New Learning in the 21st Century: a Case Study of Digital Technology Implementation in Early Primary School Classes

Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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谨以此文献给我挚爱的父亲和母亲
TO MY FATHER AND MOTHER WITH ALL MY LOVE AND RESPECT

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ABSTRACT

In recent years the use of digital technologies in education settings has increased dramatically worldwide, as devices such as tablets, digital cameras, interactive smartboards, and user-friendly software and applications have enabled teachers to harness the digital world. Research shows that digital technologies in educational contexts have had a very positive impact, because they allow teachers to enhance their teaching practices and support their students' learning.

My study explored and presented the use of digital technologies in an Australian primary school by their teachers and students. The main objective was to describe early primary school teachers' perceptions and teaching practices of including digital technologies (i.e. iPads and smartTV), and to show how young students used digital technologies enhancing their learning experiences.

The research involved one single case of a school in western Melbourne. The data collection occurred during four terms in August 2016-July 2017. Foundation Year and Year One/Two learning communities were selected for classroom observation; students were aged between 5 and 8 years which fitted in early childhood range as well as in formal education setting (the primary school sector). The case study involved interviews with six classroom teachers, and observations of four learning communities (one

Foundation Year learning community, and three Year One/Two learning communities) and students' digital artefacts. These enabled me to generate an in-depth description of the contexts and meaning of digital technology mediated learning and pedagogical practices in a contemporary Australian classroom. I employed a constructivist paradigm to inform the research design and adopted a Learning by Design framework to help explain the findings.

My study found that the participant teachers presented positive perceptions towards the use of digital technologies by young children and demonstrated a high level of understanding of the role and value of digital technologies in terms of supporting learning and teaching. These teachers used digital technologies in various ways to scaffold young students' learning including offering rich learning resources, multimodal tools, game scenarios and in-built instruction and feedback.

Learning activities involving digital technologies were categorised in the themes of I-Ready, I-Practise and I-Create to provide a complete picture of current implementation in the studied learning communities. Three themes of learning activities are important in terms of implementing digital technologies with young students. This is because young students need to be well prepared with digital operational skills with the learning activities in the theme of I-Ready. They also need to develop an understanding and gain knowledge about abstract concepts and theories from literacy and numeracy curricula in the theme of I-Practise. Since young students obtain digital operational skills and conceptualised knowledge, it is important to elevate their learning practices in the theme of I-Create which support them to be a digital producer who can apply their knowledge and skills of digital technology, literacy and numeracy to create multimodal texts and solve the new problems.

In addition, my analysis of the I-Create theme implies that early childhood and primary school teachers need to increase their promotion of learning activities for supporting young students to be digital producers. Therefore, they may need practical and rich examples to inform their future implementation of digital technologies. Documenting and sharing practical uses of digital technologies would inspire teachers to tailor these learning examples and implement them in their own classes.

DEDICATION

I, Lina Zhao, declare that the Ph.D. thesis entitled "New learning in the 21st century: a case study of digital technology implementation in primary classes" is no more than 100,000 words in length including quotations and exclusive of tables, figures, appendices, and references. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree at any other university or institution other than Victoria University.

The research presented in this thesis was approved by the Victoria University Human Research Ethics Committee, reference number: HRE16-163 in August 2016. Additionally, the project was approved by the Victoria Department of Education and Training (reference number: # 2016_003101) in July 2016.

Signature

[redacted]

Date 25/02/2020

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CHAPTER 1

Introduction

This chapter introduces the rationale for investigating young children's interactions with digital technologies and teachers' perspectives on and pedagogical practices regarding the use of digital technologies in an Australian primary school context. The chapter provides the background to the study, outlines the research questions and the purpose and the specific objectives of the study. An overview of the theoretical framework and thesis design is briefly introduced.

Digital technologies have become widely accepted as part of 21st-century literacy practices including digital technologies mediated reading and writing (Kucirkova, 2013), and are increasingly prevalent in educational domains. For instance, iPads and smart devices are now included in classrooms to support teaching and learning (Lynch & Redpath, 2012). However, questions about the impacts of technologies on young children's cognitive, emotional, and social development needs still exist in early childhood education (Siraj-Blatchford & Siraj-Blatchford, 2003). The major concerns about young children's use of digital technologies in schools and at home for entertaining and learning are inappropriate relating to specific computer programs, inappropriate online content, and the risks to children's physical health and mental development (e.g., development of poor concentration and myopia) (Cordes & Miller, 2004; Healy, 1999;

House, 2012; Plowman & Stephen, 2003). Another strong argument against the use of digital technologies by young children at home and school is that they pose a threat to young children's cognitive development and play-centered learning (Cordes & Miller, 2000). These concerns deter some teachers from actively including digital technologies into their classes (Oldridge, 2010).

Despite the aforementioned concerns, recent literature confirms the benefits of digital technologies in educational settings for the development of young children, as they are more effective than their predecessors in structuring knowledge, solving problems, and communicating and sharing their ideas when using computers and other types of digital devices (Marsh et al., 2005; Vernadakis, Avgerinos, Tsitskari, & Zachopoulou, 2005; Yelland & Gilbert, 2011; Yelland et al., 2008). The argument that digital technologies should be included in early learning is promoted through educational policies and research studies; as it is claimed that they have the potential to support young students' learning and development in formal education settings (Plowman & Stephen, 2013; Siraj-Blatchford & Siraj-Blatchford, 2003). Australian governments have emphasised the importance of implementing digital technologies into formal education sectors due to growth research findings on positive impacts that digital technologies bring to young children (ACARA, 2012b). For example, the national curriculum issued by the Department of Education Australia urges schools and teachers to develop strategies and plans to promote using digital technologies to enhance learning and teaching (ACARA, 2012b).

Although the Victorian Government and schools are aware that digital technologies have the potential to transform education by providing a multimodal learning environment, it takes more than digital tools and infrastructure to bring about the change required to make this possible (Lambert & Gong, 2010). Luke (2003) has acknowledged that there is a conflict between the new opportunities that rapidly changing communication environments are made available and a narrow view of literacy and learning practices in the school curriculum. This conflict leads to a tendency to include digital technology in classrooms with traditional pedagogies such as setting up digital technologies enriched learning environments, displaying learning content with digital devices and teaching young students how to use digital devices. Recent research on the impact of young children's use of digital technologies in homes and communities (Marsh et al., 2005; O'Mara & Laidlaw, 2011; Plowman, McPake, & Stephen, 2008, 2010) found that teachers mainly use digital technologies to enhance their traditional teaching approaches and support traditional learning practices rather than fostering critical thinking and deep learning. In other words, digital technologies are mainly being used for demonstrating and displaying learning content, rather than being used innovatively for enhancing students' learning experiences utilising their multimedia and multimodal features. These strategies of implementing digital technologies have been critiqued—see, for example, Yelland (2006)—as less effective and innovative, because deep learning is not promoted.

It has been suggested that illustrating and documenting examples and practices of how teachers use digital technologies to meet their pedagogical goals and needs is the most effective way to help other teachers to integrate digital technologies into their own classrooms (Chen, 2008). The provision of educational theories and models about digital technology integration has been characterised as less effective, because teachers may need explicit teaching and learning examples to guide them to extend their pedagogical reasoning with and about implementing digital technologies (Chen, 2008).

However, an increasing number of studies have focused on the relationships between technologies, learners, pedagogies and curricula from the educators' perspective rather than exploring and documenting the actual use of digital technologies in early childhood or primary school settings (Cviko, McKenney, & Voogt, 2015; Rowe & Miller, 2015). There are few empirical studies that investigate the implementation of digital technologies for multimodal learning with innovative pedagogies in early childhood education or primary school settings (Ching-Ting, Ming-Chaun, & Chin-Chung, 2014; Couse & Chen, 2010; Kerckaert, Vanderlinde, & van Braak, 2015; Yelland, 2015b).

To address the current challenges in early education and early primary school settings, benefits may be gained by exploring ways to implement digital technologies with new pedagogies, to encourage active engagement and, new learning, rather than merely using digital technologies as instructional tools (Kalantzis & Cope, 2012; Lankshear & Knobel, 2011; Pendleton, 2013; Yelland, Gilbert, & Turner, 2014; Yelland et al., 2008). This challenge forms the basis of this investigation, which aims to explore how digital technologies are implemented for supporting learning and teachers' pedagogical understanding of including digital technologies. The outcomes of digital technologies mediated practices in early childhood to early primary school from my research will be discussed to illustrate possible effective implementation practices.

1.1 Research Design

As noted above, previous studies have focused on teachers’ perceptions on how to integrate digital technologies into early childhood education (Plowman & Stephen, 2006), rather than examining young learners’ interaction with digital technologies in formal educational settings. Similarly, the relationships between teachers’ perceptions and pedagogical choices with respect to using digital technologies for the promotion of deep learning have received little research attention (Fullan & Langworthy, 2014). My study was designed to extend knowledge on these topics.

This research was paradigmatically aligned with the principle of constructivism and utilised a case study approach. The study was guided by the following main research question:

- How are digital technologies implemented in contemporary Australian primary school classrooms to support young students’ learning?

To answer this main research questions, three sub-questions were developed:

1. What are Australian primary school teachers' pedagogical perceptions of implementing digital technologies with young students?
2. What are Australian primary school teachers' pedagogical practices with respect to the implementation of digital technologies with young students?
3. How do digital technologies enhance young Australian primary school students' learning?

To address these questions, I interviewed teachers, performed classroom observations and collected students' digital artefacts within a state government primary school. Four learning communities, including one Foundation Year and three Year One/Two, were selected for classroom observation; and eight teachers (six classroom teachers and two specialist teachers) were involved. Six teachers (five classroom teachers and one specialist teacher) agreed to participate in two rounds of interviews. Data collection began directly after I received approval from Victoria University and the Victorian Department of Education, and was conducted over four terms from the third term of 2016 to the second term of 2017. I undertook thematic analysis using NVivo, and Excel software to assist me in identifying and classifying the observation and interview data, guided by the Learning by Design framework (Cope & Kalantzis, 2015) and literature review. The teachers' interviews allowed me to gain insight into how they viewed the role of digital technologies in fostering learning, and how they attempted to include digital technologies to enhance learning in early primary school settings. Analysis of the data from classroom observations and students' artefacts generated rich and detailed narratives of learning about how digital technologies are used for documenting, collaborating, creating and transforming knowledge in early primary school classroom contexts. In particular, the analysis generated three themes as I-Ready, I-Practise and I-Create to show the full picture of the implementation of iPads and educational applications for facilitating meaningful learning.

The Learning by Design conceptual framework was utilised throughout the data analysis process. Learning by Design was developed from multiliteracies theory (The New London Group, 1999), which combines the four aspects of multiliteracy pedagogies to inform the knowledge gain processes of children and provide a model of teaching strategies. According to multiliteracies theory, to become "multiliterate", the students are required to develop sets of skills to become proficient in multimodal meaning-making which includes visual, audio, gestural and multimodal designs (The New London Group, 1999). The theory posits that learning occurs when students try to make an understanding about their surroundings in different cultural and social contexts with the impacts of digital technologies. There are four dimensions of pedagogical practices in multiliteracies theory: situated practices, overt instruction, critical framing, and transformed practices. These four orientations guide teachers to support students to develop multiliterate capacities (The New London Group, 1999). Learning by Design re-frames these dimensions of pedagogical practices and represents the knowledge processes as follows:

- *Experiencing*—helps students to experience new knowledge as well as learned knowledge (referred to as situated practice in multiliteracies pedagogy).
- *Conceptualising*—helps students to conceptualise theories (referred to as overt instruction in multiliteracies pedagogy).
- *Analysing*—helps students to analyse the discourse, cultural background and social contexts critically (referred to critical framing in multiliteracies pedagogy).
- *Applying*—helps students to apply their learned knowledge to new context appropriately and creatively (referred to transformed practices in multiliteracies pedagogy). (Cope & Kalantzis, 2015)

Three main themes that I developed from analysis align with the four dimensions from the conceptual framework. Three themes illustrate the overall status of digital technologies implementation in the case study school in Australia. I-Ready refers to the dimension of experiencing, in which students are prepared with basic operational skills through exploring and experiencing new foundations and features of digital technologies via recruiting their prior knowledge and experiences. I-Practise aligns with the dimension of conceptualising in which the students gain explicit knowledge and skills from drill and practice, independent learning and documentation of learning practices using digital technologies. The theme of I-Create aligns with the dimensions of analysing and applying meaning that the students are encouraged to apply their various skills and knowledge critically for creating new knowledge. The four dimensions of knowledge processes provide a framework for understanding the three themes and students' interaction and behaviours with digital technologies and teachers' pedagogical practices.

1.2 Thesis Structure

This thesis includes eight chapters. The first chapter outlines the background of the study. The methodology, research design and data collection and analysis approaches are introduced briefly, and the research's aim is justified.

Chapter 2 contains a review of the literature on the use of digital technologies in teaching and learning in formal educational settings focusing on early childhood and primary school sectors and technology integration models. In this chapter, the limitations of current theory and research are identified and connected to my research questions and design.

Chapter 3 describes the research design in detail and explains my choice of research paradigm and methodological approach. It presents my methods of data collection and analytical approach used in this study. I discuss aspects of ethics, and validity and reliability relevant to the study.

Chapters 4 to 6 present qualitative data and my research findings through the three main themes of I-Ready, I-Practise, and I-Create. The chapters illustrate the ways digital technologies are utilised for learning in early primary school classrooms and the teachers' pedagogical understandings that drive such practices. The findings are presented using the participants' verbatim quotes and detailed learning stories. I utilise narrative learning stories about the children's use of digital technologies, derived from classroom observations in the case study school, to describe features and characteristics of the three main themes, along with students' learning artefacts. I analyse data from the teachers' interviews to produce insights about their roles, teaching experiences and pedagogical choices related to digital technology in their daily teaching practices

Chapter 7 presents a synthesis of the findings and shows how I answer my research questions. It illuminates the use of digital technologies in the early primary school setting. Chapter 8 summarises the main conclusions of the study and presents my reflections on their implications for classroom practices. The research questions are returned to in the summary of the findings. The chapter concludes with recommendations and suggestions for future research.

1.3 Definitions of the Terms

This section provides definitions of key terms that used throughout this thesis:

Digital devices

Equipment such as smartphones, and tablets (including iPads), digital toys and smart (TVs), which is subject to the broader meaning of digital technologies.

Deep learning

According to Fullan (2014), deep learning engages "the students to reconstruct their learning of the school curriculum in more challenging and engaging ways made possible by digital tools and resources" (p22). Through a deep learning process, the students are encouraged to create and apply new knowledge, and solve new problems in real-life contexts beyond the classroom. The 21st-century skills that are promoted through deep learning are: communication, critical thinking, problem-solving, collaboration and creativity.

Digital technologies

This term is used in preference to "information and communications technology (ICT)" in the study. It encompasses all forms of newly developed digital technologies and all activities and experiences related to the digital world. The term also includes the digitally mediated experiences of playing, reading, learning and teaching with digital devices and resources. The definition was adopted from Stephen, McPake, Plowman, and Berch-Heyman (2008), and allows for the incorporation of technologies that are both interactive and communicative. These technologies are particularly appropriate for preschool aged children because they do not rely on using text or a keyboard and are more ergonomically suitable for three to five-year-old children. These technologies are used in many preschool playrooms.

Digital Technology Mediated Learning Activities

The term refers to learning activities that are designed with the use of electronic media and digital tools for the purpose of enhancing students' learning.

Early Childhood Education

This is traditionally recognised as encompassing the educational programs, strategies, and services for young children from birth to age eight consistent with the Australian definition (Department of Education and Training, 2015). My study targeted students aged from 5 to 8 years, Foundation year to Year One/Two.

Early Primary School Setting

Refers to Foundation Years, and Year One/Two classrooms in the primary school sector.

Learning by Design

The conceptual framework that is used in this research study. The model has been developed by Cope and Kalantzis since 2000. This pedagogy model provides flexible teaching approaches considering knowledge processes: “experiencing”, “conceptualising”, “analysing” and “applying” (Kalantzis & Cope, 2010). The terminology in this framework has been applied to categorise learning activity types as well as different pedagogical choices (Kalantzis & Cope, 2016; Luke et al. 2004).

***Foundation* Year/Prep**

The term is used in the national curriculum and refers to the first year in the primary school system in Australia. In the case study school, the teachers used the traditional term ‘Prep’ for Foundation Year and called Foundation Year students ‘Preps’.

Pedagogy

Pedagogy refers to the combination of knowledge and skills required for effective teaching practices (Siraj-Blatchford, Muttock, Sylva, Gilden, & Bell, 2002)

Transformative learning

Like deep learning, transformative learning in primary school settings focuses on engaging students in the knowledge process of applying and generating new knowledge creatively and appropriately. It also aligns with the dimension of “applying” in the Learning by Design framework (Cope, 2000).

