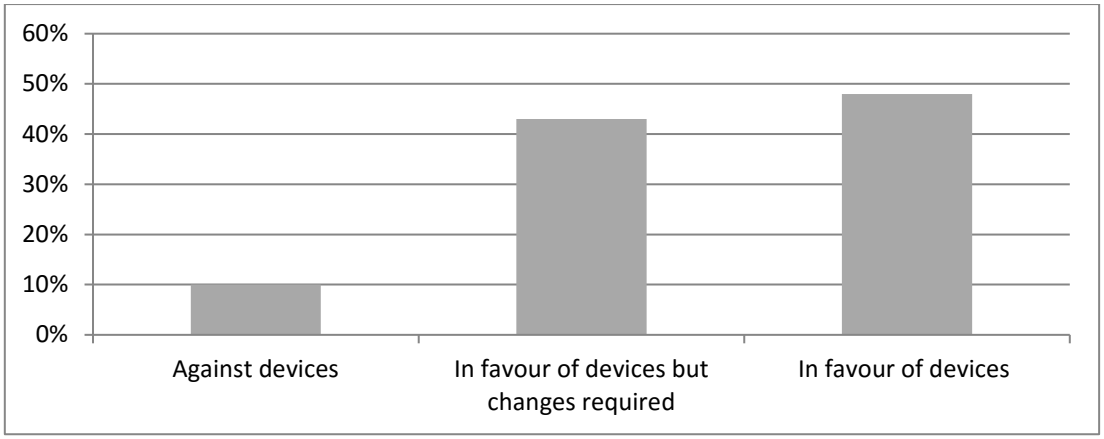

Figure 5.4: Student support for digital devices in learning measured by self-reported percentages

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 from the way NCEA[5] 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. Further, looking into their responses, a large number of students revealed some degree of worry about how BYOD would impact their performance in NCEA exams. This can potentially be one of the reasons behind motivational issues identified during the later stage of BYOD classroom initiative.

5.3.4 Summary of analysis related to digital divide issues

The integration of digital learning tools and technologies has the ability to transform the teaching and learning process. Results so far show that access to digital media has

[5] The National Certificate of Educational Achievement (NCEA) is the official secondary school qualification in New Zealand. It was phased in between 2002 and 2004, replacing three older secondary school qualifications. The New Zealand Qualifications Authority administers NCEA

improved at a phenomenal rate because of the BYOD classroom initiative. Findings do not provide any evidence of a widening gap in digital access and skills for both students and teachers. Some issues in digital skills levels were reported initially, but that was found to be improving gradually. As students interact with digital media and resources for learning activities, they become more aware of digital skills which in turn are reflected in their perception of self-efficacy measurements (Deursen & Van Dijk, 2015). Teaching methodologies and learning activities are constantly evolving within the context of BYOD classrooms and 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, the focus of investigation moved towards information literacy and computer-self efficacy to understanding of what effect it has on the learning outcomes.

This 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), predicators of digital access divide 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 learning devices (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 internet connectivity at home?). This leads to the second level or digital capability divide. In this level, study identified factors related to learning activities in formal and informal spaces (e.g., what is the ability or digital/information 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.

The interaction amongst these three digital divide levels forms the basis of how learning technologies establish a pathway towards learners' academic and social development.

5.4 Evolution of BYOD classrooms

This part of the analysis is focused in understanding of the changes occurring within the social, cultural, and educational aspects around the initiative and the evolution of the BYOD classrooms and it's curicular practices since the initiative was launched.

The focus is now on the broad spectrum of contexts within which a move to digital teaching and learning operates. The BYOD classroom initiative affects not only on the learning activities within the classroom but also affects those that take place in informal learning spaces like home. Therefore, we need an analysis framework that can help to frame the analysis across both learning spaces. The socio-cultural ecological framework for mobile learning by Pachler, Bachmair, Cook, et al. (2010) analyses interrelationships between three components, namely structures, agency and cultural practices, within formal and informal learning spaces mediated by one-to-one ICTs, and is therefore used for the purpose of this analysis.

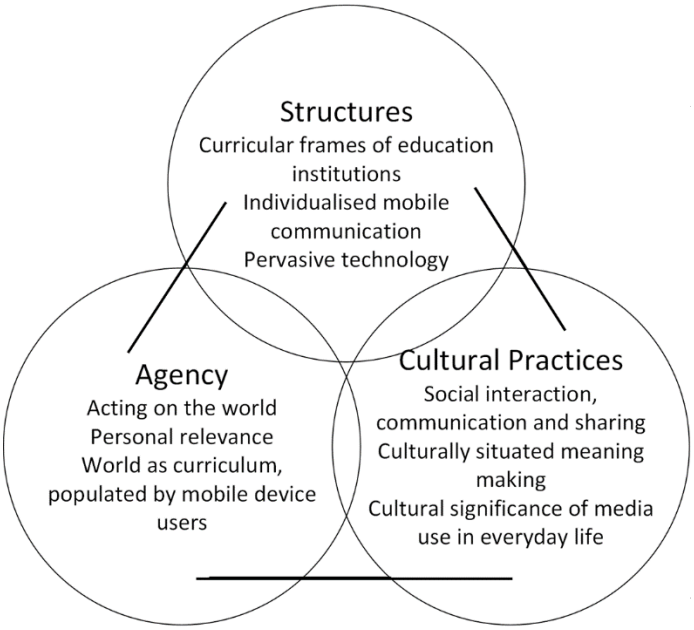

Figure 5.5: The sociocultural framework used in our analysis adapted from (Pachler, Bachmair, Cook, et al., 2010)

The role of agency, which is particularly powerful in a BYOD context, where learners have already appropriated their own devices, means that the presence of digital devices is only the starting point. The way that learners operationalize their own agency defines the actual role of these devices in the classroom; "a tool is what it is used for" (Bannon & Bodker, 1991, p. 238). On a similar theme, MacKenzie and Wajcman (1985) note that that specific technologies succeed or fail for a number of contextual reasons that derive from both structure and culture. For example, teachers (across different subjects) often utilise mobile devices in their classrooms in very subject-specific ways, and this may not be an ideal manner to be replicated for every situation (Parsons, 2013).

Once digital tools are adopted, over time there is a two-way process through which the use of these tools changes the learning activities where they are applied. The structure within which this happens is important, but the tools can, in turn, impact on that structure. In this model, for example, using digital tools within a curriculum has an

impact on that curriculum. This concept has previously been referred to as the "coevolution" of tasks and artefacts (Carroll, Kellogg, & Rosson, 1991), and the "reciprocal shaping" of technology and society (Brosveet & Sørensen, 2000). There are also echoes of McLuhan here, where we ourselves are extended by technology use (McLuhan, 1964).

The analysis seeks to identify data that relates to the specific themes within each of the three concepts of the sociocultural framework and, where possible, the relationships between them. The data is gathered from the perspectives of three different stakeholder groups; teachers, students and parents. Thus, the analysis is focused on different participant perspectives.

This study's results are presented under the main concepts of the sociocultural framework in Figure 5.5, which has been adapted for the purpose of this study. The framework is used as a means to analyse the technology-mediated teaching and learning context related to structures, agency and cultural practices with the evolution of curricular practices within the BYOD classrooms. This analysis is primarily qualitative, but some quantitative results have been included where they relate to the themes of analysis. Qualitative data has been analysed in groups based on respondent type. This allowed the study to identify variations in themes between these three stakeholder groups. In the qualitative analysis, in an attempt to identify core themes across the BYOD initiative, data from the surveys and interviews has been analyzed as a single data set. However, the quantitative data has also been searched to identify any changes that are evident over time. These comparisons have to be interpreted with the proviso that the same questions were not asked exactly as they were in each round of data collection, and it is not known to what extent the same parents, teachers and students were included.

5.4.1 Qualitative coding

Qualitative data were analysed in NVivo, coded using emergent themes (developed from repeated ideas) and subsequently gathered together under predefined broader constructs (Auerbach & Silverstein, 2003). Following a simple content analysis of repeating ideas, the broad emergent themes are outlined in Table 5.4, cross-referenced by construct and stakeholder role. These themes have been drilled down further as they are discussed within each stakeholder group in later sections.

Table 5.4: Constructs and themes by stakeholder role from the qualitative data analysis

Construct	Teacher Themes	n	Student Themes	n	Parent Themes	n
Structures	Classroom (curricular) practice	15	Technology Affordances	22	Devices in school	13
	Technology limitations	19				
Agency	Classroom roles	10	Enabling	83	Student agency (positive)	34
	Equity	11	Restricting	66	Student agency (negative)	23
	Giving students agency	24			Parent agency	20
Cultural Practices	Digital pedagogy	21	Interactions with others	14	Family dynamics	31
	Student practice	6				

From the rather general themes identified within the three main constructs of our analysis, a few observations can be made. The teachers tended to address a broader set of themes in their responses across all three constructs. Further, their negative experiences were confined only to the structural limitations of technology (e.g. occasionally unreliable wireless connectivity) rather than to any fundamental misgivings about the BYOD innovation as a whole. They also focused strongly on various aspects of the changes taking place in classroom practice; the changing roles

of teachers and students in a classroom where student agency was increased through the use of digital devices, and the potentials of new digital pedagogies. In contrast, the students reported primarily within the agency construct, with little reference to cultural practice and, like the teachers, a structural focus on the technical infrastructure of the BYOD learning environment. Although a majority of student responses reported that BYOD was an enabling innovation, there were also many concerns expressed around the potential restrictions on agency. These ideas will be explored in more detail later in the analysis. Parents' views on structures, given that they had no direct experience of the wireless infrastructure or device use in the classroom, focused more on the provision and value of the learning devices within the curriculum. In focusing on agency, like the students, there was a split between both positive and negative views of the effects on learning, though once again, positive views were in the majority. Another major issue was parental agency. Many parents felt excluded from the digital experience of their children in various ways, as discussed later. Impact on the family was the key concern in terms of cultural practice, and many parents chose to reflect on the perceived impact of the change in learning styles on the way their children behaved at home.

Overall it can be seen that the teachers responded most positively to the BYOD innovations, and parents had the most reservations. Students provided a range of views, both positive and negative, but all of which can give insights into the impact of the BYOD programme. In all three of these stakeholder perspectives, the power of agency can be noted. Teachers, who have the most agency were the most positive about the move towards BYOD classrooms, while parents, who have the least agency, had the most reservations.

5.4.2 Structures

Structures are the most straightforward of the three concepts encompassed by the model. Simply put, they relate to the BYOD devices, the technological infrastructure within which they are used, and the curriculum within which they are applied. Table 5.5 shows the repeated ideas in the structural themes.

Table 5.5: Themes and repeated ideas from the 'structures' construct

Structures	Themes	n	Repeated Ideas	n
Teachers	Classroom (curricular) practice	15	Changes in delivery of learning	10
			Differing approaches by different teachers	5
	Technology limitations	19	Connectivity issues	6
			Software problems	7
			Layers of complexity	4
Students	Technology Affordances	22	Network infrastructure	3
			Device affordance	12
			Non-digital curriculum	7
Parents	Devices in school	13	Device support	6
			Curriculum in society	7

Teachers' responses around the construct of structure focused on either classroom (curricular) practices or technology limitations, since the curriculum had been impacted by the introduction of digital devices, with a knock on effect on infrastructure dependency. In terms of curriculum structure, classrooms were more devolved, collaborative, group based and student centric. Teachers here tended to express very similar views, the following comment being typical:

> *"The focus in the classroom has changed, very student-centered. Inquiry learning style is the norm and sharing is an important component of the class environment. Front of the room instruction is less important, in fact there is not really a front of the room. Have been experimenting with different classroom set outs."*

References to different approaches used in classroom practice by other teachers were more equivocal. Some teachers were evidently somewhat resistant to change:

> *"Big gaps in pedagogical practice showing between those with devices and who are using them and others who aren't."*

There were several comments that related in some way to the layers of complexity introduced by digital tools. One example was:

> *"Remembering a plethora of passwords."*

When students commented on structural elements, a few referred to some issues with the wireless infrastructure, but a larger number expressed concerns about the affordances of different devices, with an emphasis on the relative merits of iPads and laptops. Some commented about the disruption of being in classrooms with a mix of devices. Another significant set of ideas related to the non-digital curriculum, in the sense that there was a keenness not to let digital devices take over all teaching and learning activities. This example is indicative:

> *"Occasionally I think we should be able to make big awesome projects with crafts and stuff without the iPad."*

When it came to the parents' responses, most of the comments relating to device support were around the provision and maintenance of the devices themselves. One other comment in this theme related to a somewhat different aspect, that of equity, an issue highlighted by (Bruder, 2014).

> *"The homework set was assuming that everyone had broadband which we didn't because I couldn't afford it as I was paying off a tablet (we now have it)."*

The other repeated idea in this theme was the role of a digital curriculum as it relates to 21st century society. The following comment was typical:

> *"I think it's the way of the future, and when they leave school they will need to know this technology."*

The quantitative data from the surveys also provided some useful insights into structural components. In terms of pervasive technology, the wireless infrastructure turned out to be more problematic than was first anticipated. In the 2012 survey, only one member of staff expressed concerns about network connectivity. Having actually experienced device use in their classrooms, twenty teachers expressed issues with network connectivity in the 2014 survey. Thus, it has been noted, how structures may act as constraints to agency.

When analysing individualised mobile communication, one interesting finding from the data was that the proportion of students who were using a non-iPad device actually appeared to increase between 2012 and 2014, from 4% to 19%. Most of this change was due to students using laptops. One reason given for this by a parent was due to the different handling of the laptop; some iPads were carelessly exposed to accidental damage by other students.

> *"He has a laptop now as his iPad kept cracking"*

Another motivation, again expressed by a parent, was the greater power of a laptop.

> *"We had no problems with the iPad but now he is getting more specialized it appears we may need a Mac to accommodate his learning requirements."*

This time a more positive relationship has been found between structure and agency, with choices being made from the perspective of potential benefit.

Looking at the curricular frame of the institution, most of the curriculum in New Zealand schools is driven by the National Certificate of Educational Achievement (NCEA), which is the main national qualification for secondary school students. NCEA results are recognised by employers and by higher education institutions both

nationally and internationally. In most subjects, students sit externally assessed examinations. Within this external constraint, it is clear that the in-school curriculum cannot freely evolve. Thus, the changes observed within the curriculum are confined to changes in the way that the existing content is delivered. The most common change to curriculum delivery within the school is that work has become more research based. When asked what changes students had noted in their learning (2014 survey) around 25% of the students referred to benefits for research, some explicitly. For example

> *"I have noticed that research is a lot easier for classes", and "faster to do work and better access to information"*

Despite these positive effects, some parents, teachers and students were concerned about the dissonance between digital teaching and learning and traditional written exams.