1.4 Acronyms and Abbreviations

4Cs—Critical thinking, Creativity, Collaboration and Communication

ACARA—Australian Curriculum, Assessment and Reporting Authority

AMCEETYA—Australia Ministerial Council on Education, Employment, Training and Youth Affairs

BYOD—Bring Your Own Device

ICT—Information and Communications Technology

TV—Television

VEYLDF—Victorian Early Years Learning and Development Framework

ZDP—Zone of Proximal Development

CHAPTER 2

Literature Review

As outlined in chapter 1, my study focused on gaining an in-depth understanding of how digital technologies are used for pedagogical purposes in contemporary Australian formal educational settings with young learners and their teachers. Hence, I reviewed a wide range of research about digital technologies in curriculum and documents, young students' learning with digital technologies, and teachers' implementation strategies of digital technologies in early childhood and primary school sections word widely and in an Australian context. This chapter presents a theoretical understanding of the integration of digital technologies in primary school settings with young students in early childhood age; and provides a rich context for understanding the role of digital technologies in learning and the way they are implemented in classrooms. It identifies and explores the current challenges and barriers for re-conceptualising learning and teaching in digital technology-enriched educational settings and shows what digital technology mediated learning looks like in contemporary early primary classrooms (Foundation to Year 2). I also investigated pedagogical approaches that might be effective in stimulating learning with digital technologies in the early years to primary school settings.

This chapter is divided into seven sections. This first section provides an overview of the chapter. In the second section, the historical background of young children's use of technologies is considered. The multimodal nature of digital technologies and its influence and effects on young children's learning and developing is discussed. I review recent research on children' use of digital technologies in varied contexts for learning and playing. My research includes students aged from 5 to 8 years old who are learning in primary school sector, while their ages are categorised as early childhood. Therefore, the literature includes discussions on learning with digital technologies in both sectors to provide a full overview of the research on children's use of digital technologies. The third section examines national and international trends of incorporating digital technologies in both early childhood and primary school education curricula with a focus on the Australian context to provide a better understanding of how digital technologies are mapped in Australia's curriculum and educational documents.

The fourth section explores the possibilities of using digital technologies to support young children's development with various digital technologies including iPads, educational programs and computers. The literature on digital technologies' impact on young students' learning can guide the researcher identify other research that supports or corroborates this research's data and findings. This part of literature also guide the researcher to develop the themes from the data based on the topics and issues that had been discussed in previous research. The fifth section focuses on the teachers' perspectives from early childhood education and primary school sectors on using digital technologies with young children and traces their impact on implementation, drawing on associated learning theories that place children's learning in a sociocultural context. In the sixth section, multiliteracies pedagogies and the Learning by Design model are considered as conceptual guidelines for implementing digital technologies effectively and innovatively to promote meaningful learning, in addition to discussion of 21st-century learning skills. Findings from experimental research on integrating digital technologies for pedagogical purposes are woven into these main sections to illustrate my arguments about the relationships between young children's learning and technology use in the context of contemporary education settings. The final section summarises the discussion from the previous sections and provides further justification for the need to investigate the current situations of implementation of digital technologies in early childhood education and primary school sectors.

In summary, this review maps the use of digital technologies with young children through discussions of educational policies and curriculum, teachers' pedagogies and learning theories and frameworks to highlight the gaps in the current educational research literature.

2.1 Digital Technologies and Young Children

It could be argued that children who have grown up in the 21st-century have had rich learning experiences with digital technologies, have been exposed to a wide range of digital devices and resources on a daily basis, and have full potential access to digital devices and internet at home and school (Prensky, 2001; Yelland, 2011). Moreover, the age when children start to use digital technologies has been noted as being earlier than previous generations (Marsh et al., 2015). It is reported that many children now enjoy rich experiences with portable devices such as iPads and Android tablets by the age of two, and approximately a third of them have their own portable devices when they are five in the United Kingdom (Marsh et al., 2015). The average time children in this age group spend on their tablets for leisure at home in a typical weekday is 79 minutes (Chaudron et al., 2015). Similarly, in Australia, recent research on children (aged 2 to 4 years) finds that these children spend nearly 100 minutes per day (around 80 minutes on TV, and 20 minutes on tablets) on screens at home (Neumann, 2015). These findings portray a broad picture of the current situation of children's digital technology use in their everyday life. These studies show that young children spend a long time on playing and interacting with digital technologies for various purposes.

Full exposure to different digital devices and media provides opportunities for young children to engage with them for learning purposes (Yelland, 2011). Educational researchers are increasingly calling for further exploration of these potentials, because it is argued that young children's ways of learning and thinking about the world are largely shaped by digital technologies, since they need to decode meanings from digital images, sounds, videos and other types of multimedia rather than print-based media (Kalantzis & Cope, 2012a; Yelland, 2011).

2.1.1 Children's Access and Use of Digital Technologies

In this section, I discuss the factors that might affect young children's access to and use of digital technologies in various contexts to form a better understanding on the importance and urgency to include digital technologies into early childhood and schools settings in effective ways. Many young children are exposed to a wide range of digital devices at home and school on a daily basis; however, the high-level presence of digital devices in the home and classrooms does not inevitably mean full access to digital technologies, nor effective use of them for learning purposes; because adults often decide how their children access and use digital technologies, including the duration of use and content accessed (Chaudron et al., 2015; Livingstone, Mascheroni, Dreier, Chaudron, & Lagae, 2015).

Young children's access to and activities with digital technologies are determined by their parents, teachers and schools, and socioeconomic backgrounds. For instance, parents' own use of digital technologies activities partially determines children's engagement with digital technologies in the home environment (Plowman, Stevenson, McPake, Stephen, & Adey, 2011; Plowman, Stevenson, Stephen, & McPake, 2012). Access to digital technologies has been noted as being included in parents' and teachers' reward systems for encouraging children to accomplish homework and class tasks, because children show a higher desire to use digital devices for their multimedia functions (Chaudron et al., 2015). However, regulating access to digital technology to foster positive behaviours may underestimate its potential to promote meaningful learning, as children tend to use digital technology for entertainment purposes in such circumstance. School policies towards the use of digital technologies also influence children's use of digital technologies. Children who attend schools which promote digital technology-enriched learning environments have more opportunities to use digital devices and will develop better digital competencies and skills compared with students from conservative schools that cannot afford or do not promote digital technologies (Andersson & Hashemi, 2016; Billington, 2016). Socioeconomic disadvantage may also impair children's access to digital technologies, because the amount and quality of digital devices are limited. However, no research evidence shows that socioeconomic disadvantage has a direct impact on children's development of digital competencies. Young children can still develop their digital skills when they go to school and community libraries to use computers and laptops (McPake, Plowman, & Stephen, 2013).

Children's use of digital technologies has been suggested to be closely connected with their digital skills and level of cognitive development. Prensky (2001) described how modern children, as "digital natives", have been immersed in digital technologies all of their lives and are able to use many digital devices and programs to varying extents. Many children obtain digital operational skills in their early years through exposure to all sorts of digital technologies (Chaudron et al., 2015; Plowman & McPake, 2013). Young children often learn to use digital technologies by observing and copying other capable people's use of digital devices such as their parents, and other family members at home

(Chaudron et al., 2015; Plowman, 2016a). However, some authors have argued that many young children, despite being “digital natives” need scaffolding while interacting with digital devices (Chaudron et al., 2015; Thomas, 2011). Children need to be taught properly to develop advanced skills and competencies which allow them to use digital technologies in productive and creative ways (Plowman & McPake, 2013; Thomas, 2011).

It has been noted that young children need scaffolding and support from more capable people when they use digital technologies such as installing applications, customising settings and searching on the internet (Edwards et al., 2018). Older children easily become familiar with email and social networking sites and applications such as Facebook, because they are able to put their experiences and ideas into words (Chaudron et al., 2015). Yet, many young children still need adults’ help with complex tasks such as setting up Wi-Fi connections, because their capabilities are limited by their current stage of cognitive development (Chaudron et al., 2015; Neumann, 2015). Research done in Australian contexts has found that most children develop the understanding that digital devices can enable internet access, rather than considering “interneting” as digitally mediated social practices through web pages and applications (Edwards et al., 2018). Children with limited understanding of the internet and digital technologies and nascent literacy skills and cognitive abilities may encounter problematic behaviours, especially, during online activities; due to poor awareness of risks such as inappropriate content and false information (Chaudron et al., 2015).

In conclusion, the discussions on young children’s access to digital technologies in this sector show that today’s young children have many opportunities to access wide range of digital devices and media at home, in communities or schools. However, merely exposure young children to a wide range of digital technologies does not guarantee meaningful learning. Therefore, young children need scaffolding and education on using digital technologies for learning purpose.

2.1.2 Debates on Young Children’s Use of Digital Technologies

Research on how digital technologies affect children began in the 1980s (Hill, Yelland, & Thelning, 2002), and explored the positive and negative impacts of digital technologies on young children’s cognitive and physical development. More recently, researchers have acknowledged the role and value of digital technologies in terms of supporting young children’s learning, such as literacy and numeracy development (e.g., Kervin, 2016; Marsh et al., 2015; Plowman, 2016). New research studies have emerged from China, Australia and New Zealand on the impact of digital technologies on young children’s learning and development (e.g., Edwards, 2015, Szeto & Cheng, 2014; Dong & Newman, 2016). The range and scope of studies on digital technologies and young children based in an Australian context are growing, but there remains a need to explore the educational contexts and uses of digital technologies by young children. More studies are required to help teachers gain insight into how they can improve their pedagogical practices to maximise digital technologies' potential for extending and supporting their students' learning.

Concern about the length of time that young children spend in front of digital devices such as TV sets, computers, and tablets is increasing (House, 2012; Cordes & Miller, 2004). Negative perspectives on young children's increasing time on use of digital technologies can be categorised as follows:

- digital technologies are too abstract for young children, who learn best by manipulating and playing with ideas and objects in their physical world (House, 2012; Karuppiah, 2015);
- digital technologies do harm to children's physical and mental health and might lead to developmental delay (Cordes & Miller, 2004; Hancox & Poulton, 2006; Palmer, 2015); and,
- using digital technologies may lead to problematic behaviours such as gaming addiction and antisocial behaviours (Bruner, 2006).

These objections to young children's use of digital technologies (especially desktop computers at the time) draw heavily on Piaget's theory of how children develop and construct knowledge. It is claimed that children from birth to the concrete stage are not intellectually capable of understanding abstract concepts (Piaget & Inhelder, 2008).

Therefore, teachers and researchers need to consider children's cognitive developmental stages while teaching and planning, and should not introduce computers to young children in classrooms as they are abstract (House, 2012). House and Karuppiah's statements neglect the fact that learning happens in social and cultural practices, and digital technologies are important components in social and cultural practices.

Other critiques of young children's use of digital technology also emphasise the importance of children's physical interactions with their environments, such as their needs for hands-on activities and physical play with concrete materials. Many authors believe that thinking develops from experience with concrete materials and life experiences (a developmental perspective), because concrete materials in natural settings for young children to interact with help them develop and attain the appropriate stage (Cordes & Miller, 2000; Elkind, 2007; Healy, 1999). The computer screen isolates young children from such environments. One study on examining parent's perspectives on their young children's use of digital technologies at home reported that parents expressed similar concerns that using tablets might impair their children's social, physical and cognitive development (Britain, 2013). The parents suggested that the time their children used to spend playing and interacting with people and their surroundings was reduced when digital devices were introduced. However, Britain (2013) reported that there was no evidence that could show the direct relationship between using digital technologies and their negative impact on young children's' social and physical development.

Similarly, video games and computer games have been considered “digital drugs” which might hamper young children’s cognitive development and development of social skills, because they have a high risk of addiction for young children (House, 2012; Palmer, 2015). The overall impactors including social, economic and cultural indicators such as education and family backgrounds were not considered and discussed in these studies which might have direct relationships associated with development of young children’s mental health and social behaviours.

These negative perspectives suggest that young children should not use digital technologies, and have heavily impacted teachers’ perceptions on implementing digital technologies in their classrooms (Plowman, McPake, & Stephen, 2010). Consequently, many parents, educators and policy-makers are anxious about these negative impacts and unwilling to introduce digital technologies to young children (Plowman et al., 2010).

The negative perspectives on children’s use of computers described above prompted more research studies into the positive impacts of digital technologies on young children’ learning and cognitive development (Kafai, 1995; Morgan & Siraj-Blatchford, 2013; Plowman & Stephen, 2003; Siraj-Blatchford & Whitebread, 2003; Yelland, 2006; Yelland, Lee, O'Rourke, & Harrison, 2008; Zevenbergen & Logan, 2008). The studies cited here articulated the view that children’s development is complex and strongly influenced by the social and cultural contexts of their lives (Hatch, 2010). According to

Morgan (2010), many children have had rich technology experiences at home before they start school, and they bring their digital experiences to play, learning and schooling, which argues for the inclusion of digital technologies in formal educational settings. It has been suggested that teachers should also acknowledge that young children construct and gain knowledge of the world through experiencing things and then reflecting and building on these prior experiences (Hatch, 2010). Therefore, out-of-school experiences and informal learning experiences with digital technologies should be taken into account in formal education practices (Neumann, 2016; Plowman, 2016a). It is suggested that teachers should acknowledge the differences and diversities of each individual child and re-conceptualise developmental theory by drawing on sociocultural theory to accommodate contemporary technology-enhanced learning practices (Fleer, 2011; Smith, 1996)

Studies aligned with sociocultural perspectives on young children's use of digital technologies provide some evidence that young children benefit from using them in home and school environments for learning and developing. It has been claimed that digital technologies improve young children's skills in communication and collaboration, creativity, problem-solving, mathematical thinking and emerging literacy (e.g., Chaudron et al., 2015; Holloway, Green, & Livingstone, 2013; Marsh et al., 2015; McPake, Plowman, & Stephen, 2013; Plowman, 2016b). Recent studies have demonstrated that digital technologies have the potential to support young children's learning and playing (Ching-Ting, Ming-Chaun, & Chin-Chung, 2014; Marsh & Bishop, 2013; Neumann &

Neumann, 2015; Yelland, 2011), because they can respond to children's curiosity and provide new spaces for them to explore and discover through challenging activities (Hatzigianni & Margetts, 2012). It has been suggested that digital technologies offer new opportunities to strengthen many aspects of learning practices in the early years, such as stimulating creativity and play, cognitive development and social interaction (Kerckaert, Vanderlinde, & van Braak, 2015; Locke & Andrews, 2004).

Researchers have pointed out that young children can benefit from using various digital technologies, because they:

- contribute to young children's cognitive development: they support young children's problem-solving skills, mathematics thinking, literacy abilities and higher-order thinking skills (Ching-Ting et al., 2014; Marsh et al., 2005);
- support young children's social and communication skills; young children are encouraged to work with others and communicate effectively while they are working with computers (Marsh & Bishop, 2013); and,
- engage young children in learning; computers are challenging and fun to work with (Hatzigianni & Margetts, 2012; Yelland, 2011).

It is also claimed that digital technologies have little impact on young children's physical play and interactions with their surroundings. Suoninen (2013) conducted the research to respond to the concern that using digital technologies may impact young children's physical play and interaction with other people. He found that the use of digital technologies did not affect young children's interest in physical play or print-based media. Suoninen (2010, 2013) studied the media usage of older Finnish children up to eight years of age at three-year intervals, analysing their parents' surveys sought to assess perspectives on young children's use of digital technologies as well as their observation of their children's interaction with digital technologies at home. The findings of Suoninen's studies revealed no change in children's use of printed media and physical toys when digital options were provided. Children remain interested in and willing to spend time on reading print books, physical playing, and interacting with their surroundings (Korkemäki, Dreher, & Pekkarinen, 2012).

In summary, scholars have highlighted the potential of digital technologies for improving young children's skills in communication and collaboration, creativity, problem solving, mathematical thinking and emerging literacy (e.g. Chaudron et al., 2015; Holloway, Green, & Livingstone, 2013; Marsh et al., 2015; Marsh, Hannon, et al., 2015; McPake, Plowman, & Stephen, 2013; Plowman, 2016b). These studies of the use of digital technologies in early childhood settings confirm their positive impacts on young children's learning, and present new possibilities for implementing digital technologies in supporting early learning. These findings suggest teachers to be positive towards the use of digital technologies with young children (Byron, 2010), and to focus more on the ways that digital technologies can be implemented to support young children's learning. In other words, teachers are encouraged to think about what children can do with digital technologies in wider sociocultural contexts, and how they can include digital technologies effectively in their classrooms (Morgan, 2010; Parette, Quesenberry, & Blum, 2010; Yelland, 2006).

2.2 Digital Technology in Australian Education Policy

In this section, I examine Australian policies on including digital technologies in early childhood and primary school curricula. The move towards multiple modes of communication that has been accelerated by the internet and touch-screen devices raises issues, questions, and challenges for governments and educational institutions in relation to what kind of knowledge will be valid in the future (Yelland, 2015a). It is suggested that due to advances in digital technologies which provide a diversity of means to represent concepts and ideas, academics and educators need to be mindful of the pedagogical purpose and usefulness of including digital technologies in classes (Gilakjani, Ismail, & Ahmadi, 2011). The continuous development of new digital technology challenges policy-makers and educators to rethink ways of delivering curricula and what is expected from teachers in regard to understanding, approaching and integrating digital technologies in their teaching practices. The active participation of policymakers, researchers and administrators will form a basis for teachers to make decisions on how to integrate digital technologies in early years' classrooms (Yelland, 2006).

2.2.1 Mapping Digital Technologies in the Curriculum

The increasing use of a wide range of digital technologies in many aspects of modern human life has led to many changes in the early childhood context, as they are mapped in the policies and curricula of early childhood and primary school sectors. Several major Australian Governments' policies have focused on the development of the early childhood education curriculum, highlighting digital technologies as playing a valid and vital role in young children's learning.

Digital technologies are highly valued as tools for teaching and learning, and are given priority in Australian learning frameworks and educational documents (Lynch & Redpath, 2012). The Australian Government has released statements on the development of technology policy in the educational field and the integration of technology into the curriculum across the education sectors (ACARA, 2012a), and has committed to unlock the full potential of digital technology in schools (Lynch & Redpath, 2012). Digital skills have also been identified as one of the general capabilities to be achieved in the national curriculum (ACARA, 2012b). The Victorian Curriculum Assessment Authority has promoted careful thinking about "flexible and creative learning" with digital technologies; its statement reinforces digital learning and acknowledges "the creative and productive use of technology as an indicator of a successful learner" (AMCEETYA, 2010, p.2). In Victoria and the rest of Australia, digital technologies are seen as a key component of students' future success.

Young children's rights of access to digital resources and learning through digital technologies are well articulated in the national early learning framework (*Belonging, Being and Becoming: The Early Years Learning Framework for Australia*) (Department of Education and Training, 2015). The framework identifies five learning outcomes, including a learning outcome dedicated to learning technologies:

Learning outcome five, under the heading "Children are Effective Communicators", is *"Children use information and communication technologies to access information, investigate ideas and represent their thinking*." (Australian Department of Education and Training, 2015, p. 44)

The Victorian Early Years Learning and Development Framework (VEYLDF) places an emphasis on holistic development and a constructive approach to teaching and learning informed by the national framework. It acknowledges sociocultural influences on learning and the benefit of including digital technologies to support young children's learning, setting out a clear orientation that learning is a sociocultural activity. The framework (VEYDF) (State Government of Victoria, 2015, pp. 22-29) encourages the incorporation of digital technologies into children's daily practices as exploring and experiencing via "imaginative and creative play". It reflects the expectations that young Australians should develop knowledge and skills in the digital world; and encourages early year teachers to unpack the potential of digital technologies for learning and teaching.

These educational policies extend beyond early learning frameworks at the national level, and the national curriculum acknowledges that digital technologies are relevant to students' lives and play an important role in the process of knowledge construction, allowing young students to understand the world and express themselves in various modes and media (ACARA, 2012b). In the Australian national curriculum, "Concept of Print and Screen" is included in the language learning area, and "Use of Software" is included in the literacy learning area (ACARA, 2012a). The individual learning content associated with the use of digital technologies is outlined separately, providing guidelines to what the students are expected to achieve under the learning area, as described below,

Digital Technologies F-2:

- *Recognise and explore digital system (hardware and software components) for a purpose*
- *Recognise and explore patterns in data and represent data as pictures, symbols, and diagrams*
- *Collect explore and sort data and use a digital system to present the data creativity*
- *Follow describe and represent a sequence of steps and decisions (algorithm) needed to solve simple problems*

- *Explore how people safely use common information systems to meet information, communication and recreation needs*
- *Create and organise ideas and information using information system independently and with others, and share these with known people in safe online environments*

The inclusion of digital competence in literacy development represents a positive movement in the early childhood and primary sectors. However, in the achievement standards of the national curriculum, the learning aspect of digital technologies is not included in “English”, but is listed as a specific subject as an option. There is still a heavy emphasis on improving print-based literacy skills in the national curriculum. In specific achievement standards, the “Digital Technologies” is listed under the category of “Technologies” with an explanation of what students are expected to achieve by the end of Year 2. Four criteria are outlined for teachers to assess their students’ digital technologies learning outcomes, these are: a) to see if the students are able to use digital technologies for different purposes, b) to represent learning and thoughts via digital technologies, c) to create digital content and d) to collaborate online in a safe manners (ACARA, 2012a). These criteria are very general. Moreover, no suggestions are provided on strategies and methods using digital technologies in terms of enhancing students’ learning. Therefore, there is a need for more information and resources that help teachers better understand the impact of digital technology and technology mediated learning activities, in particular, teaching examples, activity plans, educational applications and programs.

Again, the learning outcomes in the national curriculum remain focused on printed-based literacy and numeracy skills (Flewitt, Messer, & Kucirkova, 2014), as both skills are tested and reported as measurable knowledge through national foundational testing and published on the MY SCHOOL website (i.e., the National Assessment Program–Literacy and Numeracy, or NAPLAN) (Auld, Snyder, & Henderson, 2012). These all indicate that print-based literacy is still driving the focus of curricula as the key measurement of learning and success is rooted in literacy and numeracy tests and examinations. Accordingly, foundational literacy achievements are emphasised in early childhood education (McLean, 2013). Therefore, educators see teaching print-based literacy skills as a priority, even though the curriculum has shaded the lights on including digital technologies into every aspect of learning. This leads to the use of new technologies to replicate existing pedagogical approaches rather than releasing their potential for transformative learning (Sefton-Green, Marsh, Erstad, & Flewitt, 2016, Yelland, 2006, 2015a). Thus, it has been argued that early year learning curricula and policy-embedded classroom practices fail to match contemporary understandings and needs of learning (Cope & Kalantzis, 2015; Fullan, 2013; Kress, 2009; Lynch & Redpath, 2012).

The Australian curricula and policy documents relating to young children's use of digital technologies, show that digital technologies are interweaved generally throughout various learning areas. These documents provide general information about what to include in class, but do not provide clear explanations on how digital technologies should be included in pedagogical practices. Because the curriculum is designed in a broad and flexible way which allows teachers to gain maximum freedom to design their learning activities to cater for students' various learning needs, teachers may rely on traditional pedagogies in delivering digital technology mediated learning activities due to the lack of clear instructions and guidelines (Buabeng-Andoh, 2012). This might lead to a simple approach to implement digital technologies in classrooms consisting of replacing physical tools and using them as display instruments. O'Mara and Laidlaw (2011) argued that the current use of technology in classrooms is putting old wine into new bottles. Researchers have pointed out that current modes of implementation of technologies in the early years setting does not incorporate or foster transformative learning, and called for research to fully unpack digital technology's pedagogical potential (Ching-Ting et al., 2014; Kerckaert et al., 2015; Lankshear & Knobel, 2011; Yelland, 2015a, 2015b). Curriculum change, it could be argued, requires innovative use of digital technologies interwoven with a view of learning that encompasses both traditional and digital learning practices. However, Edwards (2015) argued that Australian educational frameworks and documents are not readily for promoting the use of digital technologies aligned with the principle of being creative and productive while students are using digital technologies for different learning purposes. It has been argued that teachers need to develop a better understanding of digital technology if change is to be seen in the classroom (Laidlaw & O'Mara, 2015). Effective implementation of digital technologies requires "shifting pedagogical paradigms and working with learners in new ways" (Laidlaw & Wong, 2016, p. 2).

2.3 Using Digital Technologies to Support Young Children's Learning

There is a substantial body of research on the impact of digital tools and resources on children's learning in a range of areas. In this section, I discuss the literature related to using digital technologies in formal educational settings for supporting young students' literacy and numeracy development. The use of iPads is highlighted, because these devices are implemented in the case study school from Foundation Year to Year 6. The section provides an in-depth understanding of the way iPads are utilised to support young children's learning and development.

2.3.1 Digital Technologies Support Literacy Development

Literacy is a fundamental skill for all areas of learning, because it unlocks access to a wider learning context (Moats, 1999). It is argued that the nature of literacy is closely tied to contemporary technologies (Bruce, 2003; Casey et al., 2009), as quickly advancing technologies change literacy practices along with the definitions of what it means to read and write with multimedia (Leu et al., 2015). Being "literate", then, has to be understood in the context of culturally, and linguistically diverse and increasingly globalised societies (The New London Group, 1996). This means that young children's literacy practices are influenced by exposure to a wide range of digital technologies, as they observe adults' digitally mediated literacy practices and try to use digital devices and the internet for reading, writing, and communicating (Beschorner & Hutchison, 2013).

Digital technologies can support young children's learning of literacy if multimodal meaning-making is included in literacy practices; this requires a shift between print-based media and digital media (Andersson & Hashemi, 2016; Burke, 2016; Wong, 2016; Yelland, 2015b). A study has found that children with rich digital technology experiences at home develop better digital skills for literacy purposes—such as typing, spelling and letter recognition—than those who have no such experiences (Flewitt, Kucirkova, & Messer, 2014). Flewitt et al.'s research (2014) research showed that digital technologies (e.g., iPad) have the potential to enhance young children's literacy skills, because they provide rich language resources for young children to interact in collaborative learning environments, allowing them to work closely with their peers and teachers (Flewitt et al., 2014). It has been claimed that young children are able to develop their self-identity and communication skills and express themselves in a wider social context via engaging with various digital technology mediated activities, such as digital storytelling and presentations, which contribute to their literacy skills (Chun-Ming, Hwang, & Huang, 2012; Niemi et al., 2014).

Recent research on exploring the impact of digital devices and resources on young children's literacy learning reassesses the outcomes from three previous meta-analyse research studies on examining digital technology's impact on children's literacy development (Archer et al., 2014). These three studies showed moderate to large effect size on positive impacts that digital technologies have on students' language and literacy learning (Andrews et al., 2007; Archer et al., 2014; Slavin, Cheung, Groff, & Lake, 2008). Archer et al. (2014) found that teachers who delivered digital technology mediated programs increased the effectiveness of their literacy intervention, as shown by their students gaining higher scores in designed literacy assessments than students who did not receive such programs (the figure was reported as raising to 0.57).

Lysenko, Abrami, Bernard, Dagenais, and Janosz (2014) reported similar findings in their research on the impact of applying two digital tools for reading comprehension to primary school children (aged 6-8) in Canada. The first multimedia tool was a set of literacy games and digital stories to engage learners in reading and writing activities. The second tool was a web-based digital portfolio in which the students could document their reading and learning by inputting digital text and sharing their digital works with peers, teachers, and parents to get feedback. The results of the study demonstrated that the students who worked with both types of digital technology for the whole school year had significantly better results in vocabulary and reading comprehension than the students who had no access to these digital tools and resources in their literacy learning program.

Another study which was conducted in Australian early childhood contexts measured children's literacy skills through emergent literacy texts and utilised parent questionnaries on their children's use of digital technologies. The study examined the use of tablets in home settings and their relationships to pre-school students' emergent literacy development (Neumann, 2016). The research explored young children's use of digital devices for reading and writing at home and measured children's literacy skills through emergent literacy tests utilised parental questionnaries alongside the observation of their children's use of digital technologies. The tested children gained added scores on print awareness, print knowledge, and sound knowledge assessments. These findings show that young children's digital writing and typing skills are closely related to the use of literacy programs on iPads (Neumann, 2016). It found that children who used digital technologies writing, typing and mark making demonstrated better alphabet knowledge and a higher level of recording and name writing skills (Neumann, 2014). In particular, Neumann (2016) reported a positive impact of using iPads for supporting young children's emergent literacy skills, suggesting that children can develop print-based knowledge via reading eBooks, writing digitally and playing apps-based games on iPads. The study reported that emerging literacy skills such as print awareness, name recognition, and phonemic awareness are not directly related to the frequency of application use or eBook reading (Higgins, Xiao, & Katsipataki, 2012; Neumann, 2016), but digital technologies have the potential to foster young children's emergent literacy in the creative use of digital technologies for typing, writing and drawing.

The research studies that are reviewed here confirm that children benefit from using digital technologies. These studies show that computers, tablets, and educational programs can support young children's literacy development by providing rich learning resources and multimodal tools that enhance young learners' read and write experiences. Burnett and Daniels (2015) argued that there is a little knowledge on how children make meanings around new technologies, and suggested that more research on how digital technologies support young children's literacy development should be conducted.

2.3.2 Digital Technologies Support Numeracy Development

Mathematical skills and other higher-order thinking skills are considered vital to children's cognitive development (McManis & Gunnewig, 2012; Siraj-Blatchford & Siraj-Blatchford, 2003). Recent studies have highlighted the positive relationship between the use of digital technology and young children's mathematical comprehension development within the context of early childhood and primary school education (Calder & Campbell, 2015; Carr, 2012; Panagiotakopoulos, Sarris, & Koleza, 2013).

A growing body of research confirms that digital technologies can create an innovative, effective and attractive learning environment for young children practising numeracy skills, and that they provide many opportunities for mathematical achievement (Ching-Ting et al., 2014; Judge, Floyd, & Jeffs, 2015; Neumann & Neumann, 2015; Verenikina & Kervin, 2017). Research has indicated how the implementation of tablets in education settings can enable an interactive environment which can hold children's interest and encourage them to become more closely and effectively involved in mathematical activities (Lui & Lee, 2013; Spencer, 2013). Also, it has been suggested that digital technologies increase learners' confidence in mathematics as the anxieties about doing mathematics, which is considered as barriers in teaching and learning mathematics, can be removed by the use of multimodal functions and maths games. Therefore, digital technologies increase students' motivation and interest in mathematical tasks (Huang, Huang, & Wu, 2014). It is claimed that digital technologies offer flexible and relaxed learning activities and environments which improve the students' mathematical comprehension and application (Huang et al., 2014).

Using computer games and educational programs to engage students to practise mathematics concepts in drill and practice learning activities are considered effective ways to engage young learners in mathematical learning (McManis & Gunnewig, 2012). The use of "drill and practice" programs can help children develop mathematical skills and understanding of basic mathematics concepts (Siraj-Blatchford & Whitebread, 2003). The applications of game designed drill and practice activities can make the task easier for students to understand and interact with the context of the mathematics problem. Computer-based drill and practice activities allow the students to get immediate feedback, which enables them to consistently reflect on their learned mathematics theories and concepts. In general, it is claimed that when young children use computers to do drill and practice activities with adult support and scaffolding, their mathematics skills—such as number recognition, counting, shape recognition, and composition, sorting and classification—are much improved (Clements & Sarama, 2007; McManis & Gunnewig, 2012).

Other authors claim that digital technology encourages students to try different digital tools and to explore new approaches to solve mathematics problems. Geiger, Goos, and Dole (2015) explored how digital technologies could be implemented to support South Australian primary and secondary schools' students to develop their mathematical competence. Excel software was introduced to allow the students to manage, store and present data. In their study, the students were reported to use the program to insert the data, use a formula to operate the data on the relationships between health and the time spent on physical activities. The students used the software to input data, used a formula to operate the data, and represented the data in different digital forms (such as pie, bar and line graphs) for different purposes. The research indicated that the students were motivated by using the software for the whole process of data collection and analysis, and made use of digital forms to present their data (relationships between health and the time spent on physical activities). The authors concluded that integrating digital technologies into a mathematics classroom enabled students to solve mathematics problems in a critical way (Geiger, et. al, 2015).

A more recent research study, conducted in Greek primary schools produced similar findings but with much younger children aged between 4.5 to 5.5 years (Papadakis, Kalogiannakis, & Zaranis, 2016). The study was designed to examine the impacts of using the same mathematical software on different platforms to fostering children's mathematical development (Papadakis et al., 2016). Tablets and desktop computers with educational software and games were introduced to the numeracy learning sections regularly enabling children to practise their numeracy skills, such as counting and calculating. Teachers aimed to develop young students' logical/mathematical thinking skills, such as using numbers, counting, calculating skills and understanding number facts and concepts. The children were asked to participate in the assessment task called "Test of Early Mathematics Ability" prior to and after the data collection period. The research team found both computers and tablets had positive impacts on children's mathematical learning, as the assessment records raised significantly (Papadakis et al., 2016). In addition, the children were reported as more engaged and motivated when performing mathematical tasks with digital devices than traditional methods, which implies that digital technologies made a positive contribution to improving children's performance in mathematical ability as noted in significant raising of scores in the assessment records (Papadakis et al., 2016).