> *"It concerns me that NCEA is seemingly lagging behind with assessing our students." (Teacher, 2014)*

Although the future strategy for NCEA includes at least some online assessment (NZQA, 2013), in the short term the school has to prepare its students for written exams. This is a major constraint by structure on both agency and cultural practice.

5.4.3 Agency

One of the core components of agency is the ability to act on the world. In the context of BYOD this means having a suitable skill set for making optimum use of digital tools, thinking critically, processing and applying the information to create new knowledge. Table 5.6 shows the repeated ideas in the agency themes.

Table 5.6: Themes and repeated ideas from the 'agency' construct

Agency	Themes	n	Repeated Ideas	n
Teachers	Classroom roles	10	Changing the teacher role	7
			Resistance and dissent	3
	Equity	11	Enabling individual attention	6
			Students assisted by devices and peers	5
	Giving students agency	24	Not digital natives	6
			Directing learning	9
			Devices enabling agency	9
Students	Enabling	83	Higher productivity	13
			More enjoyment of learning	9
			Better learning outcomes	12
			Ease of access to resources	45
			Ease of communication with others	4
	Restricting	66	Off-task behaviour (self)	18
			Off-task behaviour (others)	9
			Reduction in skills	33
			Physical impediments	6
Parents	Student agency (positive)	34	Increased motivation	14
			Improved performance	6
			Digital skills development	6
			Improved self-management of learning	4
			Benefits for students with learning difficulties	4
	Student agency (negative)	23	Impact on reading and writing	4
			Difficulties migrating to digital teaching and learning	15
			Lack of visible agency	4
	Parent agency	20	Homework is hidden	8
			Lack of digital skills to support students	5
			Unwillingness of students to give parents agency	7

Teachers noted that their agency in the classroom had undergone a change, usually in terms of progressing towards new roles within the classroom. The following quote indicates an example of this change.

> *"As a 'non-techie' I was keen to be involved but terrified. As the year has progressed I feel I have become far more competent, confident and really ready to take things further."*

However, another aspect of teacher agency was the tendency of some to resist and dissent, opposing imposed changes of practice. One teacher questioned the level of consensus within the staff:

> *"Consensus on the popularity of the BYOD program within school is much more varied than I believe the school realizes."*

Equity was explored from two dimensions; teachers being able to be more equitable in their teaching, and students gaining a more equitable agency in the classroom due to the support of devices and peers.

While many teachers appear to want to give students more agency in the classroom, it appears that there are several barriers. One is that teachers have found that many of their students are not 'digital natives' and cannot naturally work effectively with technology without considerable guidance. 'Digital natives' is the term used to refer to the generation group who have been born and raised with digital technologies, and it is widely believed that they can perform better in the digital/technological environment compared to the generation before them (Dingli & Seychell, 2015; Palfrey & Gasser, 2011). However, there seems to be a gap appearing between the actual ability of digital natives and the expectations from them. One teacher shares the view on the conceptions made around the term 'digital natives'.

> *"Students not being the digital natives they are purported to be. They are VISUAL natives rather than digital."*

As a result, a greater level of teacher agency is required to direct the digital classroom than some teachers expected.

> *"Biggest unexpected so far has been the amount of explicit instruction and direction students have needed to both drive the device and their own learning using it."*

Notwithstanding these issues, teachers also reported various ways in which they could transfer agency to students through the support offered by digital tools. For example, podcasts and the physical mobility of learning offered by the devices.

Students reported several repeated ideas around positive aspects of their own agency. By far the most common idea was the ease of access to learning resources. Students also expressed that they felt they were more productive in class, were better able to communicate with teachers and peers, enjoyed learning more, and had improved their learning outcomes. One student comment encapsulates a number of these ideas together:

> *"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."*

There were however a number of ideas that reflected more negative aspects of student agency. These focused around the off-task behaviour of themselves and others. Some students reported a perceived drop in certain skills, mostly related to handwriting. The following, one presumes, was written tongue in cheek, but was not unrepresentative:

> *"Cant rite az gud."*

A few students also reported physical issues such as headaches, eyestrain and poor posture.

Parents reported a number of positive effects on student agency. The most frequently mentioned was motivation, for example:

> *"We have found that our son has been thoroughly motivated by the iPad, there seems to be a huge benefit in terms of his willingness to complete tasks via the device"*

Improvements in learning performance were noted by some, often with a specific mention of agency:

> *"My child has become a more independent learner. I noticed in the last 12 months that my child's performance improved...achieving better grades."*

A side effect of using digital tools for learning also enabled students to develop digital skills, for example

> *"My child is quite computer literate since using the iPad."*

Better self-management of learning was also noted as a feature of student agency:

> *"He is well-organised and up-to-date with his homework often completing it early."*

Parents of students with learning difficulties were particularly impressed by the increase in their agency:

> *"Having a child with ADD - the difference is huge. It engages her in a way that normal teaching doesn't."*

Of course not all reflections from parents about their children's agency were necessarily positive. Some parents felt that the use of digital devices has impacted in their children's ability to read and write in the traditional way. The majority of comments however focused on various aspects of students seeming to have difficulties transitioning to the new teaching and learning environment. These often reflected back onto parental perceptions of their children's preferred learning styles:

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

Some other comments suggest that their children lack agency in the digital context. These covered several related ideas but this comment is indicative of some students' lack of agency using digital tools

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

The other theme identified by parents was their own agency, which many believed had been diminished in terms of their ability to engage with their children's schoolwork. They either felt that the homework was hidden from them, either deliberately or because it was all electronic and so not as easily visible as written homework, or they felt that their digital skills were inadequate to help their children. A feeling of lack of agency coupled with feelings of exclusion are summed up in this comment:

> *"Didn't seem to have much work to be done at home - that he told me about"*

From the quantitative data, there are some insights into digital skills, which can have a major impact on agency. It has been noted that the overall skill levels of staff appeared to be slightly lower in the 2014 survey than in 2012 (Figure 5.6). 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 agency of staff overall cannot be expected to reach its maximum potential until the BYOD approach has been fully rolled out across all school years so that all the staff have had the opportunity to fully develop their digital skills.

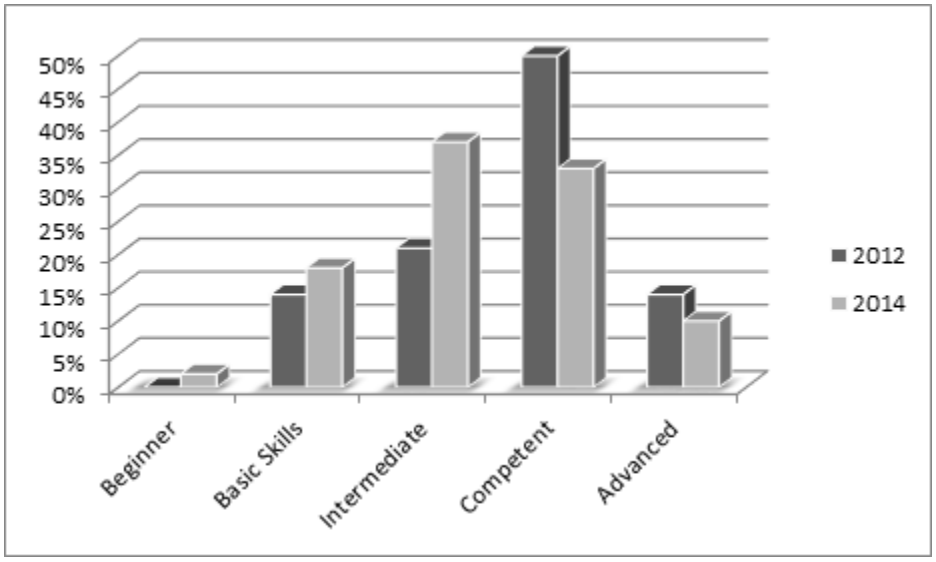

Figure 5.6: Staff skill levels in digital devices and computer technology measured by self-reported percentages

From the surveys of students, a strikingly different pattern (refer to figure 5.2) was revealed. There appeared a marked increase in the perceived level of digital skills, so the potential for agency appears to have increased over time.

Further to that, these results reported for digital skills suggest a possible digital skills gap between teachers and students; however, it is also fair to say that the skillsets that teachers bring to classroom teaching are more complex and demanding than the skillsets needed by the students. Nevertheless, for those who are already actively engaged in using the one-to-one devices, there is certainly skill development going on. Two responses from the 2013 teacher survey noted:

> *"My skills have grown SO MUCH"*
>
> *"The students and I have definitely gained some skills with using these devices"*

As student skills and agency have evolved, students appear to have developed critical thinking about the role of technology in the classroom. In the 2014 survey, although almost all of the students were in favour of using one-to-one devices for learning, around half of them suggested changes in practice (Figure 5.4).

As indicated in the qualitative data, many of the students requested a balance between digital device use and more traditional classroom activities. Perhaps underlying these feelings is a concern that well-understood agency that students have gained through skills taught in their earlier school career, such as reading books and handwriting, are being replaced by less familiar skills. We might postulate, perhaps, that some students feel a lack of agency in the process of this skills transfer, given the results outlined in Figure 5.2. Compounding this, from the qualitative data, some students and parents feel that handwriting skills are declining, suggesting a diminution of agency in this area.

In data, both students and parents occasionally referred to the students being treated as 'guinea pigs', i.e. the subject of an experiment. This response again suggests anxieties about agency; being acted upon, rather than acting on the world. It can be suggested that many of these anxieties about agency are a direct result of being part of a culture in transition. Similarly, parental concerns about their own agency with regard to their children's school work often suggests an increasing sense of separation, suggesting that there may be a significant skills gap between parents and students.

5.4.4 Cultural practices

Cultural practices emphasize the areas that can benefit learning, as they relate to collaboration, meaning making and media use. Our data indicate positive transformations of cultural practices within both formal and informal learning spaces. Indeed, the concept of space in the digital world has moved from a sense of belonging to a physical place to a sense of belonging to a communications network (Srivastava, 2005). Table 5.7 shows the repeated ideas in the themes of cultural practices.

Table 5.7: Themes and repeated ideas from the 'cultural practices' construct

Cultural Practices	Themes	n	Repeated Ideas	n
Teachers	Collaboration	6	Peer collaboration	3
			Feedback	3
	Student practice	6	Student culture (positive)	3
			Student culture (negative)	3
Students	Interactions with others	14	Student collaboration	8
			Adult communications	6
Parents	Family Dynamics	31	Media use	7
			Reduced personal contact	6
			Device addiction	3
			Changes in social behaviour	15

In terms of cultural practices, one of the most important transformations is the increase in student-to-student and student-to-teacher (and vice versa) collaboration. Peer collaboration enabled by digital media comes as part of the pedagogical transformation (Collis & Moonen, 2008), but another effect is the ability for teachers to give immediate feedback. Teachers' assessment of student culture was varied. Some comments were positive, e.g. classes being able to manage themselves even in the teacher's absence. However, there was also some evidence of negative impacts on the students' learning culture, for example:

> *"Some relationships have deteriorated in homerooms since the loss of interaction of face to face time with their peers and teachers."*

Students emphasised the communication aspects of cultural practices. Digital one-to-one devices have widened communication opportunities and provided common platforms for collaboration between students. For example, one student stated:

> *"iMessage helps kids connect with sick members of their group in group projects".*

If these digital media are considered in isolation, they might appear as somewhat one-dimensional. However, the settings and learning spaces where these communication channels are utilized, and the learning activities enabled by them, suggests that the BYOD initiative has brought a shift in the wider understanding of learning with and between contexts. In fact, it has contributed to integrating formal and informal learning spaces by extending teamwork and collaborative learning beyond the school gates. Students are now able to collaborate in real time to complete group tasks. Communication and collaboration between teachers and students has also improved, thus the idea of adult communication appears in Table 5.7. This also includes a handful of students who do claim to communicate with their parents about their learning.

Since the impact of change goes beyond the classroom, parents too noted changes in social interaction. The key theme that emerged from the data was various impacts in family dynamics. Many parents were concerned with the change in the social behaviour of their children. One parent reported:

> *"She is now constantly on the iPad, for things other than school work"*

Reference to media use tended to focus on non-educational purposes. Parents mentioned various social media sites being used at home, rather than devices used for study. Of course, it is possible that parents are just more sensitive to their children using their devices for leisure activities. One somewhat wry comment implied that perhaps learning was taking place even if this was not obvious.

> *"Well I am sure they are learning something but they are glued to the damn thing."*

In terms of social behaviour, a number of parents stated that their children had become less communicative, more aggressive, less interested in physical activities and less willing to do things with the family.

"My daughter has become withdrawn and no longer talks to me."

It is important to note that the cohort for this study was aged 13-14, when these behavioural changes are not uncommon, regardless of whether a digital device is used in the classroom. Thus, while these concerns cannot be dismissed, neither can they be isolated from effects of the BYOD classroom. Others commented that they now had to communicate with their children electronically rather than face to face. However, some others acknowledged the positive changes even while expressing some concerns, for example.

> *"...very secretive around their IPAD but also very switched on to learning."*

Another concern explicitly raised by several parents was 'addiction' with respect to student relationships with their devices.

> *"Since she got her tablet, she has been addicted to it. She's been less active, usually goes to her room and plays with it rather than plays outside with friends like she used to do."*

In a separate study, young New Zealanders suggested that a preference for cyber communication in social settings, purposeless preoccupation with a device, and feelings of anxiety when unable to use a device might be indicative of device addiction (Vacaru, Shepherd, & Sheridan, 2014). However, the authors of that study caution against using the term 'addiction', suggesting 'problematic use' is more appropriate, but such behaviour is certainly an issue of cultural practice that needs monitoring.

Looking at the quantitative data, student use of technology has, despite some concerns by parents, remained focused predominantly on educational activities (Figure 5.7). Media use has also extended the students' ability to express and communicate their work, as this parent reported in the 2013 survey:

"The quality of presentations on the device are incredible. It's great to be able to see the science assignment posted on YouTube."

Much of the reported media use might be seen as primarily substitution or augmentation, rather than more fundamental changes in teaching and learning. However, the staff surveys reveal that the true impact is seen in teaching practice and student engagement, for example; a more informal approach to classroom teaching, more ability to differentiate disparate learning styles and abilities, more flipping of the classroom and more engagement from boys in terms of their writing.