In conclusion, integrating digital technologies has a great influence on children's numeracy development. In addition, it is argued the pedagogical approaches regarding integrating digital technologies are important for maximising the potential of digital technologies to make a contribution to young children's overall learning achievement (Papadakis et al., 2016; Yelland, 2015a).

2.3.3 iPad Learning

A significant change occurred in the world of computing interfaces in 2010, when the first generation of iPads was introduced to the public. iPads are very different from traditional computers, which require the use of a keyboard and mouse. iPad allows the operator to use their fingers to input information and instructions via single and multiple touch gestures on the screen; this makes them more accessible than traditional computers for a wider range of people, especially, young children (Flewitt, Kucirkova, et al., 2014).

Before the introduction of the first-generation iPad, Couse and Chen (2010) had conducted a study indicating that the tablet computer is a viable device to assist young children to express their ideas and make meaning. They also reported that children showed high interest and spent a long amount of time while engaging with tablets (Buckleitner, 2006; Couse & Chen, 2010).

Kucirkova et al. (2014) explored parent-child talk through the activities of story-sharing on iPads using a digital story application in a Spanish kindergarten. The study found that the children's physical interactions with iPads might enhance their meaning making experience through the story-sharing activities with their parents. In this way, the iPad and application become a third member of the social group helps young children to make meaning using multiple media (Kucirkova et al., 2014). Kucirkova et al's study drew on

Vygotskian theories of learning as they considered iPads and applications as a third social group, which well presented how collaborative learning happens around screens. However, this study have focused more on the body movement and how young children interact with iPads' screen which tightly interested in "things in use" (Ihde, 1990). However, the ways in which story-sharing activities around iPads can be further extended to support young children's literacy or numeracy learning is not addressed.

Several researchers explored the possibilities that iPads afforded in terms of supporting children's learning in both informal and formal educational settings (Bryson, Holly, & Moxey, 2013). In a small-scale research project, Lynch and Redpath (2012) investigated the use of iPads in supporting literacy learning in an Australian primary school. Their findings showed that iPads are attractive to young learners, because the programs on the devices are colourful and in cartoon form. Moreover, the study presented evidence that iPads supported young children to be more independent while learning in a busy classroom. Couse & Chen, (2010) also found that children became more independent with iPads, as they rarely looked for instructions and adults' assistance after they became familiar with the iPads and applications; but, they still needed adults' scaffolding while they used iPads and applications for learning purposes, as indicated in Matthews and Seow's (2007) study. The iPads' in-time feedback and interactive interface stimulate children's concentration and engagement in both individual and collaborative learning modes; it opens the window to powerful learning in early years and formal education settings by offering countless digital tools and resources (Flewitt, Messer, & Kucirkova, 2015).

Based on observational work in two pre-school classrooms in Iowa (Beschorner & Hutchison, 2013), it was reported that iPads had the potential to improve young children's (aged from four to five) literacy skills by serving as effective writing and communicating tools. The children in the study used writing applications (e.g., Magnetic ABC) and drawing applications (e.g., Doodle Buddy and Drawing Pad) at home with their parents. It was found that these children were able to use these literacy applications for digital scribbling, writing and copying letters and words, and these digital writing activities fostered children's print knowledge. However, the study produced no clear evidence that there was a direct positive relationship between using tablet-based writing applications and children's literacy development. The authors called for further work on the specific causal effects of using digital technologies on young children's emergent literacy development.

Recent research on the use of iPads in early childhood and primary school settings explored mainly in two categories: a) how children interact with iPads in and out of school (e.g., Kucirkova et al. , 2014; Marsh et al., 2015; Merchant, 2014; Yelland & Gilbert, 2011; Yelland et al., 2014); and b) how iPads support young children's emerging literacy skills (e.g., Flewitt et al., 2014; Northrop & Killeen, 2013; Neumann, 2014). Most of these studies have found that iPads allow young children to quickly become enthusiastic and competent users, because they pose fewer technical challenges than with traditional computers (e.g., desktop/laptop computers) (Flewitt et al., 2015; Northrop & Killeen, 2013; Rowe & Miller, 2015; Yelland et al., 2014). Notwithstanding these results, research studies on the actual use of iPads, in early childhood education and primary school sectors are still limited (Kerckaert et al., 2015). Many studies of young children's use of iPads are conducted outside Australia and in home-based contexts (e.g., Andersson & Hashemi, 2016; Chaudron et al., 2015; Marsh et al., 2015; Kucirkova et al. , 2014; Plowman, 2016a; Wong, 2016). There is limited Australian research into digital technology use in formal education settings (e.g., Lynch & Redpath, 2012), and recent studies have focused on exploring children's play and interaction behaviours with iPads (e.g. Kucirkova et al. , 2014; Marsh & Bishop, 2013, 2014; Merchant, 2014; Morgan, 2010; Verenikina & Kervin, 2011), and less on how children learn through interacting with iPads, and the pedagogies that can foster such deep learning (Morgan, 2010). To address these research gaps, I sought to investigate the relationships between digital technologies and young children's learning along with teachers' perspectives and pedagogical practices in a formal education setting.

The use of digital technologies with young children in primary school settings is complex, thus a closer look at the use of digital technologies in each unique situation is needed to devise effective implementation strategies (Van Dijk & Hacker, 2003). Digital technology mediated activities are also determined by a particular socio-cultural context, therefore, the digital technologies mediated activities in a different time period or different organisations may share different cultural contexts and can have different characteristics (Burnett, 2016; Fullan & Langworthy, 2014). In addition, digital technology activities change rapidly over time, and iPad mediated learning activities look very different from computer mediated learning activities. Moreover, increasing internet access, and internet-enabled digital technology make these devices' usage very different to internet-unable digital devices (Burnett, 2016). All these factors contribute to the rationale for my study, which focuses on the status of implementation of late-generation iPads in an Australian primary school as a unique case in terms of time, place and socio-cultural context. I sought to explore and describe how young children interact with iPads in a formal education setting in which 21st-century learning skills are promoted.

2.4 Early Childhood Teachers' Use of Digital Technologies for Pedagogical Purposes

This section concentrates on the literature on teachers' pedagogical practices and approaches in using digital technologies in the classroom. Current implementations of digital technologies are described followed by a discussion of pedagogical models that may provide teachers with guidelines on integrating them more effectively.

It is suggested that teachers are the critical factors for ensuring the successful implementation of digital technologies in the classroom (Chen & Hwang, 2014). Teachers' classroom practices are highly influenced by what they think and what they do

(Fives & Gill, 2014). Therefore, teachers determine what will be instructed in the classroom rather than the external parties that participate in policymaking. According to Fullan and Langworthy (2014), what teachers deliver in class, and how they conceptualise their roles and their pedagogical choices when they attempt to include digital technologies in their daily teaching practices will lead to change in educational institutions. Several researchers have examined and investigated teachers' understanding and perceptions of using digital technologies with young children, and other factors such as their digital skills and time availability, to see how these variables affect the implementation of digital technologies in classrooms. It was found that teachers' acknowledgment, skills, beliefs, time availability and their personal use of technology influence their teaching practices in integrating digital technologies (Agyei & Voogt, 2013; Blackwell, Lauricella, & Wartella, 2014; Kafyulilo, Fisser, & Voogt, 2016). Collis and Moonen (2012) further explained that teachers are more confident in using digital technology if their initial experience with digital technology aligned with their experiences of and beliefs about learning and knowledge processing. Such teachers tended to have a more positive attitude toward the application of digital technologies and showed a greater willingness to integrate digital technologies into their daily teaching practices (Lin, Wang, & Lin, 2012).

Teachers' perceptions of the importance of digital technologies in young children's learning are also essential, because valuing digital technologies in teaching and learning is likely to make their implementation more sustainable (Eldakak, 2012). Therefore, to effectively integrate digital technologies into a classroom, teachers' pedagogical belief and perceptions towards young children's use of digital technology should be taken into account to form an in-depth understanding of digital technologies related pedagogical practices (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017).

2.4.1 Learning Theories that Influence Teachers' Use of Digital Technologies

It is important to consider theories of learning in this study connected to the implementation of digital technologies in early childhood and primary school classrooms. The potentials and possibilities of digital technologies to enhance learning can be only uncovered when the concepts of learning, teaching, and knowledge processes are considered (Derry, 2007). It is critical and timely to build a clear understanding about the intersection of learning theories and new technologies so that educators can reflect on the implication of digital technologies to enhance learning and devise a theory—informed approach to rethinking and transforming educational practices (Harasim, 2012). In other words, the learning theories that may influence educators' perspectives regarding young children's use of digital technologies, as well as their way of implementing digital technologies in the classrooms, are important to consider. In my study, I utilised cognitive development theory and sociocultural theory that are highly relevant to contemporary learning and teaching practices.

Cognitive Development Theory

Cognitive development theory was mainly developed by the psychologist Jean Piaget (Harasim, 2012); it has been used to investigate the changes in cognitive skills and development that occur with maturation. Piaget's theory places "action" at the heart of learning and holds that children learn through acting on environments. Cognitive development theory suggests that children go through a series of stages—sensorimotor, preoperational, concrete operational and formal operational stages—prior to acquiring logical and abstract thinking abilities and intellectual maturity.

Cognitive development theory has had a significant influence on early childhood programs and related curricula (Gordon & Browne, 2013). The concept of teaching developmentally appropriate content for children is conceptualised within a cognitive development theory framework, and underpins many early childhood education programs (Fleer, 2011). Recent research on children's use of digital technologies has found that their ability to interact with digital technologies is associated with their age and cognitive development (Chaudron et al., 2015). Therefore, Piaget's theory is important for teachers to consider when using digital technologies to extend young students' learning.

Whether deliberately or not, many early childhood teachers conceptualise their roles and construct their pedagogical strategies in classrooms based on cognitive development theory. Two dominant teaching approaches in early childhood education—the child-centred teaching approach and play-based learning—are closely related to cognitive development theory (Wen, Hui, & Kay, 2011). The child-centred approach stresses the child's autonomy and ability to construct knowledge and focuses on the individual children's needs, the unique characteristics of childhood experiences and their strengths and interests. Play-based learning is based on the idea that children learn better through playing with concrete materials (Piaget, 1964), and is a very common pedagogical approach in the early childhood education. Evidence suggests that teachers who hold constructivist beliefs tend to be highly active technology users and use digital technologies in a transformative way for learning purposes (Ertmer & Glazewski, 2015). According to Becker (2000), teachers who hold constructivist perspectives tend to use technology more frequently than teachers with teacher-centred pedagogical beliefs. Also, constructivist favouring teachers tend to use digital technologies in more student-led ways, for instance, allowing students to select and direct their own uses of available digital tools and resources.

Play-based learning is described as "a context for learning through which children organise and make sense of their social worlds, as they actively engage with people, objects and representations" (Department of Education and Training, 2015, p. 46). Researchers across numerous fields agree that play is a set of natural behaviours that are important for learning in the early years (Lillard et al., 2013; Piaget & Inhelder, 2008; Yelland, Gilbert, & Turner, 2014). Play gives children opportunities to assume adults' actions, language, and thinking, which allows them to work out ideas for real situations;

in doing so, they gain knowledge and the ability to self-regulate their activities through interpretation of their environment (Kafai, 2006; Laidlaw & Wong, 2016; Yelland, 1999). During play, children's cognitive, emotional, biological, and social development progress (Heidemann, Hewitt, & Heidemann, 2010). Children develop learning strategies through digital play-based experiences, similar to what occurs during regular play (Bird & Edwards, 2015). It is claimed that young students can learn to use digital technologies through play characterised activities such as exploration, modelling, observing and drawing with scaffolding by teachers and other capable people (Donohue & Schomburg, 2015; Edwards, 2015; Yelland, 2011).

Contemporary teachers who take a cognitive developmental perspective tend to arrange digital technology-enriched learning environments to engage students and organise learning activities that allow them to interact and play with a wide range of digital technologies. These early childhood teachers tend to simply set up the learning environment, organise the learning activities, and observe and to provide support (Ching-Ting et al., 2014; Sefton-Green, Marsh, Erstad, & Flewitt, 2016). For instance, they tend to devise rich activity-based learning environments that challenge children to advance to the next level of cognitive development and structure learning experiences that facilitate their students' learning through playing and discovering (Piaget & Inhelder, 2008; Rowsell & Wohlwend, 2016). In many early year settings, digital technologies are implemented as facilitators for children's physical play, for instance, replica mobile phones and computers, and keyboards or other toy digital devices for enacting play

(Cohen, 1997). These digital devices are introduced to the class as part of environment settings for young children to interact with (Laidlaw & Wong, 2016). Children treat digital devices like toys rather than using them for learning, communicating, sharing or creating (Fleer, 2011). These strategies on implementing technologies are still in the stage of introducing digital devices to children and helping them get familiar with computers or mobile phones rather than assisting them to use digital technologies to be creative and productive.

Play-based and child-centred teaching pedagogies can lead to another tendency in integrating technologies into early childhood teaching: using digital devices for free play activities with little or no adults' instructions (Campbell & Scotellaro, 2009; Kerckaert et al., 2015). "Free play" activities link to play-based pedagogy and distance the role of the adult from the process of young children's learning. The use of digital technology at home is similar to the use of digital technologies for free play at school and early childhood centres; because most parents provide little scaffolding or support during children's interaction with digital technologies (Plowman et al., 2010). However, learning may not occur if digital technologies are used in the absence of capable adults' scaffolding; thus, the role of adults in children's engagement with digital technologies needs to be considered (Kucirkova, 2014).

The concept of developmental appropriateness for early childhood education has been challenged and criticised recently as underestimating teachers' roles and those of others—such as capable peers—in children's learning process and neglecting considering the complexities of the learning process. Terreni (2010) argued that children need sufficient scaffolding while interacting with technologies. Thus, placing digital devices in the classroom and helping students to use them is not an effective pedagogy, because children get frustrated and bored quickly if technologies are used merely for free play or as simple instructional tools (Fullan, 2013; Plowman & Stephen, 2006). Therefore, it is argued that the best way to reveal the potential of digital technologies is to use them for supporting learning, which occurs when parents and educators are there to guide and support their children (Billington, 2016). However, the question of how to integrate technologies in early years to guide practitioners to support young children's development remains to be answered (Billington, 2016).

Piaget's cognitive development theory as a theoretical rationale for explaining the relationships between digital technologies and children was outlined. The next section introduces the sociocultural learning theory which views digital technologies as cognitive tools for learning rather than presenting tools of objective knowledge (Harel & Papert, 1991).

Sociocultural Theory

Sociocultural learning theory describes how the knowledge construction process is connected to sociocultural contexts. The learning process in this approach has been described as discovering and knowing as a continuous interaction between an individual and environment, and is known as a constructivist approach to learning (Gordon & Browne, 2013). Sociocultural theory emphasises the importance of sociocultural context during the learning process which is absent in the stage-based development theory focusing on knowledge processes inside individual human beings. Vygotsky (1980) proposed that learning involves social activities and cultural influences in explaining how humans construct their knowledge and experience about the world. Sociocultural learning theory argues that learning is not just an internal cognitive process (Liu & Matthews, 2005; Vygotsky, 1978, 1980) and that learning activities can be understood in the context of social and cultural background. Rogoff (2003) argued that effective pedagogical approaches are needed to establish a collaborative learning environment which encourages communication, participation and interpretation between individuals and their communities. Therefore, in sociocultural learning theory, learning is described as the result of complex interactions between multiple agents within a context where cultures and values are shared with other community members and strengthened by their surrounding society (Vygotsky, 1980).

Instructions from capable peers and adults are viewed as important to elicit powerful learning, as it happens when young learners interact with these capable people (Harel & Papert, 1991; Vygotsky, 1978). Rather than considering what children cannot do, which is characterised in Piaget theory as "developmental readiness", the concept of "zone of proximal development" (ZDP) is used to explain learning processes. ZDP is described as the area between the actual development level and the potential developmental level during the process of solving a problem with scaffolding from capable others (Vygotsky, 1978). It is argued that learning tasks should be designed to suit students' abilities and interests, but with challenges (Yelland & Masters, 2007). Therefore, children's existing knowledge, their interactions with other capable people in challenging and collaborative activities are taken into account in the learning process, which will elevate them to a higher level with increased cultural knowledge and learning skills (Plowman & Stephen, 2013).

I have mentioned the concept of "scaffolding" introduced by Jerome Bruner (2009) previously. It is developed from Vygotsky's social and cultural perspectives. It is used to describe the assistance given to children to achieve their development goals (Wood, 1998). It is suggested that learning occurs when children are scaffolded by capable others in attempting to accomplish challenging tasks (Plowman & Stephen, 2013). In early childhood education, the importance of teachers' agency and pedagogical support in the process of children's learning is increasingly emphasised as sociocultural theory is given greater attention (Arthur, Beecher, Death, Dockett, & Farmer, 2017).

From a sociocultural perspective, digital technologies can contribute to young children's knowledge building and cognitive development. Digital technologies then are viewed as a meaningful resource which allows young children to communicate and interact with the outside world in an effective way to construct their knowledge (Parette, Blum, &

Quesenberry, 2013). Papert (1993) further explained that computers engage children in the creation of knowledge that reflects their thinking and understanding of the information, a concept which engages with the constructivist perspective on young children's use of digital technologies. One major strength of digital technologies is their ability to host various forms of modes such as visual images, video recordings, film and other types of digital presentation media for engaging students in reading and writing (The New Long Group, 1996). Thus, it can be said that digital technologies provide multiple modes which enable young children to work collaboratively with and express themselves with multimodal ways with their teachers and communities (Marsh, 2004). Moreover, if young students are struggling with print-based skills such as writing sentences as responses, digital technologies allow them to use other modes to express and share their ideas and thoughts with others; for instance, they can use a cartoon, or record their speech as a response (Chaudron et al., 2015). In general, it suggests that digital technologies afford children opportunities to communicate and interact with the outside environment effectively which improves their knowledge reconstruction process (Pendergast, 2013).

Sociocultural theory suggests that early learning and development with digital technologies should focus on learning processes that rely highly on teacher supports and a digital technology-enriched learning environment (Ching-Ting et al., 2014; Yelland, 2015a). According to Siraj-Blatchford et al., (2002), in an instructive learning environment, teacher's effective scaffolding and intervention might extend children's free play activities to a higher order of thinking development. In general, teachers with constructivist beliefs use technology as a means to help students develop higher-order thinking and problem-solving skills, which implies that constructivist pedagogical understanding promotes effective implementation of digital technologies in early childhood to primary school settings (Agyei & Keengwe, 2014; Karaca, Can, & Yildirim, 2013; Liu & Szabo, 2009). In summary, sociocultural theory holds that children should be consistently involved with digital technologies during their learning process which may encourage teachers to design digital technology mediated learning activities to extend students' learning.

Constructivism

Constructivism refers to a set of theories about learning and teaching which view knowledge as a human construction (Harasim, 2012). The two theories discussed above, cognitive development theory and sociocultural theory, are closely linked to constructivism (Harasim, 2012). Piaget's cognitive development theory focuses on explaining children's learning and knowledge construction based on their biological development, which is also known as cognitive constructivism. Vygotsky explained the learning process with emphasis on the social context as humans learn through interacting with their cultures and societies, which is also known as social constructivism. Both theories reflect constructivism perspectives towards how learning take place.

Constructivist perspectives affect teachers' use of digital technologies in their daily practices. As noted earlier, evidence suggests that teachers who hold constructivist beliefs tend to be highly active technology users and use digital technologies in a transformative way for learning purposes (Ertmer & Glazewski, 2015). Therefore, constructivism can be said to be the underpinning philosophy for the implementation of digital technologies.

In previous sections, I outlined two learning theories—developmental theory and sociocultural theory and how they impact on teachers' use of digital technologies in their daily practice. I reviewed research on teachers' pedagogical practices when implementing digital technologies for learning in early childhood and primary school settings. These studies converge to a general conclusion that teachers should undertake both cognitive development theory and social cultural learning theory as guideline to develop teaching strategies of digital technology implementation in their classes to better engage their students in learning.

2.4.2 Research on Teachers' Pedagogical Practices with Digital Technologies

In this section, I examine recent research on early childhood and primary school teachers' pedagogical practices of inclusion of digital technologies. The term "pedagogy" usually refers to instructional methods in an educational context, which enable learning to take place and influence the learning through the design of the learning environment (Siraj-

Blatchford & Siraj-Blatchford, 2003; Tondeur et al., 2017). Therefore, having technological devices such as computers, tablets or interactive smartboards in one's classroom does not dictate a pedagogical approach (Lawless and Pellegrino, 2007); rather, the strategies that enable digital devices to support and extend students' learning effective reflect one's implementation pedagogies (Tondeur et al., 2017). According to Pitler (2006, p.38), "applied technologies does not only increase students' learning, understanding, and achievement but also augment their motivation to learn, encourage collaborative learning and develop critical thinking and problem-solving strategies". Therefore, effective implementation of digital technologies requires teachers to design meaningful learning activities alongside consideration of how digital technologies promote learning.

Over two decades ago, the National Association for the Education of Young Children (NAEYC, 1996) in the United States issued a position statement urging teachers to include digital technologies in their classes to benefit students' learning. Although teachers and policymakers show increasing interest in implementing digital technologies, effective implementation practices have not been widely documented (Garvis, 2015; Leung, 2012). Traditional schooling still emphasises the narrowly defined literacy learning outcomes and meaning-making from multiple modes is not fully addressed. Therefore, as discussed earlier, digital technologies are implemented to reinforce traditional learning skills, such as using computer programs for drill and practice, and to assess measurable print-based learning skills (Schultz & Hull, 2008; Vasudevan, Schultz,

& Bateman, 2010; Yelland, 2011, 2015a). The following studies illustrate teachers' pedagogical practices for implementing digital technologies.

Dong (2016) conducted research on exploring the current use of digital technologies in early childhood settings in Shanghai. She found that teachers were not applying a repertoire of teaching strategies to support young children's learning with digital technologies in their classrooms, but simply providing resources, setting up environments and modelling the use of digital devices. Dong (2016) characterised this as a lower level of interaction and engagement between teachers and their students which digital technologies were included in a learning process. She argued that such pedagogical approaches prevented these teachers from building close relationships with their students and extending their learning and thinking to the next level of development. She concluded that the teachers' pedagogical approaches of implementing digital technologies were less effective (Dong, 2016).

Kerckaert et al. (2015) examined influences on the use of digital technologies (desktop and laptops computers and software) in preschools. They identified two main types of digital technology implementation approaches: a) developing computer skills; and b) the use of digital technology as an educational facilitator for developing learning skills (Kerckaert et al., 2015). Their findings indicated that higher rates of digital technology implementation in preschools and primary schools were aimed at developing students' digital skills so that they were able to master digital devices and applications. They identified relatively little use of digital technologies for supporting and improving learning or even reforming education (Kerckaert et al., 2015). These findings echo Plowman et al.'s (2012) conclusion that teachers tend to design learning activities that teach children how to use operating systems or particular software such as opening programs, creating documents, typing texts, and searching for information from the internet. These types of digital activities do not engage the students in deep learning, due to focus on lower-level tasks such as word processing and internet searching (Plowman, et al., 2012; Walters and Fehring, 2009). More generally, these types of teaching practices represent passive involvement with digital technologies in early year educational settings.

Australian research reported similar findings with an examination of iPads implementation in the classroom. The project called "The Children of the New Millennium" which involved the Department of Education and Children's Service of South Australia and the University of South Australia and the Australia Research Council documented the way young children aged between four and eight years old used iPads in informal and formal education settings (Hill, 2004). Children's learning with iPads was explored and documented using a multiliteracies map as an observation tool. The research revealed that teachers found it hard to critically analyse learning stories, particularly when it came to the use of digital technologies for critical thinking. The report also highlighted that teachers had difficulty in identifying and articulating how children developed knowledge or new ideas from their involvement with digital technologies. Teacher's use of digital technologies was found to be similar to that described in other research studies mentioned previously in helping students to develop operational digital skills and perform lower-level tasks such as typing words and taking photographs. The teachers tended to use digital technologies mainly for capturing and documenting children's learning, rather than as a means to enrich and extend children's learning by engaging them in more critical thinking and problem-solving activities. Nevertheless, Hill's research illustrated some examples of teaching practices of using iPads from contemporary classrooms. It indicated that these teachers already recognised that their use of digital technologies was at the lower end of the interaction spectrum, and that they were attempting to integrate them more innovatively and effectively to extend students' learning (Hill, 2004).

Similarly, Masoumi (2015) identified features of how early childhood teachers use digital technologies for teaching and learning purposes. The study found that six teachers from three preschools made considerable use of digital technologies and used them for several purposes, such as interactive smartboards, were used as a means for displaying literacy materials, and iPads were used to support second-language acquisition, and interactive games and videos to "keep children busy" (p.12). However, Masoumi (2015) reported that digital technologies were used mainly for documentation. Flewitt et al. (2014) argued that immersing students with digital resources and practising lower task skills such as documenting and typing and entertaining was not an effective means of implementing, because deep learning was not promoted. Therefore, it is suggested that early year and primary school teachers need to carefully design their programs to deliver supportive activities that incorporate digital technologies to meet students' intentional learning goals (Flewitt, 2006).

Research undertaken by Kucirkova (2014) in exploring iPad use in early childhood education and early primary schools, argued that teachers' pedagogical understanding of the use of digital technologies was important for leading to effective use of digital technologies to make a difference to children's learning. Like many others in the field, these researchers asserted that the benefits of digital technologies could not be fully realised if they are used to support with traditional pedagogies that reinforce traditional learning outcomes, and argued that teachers need to understand the direct pedagogical approach to realise their full potential (Kucirkova, 2014). Researchers have proposed few explanations as to why teachers tend to implement digital technologies in relatively ineffective ways in early childhood and primary school settings. The first is that early primary school teachers are unwilling to spend more time on utilising technologies innovatively for teaching and learning with current curriculum design, because they need to ensure the students achieve measurable goals that will be assessed in national exams (Lynch & Redpath, 2012). The other reason is a lack of professional training and explicit guidelines supporting early childhood and primary school teachers to develop the necessary pedagogical knowledge and skills to include the use of digital technologies into their teaching effectively (Ajayi, 2011; Ryan, Scott, & Walsh, 2010). Therefore, it has been suggested that teachers should be given clearer guidelines for the meaningful application of new technologies in early learning along with a digital technology-friendly curriculum (Flewitt, Messer, et al., 2014; Fullan, 2013).

To summaries this section, there are challenges in implementing digital technologies in supporting learning in early childhood and primary school education. The research findings reviewed above that digital technologies can be applied as a catalyst for educational change rather than as an isolated activity to foster basic digital skills if transformative curricula and pedagogies are promoted (Plowman & Stephen, 2003; Yelland, 2006). The main challenge is to weave digital technologies thoroughly into the daily classroom practices of professionally trained teachers to support students' deep learning (Flewitt, Kucirkova, et al., 2014). However, insufficient attention has been paid to the strategies needed or being employed to remove the barriers to digital technology implementation learning and teaching contexts, and what can be done to prompt teachers to improve these aspects of their works (Billington, 2016; Plowman & Stephen, 2006; Yelland, 2015b). These arguments form the base for my research study which tries to address the main research question.

2.4.3 Digital Technologies and 21st-Century Skills

Including digital technologies in learning and working can mean the acquisition of new skills for students, new roles for teachers and new scenarios for education. Eldakak (2012) argued that teachers who focus on using new technologies to foster 21st-century learning skills could provide meaningful learning experiences for students. Therefore, it has been suggested that teachers need to reconstruct their strategies to be about preparing students with skills such as "sophisticated thinking, flexible problem solving, and collaboration and communication skills" using digital technologies (Binkley et al., 2012, p. 18). The goal of equipping students with 21st-century skills is characterised as moving beyond knowledge transforming and moving towards applying and creating knowledge to solve new problems in the world with multiple purposes (Kalantzis & Cope, 2015; Fullan & Langworthy, 2014).

The concept of 21st-century skills was first proposed by a group of American researchers (Binkley et al., 2012). The term is defined later as the ability to "apply knowledge and skills in key subject areas and to analyse, reason and communicate effectively as they raise, solve and interpret problems in a variety of situations", with digital technology being at the core of these 21st-century frameworks (Ananiadou & Claro, 2009, p. 7). Binkley et al. (2012) identified critical thinking, creativity, collaboration and communication (the 4Cs) as the key 21st-century skills. Critical thinking skills can be subdivided into reasoning, decision-making and problem-solving. Creativity includes reproducing information in an innovative way via multiple modes, inventiveness and self-improvement. They defined collaboration as the ability to work effectively and respectfully within a group of people, and exercise flexibility and willingness to achieve goals with shared responsibilities. Communication refers to the ability to organise thoughts and ideas from different modes, and then share the thoughts in different contexts via digital media (Binkley et al., 2012). Fullan and Langworthy (2014) extended the 4Cs skills by adding two new elements: character education and global citizenship. These new elements incorporate an appreciation of cultural diversity, global awareness, environmental sustainability and a well-developed character which values life and learning (Fullan & Langworthy, 2014). Guernsey and Levine (2015) concurred with Fullan and Langworthy (2014) in advising that 21st-century skills needed to be addressed while incorporating digital technology into early learning for promoting deep learning. These features stimulate the engagement and excitement of students in their learning enable them to become a lifelong learner (Kalantzis & Cope, 2012b).

Teaching approaches that develop students' 21st-century skills are considered vital to the effective integration of digital technologies, because they enable students to apply their knowledge to solve new problems critically and creatively. In the following sections, I review research on the implementation of digital technologies for supporting students' 21st-century learning skills.

Fostering collaboration and communication

It has been argued that digital technologies can enhance collaboration and communication in classrooms (Niemi et al., 2014; VanderArk & Schneider, 2012). As suggested in the research cited in previous sections, many young students are naturally engaged in learning activities with digital tools and resources such as mobile devices, the internet, and computers, and work together to exchange their ideas and learning experiences, create digital artefacts, for constructing new knowledge (Chun-Ming et al., 2012). Fostering collaboration and communication is considered an important teaching approach in contemporary education, because collaborative learning allows students with various learning abilities to work together confidently and learn and support each other to achieve a common academic goal (Gokhale, 2012; Slavin, 1996). Learning occurs socially as the students collaboratively construct knowledge by sharing and communicating their ideas and experiences (Roschelle & Teasley, 1995). Students obtain a range of skills while they work collaboratively and engage with digital content such as problem-solving skills, communication skills and digital operation skills. Moreover, compared with individual learning, collaborative learning helps students to achieve a higher level of comprehension, thought and preservation of knowledge (Stahl, Koschmann, & Suthers, 2006). Development of the ability to collaborate with others ensures students can learn and work effectively and successfully in a globalised digital world (Niemi et al., 2014). Therefore, teachers are encouraged to apply digital tools and resources to support collaboration and communication in their classrooms.

The research shows that using digital technologies for story writing is more effective, in terms of fostering collaboration, than traditional teaching approaches (Hung, Hwang, & Huang, 2012). Hung (2012) reported that students gained in confidence and enhanced their engagement and motivation towards learning while working in small groups with digital tools and resources. The communication between the students was enhanced in story writing using digital tools as students shared and discussed their ideas about the content of stories, and helped each other to use digital tools and resources in the most effective and creative ways. Interactions between students in a small group can improve individual performance due to intensive personal interaction and peer tutoring (Hung et al., 2012).

Furthermore, digital technologies provide students with a flexible learning environment that promotes collaboration and communication between students. Digital technologies can help to form networks (Niemi et al., 2014; VanderArk & Schneider, 2012), for example, teachers can use Seesaw online learning space to encourages students to share resources and utilise their strengths to produce their final digital works. At the same time, students are able to develop their skills in understanding, listening and interacting with others when they are provided with multimedia tools to present their ideas and understandings (Niemi et al., 2014). In conclusion, the literature shows that digital technologies may enhance collaboration and communication in the classroom, and teachers should implement digital technologies in terms of developing students' collaboration and communication skills (Niemi et al., 2014).

Fostering critical thinking

It is claimed that students' critical thinking can be promoted in a digital technology enrich learning environment (Kong, 2014). Critical thinking is defined as the ability to think reflectively and judge skilfully to decide what information is reliable and what actions should be taken during reasoning and problem solving (Gut, 2011; Kong, 2014). Teachers that promote critical thinking in their classrooms should apply various teaching approaches such as posting inquiry questions, allowing on-time discussions and encouraging reflection to help students gain an in-depth understanding of concepts and principles (Deng, 2011; Kong, 2014).

Digital technologies such as smartphones, tablets and laptops enable students to access digital resources including information from the internet and online learning space (Kong, 2014). Students in such learning environments can progressively develop a deep understanding of the knowledge specified in the curriculum through easy access to appropriate resources and extensive sharing useful information (Kong, 2011). Learning tasks that involve sourcing information online or communicating an idea through an internal platform often require primary school students to process information from different sources and then critically analyse it, based on its appropriateness and authenticity with consideration of its social and cultural impacts. In this way, digital technologies enable students to develop and apply critical thinking skills in daily learning practices (Gut, 2011; Kong, 2011). Consequently, digital technologies can promote students' critical thinking in 21st-century classrooms.