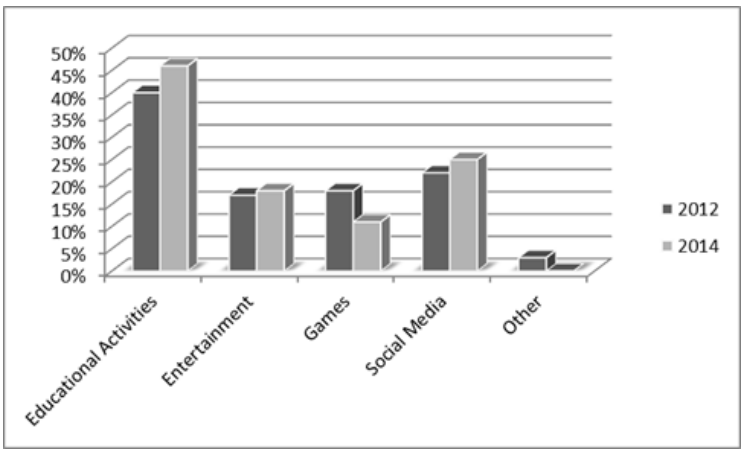

Figure 5.7: Student's nature of technology usage in school and at home (self-reported)

The structural impact of pervasive technology has of course impacted on the culture of the school, and leads to challenges for teachers such as keeping an eye on students during classes to prevent them from going off task.

5.4.5 Interaction of structures, agency and cultural practices

As described previously, structures, agency and cultural practices characterise the sociocultural framework. Most importantly, this framework sees learning through mobile devices in and around different learning spaces and is governed by a triangular relationship between the three components represented in Figure 5.6. There are a

number of aspects associated with each component and these aspects have either positive or negative impacts on each other in the experiences of students, teachers and parents in both formal and informal learning spaces.

Looking at the structure component, it contributed positively to the agency of students and teachers in terms of digital skills. The BYOD device and the technological infrastructure in school provided an opportunity for skills development. The results show that digital skills have improved in students since the BYOD initiative and suggest a slow but positive trend in the digital skills of the teachers (Figure 5.6).

Other aspects of structure, however, act as constraints, in particular the curricular frame and its associated external examinations. Our results indicate that many students have included time with pen and paper, combining learning strategies to prepare for the NCEA assessment method. For example:

> *"I do think learning with devices is great but we need a balance until NCEA is done via computers as it's hard to get back into using pen and paper for exams"*

In a different context, one of the aspects of cultural practices (media use) is having an impact on structure (learning environment). There are some concerns for classroom management and distractions caused by the inappropriate usage of the one-to-one devices by students within the classroom.

One of the most important benefits of the BYOD initiative is the increase in collaboration (cultural practices) across formal and informal learning spaces. This is enabled by improved mobile communications (structure) and contributes to the development of agency in the students.

Despite some contradictions and challenges, interaction between the three components of the social-cultural framework in the context of BYOD has resulted in

positive outcomes. However, there are a number of constraints caused by structure, and tensions raised by changes in culture.

5.4.6 Summary of analysis related to BYOD classrooms

The longitudinal analysis of the BYOD classrooms initiatives, based on the multiple surveys conducted with different stakeholders at different points in time has led to a good understanding of how the BYOD classroom has developed since its introduction. The analysis of data based on the social-cultural framework has been worthwhile to understand the relationships and interactions between the digital devices and infrastructure, the various stakeholders and the learning environment.

The majority of the quantitative results were positive, including improvement in the digital skills of students and teachers, increases in opportunity for individual mobile communications and collaboration for learning activities and the advancement in social and personal development of students. From the qualitative data, there were some persistent issues around the nature of media use by students and the impact it is having on teaching and learning activities. Qualitative data from teachers was substantially positive, while responses from parents and students were more mixed. This may suggest the impact of agency; in this context, teachers have the greatest agency, parents the least.

The findings also suggest that students perceive their digital skills as developing rapidly, while teachers are more circumspect. Interpretations made from qualitative data suggest that this is because members of staff are considering the development of their skills in the context of transformations of classroom practice, which demands a more extensive skill set than student use of one-to-one devices.

The data collected suggests that this is a period of transition and in many ways; the BYOD classroom initiative is being used also as an opportunity to redefine itself. There are skills that need to be developed further, dissonances between new forms of teaching and learning and traditional assessment structures, and anxieties about the unknown impacts of such major changes to schooling. There is clearly much more work to be done before the implications of what is currently happening in the BYOD process can truly be understood.

NOTE: Chapter 5 is a partial re-print of two articles:

- Adhikari, J., Mathrani, A. & Scogings, C. (2016) Bring Your Own Devices Classroom: Exploring the issue of digital divide in the teaching and learning contexts. *Interactive Technology and Smart Education (ITSE).*
- Parsons, D., & Adhikari, J. (2016) Bring your own device to secondary school: The perceptions of teachers, students and parents. *The Electronic Journal of e-Learning (EJEL).*

The thesis author was the primary investigator of these articles.

Chapter 6: Summative Data Analysis

6.1 Introduction

Since 2011, data have been gathered from one of the first secondary schools in New Zealand, which introduced a BYOD classroom initiative with special recommendations of using iPads as learning devices. This chapter analyses the data collected over the last stage of study based on the summative data collected from mid-2014 to late 2016. Over this time, the BYOD initiative had been implemented throughout the school.

During the earlier stage of analysis, the research identified the role of teacher as an enabler, since their strategic positioning enabled them to influence the formal/informal curricular practices within the BYOD classrooms initiative. Despite the school-wide implementation of the BYOD classroom initiative based on the same goals, principles, and technological infrastructure, the earlier stage of analysis indicated varying teaching methodologies and curricular practices across the different year groups and subject areas. This finding was in line with the differences in the teaching methodology approaches taken by the individual teachers in the context of BYOD classrooms, evident in the data. The study has employed somewhat different approach for this stage of research and focused the further investigation to the teaching staff. That will allow the study to capture teachers' reflections on BYOD classroom like their teaching methodologies and classroom curricular practices in view of the BYOD initiative. The research at this stage aimed to explore their individual approaches, which enabled students towards achieving better learning outcomes.

While doing so, the study tried to gain insights into the knowledge acquisition, skills development, and progression of attitudes and motivation among the students.

At the last stage (or, summative stage), when BYOD had become the norm, two rounds of open-ended interviews were conducted with teachers to capture their chain of thoughts. Some of the work at this stage is already published (Adhikari, Mathrani, & Scogings, 2016; Adhikari, Scogings, Mathrani, & Sofat, 2017).

Table 6.1: Stages of data collection (3rd stage)

Stages	***Data collection timeline***	***Data collection methods***
Stage 1: Baseline	Early to mid-2012	• Open-ended surveys with students, teachers, and parents • Classroom observations in targeted subject areas
Stage 2: Follow-ups	Mid-2012 to mid-2014	• Semi-structured interviews with a randomly selected sample of students, teachers, and parents • Two rounds of open-ended follow-up surveys with students, teachers, and parents
Stage 3: Summative	Mid-2014 to late-2016	• Two rounds of semi-structured interviews with teachers

Overall, the research activities in this stage were focused mostly on finding the answer to the third research question about digital capability divide, that is, *How have the learning outcomes (knowledge acquisition, skills development, and progression of attitudes and motivation) evolved because of the BYOD classroom?*

6.2 Data and analysis framework

The source data for answering these questions comes from a set of semi-structured interviews conducted with five teachers each in two different rounds involved in the BYOD policy. The criterion for selection of teachers was that they should have been with the school since the start of the BYOD policy. Ethical approval was again sought before conducting teacher interviews, since the earlier ethics approval period had completed. All interviews were voluntary and teachers were assured of their

anonymity. The interviewees provided rich insights into the BYOD classroom and the range of curricular practices within it. Thematic analysis of interview data was approached followed by qualitative coding of the interview data. As Saldaña (2015) notes, coding of qualitative data has potential to be influenced by a number of factors shaping the interpretation of the data. In this case, the focal constructs (digital/information literacy, computer self-efficacy, and nature of technology usage) identified during the earlier stage of research are used as main constructs for qualitative coding (Adhikari et al., 2016). Further, the three components from the sociocultural framework explained in chapter 2 section 6.3 (in Figure 2.3), have been used as three dimensions of each focal constructs to explore the interrelationships between key stakeholders, practices, and structures governing the teaching and learning. Therefore, analysis at this stage aims to investigate the focal constructs informed from the earlier stage of research, and possible relationships with specific enablers within each of the three components of the sociocultural framework where possible. Narrative storylines regarding learning outcomes divide existing over the course of the BYOD policy implementation, starting from the inception to the full rollout stage obtained from teacher interviews are shared.

Drawing on from the earlier research (Adhikari et al., 2016; Adhikari et al., 2012; Parsons & Adhikari, 2016), further investigation next focused on the influences of digital/information literacy, computer self-efficacy and nature of technology usage. The investigation at this stage aimed to increase understanding of how personal, behavioral and environmental factors influence learning outcomes that can result in digital outcome divide. The focal constructs identified for further investigation have potential to impact learning activities not only within formal spaces like classrooms, but also across informal spaces, such as homes and anyplace outside the school

premises. Therefore, a sociocultural approach is adopted to investigate the learning process within formal and informal learning spaces mediated by one-to-one digital learning devices. The socio-cultural ecological framework discussed in chapter 2 (Figure 2.3) adapted from (Pachler, Bachmair, Cook, et al., 2010) has helped in analyzing the engagement with learning activities using one-to-one digital learning devices in and around different learning spaces (Pachler, Bachmair, Cook, et al., 2010; Pachler, Cook, et al., 2010). Therefore, socio-cultural ecological framework has been contextualized to show various points of reference within each component (i.e., agency, cultural practices and structures) that relates it to this study.

6.3 Case analysis and findings

Semi-structured interview data from teachers were analyzed in NVivo, coded using emergent themes (developed from repeated ideas) and subsequently mapped to predefined focal constructs (digital/information literacy, computer self-efficacy, and nature of technology usage) and three components (agency, structure, and cultural practices) of the sociocultural framework used as analysis framework for this study. Following a simple content analysis of repeated ideas, the broad emergent themes are outlined in Table 6.2, cross-referenced by three components of the sociocultural framework for mobile learning (i.e. structures, agency, and cultural practices).

Table 6.2: Qualitative coding of teacher interview data

Focal Constructs for Investigation	**Structures Themes**	**n**	**Agency Themes**	**n**	**Cultural Practices Themes**	**n**
Skills Development	Classroom curricular practice	13	Improved access to resources	12	Student learning practices	11
	Suitability of technology used for learning activities	9	Digital skills and agency of learner	25	Support from parents and teachers	12
	Technological and other support from School	9				
Changes in Attitude and Behavior	Availability/affordability of learning technologies	16	Student attitude and behavior	37	Flexibility in learning	14
			Impacts on student learning activities	14	Skills and motivation of teachers to encourage learners to learn	41
	Curricular framework and teaching practices	16	Acceptance of BYOD	12	Student motivation	36
Knowledge Acquisition	Teaching and learning strategy within classroom	33	Ability of meaning making in the context of BYOD	14	Learning support between formal and informal spaces (Extension of formal learning).	29
	Giving agency to students	41	Student learning outcomes	31		

Responses of the semi-structured interviews with teachers focused strongly on the teaching and learning strategies, agency of the learners, skills and motivational aspects as some of the key areas influencing the learning outcomes of the learners. The coding of data also shows some observations about the increased acceptance of BYOD, improved availability and affordability of technology, and greater flexibility around the teaching and learning practices. Changes observed in some of the areas are quite significant, like availability and affordability of technologies was once considered one of the biggest concern at the beginning of BYOD classroom initiative (Adhikari et al., 2012); however, no longer an issue as the BYOD classroom initiative progressed to a mature stage. The following sections will provide the analysis of the interview data, and explore the evolution of the three focal constructs and its impact on the learning outcomes divide (i.e. knowledge acquisition, skills development, and progression of attitudes and motivation) from the multiple dimensions (structures, agency and cultural practices) coming from the analysis framework.

6.3.1 Skills development

Digital or information literacy has been one of the most important areas of inquiry in the study since the start of the BYOD classrooms journey, as it has been identified as one the key focal construct for the investigation of the digital capability divide. Three level digital divide framework for learning explained in chapter 2 Figure 2.2 (adapted from (Wei et al., 2011)), not only describes digital/information literacy as one of the main predicators of digital capability divide, but it also leads to learning outcome divide as it will contribute directly to the skills development through personal, behavioural and environmental factors within the BYOD classroom. With the greater integration of technologies into every aspect of teaching and learning practices, it is

critical that learners have appropriate level of skills development (in terms of digital/information literacy) to be able to achieve better learning outcomes (Bailey et al., 2012). Better digital/information literacy leads to improved skill development helping further to achieve better learning outcomes.

In terms of skills development construct, interview data shows that the comments related to the school structure were generally of positive nature. Themes that emerged from the qualitative coding in this construct include classroom curricular practices, and suitability of technology used for learning activities and technological and other support from school. Undoubtedly, transition to the BYOD classroom was a big shift for school, teachers and learners, and majority of teachers seemed to have embraced the opportunity to make positive change from their part. Change in the curricular structures within the classroom practices is revealed as exciting by teachers. Comments from teachers highlighted how teachers are putting their individual efforts to make the BYOD classroom successful. One teacher's comment below shows how digital technologies in classrooms have changed their approach of teaching.

> *"It has changed my whole approach from being at the front of the class to being alongside the students. I would not say I have become one of them, but I am definitely alongside them now"*

In reference to school infrastructure and planning to support the BYOD classrooms, following comment shows level of determination from the school to ensure the inclusive access to digital learning devices for learners.

> *"School did a really good job in managing that by having laptops to help students whose family couldn't afford devices"*

This has provided every learner a comparable opportunity to develop his or her skills required for the learning in the BYOD classroom environment.

With the huge shift in the school's pedagogical approach, school has put an exceptional effort to develop the required level of skills among teachers through conferences, seminars, mentoring programs and peer support. Comments from teachers reflect the professional development opportunity provided by school in the context of the BYOD classroom implementation. The following comment reiterates the supportive transition.

> *"Because all of the professional development, our journey has been easy so far. Even the training around Ultranet[6] has been fantastic. So I found it a really good journey."*

With a number of support mechanisms for student and teacher, school has supported inclusive participation of teachers and learners into BYOD classrooms. This includes nurturing and supporting the digital/information literacy among students. As long as better information literacy skills among students are on making, changes in student learning practices will contribute to skill development, knowledge acquisition and overall learning outcomes.

> *"I think we are in a position where we are able to focus on merit and excellent rather than achieve. That's because students have resources at their fingertips and don't have to spend time here and there (like computer labs, library) and can invest that time on higher order thinking"*

Regarding cultural practices, generally the teachers expressed trust over the classroom curricular practices and believed that student-learning going in the right direction.

> *"I don't think all of my kids are on task all the time but I do think they are able to flip between things, and still produce really good quality work within the timeframe available."*

[6] Ultranet is a learning management system used by the school.

Providing greater agency and trust on what they are doing during the learning activities have emerged as important aspects for better skills development in learners. BYOD classroom and available technologies have leveraged the learners to go beyond the traditional boundary of information gathering and teachers are now increasingly supporting their agency of following any direction they think appropriate in their learning. The following statements from teachers confirm that.

> *I believe that it has, because having access to the range of technology and the media has given the students a next step in their learning.*

> *Well, the kids are globally connected, so they know what works and what doesn't.*

In addition, because of their extended ability students are more and more confident in taking responsibility and ownership of their learning. Moreover, while doing so, they are not just learning but also engaging with the subject content through critical evaluation and discussion.

> *I think that the ownership of what kids are doing- I just had a class, my year 10s that I just left, they're like the bottom year 10s in this school. The thing we were doing with them, I don't think it would have been as easy to do without a device.*

> *I've got a level 3 media class that had to do a report, a critical report, on examining how meaning is put together in film. They were able to devise questions that they could ask, which enhanced their critical thinking ability and helped to achieve excellence and merit on their own without any input from myself, which meant that they were able to go through the criteria and they were able to reflect on their own work.*

With the positive changes in the student participation and ownership of their learning activities, teachers are also opening up to give more and more agency to the students to create the learning environment more flexible, motivating, and student led, which eventually helps them to expand and solidify their skill sets.

> *So they might discover something else that works a whole lot better for completing a certain task, and we need to be able to give them the freedom to use that tool, to present their work or their learning. But we do have some basic tools that we use across all classes. So they'll be common to all classes.*

To summarize the analysis of the skills development construct, there is a reasonable amount of evidence to conclude that the existing practices among students, teachers and school and the improvement in interactions has resulted from the greater agency and trust for student. These steps are in the right direction to achieve the goal of improved learning outcomes among students.

6.3.2 Changes to personal, motivational and behavioral factors

Personal and behavioral factors affecting the objectives of the BYOD classrooms are the most talked about topic since the beginning of the initiative, and attracted the inquiry of this topic in all of the research activities conducted as initiative evolved over the last 5 years. So much so, this was one of the most important focal construct for investigation in the first two years of the research study, perceived as the challenges in BYOD classroom initiatives (Adhikari, Mathrani, & Parsons, 2015; Adhikari et al., 2012). Initial approach was to capture any issues and challenges that are of personal motivational and behavioral nature among students and teachers. The study let the discourse of the BYOD initiative guide the direction of the research, in terms of any challenges identified as it evolved from its inception to full implementation stage. After the initial stage of inquiry into the BYOD classrooms, personal motivational and behavioral factors have been identified as the key challenges in bringing about inclusive learning outcomes among learners. Therefore, it is very important to address these issues as the positive motivation, attitude and behavior of students and teacher

is of paramount concern, and defines the success and failure of the whole BYOD classroom policy.

In the context of the BYOD classrooms, many aspects of the technology-mediated learning invoke personal, motivational and behavioral issues. It is of no surprise that one of the biggest concerns that came out during the initial stage of the initiative was the availability and affordability of the digital learning technologies among students. It had created a debate of the digitally divided classrooms based on the assumption that a large number of students are going to turn up at school without any one-to-one devices to support their learning. Because of that concern, a significant proportion of students and parents had difficulty accepting the BYOD classroom initiative and helped in forming their own opinions and attitudes towards the initiative. To some extent, the teachers also felt this and not everyone was buying into the idea of the BYOD classrooms at the initial stage. Interestingly, not just the students, but also some of the teachers who are the most important change agents into the BYOD classroom initiative still stand by their opinions questioning their acceptance of BYOD classrooms. Following comments says:

> *"I don't think just putting a screen in front of somebody actually changes their ability to think critically. The ability to get them to find the information is changed, but what they do with it makes a different story."*

> *"We've had a few amazing successes with some students and done well nationally but all of those students have come in with a strong desire to learn before we have even touched them. This has allowed them to make contact in their interest level, top level all the way around the world. For me what does that do for our more average kid? I think we're yet to unpack that. I don't think we've got much further than a different type of book, a more exciting book."*

Despite some initial issues, the subsequent evidence of the obvious benefits from the BYOD classroom helped this discourse out of the acceptance debate among the students and teachers.

A positive indication on the success of the BYOD initiative can be gauged from recent comments made by teachers, which unveils a narrowing of the gap for access/availability to technologies. It is fair to say now, that this has now reduced to a nominal level. The following comment presents the current state of this issue:

> *"These issues are still there to a certain extent. I have had one student this year that's been most of the year without device. And she got a device later in the year. So, instead of three or four at the beginning of BYOD policy, it is now minimal and down to one or two"*

On the occasions where any student comes to school without any devices, school loans a learning devices to be used during the classroom learning activities through library. The issue of access comes in a range of variations like students without any devices but internet and computer at home, and students with devices but no internet at home. There are also some students coming to school without any device because of the damage to their devices.

Despite few concerns for access and affordability of one-to-one digital learning devices, acceptance of the BYOD classrooms has increased among students, teachers and parents.

Some issues were also reported regarding the quality of technological infrastructure as a result of the sudden shift in pedagogical approach. Teachers expressed concerns over some issues they faced related to their teaching. Majority of comments about technical issues referred to the quality and reliability of internet connectivity.

> *"If I talk about our school, we need to improve on the connectivity and bandwidth we have. We have improved a lot over the years but it needs more of it."*

Other concerns which were reported related to the technological infrastructure was a lack of a unified approach around the learning management system and other tools (software) to support overall learning activities. Even after going to digital delivery of learning resources, there seemed an absence of a common workflow model related to the submission, marking and feedback. The following comments being typical:

> *"I think the other challenges we have is not having the appropriate method of submitting large assessment files to teachers. We don't have a universal system that works electronically for everything. We have to use different applications for different tasks."*

The issue reported under the limited access situations quality of the technological infrastructure to support the learning is of particular interest to the analysis, as this has potential to affect the motivation of students into technology-mediated learning activities and give them a reason to go back to the pen and paper.

Subsequently, the denial in transition to BYOD classroom then appeared in the form of the behavioral issues in the nature of using the one-to-one devices and lack of motivation for participating in learning activities using devices. This has created a massive challenge in the classroom management for teachers. Many teachers expressed challenges in classroom management during first two years. The following comments reveal some issues regarding attitude and behavior within classrooms within that period as:

> *"Yes. Initially when students came in with parents' misgivings and saying well that's not how I have been taught so why should we change things. They will come in without realizing with pre-conceived ideas. Those were the challenges you would have to breakdown."*

> *"Well, what makes people learn is interest and engagement. And that's what the technology gives them. That makes learning interesting and engaging. You could be the brilliant and intelligent person in the world with the best information literacy. But if you are not interested in something you are not going to bothered, are you? So that's what these do, they make you interested."*

> *"In a negative point of view, the changes we have seen is some of the inappropriate behavior using their one-to-one devices."*

Another teacher goes even deeper into the issue and confirms one of the worst fears of parents.

> *"I think because they have got access to internet 24x7, they are exposed to a lot of things, which they wouldn't have otherwise, like pornography. When I walk past kids iPads, I don't know how to deal with it because I quite often get objectionable materials being opened. And that of course changing their attitudes, they are not as innocent as they should have been."*

Despite some tough and challenging situations in terms of managing classrooms during initial days, the findings reveal the positive change in student engagement in leveraging technology to up-skill themselves. Despite few issues, many teachers agreed on the positive changes in students' behavior:

> *"As far as I am aware, we haven't had many changes apart from more positive changes with kids, that a disengaged being more engaged."*

On the other side, it was revealed that some of the teachers (specifically the older teaching staff) were not buying in the whole idea of BYOD classroom and taking this as just the introduction of another stationary item and think that it will just add extra work load to the teachers (Selwyn, Nemorin, & Johnson, 2016). Because of that, there was a lack of interest in leveraging technology for maximizing of their teaching delivery.

> *"My style unlike other teachers in the school hasn't changed radically; devices are just means to an end"*

Teachers are the most important stakeholders in the whole BYOD policy and are key strategic enablers to bring positive change. However, if there are individual teachers with lack of interest in leveraging technology for maximizing benefits of the BYOD classrooms, it directly affects the students learning. The following comment from a teacher explains the impact that:

> *"The most important thing is, if you don't upskill you will fall behind. And when you fall behind, it obviously means your students fall behind. We have got 100 teachers in the school and if 10 of them are step behind, that's going to affect those 10 teachers and their 20/30 students in each class. And that's a lot of students to be affected by that."*

With the presence of few teachers not so keen on the BYOD classroom even after the years of implementation, there seemed some dissatisfaction among other fellow teachers within school. One typical comment sums up the feeling:

> *"I think it depends on the teacher expectations to some extent. Like, I don't entertain any of that grumbling. And if they start going on like that, I say you have right to choose another school and this is the way we do things here. There is no other option and you have to participate and cooperate if you choose to be here. It might be exempt in few situations if there is a reasonable excuse on why they can't do it."*

With the evolution of the BYOD classroom, challenges caused by the personal and behavioral issues like the acceptance of initiative by all stakeholders, nature of technology usage by students, and challenges into classroom management is no longer a pressing issue. Analysis of BYOD classrooms has also indicated some positive changes in personal and behavioral aspects. As an example, students during the later stage seemed to amaze teachers with positive changes in their learning activities somehow, despite some concerns here and there like poor handwriting skills. The following comments shows students acceptance of BYOD policy.

> *"Nobody has complained over the last few years for the fact that having to use the devices have an impact on their learning. I think it has improved their learning capabilities."*

> *"I love the fact that students are not so much consumers as they used to be. They are more creators of knowledge and that for me is amazing. I love the fact that, they gather information to create something to show they have understood. They are more creators then consumers now. So I think that for me is the best thing about BYOD."*

The positive change in the motivation was not just limited to the students. Majority of teachers are also very enthusiastic and enjoying the BYOD classroom.

> *"I think, looking at it and thinking totally invigorated teaching. I have been teaching for 25 years, and the first time we are not talking this naughty or that naughty one, but about what everyone tried in their teaching and all the positive things."*

To summarize, despite improvement in access and affordability of technologies and the positive changes in motivation among students and teachers, there remain some challenges. Most importantly, there needs to be a strategy to ensure positive changes in student attitude and behavior within the classrooms. Moreover, giving more flexibility and ownership of their learning activities might address the challenges in this front, which is described in detail in the following section.

6.3.3 Knowledge acquisition

Adequate level of knowledge acquisition is paramount to achieve better learning outcomes for students, and therefore is one of the main predicator for the digital outcomes divide. In the technology-mediated learning context, the ability to acquire the knowledge is largely dependent on the computer self-efficacy of the learner. The three level digital divide framework for learning explained in chapter 2 Figure 2.2 (adapted from Wei et al. (2011)) describes self-efficacy as one of the major predicators of the digital capability divide. Self-efficacy levels in learner further plays a vital role

to influence how learners engage and apply technology to shape their learning outcomes, causing life-long impact on individuals learning tendencies and ability which can restrict them in gaining new knowledge, in turn leading to digital outcome divide. Therefore, exploring how self-efficacy in learner has an impact on the knowledge acquisition through personal, behavioural and environmental factors has become very important in investigating the learning outcomes divide. Analysis in this section will cross-examine knowledge acquisition using the three components – agency, cultural practice and structure – of the sociocultural framework (Figure 2.3 in chapter 2).

In reference to the school curricular structure, majority of the learning activities are designed with emphasis on student-led learning with greater responsibility and giving agency to learners on their learning activities. The following comment reflects this change:

> *"We are doing more student-focused activities, rather than teacher sitting in front of the class and teach. Students are going and finding their information and that's what the devices are good for."*

Teaching and learning strategy being practiced by teachers not just maximize student engagement, but also gives them more responsibility. Responsibility in this context has been given through learning designed to 'lead by' learners. There can be a range of learners within the same classroom in terms of their pace and ability of learning; therefore, giving extra flexibility and responsibility to students through student-led learning might seem unfair in the first instance. However, it has worked quite nicely to bring the balance between the fastest and the slowest learners. The student-led learning approach has provided an extra opportunity for students to learn and understand on their own pace, without having to worry about the pace of others. One teacher says:

> *"The kids are way more relaxed in terms of the pressure on them to learn, because they can choose their environment. They can choose to sit on a couch. They can choose to sit on the floor. They can go outside. They can go to another room. They can choose their own learning spaces."*

> *"It is a game changer when slowest student doesn't have to go at the same pace as the fastest student in class. Where you go with your own pace and teachers will be available to support you throughout your learning activities."*

Apart from the greater responsibility for their learning, literature suggests giving more agency to the learners as an integral part of the process in the technology enhanced teaching and learning context (Pachler, Bachmair, Cook, et al., 2010). This has found to be practiced in the context of BYOD classroom, within the case study under study by giving more freedom and ownership of their learning. Teachers have embraced the idea of giving more autonomy and ownership to students in many different ways. The following comments from teachers show the change in their mindset in the evolution of BYOD environment and the benefits of the greater learner agency and flexibility for the better knowledge acquisition.

> *"One change we have seen is people develop into independent learners."*

> *"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."*

One of the most significant change that emerged from BYOD classrooms initiative is the disappearance of boundaries between formal and informal learning spaces. Effectively, the learning activities that start in the classroom can still be completed and collaborated from anywhere, making the process of learning a lot more flexible,

inclusive and engaging. With technology-mediated learning now becoming the norm, availability of the innovative learning apps and good quality internet can extend the scope of ability to participate in learning and collaborate from anywhere, thereby eliminating the boundaries that formed the differences between formal and informal learning spaces. One typical comment about boundaries states it simply:

> *"Students, whereas in the previous environment a student could learn in the classroom, now they can learn still while being outside of the classroom."*

> *"I've got kids going overseas and they're still handing in work from wherever they are. That kind of situation. Or if they're sick at home, they can work on things at home. Whether that's what you're looking for, I don't know."*

The following comment explains the transformation in terms of the ability to participate and collaborate across formal and informal learning spaces.

> *"If the student is working on a project in google docs, I can be at home and monitor and offer my help if needed. Sometime, when I check student work, it happens to be that they are working on it on the same thing at the same time."*

The ability of being able to learn anywhere and anytime is now embraced by both the teachers and students, with the practice now an essential part of the teaching and learning. This in turn has contributed to increased opportunity for learners to access their learning needs, such as related to support from teachers.

> *"Kids actually do take advantage of the fact that we're accessible outside of school hours."*

> *"The formal and informal, I almost feel like it's all turning into the same thing. I don't know how to define the two."*

Combining all of the innovative and positive changes discussed above, there is a lot of scope in shaping students' ability of meaning making and critical thinking ability to

improve their learning outcomes. That in turn has potential to shape the self-efficacy of the learners. One comment states the positive changes experienced simply:

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

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. Following comments supports that.

> *"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."*

Based on the themes emerged during the analysis of data, it is evident that everything including transformation of school curricular practices, greater agency and responsibility to student and improved ability of meaning making are supportive to build self-efficacy. This is in turn is contributing to the knowledge acquisition among learners through improvement in student self-efficacy levels.