Fostering creativity

It is claimed that digital technologies empower students' creativity, especially, when they are integrated innovatively with student-centred and constructive teaching approaches (Ertmer & Glazewski, 2015). The definition of creativity is complex. But the general definition of creativity is a process of achieving an outcome that is recognised as innovative and is deeply connected to digital technology integration (Edmonds & Candy, 2002). Many schools acknowledge the importance of creative thinking skills and consider them integral of their students' success (Jerald, 2009). Duffy, Lowyck, and Jonassen (2012) highlighted the importance of promoting creativity in the education setting, especially, in early year educational settings. They noted that young students' creative skills are enhanced through participation in visual and performing arts using various digital tools and resources (Duffy et al., 2012). These learning activities encourage young students to learn while discovering, exploring, experimenting and inventing using digital technologies.

Digital technologies generate new possibilities for students to be creative. It is claimed that digital technology provides unlimited opportunities for creative sharing, for instance, students can source information as well as exchange ideas and learning experiences online (Henriksen, Mishra, & Fisser, 2016). New digital programs that enable content editing and development allow students to remodel and extend recreate digital content as well as share it with others online (Henriksen, et al., 2016). Individual students pursue their interests more promptly and easily with wide access to digital resources and tools for creating new knowledge (Henriksen et al., 2016). The explosion in the range of and access to digital technologies for content sharing and editing empowers the students' experiences on creating content.

Digital technologies also afford new ways of constructing and representing knowledge, enhancing students' creative output in ways that are not possible with traditional learning tools and media. Research shows that young children rapidly develop and display emerging creative behaviours when they are introduced to digital technologies. Mishra and Henriken (2013) explored and described young children's experiences with digital technologies at home, comparing their communicating and creating skills with those using traditional tools (i.e., paper and pen). They reported that young children actively explored the functions of a digital camera, and came up with new, surprising and valuable ideas while taking pictures and retelling the associated stories about the pictures. When the children tried to tell a story in meaningful and engaging ways based on their photos, they began to develop new skills to create digital narratives. The children from the study were observed to find ways of using existing images to enhance their imaginative play and develop the ability to embellish existing narratives and create their own stories.

Creative activities with digital technologies can include developing ideas, making connections, creating and meaning-making, collaboration, communication, and evaluation (Mishra & Henriksen, 2013). Each of these activities draws upon an interaction of the features of digital technologies and elements of creative processes encouraging playful exploration and the testing of ideas which enable learners to construct their own models and test hypotheses (Kemmis, Wright, & Atkin, 1977). Consequently, digital technologies can engage students in creative learning activities by building on their prior knowledge and experiences.

In conclusion, as educational domains move from traditional learning methods towards new learning environments, digital technologies are emerging as powerful tools that help teachers to foster students' 21st-century skills. New understandings of reconceptualising learning, pedagogies, and schooling in terms of integration of digital technologies raise the question of what new learning activities and pedagogies look like in an early learning context, and how these new practices work to achieve multiliteracy in the 21st-century. These changes are happening already in many classrooms and schools as many teachers attempt to include digital technologies into their daily teaching practices, but few efforts are being made to record and articulate what is currently happening (Fullan & Langworthy, 2014). Documenting and examining these changes can bring greater precision and clarity to the quest to implement digital technology in the most effective way. My study then endeavours to represents a new development in teaching and learning with the integration of digital technologies in a digital technologies enriched school context followed by the discussion of its features, the way it works, achievements, errors and then sheds light for further development.

2.5 Digital Technology Implementation Models

Numerous models and pedagogical guidelines explain aspects of technology adoption and its innovative use in formal educational settings. In this section, I explore multiliteracies theory and the Learning by Design framework, based on the multiliteracies principle as an educational response which can be utilised for analysing and evaluating teaching and learning with digital technologies (Cope & Kalantzis, 2015).

Models and theoretical frameworks for implementing digital technologies to support students' learning include the "guided learning model" (Plowman & Stephen, 2006) and "sustained shared thinking" (Siraj-Blatchford et al., 2002). However, these models explore adults' scaffolding in the use of computers (mainly desktop computers) in the classroom. These models may be less suitable for nowadays schools as most schools use tablets as their main digital learning tools. The pedagogical guidelines for implementing digital technologies suggest applying a wide range of teaching strategies for designing learning activities, selecting appropriate digital resources, and creating digital technology-enriched and student-centred learning environments (Plowman & Stephen, 2006; Siraj-Blatchford et al., 2002). Turja, Endepohls-Ulpe and Chatoney (2009) proposed sets of guidelines for integrating digital technologies into the curriculum which suggest children should be treated as active learners by providing opportunities for them to observe, experience, explore, select and produce during learning with digital technologies. Digital technology mediated learning activities should be fun, engaged, spontaneous and authentic to promote deep learning (Turja et al., 2009). These principles combine a cognitive developmental perspective with a child-centred approach; however, the teachers' role is neglected in this framework. If the pedagogy of technology mediated learning merely emphasises children-centred and play-based learning, then teachers may confine themselves to managing students' learning behaviours in the classroom such as organising, routinising and rule-instructing (Edwards, 2015). These frameworks and guidelines do not represent effective teaching approaches in terms of full integration of digital technologies in early childhood education; more effective pedagogies are needed.

Table 1 shows the knowledge process of two pedagogical models and how it relates to the pedagogy of multiliteracies. The table illustrates the similarities and differences among the three models to show the use of digital technology in multiliteracy practices.

A pedagogy of Multiliteracies (The New London Group, 1996)		Learning by Design (Cope & Kalantzis, 2015)		Information and Communication Technologies Framework (Hill, 2004)	
Situated practice	Immersion in the experience, and bringing learners' primary discourse into the education process	Experiencing	*The known* – reflect on existing experience and knowledge *The new* – experience something that is unfamiliar	Functional user	Decoding icons, signs and digital texts Basic use of the computer, Shifting between different media
Overt instruction	The systematic, analytic and conscious understanding of explicit information with instruction scaffolding	Conceptualising	*By naming* – classify and defining terms *With theory* – understanding and using concepts	Meaning maker	Understand the meaning of multimodal context Making a connection to prior knowledge
Critical Framing	Interpreting the social and cultural contexts in which students critically view their study topic in relation to its context.	Analysing	*Functionally* – analyse logical connections, cause and effect, structure and function. *Critically* – evaluate owns learning and learned knowledge.	Critical Analyser	Analysing discourses, and related context Selecting the appropriate mode
Transformed practice	Transferring between meaning making practices. Putting transformed meaning to work in other contexts or cultural sites	Applying	Apply the knowledge to the new context in an appropriate and creative way	Transformer	Apply new knowledge and skills to solve real-world problems Designing programs and producing new digital works

Table 1 Relationships between three pedagogies

2.5.1 Multiliteracies Pedagogies

The term “multiliteracies” has been promoted for years in responding to reconceptualise the understanding of literacy and learning with consideration of multimodalities, digital technologies, global connectivity and cultural and social diversities (Cope, 2000; Kress, 2009; Street, 1993). The New London Group (1996) proposed to reconceptualise literacy and learning and developed the concept of multiliteracies and pedagogies of multiliteracies. Multiliteracies acknowledges that, in the digital age, the nature of literacy and learning involves the combination of text, audio and images, and animation; and that language exists in multiple forms embedded within various social and cultural contexts (Cope & Kalantzis, 2009a; The New London Group, 1996). In short, students with multiliteracy skills can make meaning from different modes (e.g., audio, image, and gestures) for different purposes within and across contexts. The Australia national curriculum and Victoria curriculum all make reference to multimodal texts in the literacy sections and point out the importance for students to use texts for a variety of social purposes (ACARA, 2012b).

Multiliteracies pedagogies express itself as the whole learning progress (Cope & Kalantzis, 2009a). Multiliteracy pedagogy can be described in four orientations: situated practice, overt instruction, critical framing and transformed practices (The New London Group, 1996) (see Table 1). These four pedagogical orientations support diverse learners encouraging the transforming learned knowledge and skills into a new context. Each of the four orientations represents a pedagogical approach with a theoretical base, and has strengths and limitations in a contemporary educational environment. They should be applied in combination so that the limitations of one pedagogy can be offset by the strengths of other orientations (The New London Group, 1996). Such a pedagogical palette will support teachers to design the high-quality multiliteracy practises that include digital technologies.

The pedagogical orientation of "situated practice" values the involvement of authentic experience, which makes the necessary connections with the learner's lifeworld in the classroom, and situates meaning making in real world contexts (Gee, 2000). The learners' sociocultural contexts are considered the most important part of situated practice. Students' primary discourses are included in the learning process, which enables them to actively apply their learned knowledge and skills in the process of making-meaning (Gee, 2000; Street, 1984). Situated practice also allows teachers to understand what their students already know and what they ready to do, and immerse their students in learning to promote better learning performance (Gee, 2004).

The pedagogy of "overt instruction" takes the form of didactic teaching and explicit instruction that focus on reinforcement of memorising taught information to develop conceptualising understanding of the learning topic. Metalanguage which is used to describe language is usually taught in overt instruction. Overt instruction positions students' prior experience and knowledge as important aspects, enabling teachers to organise learning practices building on students' already learned knowledge and experiences (Kalantzis et al, 2005; The New London Group, 1996). According to the New London Group (1996), overt instruction encourages teachers to identify their students' specific learning needs and create learning activities to address these learning needs. Gee (2004) suggested that teachers should encourage their students to contribute in the class activities to avoid developing teacher-centred practices in overt instruction. Moreover, overt instruction should be positioned as an element within wider teaching and learning contexts, creating a classroom environment in which the students are elevated in the ZDP to accomplish challenging tasks with sufficient support and scaffolding (Vygotsky, 1978).

"Critical framing" which stems from critical literacy assists students in considering the work and perceptions of other people and reflecting on their own tasks as a means of achieving their own goals and purpose (The New London Group, 1996). Critical framing thus leads purposefully to "transformed practices". Transformed practice occurs when existing knowledge is transformed to new context to make new meaning (The New London Group, 1996). For learners, transformed practices involve bringing their lifeworld and their learned concepts and theories together, engaging in critical practices, and then applying the combined information to perform some type of creative and appropriate transformative practice such as solving a new problem. The new process of learning then returns back to the orientation of situated practices in a reflective way, consequent on having developed understandings through overt instruction and critical framing (The New London Group, 1996). According to Kalantzis et al. (2005), it is important to develop a repertoire of reflexive teaching strategies which allow both teachers and students to be agents and to rebalance their roles during such knowledge processes, so that teachers can purposefully deploy them in designing multimodal textual learning activities. The combination of the four orientations helps teachers maximise their advantages in designing and delivering successful learning activities using digital technologies. Furthermore, the multiliteracy pedagogy has advantages in guiding the researcher to analyse learning activities in contemporary Australia classrooms as the pedagogy is already an important part of Australian educational policy and is being enacted in schools (Mills, 2006). However, the multiliteracy pedagogy only emphasises teachers' roles during the process of construction of knowledge, although it acknowledges individual cultural purposes during the learning process; the students' knowledge gain is not addressed in multiliteracy pedagogies (Hesterman, 2013).

2.5.2 The Information and Communication Technologies Framework

To illustrate what learning practices with digital technologies look like, Hill (2004) has developed the Information and Communication Technologies Framework (see Table 1) to provide explicit information about the use of digital technologies in literacy learning practices. This framework was developed from Durrant and Green's (2000) 3D model which encourages teachers to rethink the role of digital technologies in classroom contexts. The 3D model has: operational, cultural and critical dimensions. The operational dimension includes basic digital skills, such as turning on the computer, opening software and physical skills in using digital devices. The cultural dimension is about understanding how to make meaning with digital text for a certain purpose. The critical dimension refers to using digital technologies critically, considering cultural, social and historical contexts (Durrant & Green, 2000). Hill (2002) extended the 3D model and maps digital technologies mediated learning practices into literacy learning by adding a "transformer" dimension to show teachers what digital technology mediated learning practices look like in classrooms in a transformative way. Hill's model has four dimensions that need to be considered to scaffold children's learning with digital technologies: functional user, meaning maker, analyser and transformer (see Table 1) which is very similar to the New London Groups' multiliteracy framework but put more emphasis on what students will achieve in terms of using digital technologies. The functional user dimension refers to students obtaining basic technology knowledge and skills. The meaning maker dimension describes students' ability to reconstruct information from digital texts. The critical analyser dimension is about analysing digital information with various digital devices while considering social and cultural values, and the transformer dimension refers to students applying this new knowledge to new contexts using a wide range of digital tools and resources (Hill & Nelson, 2011).

Hill (2002) suggested that the transformer dimension in his model should be highlighted as students need to transform their critical knowledge of using digital technologies to the new context for different purposes with sufficient adults' scaffolding. It is claimed that active learning occurs in a process of applying generalisable knowledge from an existing context to a new context; therefore, pedagogies that support students to achieve the transformer dimension are considered more effective ways to include digital technologies in classrooms (Cope & Kalantzis, 2015; Luke, 1994). Hills' framework is a tool for teachers to analyse young children's learning during digital technology designed learning practices. This implementation model focuses on what students would achieve while they use digital technologies for learning. However, how to integrate digital technologies effectively into teaching strategies and how to support students to extend their learning to other areas and solve new problems with digital technologies is not mentioned in this framework.

2.5.3 Learning by Design

Building on the concept of multiliteracies and its pedagogical framework, "Learning by Design" identifies four dimensions of the knowledge process that informs the pedagogy that enables teachers to deliver multiliteracies practices effectively in their classroom (see Table 1). The Learning by Design framework is essential in the epistemology of constructivism, because it states that knowledge is socially constructed (Vygotsky, 1978). Learning by Design provides explicit and systematic explanations of how to implement digital technologies, with consideration of both students' and teachers' roles in the knowledge process (Cope & Kalantzis, 2015). The framework then offers a wide lens to understand teachers' pedagogical practices, and students learning journeys, when considering the role of digital technologies.

The following figure illustrates the knowledge processes in the Learning by Design framework into four dimensions as experiencing, conceptualising, analysing and applying (Kalantzis & Cope, 2005; Yelland, Lee, O'Rourke, & Harrison, 2008) (see Figure 1). These four dimensions describe each approach and the associated knowledge gain and illustrate the growth of knowledge itself in shifting conditions.

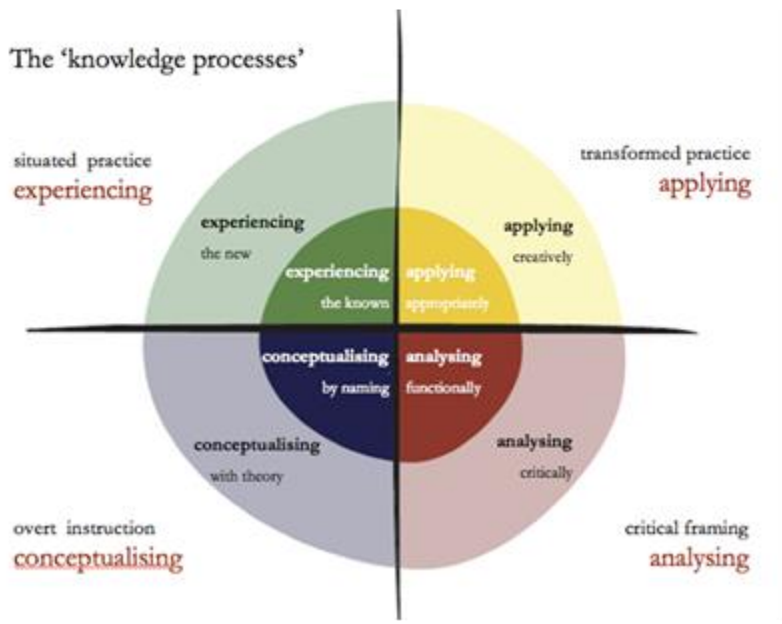


Figure 1 Learning by Design (Kalantzis & Cope, 2005)

Learning by Design, which unites theories of knowledge with pedagogy and theories of learning, describes four knowledge processes which relate to four orientations of multiliteracies pedagogy. It offers teachers a holistic teaching and learning model so they can make choices to ensure learning occurs in multiple contexts, especially when digital technologies are included (Kalantzis & Cope, 2010). In the experiencing dimension of the knowledge process, teachers connect students' interests and their life experiences to learning activities. In a multiliteracy pedagogy, experiencing also requires the teacher to recruit students' prior knowledge and their lifeworld experience in the classroom. Therefore, the inquiry and play-based approaches are applied during the teaching practices related to the experiencing dimension which take account of digital technologies because they are important parts of children's lives (Yelland, 2015b). The conceptualising dimension, which involves naming, defining and applying concepts, asks teachers to provide efficient scaffolding for the students to achieve challenging tasks in a wider learning environment (Vygotsky, 1978). Rather than applying didactic teaching strategies and designing drill and practice learning activities, the teachers are urged to focus on guiding the students to gain access to explicit information so that they can reconstruct their prior knowledge and produce new knowledge. The teachers' roles as scaffolders and facilitators are highlighted in this dimension. The third dimension is analysing which involves the use of any knowledge, action, and media in a critical way. In this dimension, teachers will reassess their teaching plan and practices to see if their students critically analyse what they have learned in considering historical, social and cultural values in the real world. Both teachers and students participate in the process of analysing to critique the purpose, position, perspectives, and consequences of any gained knowledge and skills (Kalantzis & Cope, 2010). The last dimension, applying, aligns with the fourth orientation in multiliteracies pedagogy (transformed practices), in which teachers support the student to develop ways of presenting the gained knowledge and applying them to a new context. This may involve a typical or accepted application, and it is never merely replication but always transformative in some degree. The learners will creatively apply their knowledge in a new situation, or even generate new knowledge during the process of applying practices. This practice evaluates the critical approach (analysing) and then leads students back to the dimension of experiencing to start a new circle of learning (Cope & Kalantzis, 2009a).