6.3.4 Summarizing the analysis in the context of learning outcomes

The most obvious question that comes in the mind after the implementation of BYOD classroom is that, did it bring any changes to the student's learning outcomes in any ways? The answer to this question is not simple, because the changes introduced by BYOD classrooms altered the traditional teaching and learning landscape. It

transformed the role of teacher within the classroom, changed the way students and teacher communicate, expanded the way learners participate and collaborate on learning activities. One amazing discovery of the BYOD classrooms is the realization of the greater learner agency into the learning process coupled with the trust from the school curricular structure and flexibility offered to learners by leveraging the educational technologies and methods. The outcomes of the BYOD classrooms initiative can be categorized into two major areas, one is motivation, knowledge acquisition and progression towards learning and other is transformation in attitude and behavior of learner.

In terms of the motivation, knowledge acquisition and progression, the analysis shows positive outcome. Following comments from teachers indicate success of BYOD policy in terms of access to information and ability to think critically and use available information in a meaningful way.

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

> *"I am marking essays at the moment and they have done more than five paragraphs of writing on an average. For the same task students used to come up with just a paragraph or so. Therefore, we know that they are more engaged and motivated towards learning."*

At the same time, whereas majority of students are doing well and are more motivated and engaged, some of the students are not. The real point of difference between them is the *'information literacy'*, which one group has and other does not. The following comment explains the real reason for that difference.

> *"Some students are lot more confident in finding, processing and applying information they come across and other 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."*

Despite few challenges and difficulties, the feeling from all the stakeholders and overall outcome in the motivation, knowledge acquisition and progression is positive, and shows in the following representative comments.

> *"As I said earlier, digital skills are improving among students for sure. They are getting better at operating the learning devices every day."*

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

> *"Nobody has complained over the last few years for the fact that having to use the devices have an impact on their learning. I think it has improved their learning capabilities."*

In terms of the category related to the attitude and behavior, the results are not on the same level of progression as the earlier category. Following comments reflect the current situation:

> *"But then some kids they seem to be on task may not necessarily be on task. You are still catching them in Facebook and they are still playing game."*

> *"You are never going to stop students going off task. It's the way you manage that's important."*

> *"Although we put responsibilities to the kids, they don't always take their responsibilities. They will be the kids no matter what and they like saying no and being rebellious sometimes."*

> *"In a negative point of view, the changes we have seen is some of the inappropriate behavior using their one to one devices. And I think that's always going to be a problem. You are trying to crack down as hard as you can with putting them off the internet connection, but the students are very clever to hide things and work around loopholes."*

> *The other thing is, the hype of it is coming down and students are getting comfortable using it, as I have said earlier they are getting*

better in finding loopholes and there is an increase in students going off task.

Overall, there seem to be a positive trend in terms of motivation, knowledge acquisition and progression towards learning, while there are still some issues around the attitudes and motivations. However, the outlooks from teachers indicate that they are not too much concerned with student attitude or behavior issues, as long as students are doing well in their learning activities.

6.4 Conclusion

This chapter combines two frameworks to cross-examine the relationships between the various sources of social cognitive abilities related to individual's information literacy, motivational and behavioral aspects, and computer self-efficacy levels to explore how skill development, knowledge acquisition, and changes in personal and behavioral aspects have evolved during the BYOD classroom initiative. Therefore three main constructs identified from the earlier research (Adhikari et al., 2016) have been used to investigate social cognitive abilities, and cross-referenced it with socio-cultural framework for mobile learning (Pachler, Bachmair, Cook, et al., 2010) to explore how each of the three component govern the student learning activity in the BYOD classroom context. The research has been able to establish that information literacy and self-efficacy level in learners can potentially affect their knowledge acquisition, skill development and brings about changes in attitudes and behaviors, which in turn has a greater impact on the learning outcomes. This has led to many interesting findings and has been helpful in identifying certain key emergent themes over the five-year BYOD journey.

First, there has been a sense of satisfaction in terms of better access to information enabled by personalized digital devices, resulting into improved critical thinking ability among students. The speed and ease of accessing any kind of learning resources have helped students to engage into critical thinking and meaning making. This led to teachers feeling confident to introduce innovative pedagogies to change their classroom curricular practices and become facilitators from teachers in front of the class.

Second, analysis clearly shows the gradual disappearance of the boundaries between formal and informal learning spaces through different collaborative activities, resulted into improved student motivation. That in turn has helped teachers change their whole classroom curricular strategy to maximize the potential benefit of BYOD policy.

Third, growing enthusiasm in teachers in providing more agency to students by giving them more freedom and the responsibility over their learning. This has certainly helped students take ownership of their learning and keep themselves motivated. There was no theme emerging from the analysis about the workload, but greater responsibility and ownership of learning by students, relieved teachers from excessive workload in some ways. This was a huge improvement as excessive teacher workload was identified as major challenge at the early stage of the research.

Fourth, analysis found a theme emerging from data, that the whole BYOD policy and school curricular practice lacks a unified approach to teaching and learning. This has probably caused a sense of dissatisfaction among students as they adapt to the teaching styles of various teachers. Teachers are aware of this situation and recognized the amount of effort students require because of this. However, individual teachers are not in a position to set a universal workflow approach to address the issue. There is a

scope for school to fill this gap and develop a teaching and learning strategy to fit across the various subjects and school year levels to support the BYOD classroom.

Last but not the least, parents and teachers have expressed some concerns over the 24x7 unsupervised access of internet by students. Data from the teacher interview shows concerns about the safety of students from the risks imposed by unsupervised access to internet. Some of the comments from teachers show that students are already exposed to risks like pornography and cyber bullying. This insight can be used as one of the most important lead for the purpose of the future research on the topic to capture and track the continuously evolving nature of the research topic.

NOTE: Chapter 6 is a partial re-print of two articles:

- Adhikari, J., Mathrani, A. & Scogings, C. (2016) Understanding Learning Outcome Divide in the Learning Process from a Teachers Perspective: A BYOD Case Study. *Australasian Conference on Information Systems (ACIS), Australia 2016.* ACPHIS KIT DAMPNEY Best Education Paper Award.
- Adhikari, J., et al. (2017). Evolving Digital Divides in Information Literacy and Learning Outcomes: A BYOD Journey in a Secondary School. *International Journal of Information and Learning Technology*.

The thesis author was the primary investigator of these articles.

Chapter 7: Closing Discussion

7.1 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 changes to curricula and teaching methodologies, 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). Integration of digital learning technologies in the form of the technology-mediated teaching and learning practices can greatly improve the quality of the education and transform the teaching and learning to match the skills sets required for the 21st century. However, there is also a risk associated from the same digital technologies. On one side, the access to digital technologies will improve the learning opportunity through better and fast access to resources, but on the other side it can

also create a gap between individuals based on their ability to afford the digital medium required for learning causing the 'digital divide'. Therefore, despite the benefits offered by the technology-mediated teaching and learning, answers to some of the questions related to the digital divides in learning have to be determined, to be able to reap the full potential offered by the digital technologies within the teching and learing process.

There has been some evaluation studies in the past, based on the technology-mediated teaching and learning practices, called digital opportunities pilot projects in New Zealand (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004b). Findings from the evaluation studies indicate that these projects have failed to contribute to the teaching and learning as were expected from them. It has been later concluded in the study that such an integration of digital technologies into teaching and learning activities might end up contributing nothing more than an effort to facilitate physical access to ICTs (Rivers & Rivers, 2004). While digital learning technologies can transform the education positively, , findings from the evaluation studies conducted on digital opportunities pilot projects even warned that the whole exercise of integrating digital learning technologies can turn into a bitter experience of digitally divided learning environment (Parr & Ward, 2005; Rivers & Rivers, 2004; Winter, 2004b). The reason is the risk that not everyone is going to have same level of opportunity to access and be able to use the learning technologies, creating potential gap between individual learners leading to digital divide within learning environments.

The results from the digital opportunities pilot projects have been used as the baseline to start the investigation into this study, which aims to provide answers to the complex questions around the digital divide in the learning environment within the context of

technology-mediated pedagogical practices. This study has been conducted within a secondary school in New Zealand, which made a decision to adopt technology-mediated teaching and learning in the form of a bring your own devices (BYOD) classrooms initiative. In this initiative, students have been asked to bring one-to-one digital learning devices to support their learning in school. In the first year of 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 improving the initial challenges like access to learning tools and digital skills. As the adoption and acceptance of digital learning technologies expanded, new levels of digital divides started to emerge, allowing us to expand the focus of the study beyond the baseline digital divide issues like access and digital skills. Wei et al. (2011) has explained, how ICT adoption stages evolve to cause further levels of digital divides in teaching and learning. Figure 2.1 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).

Therefore, as the BYOD initiative progressed into mature stages and gained momentum in terms of the changes into teaching methodologies and learning activities, the enquiry into digital divides in learning entered into the next phase.

Subsequently, as the digital skills, ability of meaning-making and critical thinking among students matured, a deeper investigation has been carried out, on factors pertaining to the digital capability. Further, how this affects knowledge acquisition, skills development, changes in attitudes and motivation that ultimately leads to digital outcomes divide. During this stage of study, that is from the middle of 2014 to late 2016, three focal constructs identified from the earlier stages of the study including digital/information literacy, computer self-efficacy, and nature of technology usage have been analyzed using the socio-cultural ecological model (SCEM) for mobile learning explained in Chapter 2 (Fig 2.3) (Cook, Pachler, & Bachmair, 2011; Pachler, Bachmair, Cook, et al., 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.

7.2 Discussion on the research questions

This is evident from the findings of this study that, factors pertaining to one level of divide can also affect and contribute to the divide in the subsequent level. For example, limited or no affordability and ability to operate digital technologies along with the social and environmental conditions of homes and schools (digital access divide), 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 both levels of divide (digital access divide and digital capability divide) will, in turn, affect how new skills

and knowledge are honed; having further implications on the individuals' learning outcomes leading to digital outcome divide.

This section presents the summary and the discussion of the study findings based on the three levels of digital divide framework in learning applied to the context of the study in Fig. 2.2, adapted from Wei et al. (2011), using the analytical lens of the sociocultural ecological model (SCEM) for mobile learning by Pachler, Bachmair, Cook, et al. (2010), as explained in Chapter 2 (Fig 2.3).

This following sub sections describe how the learning process changed over the last five years since the inception to mature stage of BYOD classroom initiative to answer the three research questions posed earlier in the study. Each of the questions are directly related to three aspects of digital divide, namely, digital access divide, digital skills divide and digital outcomes divide.

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

Initial results coming out of the analysis based on the baseline data indicated no presence of digital access divide of any nature within the BYOD classrooms. Despite survey data indicating 100% access, few students turned-up 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 only. However, these students could not take those devices to home.

However, further enquiry of the issue at the subsequent stage of the investigation revealed more details about access issue among students in terms of the varying level

of acces to digital learning tools and technologies. While majority of the students had access to the one-to-one digital learning devices and internet at school and home to support their learning, others in the classroom had limited levels of access (including no internet access at home, poor internet connection at home, computers at home but no one-to-one devices to use in classrooms) thereby restricting their opportunities.

Therefore, despite the school's efforts to bridge the gap of access by facilitating learning devices during school hours, a significant number of students were missing the opportunities offered by the full access to digital learning tools and technologies. This finding was in contrast with the fact that the school area is ranked decile nine (representing a region where citizens belong to a relatively higher socioeconomic status). 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 related to digital access was the compatibility issues between different types of one-to-one devices within the classroom learning. Interview responses from student indicated 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 prompt in making alternative ways for those affected to participate into learning and complete activities in these situations. Also, the overall survey responses do not reflect incompatibility issues to be prevalent on a larger scale in everyday learning, making this a relatively non-significant issue for the further investigation.

Despite some degree of access, compatibility and technology issues being discovered, BYOD initiative had certainly provided a greater degree of access to digital learning technologies to learners. 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, marking a gradual improvement. Looking into the positive change in terms of access/reach, BYOD initiative can be considered therefore an enabler in this context.

7.2.2 How have the digital capabilities divide evolved because of the BYOD classrooms?

The baseline and follow-up survey data between 2012 and mid-2014 helped in laying the foundation of the study and framing aspects of digital divide issues as they evolved in the BYOD classrooms. As the pedagogical practices, including teaching methodologies and learning activities progressed, so did, the different nature of digital divides in learning which 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 as a result of those changes.

Because of this shift in teaching and learning practices/activities from consumption to analyzing critically before applying it into their learning, the area of investigation shifted from just digital skills to much broader skills (i.e. information literacy and computer self-efficacy). Survey and interview data from this phase suggest that a significant proportion of students lack critical analysis of information to apply to their learning activities. Information literacy and computer-self efficacy skills are critical to lift the student's ability around the meaningful usage of technology and critical thinking and analysis, which affects the acquisition of knowledge in students. Therefore, it is necessary that information literacy and computer self-efficacy are considered as the key factor into the investigation of the digital capability divide and also the evolving nature of digital divides in learning, since that can either help or risk the learning outcomes, determining the digital outcomes divide.

The investigation into this phase also looked into the motivational and behavioral and aspects related to the students, potentially affecting their digital capability. 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 to caution students, but this had little or no effect. Therefore, the issue remains one of the challenges for the 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. While students are exposed to the different forms of digital technologies as an integral part of their learning, their parents severely lack the ability to monitor their digital activities. In a different study, Newhouse et al. (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 from online content. 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 this 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.

7.2.3 How have the learning outcomes (knowledge acquisition, skills development, and progression of attitudes and motivation) 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, a shift in the teaching and learning practices and activities has been seen. The learning activities are now designed in such a way that it requires 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 2.2), 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.

7.3 Comparison with results from other studies

In 2015, National Council for Educational Research (NZCER) conducted a survey to understand current situations of learning with digital technologies within New Zealand schools. Their findings have been published in a report 'Secondary Schools in 2015', along with other aspects of education and learning (Wylie & Bonne, 2016). Some of the findings reported by NZCER under the section 'learning with digital technologies' match with the findings of this BYOD study, proving reassurance on the validity of the thesis study findings. Similar findings observed across both this study and the NZCER report are explained next.

- There is very little evidence of absolute digital divide in terms of the access, as all of the students had access to digital devices and the internet in some capacity. However, there were some exception in terms of opportunity for full digital access for every student, as the level of access to devices and the internet was dependent on the individual's circumstances. This is also evident from the thesis study, as few students in the BYOD classrooms had limited or no internet connection at home, despite having their own devices and full internet connection at school. However, the proportion of students with limited access situations were negligible.
- Initially there was an understanding that all the children are digital natives, which seems to have changed over the time. Teachers are clearly identifying distinction between digital skills and information literacy skills as digital technologies are being integrated into everyday teaching and learning. This makes the interrogation made by this thesis study valid and relevant to current pedagogical practice needs.

- Despite teachers agreeing that technology-mediated pedagogical practices are helping students, they are increasingly facing challenges around their workload (especially for decile 9-10 schools). This issue has been probed in the current study in relation to the challenges faced with BYOD classroom implementations.
- Digital learning technologies are helping to make connections between school learning and learning at home. This indicates towards extensions in learning environments from formal learning spaces to informal learning spaces. Also, this supports the use of the socio-cultural ecological model as a relevant framework and analytical lens to analyse the evolution of the BYOD classrooms and divides.

Further to the above mentioned report, an educational review article on Bring Your Own Devices (BYOD) practices has explored some of the fundamental aspects of BYOD initiatives covering social, technological and learning issues (Barback, 2016). This article shares the same concerns raised in this study around threats to BYOD, acceptance, transitional classroom learning management and the economies around the BYOD affordability and responsibility to make devices available for classroom learning. Some of the concerns that have been probed in this thesis study are also raised in this recent education review article. They are as follows:

- To start with, this article has echoed the same initial findings as this study. Parents are fearful of theft and damage to expensive learning devices, because of which they are reluctant to let their children handle the devices. However, parents are equally concerned that their children may miss on opportunities offered by devices, if they cannot entrust devices because of affordability concerns.
- The article discusses about the increasing acceptance of the digital devices into school teaching and learning practices, even from those schools who had enforced strict rules in the past regarding digital devices.

- One other aspect this thesis probed is regarding the challenges that come with variety of devices being used for learning within a cohort. However, this review article states that, even with some challenges, this is a good sign for advancement of BYOD initiative and is a step forward to bringing digital equality, thereby implying that BYOD policies can help bridge the digital access divide, no matter in what shape (i.e. varying types of devices) and nature (i.e. compulsory or voluntary).
- Regarding the debate around who should ultimately bear the cost towards the devices to be used in student learning, there are different understandings. The Ministry of Education's general understanding is that each school should address this issue and make their own decision. However, there are some arguments from educational experts and leaders from the Ministry of Education that the introduction of compulsory BYOD policies from schools might be in the breach of an act which guarantees "free education" at schools for all children between the age of 5 and 19 (Collins, 2017).

7.4 Conclusions

As a part of the five-year study of the technology-mediated teaching and learning practices, the study have been able to explain some of the unanswered questions around the issue of digital divide in the learning process. The study has 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. 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. Key outcomes of this study is summarized briefly next.

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.

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.

NOTE: Chapter 7 is a partial re-print of two articles:

- Adhikari, J., Mathrani, A., Scogings, C., & Sofat, I. (2017). Moving beyond access and skills: Transformation in teaching and learning in a BYOD case. Proceedings published in 21st *Pacific Asia Conference on Information Systems from 17th – 20th July 2017 in Langkawi, Malaysia*.

- Adhikari J., Mathrani, A. & Scogings C. (2017). A Longitudinal Journey with BYOD Classrooms: Issues of Access, Capability and Outcome Divides. Australasian Journal of Information Systems (AJIS). http://dx.doi.org/10.3127/ajis.v21i0.1693.

The thesis author was the primary investigator of this article.

Chapter 8: Conclusions and Future Research

8.1 Introduction

This study reports on a longitudinal investigation of a technology-mediated teaching and learning initiative, in the form of BYOD classrooms in a New Zealand secondary school. The study draws on findings from start of the BYOD initiative onto 5 years of its implementation. Using a narrative approach, the study has described how the teaching methodologies and learning activities have changed over the years, and how the existing and new digital divides in learning evolved within those changes and with increased penetration and adoption of digital learning technologies across the formal and informal learning spaces. The data for the study comes from a variety of stakeholders into the BYOD classrooms initiative (including teachers, students and parents). The longitudinal inquiry at each stage of study was guided by data collected from previous stage, as the issues that evolved at previous stage became part of the subsequent inquiry. The study reported these issues as they came up, discussed their resolutions and informed on new issues, which came at the forefront over the 5-year period.

This research study has utilized two main frameworks to analyze transformations within the technology-mediated teaching and learning (BYOD classrooms) environments. The theoretical framework developed for the study (chapter 2, figure

2.2) has been adapted from the three level digital divide by Wei et al. (2011) which helped the study to capture the continuously evolving nature of the digital divides with the advances in the technology adoption into teaching methodologies and learning activities. Also, the study uses analytical lenses of sociocultural ecological framework for mobile learning by Pachler, Bachmair, Cook, et al. (2010) to allow the analysis to capture the interrelationships between the various stakeholders, the learning environments and curricular structure of the school. The key constructs identified for the study (which includes digital/information literacy, computer self-efficacy, and nature of technology usage) from the three level digital divide framework for learning (i.e., theoretical framework developed for study) have been cross-referenced with the three components of the sociocultural framework for mobile learning (agency, cultural practices and structures). The combination of these two frameworks in analysis helped to capture the learning activities situated across the formal and informal learning spaces and investigate various sources of social cognitive abilities related to individual's information literacy, learning activities and computer self-efficacy levels and its effect on the learning outcomes of the students. The next section summarizes the key findings from the BYOD case.

8.2 Key findings and contributions

The study has shared rich insights on how existing and new digital divides have evolved within BYOD classrooms as the initiative progressed to the mature stage. The study reveals many opportunities in innovative teaching and learning practices facilitated by modern digital technologies. However, while digital learning technologies have opened up unlimited possibilities for access to information, ease of handling and processing information and improved collaboration resulting in

improved teaching and learning activities, it also shapes a new type of gap between individuals as the penetration of technologies and adoption stages advances. This gap has been conceptualized in a research paper with a three level digital divide framework (Wei et al., 2011). Further to that, this study shares rich insights concerning this new type of gap in a real world technology-enhanced teaching and learning context.

Study posed a series of research questions in response to the research problem identified for the investigation. The main overarching question was aimed at the overall evolution of the digital divide in learning in the context of the technology-mediated pedagogical environments. To answer the overarching question three sub-questions aimed at the three levels – digital access divide, digital capability divide and digital outcome divide – were posed. Therefore, the study findings are mapped under these three broad digital divide levels. These findings are explained below.

8.2.1 Findings related to digital access divide

The enquiry into the study began with the exploration and identification of any existing digital divide within the context of the case study selected (i.e., BYOD classrooms initiative). After gathering the data from the various stakeholders during the initial phase, broader anticipation of the digital access divide was evident. Therefore, the initial stage of the study investigated access related issues using online surveys with teachers, students and parents, and by classroom observations. Despite the speculation and anticipation, the findings suggested no evidence of a widening gap in terms of the digital access divide within the BYOD classrooms. To be precise, there were some reports of limited or no access to internet at homes, which eventually improved at the later stage of the study. The BYOD classroom also experienced some issues related to the compatibility of one-to-one devices in terms of participating into

the classroom learning activities, as the majority of the resources and activities were found to be developed keeping recommended devices (i.e. iPad) in mind. This led to increased efforts by teachers to bridge the capability of the various devices.

An earlier study had cautioned that technology integration initiatives in schools might accentuate existing digital divides (Rivers & Rivers, 2004). This study finds that such an initiative (i.e. the BYOD classroom initiative) did not trigger or widen the existing gaps/level of gaps in access to digital divides. It is specifically clear that the fear of having digitally divided school environment based on the previous notions about the integration of technologies proved to be unfounded.

8.2.2 Findings related to digital capabilities divide

The second stage of study started on a relatively firm base, after finding not much evidence of digital access divide within the BYOD classrooms, where various aspects of the digital capability divide were investigated using online surveys and semi-structured interviews. In addition, the continuing classroom observations data was also used to inform the analysis at this stage. A major finding from the analysis at this stage indicates that digital skills in learner do not support their ability of learning as understood earlier. Students may have an excellent level of digital skills in operating the digital learning devices, but they may not be able to take advantage of that skill without the adequate information literacy skills, suggesting ability of learning in learners is guided largely by the information literacy skills.

The BYOD classrooms initiative enabled teachers to be more innovative in classroom learning activities, for better student engagement. Students were offered greater flexibility and agency making them more responsible for their own learning. At this

time, the difference between digital skill and information literacy skills become evident. The analysis found an increase in frustration and motivational issues among the students with no or limited information literacy and critical thinking ability. Because of this, the gap in ability to learn between students with and without the information literacy and critical thinking skills emerged. The analysis strongly indicated the presence of this gap mid-way during the five-year long research.

However, this gap become narrow at the later stage of the analysis, which suggests a possible explanation that 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.

8.2.3 Findings related to digital outcomes divide

The findings of the second stage of the research provided the informed beginning of the third stage enquiry as more understanding was gained around factors pertaining to the digital capability divide. This was important, as the factors pertaining to the digital capability divides are the focal constructs for this study (digital/information literacy, computer self-efficacy, and nature of technology usage), through which personal, behavioural and environmental factors further influence learning outcomes resulting in digital outcome divide.

From the analysis of these focal constructs, computer self-efficacy emerged as the factor with greater influence in shaping up the learning outcomes. The learner self-efficacy when combined with the other predicators of the digital capability divide, further influenced affordances in various sources of social cognitive abilities affecting individual learner's knowledge acquisition, progression, and changes in their attitude

and behaviors. This leads to difficulty in learners to engage and apply technology to attain their learning requirements, and therefore puts them to the wrong side of digital outcome divide.

8.3 Implications of the study

This research study has extended our understanding of digital divide in the teaching and learning practice by studying the case of a BYOD classroom policy in a secondary school. In doing so, we have adapted the framework from Wei et al. (2011) explaining the different nature of digital divides that emerge with advances in the adoption level of ICTs, and developed and evaluated three level digital divide framework in a teaching and learning context. Therefore, the outcomes of this study has implications for both theory and practice in technology-enabled interventions in education.

8.3.1 Implications for theory

Analysis of current literature in this research topic helped identify a number of predicators on technology access and usage leading to digital division or digital inclusion in teaching and learning environments. The case study selected for the research study within the context of technology-mediated teaching and learning further helped the researcher to assess the predicators identified with real-world teaching and learning practices.

A three level digital divide framework for teaching and learning has been developed as a part of this research study. The study's framework builds on the three level digital divide framework from Wei et al. (2011), by applying the socio-cultural ecological framework for mobile learning by Pachler, Bachmair, Cook, et al. (2010) as the analytical lens while assessing the case data. Consequently, both frameworks have

provided methodological guidance to make empirical assessments and give meaningful explanations on digital divides in a technology-mediated classroom teaching and learning context.

This thesis extends currently available literature on the digital divide phenomenon and provides a contextualized analysis of digital divide in teaching and learning processes. Specifically,

1. The research study has developed a three level digital divide in learning framework by adopting there level digital divide framework by Wei et al. (2011), based on the comprehensive review of the literature. The model brings the all-possible levels of digital divides in one place and describes how one level of divide leads to another based on the social, behavioural and cognitive factors.

2. The research study has utilised the socio-cultural ecological framework for mobile learning by Pachler, Bachmair, Cook, et al. (2010) to conduct an empirical inquiry in a longitudinal case study. This has provided both a theoretical and methodological lens in the structuring and analysis of the data.

3. The research study provided a descriptive narrative starting from the announcement of the BYOD initiative where many doubts on its viability were expressed onto the initiative finally being accepted as a norm. Rich insights were shared over the course of the investigation as new factors unravelled and informed the study on focal constructs relevant to digital divide thereby contributing towards improving understanding of the higher levels of the digital divide phenomenon. Technology-mediated innovative pedagogies have been discussed to reveal how

digital divides were overcome and moved beyond access and skills to ensure inclusive learning outcomes.

8.3.2 Implications for practice

This study has not just provided an explanation around the digital divide phenomenon in learning, but has also provided an in-depth understanding of the various challenges surrounding technology-mediated teaching and learning practices. Educational institutions and governments are currently investing heavily on innovative learning technologies and this has been dubbed as 21st century teaching and learning, or as smart education. This study has shared aspects of technology diffusion via educational interventions to inform practitioners on technology-mediated teaching and learning issues, which could subsequently arise. Specifically,

1. The research study has provided a much-needed empirical study to answer the questions raised around the challenges of technology-mediated teaching and learning. This is especially relevant since more and more educational institutions are embracing digital learning technologies and integrating them into their pedagogical practices. This study reports on how existing and new digital divides have evolved with increased penetration of digital technologies into teaching and learning spaces.

2. The study showed no evidence of a widening gap in terms of digital access in the selected case. This can certainly inform practitioners take informed decision that technology led classroom initiatives might not always accentuate gaps between haves and have-nots in certain school and societal contexts.

3. The research study has also provided much needed clarity and provided the evidence that students' ability to learn is not guided by their digital skills, rather by adequate information literacy skills and computer self-efficacy. This is an important finding and will help practitioners to plan their actions and prioritise their focus on building skills to put their learners into the path to succeed.

4. 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 in the real-time as the investigation progressed. Therefore, the study findings will provide value to policy makers and education government agencies in their ongoing quest for bringing about an inclusive digital transformation.

5. During the time of this study, NZQA (New Zealand Qualifications Authority) held paper based NCEA (National certificate of Educational Achievement) assessment methods. However policy makers have recently introduced online assessment methods (MoE, 2017) which has been implemented as a pilot test for the first time in November 2017 (NZQA, 2017). This study had already been completed at this point of time. However, the BYOD classroom initiative was one of the first steps, which has led to further ongoing transformations supporting technology-mediated educational practices to occur across secondary schools.
6. In 2017, the New Zealand government purposed the digital transformation of the curriculum to be started from 2018 and expects this to be completed by 2020. The aim of the digital curriculum is to develop the 'computational thinking in the students' from the early learning years, in a bid to prepare them for future workplaces and jobs (Crown, 2017). This initiative from the government will further enforce and expand the BYOD classrooms initiative to all the New Zealand

schools, thereby improving the development of digital courseware learning materials, digital assessment methods and examinations methodologies across the education system.

From the observations made in the early stage of this initiative, the initial debates are already indicating towards some of the challenges that can come in the way of successful implementation of digital curriculum in schools. This includes opposition from teachers and parents, concerns around professional development of the current teachers so that they can perform confidently in the new teaching and learning environments and concerns around the availability of teachers who are already in decline, nationally (Kenny, 2017).

Given the similarity between the 'BYOD classroom initiative' and the 'digital curriculum' based on their goals, the findings form the thesis can be very valuable for the schools and the implementation partners (like Ministry of Education). Further, the thesis findings and the analytical lens approach applied in this study can be used particularly in understanding some of the challenges which occur during evolution of such technology-driven initiatives within both formal and informal learning spaces.

8.4 Limitations

As with any research, this study has some limitations. This section identifies the limitations of the research and presents suggestions for conducting future research to overcome them. These are as follows:

1. The choice of the case study was restricted by the availability of the suitable cases representative of the research problem at the time of the start of the study. The case study selected for this research is one of the first schools to introduce the fully

technology-mediated pedagogical practices in the form of the BYOD initiative. That has limited our options in terms of the selection of the case for the study. That led the study to use the single case of a BYOD initiative in a secondary school in New Zealand with the decile ranking of nine based on the New Zealand school ranking system. 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.