Cope and Kalantzis (2009a) have suggested that this framework prompts the movement towards the new learning, because it opens access to learning within the whole context where diversity is becoming more critical. Meanwhile, it allows learners to produce dynamic multimodal texts and closely relates these multiliteracies learning experiences to their own communities and life experience (Kalantzis & Cope, 2012b; van Haren, 2015). Consequently, students are able to transform their learning experiences with digital technologies from classrooms into knowledge repertoires, and they can apply these skills and knowledge into a new context with consideration of digital, social, historical and cultural contexts (Pandian & Balraj, 2005).

It is suggested that the key to effective implementation of digital technologies is to extend basic digital skills for developing higher order learning and thinking skills (Zammit, 2013). Therefore, teachers may consider to implement the digital tools and resources with pedagogical choices from the applying dimension. In doing so, they prepare their students to be knowledge transformers to ensure powerful learning (Cooper et al., 2013; Hill & Nelson, 2011; Sefton-Green et al., 2016). However, Yelland (2015) has argued that the elements of analysing and transforming which are considered as keys elements of effective integration of digital technologies, are often missing in teachers' planned learning activities, which may lead to ineffective integration of digital technologies. The Learning by Design framework prompts teachers to ensure all the elements or dimensions are included based on the reflection of their own teaching experiences and students' learning needs to maximise the potential of digital technologies for new learning (Cope & Kalantzis, 2015; Kalantzis & Cope, 2005; Yelland 2015).

All these frameworks and pedagogies indicate that to effectively integrate digital technologies, teachers are required to view students as active agencies in constructing their own knowledge of the world, rather than be passive digital receivers. However, there is minimal research that explores such transformative approaches and shows how to support deep and transformative learning. There are even fewer studies demonstrating what transformative teaching and learning would look like, and how it would work in terms of using digital technologies in early years and primary school classrooms (Plowman & Stephen, 2006; Yelland, 2015a). My research study is designed to fill this gap by investigating the current use of digital technologies in early primary school classrooms using Learning by Design framework. Both teachers' pedagogical understanding and practices in terms of using digital technologies with young children as well as students' learning practices with digital technologies will be carefully analysed under the lens of Learning by Design framework.

2.6 Chapter Summary

This chapter presents a review of research literature on young children's (from toddlers to primary school students) use of digital technology in formal and informal settings. The first section briefly introduces the contemporary situation and historical debates with respect to young children's access and use of digital technologies. The second section briefly outlines the current Australian early year and primary school sectors' policies and curricula that impact on young children's use of digital technologies. The third section contains a review of the empirical research related to possibilities and issues of digital technologies that can be implemented in terms of support young children's learning. The use of iPads to support young children's learning and developing is highlighted in this section. The fourth section explores learning theories and teachers' pedagogical strategies in early childhood education and their impacts on integrating digital technologies. The last section introduces the reconceptualised literacy and learning practices taking on digital technologies. It suggests that new ways of teaching, learning and schooling need to be embraced with multiliteracies, because learning practices are closely associated within the social-cultural context, and are now heavily influenced by digital technologies.

The literature demonstrates that digital technologies play vital roles in children's lives and impact on their ways of learning and developing. My literature review reveals the importance of social-historical and cultural contexts impacts on research studies of young children's use of digital technologies, and their classroom teachers' daily practices towards using digital technologies. An awareness of the need of implementing digital technologies is rising among many early year and primary school teachers, but explicitly pedagogical guideline from the Australian curriculum is lacking. Consequently, students' engagement with digital resources may remain at a functional level that falls short of the deep, complex, and transformative learning that digital technologies make possible. This literature review reveals several reasons why early years educators inadequately to integrate digital technologies in their classes because their pedagogy and practise is not effective in extending using digital technologies for deep learning. Furthermore, the literature supports the reconceptualised view of learning, pedagogies, and schooling and the move away from the emphasis on traditional skills (Kalantzis & Cope, 2015).

The complexity of relationships between learning and new technologies, and learning and pedagogies, in early childhood settings indicates that further research on these relationships is needed. The literature review acknowledges that literacy practices are changing, by increasingly utilising digital technologies, to prepare students for the 21^{st}-century. Although digital technologies are promoted greatly in Australian education policies and curricula, meaningful implementation has not been widely documented in life-related situations. More research is needed to document, investigate and analyse these changes to evaluate current practices, articulate the issues and provide insights for new developments in the future.

The next chapter details the theoretical and methodological approaches to the study. It describes the research design, research settings and my role as a researcher. The theoretical and methodological framework is described in detail followed by explanations of the data collection strategies and data analysis procedures throughout the study.

CHAPTER 3

Research Methodology

This chapter provides an overview of the design and procedure of this study. I explored the implementations of digital technologies such as iPads, Smart TVs, and Smartboards in early primary school classrooms in Melbourne, Australia. It is a qualitative study based on one public primary school, with an underlying constructivist paradigm. Primary data was obtained from three sources: teachers' interviews, classroom observations and students' digital artefacts. The classroom observation data was primary data and analysed using the Learning by Design framework (Kalantzis & Cope, 2005). Teachers' interview and students' artefacts were weaved into primary data to provide better understanding of themes that were developed from analysing classroom observation data from different perspectives. The chapter introduces the research objectives, research questions, and research settings followed up with the discussion of constructivist influences on the research design. The methodological rationale is discussed, and the details of the location of the study, participants, and procedures for granting consent from the school, students and parents will be described. The chapter also provides an overview and rationale of the methods of data collection and data analysis. Furthermore, the ethical considerations, and the limitations of the study will be included.

3.1 Rationale

The primary objective of this project was to explore and investigate the possibilities that digital technologies—particularly iPads, Smart TVs, and mobile phones—afford for teaching and learning in early primary school settings. My study aims to explore and document teachers' pedagogical practices when implementing digital technologies to support their students' learning; and learning practices with digital technologies to provide a vivid picture of current use of digital technologies in an Australia formal education setting, of the students in early childhood ages (age from 5 to 8). The learning activities and teaching strategies with digital technologies documented in my research will provide some good samples and ideas of how educators and teachers use digital technologies from early year education and primary schools. In this way, these practices can contextualise the guidelines from Victoria curriculum and provide more engaging learning activities using digital technologies to address their students' learning needs. The knowledge generated from my study is in response to calls for more research into implementation of digital technologies with new pedagogies that more effectively encourage active engagement and new learning in educational settings (Kalantzis & Cope, 2012a; Lankshear & Knobel, 2011; Pendleton, 2013; Yelland, Cope, & Kalantzis, 2008; Yelland et al., 2014). These researchers have advocated exploration of the effectiveness of implementing technologies to scaffold or assist young children's learning in formal educational settings (Ching-Ting et al., 2014; Couse & Chen, 2010; Kerckaert et al., 2015), because "transformative practices in schools remain out of reach" (Yelland, 2015b, p.161). Cope and Kalantzis' model of Learning by Design is used as the lens to examine digital practice and pedagogy in the primary school to see which dimensions (experiencing, conceptualising, analysing and applying) the students and teachers are achieved to demonstrate the learning process with digital technologies.

The main research question for this study was:

- How are digital technologies implemented in contemporary Australian primary school classrooms to supporting young students' learning?

In addition to this main research question, three sub-questions were developed;

1. What are teachers' pedagogical perceptions of implementing digital technologies with young students?
2. What are teachers' pedagogical practices towards the implementation of digital technologies with young students?
3. How do digital technologies enhance young students' learning?

3.2 Research Paradigm

According to Antia (2000), a research paradigm is a simple systematic network of ideas and beliefs relating to the nature of the world and the objective of the research which provides the guidelines for researchers to establish a set of research practices. A paradigm is an overarching net that covers the researcher's ontological, epistemological and methodological positions (Denzin & Lincoln, 2011). An understanding of ontology and epistemology provides the foundation for a researcher to act on his/her research project such as what should be studied, how research should be done and how results should be presented (Crotty, 1998).

The ontology and epistemology positions are always consistent under one paradigm which also echo one researcher's stance, and what s/he believes counting as truth. Theories of ontology and epistemology form a foundation of understanding how different types of knowledge are produced from different research approaches. Ontology involves researcher's assumptions about basic elements of reality, and her/his beliefs on the nature of reality (Hoepfl, 1997; Mason, 2002); in short, what is real to the researcher? The concept of epistemology refers to nature of the relationship 'between the knower and would-be knower'; in other words, the researcher's belief on how knowledge can be gained (Guba & Lincoln, 1994, p. 108).

My study is under the constructivism paradigm. My ontology and epistemology are established on my personal understanding of social and cultural difference. I have cross-cultural educational experiences, as I has spent the past 25 years in mainland China studying and teaching. When I have studied overseas, I noted that my learning and teaching experiences were very different from what I had experienced in China. I first obtained the perspective that learning happened when knowledge was passed successfully from teacher to students with my learning and teaching experiences in China. However, my four years' study in Australia produced a different understanding of learning and teaching: I began to realise that learning happens when knowledge is transferable and applied to different contexts appropriately. Such changing perspectives on learning and knowledge processing makes me realise that knowledge can be constructed from an individual's social and cultural practices, and this aligns with the constructivism paradigm. As a consequence, realities are varied and constructed by individuals in their own minds within historical, cultural and social contexts, and this impacts my understands about human learning, thinking and acting (Creswell, 2013; Mertens, 2014), and places my research under the constructivism paradigm.

The constructivism paradigm is defined as an approach that believes human construct their knowledge through experiencing things and reflecting on those experiences (Honebein,1996). Stake (1995) further explained that contemporary researchers who frame their research within the epistemological paradigm of constructivism locating knowledge as "constructed" rather than "discovered". Crotty (1998) also wrote that most social research under the constructivism paradigm made efforts toward seeking "culturally derived and historically situated interpretations of the social life-world" (p. 67).

Furthermore, the constructivism paradigm also aligns with Vygotsky's perspective (1980) on teaching and learning, as learning is socially and culturally constituted, which heavily influences Australian education policies and schooling. This makes the constructivism paradigm appropriate for underpinning my study because it involves the observation and analysis of early primary school students learning and teachers practices of digital technologies in an Australia context. The constructivism paradigm recognises that the researcher plays an active part in constructing and interpreting the collected data, and allow the researcher to collect multiple data using multiple methods. These provide a wide range of perspectives and produce a deeper understanding of participant's behaviours and perceptions in their natural surroundings (Cohen, Manion, & Morrison, 2013; Denzin & Lincoln, 2011).

In conclusion, the constructivism paradigm focuses on participants' perspectives and behaviours in a specific social context; to collect naturalistic and authentic data and present the results in rich descriptions (Geertz, 2008), which suits for my research design.

3.3 Research Methodology

I adopted a qualitative research approach to examine the phenomena of young children's learning and teacher's pedagogical practices with digital technologies in formal educational settings. Qualitative Research is primarily exploratory research that involves none-number data and its analysis (Stake, 2013). It is used to gain an understanding of phenomena relates to human beings' interactive activities with consideration of social and cultural contexts in a natural setting, which can be examined and investigated to answer the questions by illustrating, describing and interpreting reasons, perceptions, and motivations. Qualitative data collection methods include focus groups (group discussions), individual interviews, and participation/observations. The sample size is typically small, and respondents are selected to fulfil a given quota (Stake, 2013).

The qualitative approach is always employed to examine the learning and teaching practices in an education context (Stake, 2013). Therefore, to gain better understanding of the phenomenon and provide the answer to the research questions, I have to stand closely with participants to look at their practices and listen to their stories. Thus, this study applies qualitative research design to unpack participants' activities, experiences, insights and perspectives in answering the research questions about the use of digital technology in early year education and primary school settings. A qualitative research approach allows researchers to gain a better understanding of the phenomenon.

There are several advantages to apply a qualitative methodology. First, qualitative research interview questions are often open-ended and allow researchers to have maximum freedom in investigating the event for new information (Corbin & Strauss, 2008). Secondly, qualitative data, produced from personal reflections, life stories, interviews, artefacts, and observational and interpretational texts can usefully describe routines, problematic moments and meanings in an interpretive and naturalistic way (Merriam, 2014). In this study, I drew on multiple data resources and multiple data collection methods to gain a wide range of perspectives. Those various types of data enable productive comparison, and contrast between different sets of data to generate themes for further analysis (Cohen et al., 2013; Denzin & Lincoln, 2011).

Thirdly, it has been claimed that a qualitative research design can provide a deep understanding and unpack the phenomenon and events in formal education settings (Billington, 2016; Johnson, 1995; Plowman, 2016b). Researchers can gain detailed information about students' behaviours and in-depth descriptions of teachers' pedagogical practices and perspectives (Burnes, 1997). This potentially permits the qualitative researcher to develop a holistic understanding by exploring each layer of data that contributes to understanding the whole event (Yin, 2011). Therefore, a qualitative research approach allows researchers to gain a better understanding of the phenomenon. Hence, I used a qualitative approach to obtain an understanding of teaching and learning in a naturalistic setting (Johnson, 1995).

3.3.1 Case Study as a Tool to Gather the Story

Many researchers provide definitions of the case study and suggestions on how to design case studies. Yin (2002) defines the case study as investigating “a contemporary phenomenon within its real life, especially when the boundaries between a phenomenon and context are not clear and the researcher has little control over the phenomenon and context” (p.13). Case studies are widely utilised in qualitative studies in educational fields (Punch, 2013), as they provide deep, rather than surface understanding, rich in detail and insight of participants’ experiences (Billington, 2016; Johnson, 1995; Plowman, 2016). Stake (2000) pointed out that case studies attempt to discover what is both common and particular about the phenomena to provide a full story to the audience. Outhwaite (1983) argued that if the purpose of the research is to discover, identify, describe and analyse the variables of a complex social situation, a case study is likely to be the most appropriate method. In other words, a case study is suited for understanding complex social phenomena involving multitude interests and multiple resources, and guiding the data collection and analysis with a theoretical framework (Yin, 2011, 2013). This suits my investigation on the use of iPads, Smart TVs and mobile phones in complex learning environments.

Case study design includes single and multiple case studies (Yin, 2011). My study was a single case study of several classes in one primary school (WPS) as a single analysis unit. According to Yin (2013), the single case study method can be used to confirm or challenge a theory or to represent a unique case. It is also ideal for revelatory cases, meaning that the observer have access to a phenomenon that was previously inaccessible (Yin, 2013). The single case study research design allowed me to collect rich and first-hand data on how the newest digital technologies have being implemented in a formal education setting.

Yin (2011) suggested designing the case study before conducting the research. My project is developed from a research proposal which includes a brief literature review, project objectives, key research questions, framework and potential ethical issues to provide a guideline for designing a case study, which is in line with Yin's research framework (2002). The case study protocols assist me in identifying the issues in the research field, research gaps and potential themes.

3.4 Research Setting

The West Primary School (WPS) is a state public-school which offers programs from Foundation Year (Prep) to Year 6. The students start Foundation Year at this school when they are five years of age or older by 30 April. They will spend one school year (four terms) in their Foundation Year level to learn some foundational knowledge and to be familiar with school life and learning routines. The rest of the Year levels are organised in Year One/Two, Year Three/Four, and Year Five/Six. The Victoria curriculum is packaged into combined year levels in a flexible way to address different levels of students' attainment. For example, in Year One/Two, the Year One/Two teachers have choices on teaching Year one or Year two curriculum to their Year One/Two students based on their students' current level.

The school has a very diverse student population, with a high proportion of students who come from non-English-speaking cultures who have English as a second language. In 2016, about 54% of the students were classified as English as an Additional Language (EAL), while 1% had Aboriginal and Torres Strait Islander (ATSI) heritage; more than 60 languages were represented. The overall socio-economic background of the school fits into the mid-range according to the school annual report. In 2016, there were 720 students enrolled, with 39 full-time registered teachers. The school building includes 17 general Learning and Teaching areas, five Learning Environments, a learning centre, a gymnasium and a music room.