However, a comparative study involving more than one case study including schools with varying level of decile ranking relevant to the research problem would give a better understanding of digital divide in learning across various socio-economic regions.

In a recent development in the education policy, the government reform to scrap the decile ranking of schools by 2019 is currently under discussion (Parliament, 2017). The discussion is around the argument that decile ranking is a blunt tool, which measures schools with socio-economic region rather than quality of education.

2. Because of being the pioneer school to introduce such initiative in New Zealand there was a huge media controversy surrounding the school's decision and was covered in many of the national and local media (Mass, 2011; Moore & Tasman-Jones, 2011; Tasman-Jones, 2012). The media spotlight and speculation surrounding the initiative could have had some impact on steps taken by staff to better manage digital exclusion. However, triangulation of data sources (i.e.,

classroom observation, student surveys and parent and teacher interviews) has been used in data gathering process to strengthen the study findings.

8.5 Future research

This study provides a very good understanding on the issue of digital divides in learning and captures the evolution of the existing and new digital divides in the context of the technology-mediated pedagogical interventions and initiatives. While doing so, the study predominantly collects and analyses the qualitative data from the longitudinal case of a BYOD initiative, involving various stakeholders like students, teachers and parents.

However, analysis of student learning outcomes based on quantitative measures (like student performance data) have never been included into the study. Therefore, the future directions of research on this topic lie in the inclusion of the quantitative analysis of the student performance data captured through the school's assessment process. Further research can use the three level framework for technology-mediated learning as a base and combine it with different analytical lens, which are suitable for quantitative data analysis. This will not just help to validate the three level digital divide framework in learning from the quantitative prospective, but also provide an extension to this research study and contribute to teaching and learning theories.

Finally, at a personal level, the experience, exposure, academic networking and collaboration opportunities I received during this study have been invaluable to help me grow as a researcher and as an academic. Being an educator myself in various capacities over the last ten years, the field of education-based research has always been my passion. After having conducted this study, it has transformed my understanding

of digital technologies from simply being a tool to being a medium that comes with both opportunities and challenges. I have been able to publish ten peer-reviewed research articles covering issues of digital divides in learning, particularly within the context of technology-mediated pedagogical settings. My future research direction is to investigate further applications of new and emerging technologies across wider educational settings, and across formal and informal learning environments. My career plan is to grow as a researcher and conduct further research spanning areas of curriculum development, which can help increase pedagogical understandings while incorporating digital technologies into instructional practice.

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Appendix A : Ethics Approval Letters

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

15 February 2012

Janak Adhikari
c/o Institute of Information and
Mathematical Sciences
ALBANY

Dear Janak

Re: iPad2 in Classroom (Orewa College)

Thank you for your Low Risk Notification which was received on 1 February 2012.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

J. O'Neill

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc Assoc Prof David Parsons
Institute of Information and Mathematical Sciences
Albany

Prof Tony Norris, HoI
Institute of Information and Mathematical Sciences
Albany

Dr Anuradha Mathrani
Institute of Information and Mathematical Sciences
Albany

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Date: 12 May 2016

Dear Janak Adhikari

Re: Ethics Notification - **4000016088 - Bring Your Own Devices Classroom: Issues of Digital Divides in Teaching and Learning Contexts**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please go to http://rims.massey.ac.nz and register the changes in order that they be assessed as safe to proceed.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:
"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director - Ethics, telephone 06 3569099 ext 86015, email humanethics@massey.ac.nz. "

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

BJFinch

Dr Brian Finch
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Appendix B: Study Information Sheet

A study on Bring Your Own Devices Classroom: Issues of Digital Divides in Teaching and Learning Contexts

Information Sheet

This research project is part of the PhD study on the "Bring Your Own Devices Classroom: Issues of Digital Divides in Teaching and Learning Contexts" by Janak Adhikari.

Technology-mediated teaching and learning provide potentially valuable resources for learners' academic and social development. However, according to recent researches, as the adoption stages of ICTs advance there arise further levels of digital divides in terms of equity of digital capability and learning outcomes. Therefore, we have been working with the school to study the introduction of Bring Your Own Device (BYOD) policy to gain the insights into the digital divide issues in the context of technology-mediated teaching and learning environment. Our research has included a number of methods, including surveys, interviews and classroom observations.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern. If you have any concerns about the conduct of this research, please contact Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43404, email humanethicsnorth@massey.ac.nz.

Researcher: Janak Adhikari (Email: J.Adhikari@massey.ac.nz)

Research supervisor: Dr. Anuradha Mathrani (Email: A.S.Mathrani@massey.ac.nz)

Participant's Rights:

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- Decline to answer any particular question;
- Withdraw from the study;
- Ask any question about the study at any time during participation;
- Provide information on the understanding that your name will not be used unless you give permission to the researcher;
- Be given access to a summary of the project findings when it is concluded;
- Ask for audio recording to be turned off at any time during the interview.

Appendix C: Participant Consent Form

A study on Bring Your Own Devices Classroom: Issues of Digital Divides in Teaching and Learning Contexts

Participant Consent Form

Note: This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern. If you have any concerns about the conduct of this research, please contact Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43404, email humanethicsnorth@massey.ac.nz.

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand the following:

- That I may ask further questions at any time and am free to withdraw at any time.
- That I agree to the interview being voice recorded.
- That all information I provide will be dealt with in a confidential manner.
- I agree that the researcher may contact me.

Full Name (Printed) _____

Signature: _____ Date: _____

Address (Optional): _____

Telephone Number (Optional): _____

Appendix D: Baseline Survey Questions

Parent Survey Questions:

1. What is your opinion about the introduction of digital learning technology in school education?

   Possible Answer Set:
   - *This is unnecessary for better education*
   - *This is necessary but the government should provide help to cover the cost associated*
   - *This is very necessary and I am happy to pay for the device*
   - *Others (please specify)*

2. Did you find any difficulty to provide recommended device for your children?

   Possible Answer Set:
   - *Yes (please specify)*
   - *No*

3. Does your child have the one to one digital device (iPad2) which is recommended by school?

   Possible Answer Set:
   - *Yes*
   - *No, but they have another type of one-to-one digital learning device (please specify)*
   - *No, they do not have any one-to-one digital learning device to take to school*

4. What is your computer/internet usage pattern in a typical day?

   Possible Answer Set:
   - *Only emailing*
   - *News and entertainment*
   - *Job activities as a part of job requirements*
   - *Others (please specify)*

5. What level of access to ICTs do you have in home?

   Possible Answer Set:
   - *No access to ICTs*
   - *Only Computer*

Computer with internet connection
Other (please specify)

6. What is the status of internet connection at your home?
   Possible Answer Set: *Dial up*
   Fixed line Broadband
   Wireless Broadband
   If other, please specify

7. How do you get involved with your children when they are engaged with computer and internet in home?
   Possible Answer Set: *Leave them in their own*
   Only supervise their computer and internet usage
   Encourage them to make positive and productive use of technologies
   Help them learn new things
   Others (please specify)

8. What is your opinion about the role of digital technologies and ICTs in social, economic and educational development of the any society?
   Possible Answer Set: *Very important*
   Necessary
   Not important

9. What difference you think, it makes in the academic outcome of learner by the use of one-to-one digital learning devices?
   Possible Answer Set: *It makes no difference*
   It motivates learners to achieve even better
   It facilitates the learners with easy and instant access to information and resources
   Affect negatively because of the unsupervised and non-educational use of available technology
   Others (please specify)

Staff Survey Questions:

1. What is your area or subject of teaching?
   Possible Answer Set: *Please Specify*

2. Have you ever used any ICT in your instructional activities?
   Possible Answer Set: *Never*
   Sometimes
   Regularly

3. How would you rate your level of skill in using new digital devices and computer related technology?
   Possible Answer Set: *Beginner*
   Basic skills
   Intermediate
   Competent
   Advanced

4. Do you anticipate any difficulty in using digital learning devices for your instructional activities?
   Possible Answer Set: *No*
   Yes (please specify)

5. Do you feel you have sufficient skills for making use of ICTs in your instructional activities?
   Possible Answer Set: *Yes*
   No

6. What level of computer and internet usage opportunity do you have?
   Possible Answer Set: *Casual*
   Regular
   Frequent
   All the time

7. What kind of activities you perform mostly while using computers and internet?
   Possible Answer Set: *Communication (Emailing/messaging/video calling etc.)*
   News and Entertainment
   Scholarly Activities
   Other (please specify)

8. What do you think about the academic performances of learners after introducing one-to-one digital learning device as a medium of learning?
   Possible Answer Set: *Makes no difference*
   Improve by facilitating wide range of resources
   Affect negatively because of the unsupervised and non-educational use of available technology
   Other (please specify)

9. What do you think about the students support in the school's initiative of one-to-one digital technology mediated teaching and learning?
   Possible Answer Set: *Participate fully*
   Participate partly because of the lack of understanding and skills required
   Very low participation due to the lack of attitude and motivation towards technologies
   Other (please specify)

10. What kinds of support did you get from the school administration regarding the school's initiative of one-to-one technology mediated teaching and learning?
   Possible Answer Set: *Technical support*
   Financial support
   Training for upgrading skills and knowledge
   Other (please specify)

Student Survey Questions:

1. Do you have one-to-one digital learning device for using into classroom learning, as requested by school?
   Possible Answer Set: *Yes (please specify)*
   No

2. Are you feeling happy about the use of digital learning device in classroom?
   Possible Answer Set: *Yes*
   No

3. What level of access to ICTs do you have in home?
   Possible Answer Set: *No access to ICTs*
   Only Computer
   Computer with internet connection
   Other (please specify)

4. What is the status of computer access at your home (tick all that apply)?
   Possible answer set: *No access*
   Desktop Computer
   Laptop/Notebook Computer
   Tablet Computer
   Games Console
   Small Mobile Device (e.g. smartphone, iPod)
   Other (please specify)

5. What is the status of internet connection at your home?
   Possible Answer Set: *No access*
   Dial up
   Fixed line Broadband
   Wireless Broadband
   If other, please specify

6. What level of skills do you currently have to make adequate use of available technology?

   Possible Answer Set: *Beginner*
   Intermediate
   Advance
   If other, please specify

7. Please tell us about how your parents support you regarding technology mediated learning?

   Possible Answer Set: *Not any support*
   Facilitating technology and resources only
   Help in learning new things and motivating to achieve improved learning outcome

8. Which is the primary place where you access computers and internet?

   Possible Answer Set: *At home*
   At school
   Other (please specify)

9. Which activities do you perform most of the time while using computer and internet?

   Possible Answer Set: *Educational activities*
   Entertainment
   Games
   Social media
   Other (please specify)

10. Where do you carry out most of your educational activities like completing your project and assignments, outside of classroom time?

    Possible Answer Set: *At school*
    At home
    Other (please specify)

Appendix E: Followup Interview and Survey Questions

Interview Questions for Teaching Staff:

1. Please tell me about your teaching area/subjects. What do you think the impact will be on the students' performance from the use of digital learning devices?

2. What kind of difficulties do you anticipate while using digital devices for instructional activities?

3. Have you used ICT devices for the purposes of instructional activity in past?

4. How is the initiative being supported by the school administration?

5. How do you expect the students to respond to, and participate in, the school's plan for the technology mediated teaching and learning process?

Interview Questions for Students:

1. Please tell me about your level of access to ICTs (computers and internet) in your daily life

2. What do you feel about the use of one-to-one digital devices in classroom for learning purposes? Do you think using this device will improve your learning?

3. What do you think about possible difficulties in using digital devices in your classroom learning activities?

4. How do you spend most of your time with computers and internet?

5. How could you be assisted to better understand and apply meaning to any educational or informational material found?

6. What motivates you to use the computers and internet at home and at school?

7. Tell me more about your home use of computer and internet?

Interview Questions for Parents:

1. What do you feel about the school's decision to use digital learning device as a compulsory item in classroom?

2. What do you feel about the roles of these new digital devices and computers in the social, economic and educational development of society?

3. What type of ICT facility do you have at your home?

4. In what ways do you get involved with your children while they are engaged with computers and the internet?

5. What is your opinion about the role of motivation on children's willingness to learn, making good use of available technology and achieving good academic results?

Survey for Students (First):

1. What changes have you noticed since you started using one-to-one devices for learning? (Please describe)

2. What is the status of your grade performance since you started using one to one devices for learning? (Please specify the reason)

    a. My grades have improved.
    b. My grades are falling.
    c. I don't know.

3. After using one-to-one devices for almost a year, what is your opinion about the usage of such devices for learning activities?

        a. I am in favour using one-to-one devices for learning activities.
        b. I am against using one-to-one devices for learning. I would prefer an alternative approach. (please describe)
        c. I don't know.

4. Are there any specific applications, websites or sources of information which you believe could help you to learn, but have been restricted by the school?

    a. There are some restrictions but they do not affect my ability to learn.

b. There are some restrictions and this is limiting my learning. (please specify which restricted applications, websites or information sources you would like to use)
c. There are no restrictions that I am aware of.
d. I don't know.

5. How do you make use of the information you collect or create using your one-to-one device?

    a. I find suitable material and use that as it is, because it is difficult and time consuming to create my own learning material.
    b. I prefer to create my own learning material by adapting and creating resources. I do not find it difficult.
    c. It depends on the purpose. I construct my own learning material only if is for an important assignment as it can be difficult and time consuming. Most of the time I use suitable material as it is.
    d. I am not interested in using material accessible from my one-to-one device.

6. How do you make use of your one-to-one device for learning activities inside or outside of the school? Please select the option which best describes your learning practices using one-to-one devices.

        a. I just use my one-to-one device as a medium to access or gather information from various sources.
        b. I use my one-to-one device to process the information to create my own learning material to use for my learning.
        c. As well as creating my own learning material I use my one-to-one device to publish and share those materials with my friends so that others can also use it.

7. Have you ever felt excluded from the learning activities in class or disadvantaged in terms of your access to a suitable device?

        a. No, I haven't felt excluded or disadvantaged.
        b. Yes, I have felt excluded and/or disadvantaged in the classroom. (Please describe in what way)
        c. I don't know.

8. How is the school's Ultranet site helping you in your learning?

    a. I don't use the Ultranet site much. (Please explain why)
    b. I use the Ultranet site but only for accessing classroom materials and assignments provided by the teachers.
    c. I use the Ultranet site frequently using most or all of its features.

d. Other. (please describe)

9. Do you think including some kind of social networking or web 2.0 tools in your learning process would be helpful in improving your learning experience?

    a. I like social networking and web 2.0 tools and I think they would help the learning process.
    b. I like social networking and web 2.0 tools but I am not sure how those could help me to improve my learning.
    c. I do not like using social networking and web 2.0 tools
    d. I don't know.

Survey for Teachers (First):

1. What changes have you found since you started using one-to-one devices for teaching purposes? (Please describe)

2. What have been the major challenges for you in using one to one devices in teaching? Please arrange following items in order from the most challenging to the least challenging.

    a. Increased workload
    b. Time management
    c. Controlling behaviour and activities of students
    d. Technology issues
    e. Integrating one to one devices into the curriculum
    f. Other (Please specify)

3. Did you feel the need to change the method of your teaching after the integration of one-to-one devices into teaching/learning practices?

    a. I am continuing with my old method of teaching. I don't feel there is need to change the method of teaching.
    b. I have changed my teaching method. It is not possible to continue with old methods of teaching in a new context of mobile learning practices. (please describe how you changed your teaching methods)
    c. I don't care much about it. My only concern is delivering appropriate information to the students through any method.

4. Which of the option below best describes the changes in students' attitude and behaviour since they started using one-to-one devices in learning?

a. Students are more motivated towards learning activities and the performance of the majority of students has improved.
b. Students are less motivated towards learning activities and the performance of the majority of students has deteriorated.
c. I have not noticed any major impact on students' attitude and behaviour
d. Students' attitude and behaviour varies considerably and it is not possible to make an overall judgement

5. What do you think about the Ultranet site used in your school? Is it successful in engaging students in their learning inside and outside of the school?

    a. Yes, it is very effective tool for students and teachers. Our students spend significant time on the Ultranet site to support their learning activities.
    b. It is not very popular among students and teachers. It does not engage students, because something is missing to engage students. (please describe)
    c. Even I don't use the Ultranet site much. So I don't want to comment
    d. I don't know.

6. Have you ever considered using social media or web 2.0 tools for classroom activities to improve the learning experience and motivation of students?

    a. Yes, I have used those tools before in classroom activities. (Which tools do you use and for what purpose?)
    b. I have not used these tools yet, but I am planning to use them in the future. (Which tools do you expect to use and for what purpose?)
    c. No, I have considered these tools but do not wish to use them in the teaching and learning process.
    d. No, I haven't considered this at all

7. What would be your impression if a student carried out some activities to support their learning, but violated the school's rules regarding the use of one-to-one devices inside the classroom?

    a. That would be ok with me, but I would insure they were using it appropriately.
    b. If it violated the school's rules regarding the usage of device, I would never allow them to do that.
    c. Students should be allowed to do the activities which could support their learning. I would talk to school administration and try to find some way to allow those activities in the classroom.
    d. I don't know.

8. In your opinion, what can be done for even better utilization of one-to-one devices to improve learning outcomes? (Please describe)

Survey for Parents (First):

1. What changes, if any, have you noticed in your child since they started using one-to-one devices for learning? (Please describe)

2. Are you satisfied with your child's usage of their one-to-one learning devices at home?

    a. I am happy that they seem to be engaged in learning activities most of the time.
    b. I am concerned that one-to-one devices seem to be engaging them in activities other than learning (e.g. gaming, Facebook and entertainment).
    c. One-to-one devices seem to be engaging them in activities other than learning but this does not concern me
    d. I don't know.

3. Is your child having any kind of difficulty in using one-to-one devices for learning?

    a. I haven't talked to him/her regarding this.
    b. Yes. (Please describe)
    c. No, not at all.
    d. I don't know.

4. Have you been able to provide enough help and supervision for your child's learning?

    a. I am totally involved in my child's learning activities and providing as much help and support as I can.
    b. I feel that I have been unable to help and supervise as much as I would have liked on some occasions (please describe why)
    c. My child is capable of using the device for learning without my help and supervision
    d. I don't know.

5. Are you in favour of the continuation of using one-to-one devices in classrooms next year as well? (Please provide reasons for your choice)

    a. Yes, it should be continued.
    b. It should be continued but changes are required (please specify)

c. No, it should not be continued.
d. I don't know.

6. Would you like to add anything regarding the usage of one-to-one devices in your child's learning?

Survey for Students (second round):

1. Would you like to add anything regarding the usage of one-to-one devices in your child's learning?
    a. iPad
    b. Laptop
    c. Netbook
    d. Other (please specify)
    e. Android Tablet
    f. No Device

2. How would you describe your current level of skill in being able to make meaningful use of one-to-one devices in your daily learning activities?
    a. Beginner (still learning)
    b. Intermediate (I can carry out most of activities required in daily learning)
    c. Other (please specify)
    d. Advanced (I am very confident and can carry out all of the activities required in daily learning)

3. What percentage of your time using one-to-one devices do you spend on the following activities? (Please ensure the total adds up to 100%)?
    a. Educational activities
    b. Entertainment
    c. Games
    d. Social media
    e. Other (please specify)

4. What changes have you noticed in your learning since you started using one-to-one devices in the classroom? (Please describe)

5. What has your grade performance been like since you started using one to one devices for learning? (Please specify the reason, if you can)
    a. My Grades have Improved
    b. My Grades are Falling
    c. No Change in my Grades

6. From your experience of using one-to-one devices so far, what is your opinion about the use of such devices for learning activities?
    a. I am in favour of using one-to-one devices for learning activities.
    b. I am in favour of using one-to-one devices for learning activities but would like to make recommendations for changes to current practice (please describe).
    c. I am against using one-to-one devices for learning. I would prefer an alternative approach. (please describe)

7. Digital devices are frequently used for accessing, storing and processing digital information, but have you ever created any digital artefacts (e.g. animations, musical compositions, computer programs etc.) by using your one-to-one device?
    a. No, I haven't created anything like that yet.
    b. Yes, I have created those kind of digital artefacts. (Please give an example).
    c. I would like to create those types of digital artefacts but I do not yet have the required skills.

8. Have you ever felt excluded from being able to carry out learning activities in class or disadvantaged in terms of your access to an appropriate device?
    a. No, I haven’t felt excluded or disadvantaged.
    b. Yes, I have felt excluded and/or disadvantaged in the classroom. (Please describe in what way)
    c. I don’t know

9. Do you think that the current approach to digital teaching and learning at the school will have prepared you effectively for NCEA exams?

a. I am sure I am prepared for NCEA exams. I am not worried about this at all.
b. The way we have learned in the classroom and the way the NCEA exams are conducted is different. Therefore, I am worried about that.
c. I don't know until I sit the exam

10. Is there anything else that you would like to add regarding this survey? If so, please enter it into the box below (optional)?

Survey for Teachers (second round):

1. How many years' experience do you have in teaching at intermediate and/or high school levels?
    a. 1-2 years
    b. 2-5 years
    c. 5-10 years
    d. 10 or more years

2. How would you rate your current level of digital skills in the context of teaching and learning using digital devices?
    a. Beginner
    b. Basic skills
    c. Intermediate
    d. Competent
    e. Advanced

3. Have you experienced any difficulties in using digital devices for teaching and learning in the classroom?
    a. No
    b. Yes (please specify)

4. What have been the major challenges for you in using one to one devices in teaching? Please arrange the following items in order from the most challenging

(at the top) to the least challenging (at the bottom). You can drag the items into position.

   a. Students' Digital Skills.
   b. Attitude and Motivation of Students
   c. Nature of Technology usage by Students
   d. Other. Please Specify

5. What do you think the impact on the academic performance of students has been since one-to-one digital devices have been introduced to support learning?
   a. Made no difference (please explain why you think this)
   b. Has improved performance (please explain why you think this)
   c. Has affected performance negatively (please explain why you think this)

6. What have been the major challenges for you in using one to one devices in teaching? Please tick all options that apply.
   a. Increased workload
   b. Time management
   c. Managing the classroom. (Controlling the behaviour and activities of students)
   d. Other issues (please specify)

7. Which of the options below best describes the changes in students' attitude and behaviour since the introduction of one-to-one devices for learning?
   a. Students are increasingly motivated towards learning activities and the performance of the majority of them has improved.
   b. Students are less motivated towards learning activities and the performance of the majority of students has deteriorated.
   c. I have not noticed any major impact on students' attitude and behaviour.
   d. Students' attitude and behaviour varies considerably and it is not possible to make an overall judgement

8. During the time you have been teaching with one-to-one devices, what changes have made to your teaching practices?

9. What is your feeling about students being assessed with hand written NCEA exams when their classroom teaching has been based on using digital devices?

10. Is there anything else that you would like to add regarding this survey? If so, please enter it into the box below (optional)

Survey for Parents (second round):

1. What is your opinion about the introduction of one-to-one devices into school education?
    a. School education can be delivered without these devices.
    b. This is important for school education but the government should provide some financial support to cover the associated costs.
    c. This is very important for school education and therefore I am happy to pay for my child's one-to-one device.
    d. Other (please specify)

2. Did you find any difficulty in providing a one-to-one learning device for your child's to take to school?
    a. Yes (please specify)
    b. No

3. Does your child / do your children have the one-to-one Digital Learning Device (iPad2) which is recommended by the school?
    a. Yes
    b. No, but they have another type of one-to-one digital device (please specify)
    c. No, they do not have any one-to-one digital device to take to school

4. Are you satisfied with your child's usage of their one-to-one devices for learning activities while being at home?
    a. I am happy that they seem to be engaged in learning activities most of the time.
    b. I am concerned that one-to-one devices seem to be engaging them in activities other than learning (e.g. gaming, Facebook and entertainment).

c. One-to-one devices seem to be engaging them in activities other than learning but this does not concern me.
d. I don't know.

5. How would you describe the changes or impact of one-to-one devices on the learning of your child? (for example, any changes in their attitude, motivation and ability in their learning).

6. Are you in favour of continuing the use of one-to-one devices in classrooms in future? (Please provide reasons for your choice)
    a. Yes, it should be continued (please indicate the main reason why)
    b. It should be continued but some changes are required (please specify)
    c. No, it should not be continued (please indicate the main reason why)

7. Have you seen any kind of impact (either positive or negative) on your family or on wider society since your child started using one-to-one devices for their learning activities?

8. Do you have any concerns regarding digital teaching and learning in the classroom, and the current methods of assessment used by NCEA?

9. Is there anything else that you would like to add regarding this survey? If so, please comment in the box below (optional)

Appendix F: Summative Interview Questions (Teachers)

First Round:

1. How has the BYOD policy changed your everyday teaching and learning?
    a. Did you had to change the way you teach?
    b. If so, what did you changed and how?

2. How has the BYOD policy changed the way students learn?
    a. Were there any challenges for them?
    b. What changes you can see in student learning, since the introduction of BYOD policy?

3. Do you think there have been any issues related to digital divides in classroom, in the context of BYOD?

4. How would you describe the changes in technology usage patterns (i.e. nature of technology usage) among students into 3 years of BYOD classrooms?

5. How would you describe the changes in attitude and behaviours in students for BYOD classrooms?
    a. Has NCEA examination method or anything in particular made any difference?

6. How digital skills/literacy of the students have been transformed by the BYOD policy?
    a. How would you describe their skills on, operating the learning devices vs finding, analysing and applying knowledge in their learning?

7. Did BYOD classrooms extended the boundaries of teaching and learning between teachers and students?
    a. Do you facilitate student learning into informal spaces along with formal space (i.e. classroom/school)?

b. Does computer self-efficacy of learners ever had an impact on their ability to make use of the learning devices and engage in learning activities in formal and informal learning spaces?

8. What do you consider the most important lessons learned into 3 years of BYOD classrooms?

9. Did BYOD classroom added value to the students learning outcomes?

10. Do you think level of information literacy, nature of technology usage and computer self-efficacy among students might have an impact on the student learning outcome (i.e. knowledge and skills outcomes, changes in attitude and behaviour)?

11. Do you believe that, student learning outcomes depends on the level of information literacy, nature of technology usage and computer self-efficacy among students?
    a. How BYOD classrooms is contributing towards enhanced learning outcomes among students?

12. How would you describe your journey into BYOD classrooms in the context of your teaching practices and student learning outcomes?

13. What do you think can be done to enhance the BYOD policy for even better experience for students and teachers?

Second Round:

1. Whether the ease of access to learning resources has helped students to engage in critical thinking and meaning making?

2. What is the biggest change into your classroom curricular practices?

3. Can you please tell something about the extension of boundaries between formal and informal learning spaces through different methods and activities?
    a. If it helped on improving student motivation for learning?

4. Would you trust agency (more ownership, responsibility and freedom) to students during classroom pedagogical practices?
    a. Would it be helpful in relieving teachers from excessive workload?

5. Do you believe that there is a universal approach to classroom curricular practices in school?
    a. How is it affecting the learners?

6. What is your opinion about concerns of parents over the 24x7 unsupervised access of internet by students?
    a. What do you think about their fear of exposure to harmful content and risk associated with that?
    b. Do you believe that risk to cyber bullying and pornography have increased over the time?
    c. Do you see any links of this with classroom management, in class behaviour and attitudes of students?

7. Would you like to express overall feeling towards the idea, progress challenges and benefits of BYOD policy?

8. Would you like to add anything else?

Appendix G: Publications List

Research publications generated from this research study so far are:

1. Adhikari J., Mathrani, A. & Scogings C. (2017). A Longitudinal Journey with BYOD Classrooms: Issues of Access, Capability and Outcome Divides. Australasian Journal of Information Systems (AJIS). http://dx.doi.org/10.3127/ajis.v21i0.1693
2. Adhikari J., Scogings C., Mathrani, A. & Sofat, I. (2017). Evolving Digital Divides in Information Literacy and Learning Outcomes: A BYOD Journey in a Secondary School. International Journal of Information and Learning Technology. https://doi.org/10.1108/IJILT-04-2017-0022
3. Adhikari, J., Mathrani, A. & Scogings, C. (2016). Bring Your Own Devices classroom: Exploring the issue of digital divide in the teaching and learning contexts. Interactive Technology and Smart Education. 13(4), pp 323-343 http://www.emeraldinsight.com/1741-5659.htm
4. Adhikari, J., Mathrani, A., Scogings C. & Sofat, I. (2017). Moving Beyond Access and Skills: Transformation in Teaching and Learning in a BYOD case. 21st Pacific Asia Conference on Information Systems from July 17-July 20, 017, Langkawi Island, Malaysia.
5. Adhikari, J., Mathrani, A. & Scogings, C. (2016). Understanding Learning Outcome Divide in the Learning Process from Teachers Perspective: A BYOD Case Study. 27th Australasian Conference on Information Systems. Wollongong, Australia: 27th Australasian Conference on Information Systems (5th – 7th December, 2016). ACPHIS Kit Dampney Best Education Paper Award.
6. Parsons, D. & Adhikari, J. (2016). Bring Your Own Device to Secondary School: The Perceptions of Teachers, Students and Parents. Electronic Journal of e-Learning, 14(1), pp 66-79.
7. Parsons, D. & Adhikari J (2015). The Ups and Downs of BYOD: A Sociocultural Perspective. *European Conference on e-Learning*: pp478-486.
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