The main criterion for this study was to find a school that implemented iPads from Foundation Year to Year One/Two in the curriculum which allowed me to examine the use of digital technologies in the early years' schooling. The school presents itself as an "iPad School". The State Government of Victoria (2007) suggested that Victorian Schools play an important role in introducing technology to children, and encourages schools to implement the 1-to-1 learning program which means each student have access to a device to complete learning tasks. The case study school shares this vison that is promoted by the state government, and runs the iPads program from Foundation Year to

Year Six by promoting "Bring Your Own Device" (BYOD) policy. The students bring in their own iPads purchased directly by families. They bring their iPads to school for learning each day and bring them back home for homework or entertainment after school. The students have full responsibilities in managing their own iPads in the school. Other tasks including charging iPads at home, downloading applications and setting up Wi-Fi connections are done by their parents. The school IT specialists assist students in trouble shooting and iPads setting.

Teachers and students work in open planned learning communities (see Figure 2), rather than traditional isolated classrooms. Normally, one learning community contains three small learning groups which are the same size as a traditional class. All learning areas in a learning community are open planed, so the walls of classrooms are foldable and usually open to allow students to move freely between learning spaces and to access their bags, library books, and other learning resources. Foundation Year students are grouped into two learning communities according to their age, and the rest of the students are grouped into multi-aged learning communities. Classroom teachers take turns to teach routine tasks (e.g., learning the days of the week, the months of the year, counting numbers) and some group activities in a learning community. They teach mainstream learning subjects, such as literacy, numeracy and science literacy to individual learning groups of around 20-25 students.

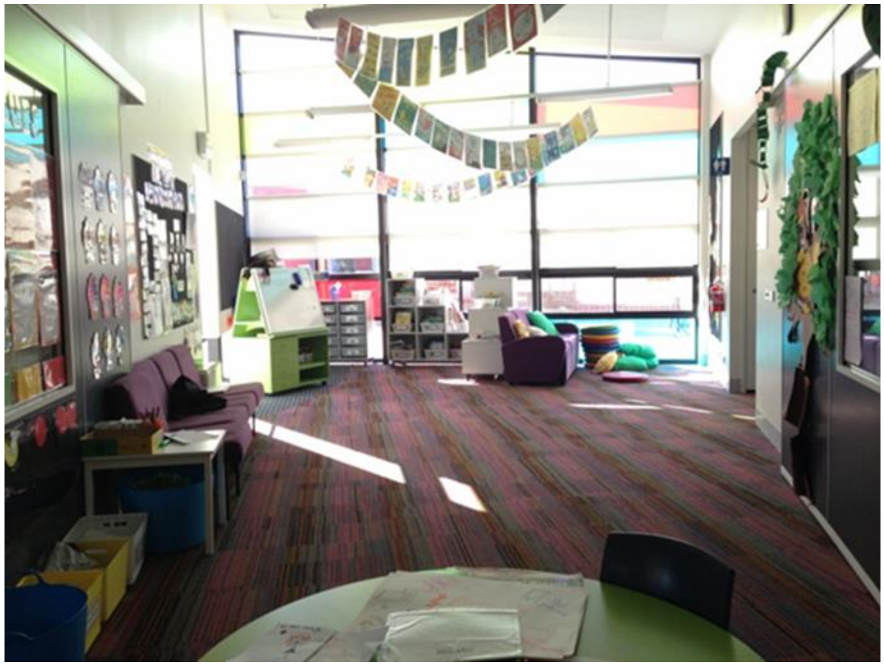


Figure 2 An open-planned learning community area

Each classroom is equipped with one Smart TV set, with an Apple Air adaptor to screencast from iPads to the TV set. Each teacher owns a laptop, and some of them use their iPhones for the class roll and assessment. The school hosts a filtered Wi-Fi network that is accessed in all the learning spaces. Students' iPads are pre-linked to the school's Wi-Fi network, and all games and applications are password protected. Each student has the relevant information of password and account names pasted into their information book, and there are 40 iPads in the school library for teachers to borrow. Only the teachers can borrow the school iPads, and then distribute them to the students who do not have iPads during the class time. As there is a limited the number of school iPads, teachers need to book them ahead. Most of time, teachers prefer to have non-iPad students work with iPads students to ensure equal access to iPads. The desks are joined to facilitate collaborative work, and students are usually grouped according to their learning needs for different learning subjects (See Figure 3).

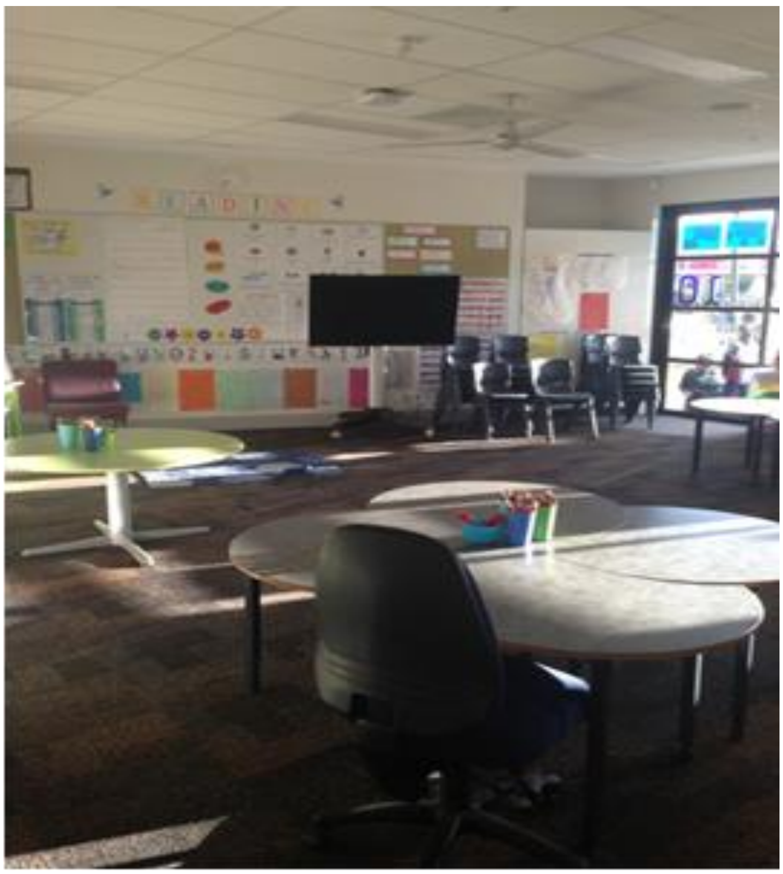


Figure 3 The classroom area

3.5 Methods of Data Collection

My study uses teacher interviews, classroom observation and students' artefacts (digital photos, animation, posters, screenshots, and eBooks) from the case study school to provide rich detail and gain knowledge of the school's complex technological learning environment (Cope & Kalantzis, 2009; Flewitt, 2006). Merriam (1998), Yin (2013), and Stake (1995) noted how a case study approach enabled the potential to incorporate multiple sources of evidence, establish key events and accurately capture and represent participant's voice and behaviour in a natural setting. In this way, multiple realities and contexts of the different participants' groups—teachers and students—can be cross-referenced to provide the full picture of the story (Cohen et al., 2013).

Data collection procedure

The data collection procedures are outlined as the diagram in Figure 4. Before conducting the research, I visited the school with my supervisor to gauge the principal's interest in participating in the research project in July 2016. After a positive response to our initial visit, I conducted an informal meeting with the principal and leader teachers from Foundation Year and Year One/Two to give them a background about the study and obtain their in-principle permission. All the teachers from Foundation Year and Year One/Two were introduced the project including the observation process; and how the data would be collocated and used.

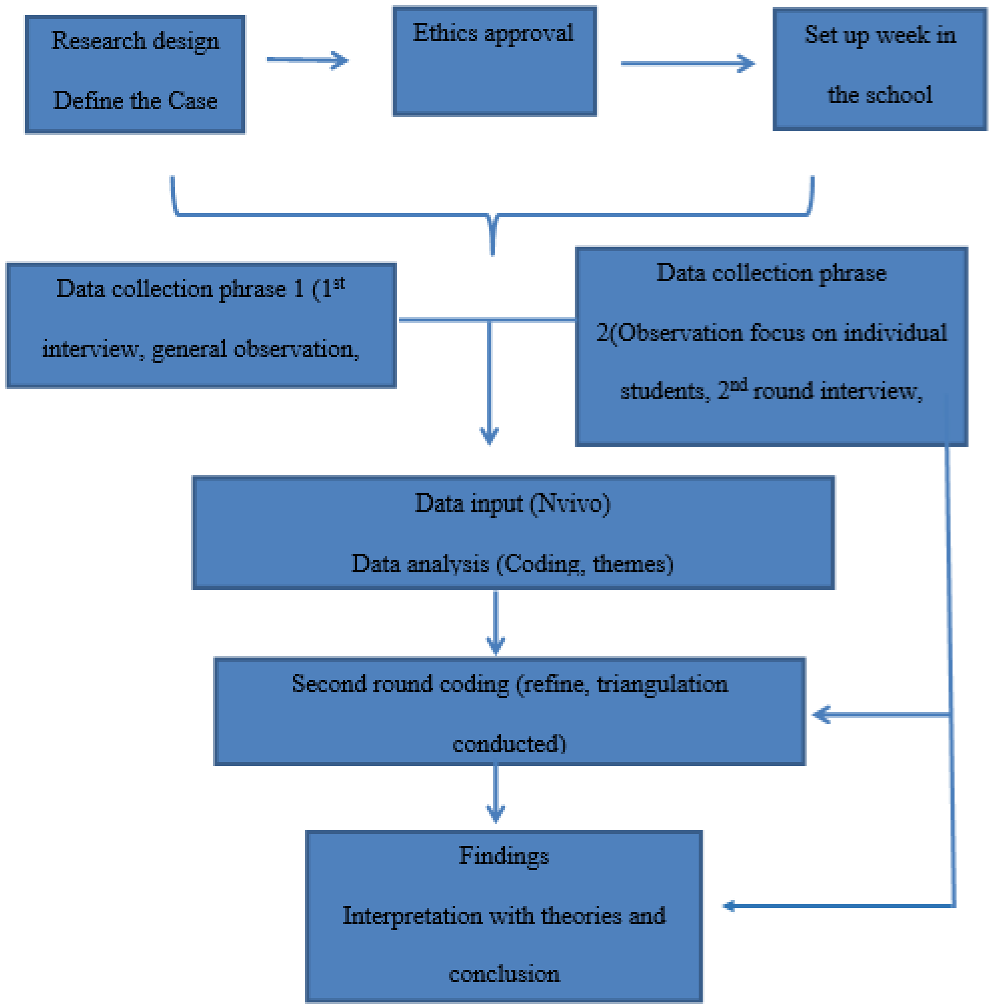


Figure 4 The phases of the case study

As part of the data collection, I visited the school several times to become familiar with the school's physical environment, timetable, class schedule and to select classrooms for data collection. I selected two learning communities (one Foundation Year and one Year One/Two) in 2016 due to their geographical locations, which allowed me to move between them easily in the main building for observation. I then followed most of the students from the observed Foundation classes in these two learning communities as they moved to two Year One/Two learning communities in 2017. In all, I observed four learning communities during the school year 2016 and 2017.

I organised “set up week” at the beginning of August 2016. Each of the teacher participants explained the research project to their students while I was present in their classroom, and then data collection commenced. I usually spent around 2-4 hours per visit in the morning and early afternoon sessions due to my personal schedule. The students' artefacts were collected when I observed the class. I undertook first-round interviews with teachers during the third term of 2016, and the second round of the interviews was conducted in the first term of 2017.

Interviews

An interview is an important source for gathering the information for a case study as it is described as the best approach to be utilised for short time period case studies (Merriam, 2014). The purpose of the interviews was to gain participants’ perspectives in as much detail (thick description) as possible through posing several types of questions (Creswell, 2014; Geertz, 2008; Merriam, 2014; Yin, 2016). The interviews varied in length (from 20 to 40 minutes) and took place in their learning communities/classrooms, at the teachers’ convenience.

I interviewed six teachers; one specialist teacher (Art), two Foundation Year teachers (2016) and three Year One/Two teachers (2016 and 2017) for two rounds (fourth term in 2016 and first term in 2017). All the teachers were female (the school had no male teachers at these levels, except in Physical Education). Table 2 contains some basic information about six interviewed teachers and two teachers who only participated in the classroom observation.

Teachers' pseudonyms	Teaching Years	Interview	Classroom Observation
Amanda	Foundation year (2016)	Yes	Yes
Jessica	Foundation Year (2016); Year One/Two(2017)	Yes	Yes
Rose	Year One/Two (2016 & 2017)	Yes	Yes
Kate	Year One/Two (2016 & 2017)	Yes	Yes
Lauren	Year One/Two (2017)	Yes	Yes
Kelly	Year One/Two (2016 &2017)	Yes	Yes
Maria	Year One/Two (2017)	No	Yes
Nicole	Foundation Year and Year One/Two (2016 &2017)	No	Yes

Table 2 An outline of the teachers and classes involved in the study

In this study, semi-structured interviews sought out the teachers' perspectives and insights into their pedagogy and how they used digital technologies in the classroom. The semi-structured interviews are based on less structured interview questions including open-ended and semi-opened questions which point to a specific area to be explored (Britten, 2007; Denzin & Lincoln, 2011). One of the main advantages of semi-structured interview is that they allow the interviewer to follow up on relevant and interesting anecdotes and stories that may have otherwise been missed (Gordon, McKibbin, Vasudevan, & Vinz, 2007; Mertens, 2014), and provide flexibility in the order or wording of the questions (Denzin & Lincoln, 2011).

As noted earlier, I performed two rounds of interviews. The first round interviews used semi-opened questions that were developed from the literature review, and aimed to build up general understanding about participant teachers' perspectives and teaching experiences of including digital technologies in their classroom (Cohen, Manion, & Morrison, 2013). The second round of the interviews were applied with more open-ended questions for new information, fresh reflections and unexpected answers (Cohen et al., 2013; Merriam, 2014), targeting teachers' reflections on their pedagogy and classroom practice in implementing digital technologies and extending students' multi-literacies skills. The interview questions for the second-round interviews were developed from my classroom observations and personal reflections on each participant's teaching practice. The teachers in the second round of interviews had time to reflect on and explain how they implemented digital technologies and the opportunity to add to previous reflections and evaluations on their lessons, allowing for a deeper and more complex understanding of the data (Yin, 2011, 2013).

The interview questions covered teachers' personal experience, skills with digital technologies, pedagogical understandings about the implementation of digital technologies and any challenges they faced:

- How do you believe technologies should be used in the classroom? Why?
- Are there any pedagogical strategies you have found most successful in terms of using digital technologies in class? What are they?
- What value do you place on digital devices, and their functions in your teaching?

These questions enable me to collect in-depth data on the participants' opinions, feelings, and self-reflections on events or facts and to perform the data to be comparative analyses across the participants (Patton, 2005). The full set of interview questions is in Appendix L: Interview Questions. Interview transcripts/notes were shown to teacher participants to confirm their accuracy. Any interview data that might identify as disadvantaging to the participants or make them vulnerable was discarded.

Classroom observations

I observed four learning communities (Foundation Year and Year One/Two) from 2016 to 2017. Eight teachers participated in classroom observation, two of whom were specialists in Art and Science (see Table 2). Generally, students were observed when they engaged with digital technologies, such as iPads, Smart TVs and a range of software applications. The teachers were observed for their pedagogical practices in terms of engaging young students with digital technologies for learning purposes. Each class/learning community was observed for 32 hours each for a total of 128 hours. Table 3 is developed for a breakdown of the observations.

Year	Learning Community/Class	Hours	Occasions	Observation Entries
2016 Term 3-4	Foundation Year *1 class	32	10	10
	Year One/Two * 1 class	32	8	8
2017 Term 1-2	Year One/Two * 2 Classes	64	8*2=16	16
Total		**128**	**34**	**34**

Table 3 Details of classroom observations

28 out of 34 observation notes were selected to use for further data analysis, because the observation entries that did not relate to digital technologies were excluded. I collected the students' digital artefacts while observing their interactions with digital tools and

resources using iPhone photos and screenshots. Yin (2016) and Hoepfl (1997) stated that observation is able to uncover information within a particular context that participants themselves are not aware of, or that they are unwilling to discuss. I recorded the digital learning tasks, teachers' pedagogical practices and resources in order to document full learning stories from the perspectives of both students and teachers. The focus was on students' use of digital technologies for learning, while for teachers, it was on their role and teaching practices. Classroom observations allowed offers a greater in-depth understanding about the case than interviews alone.

Participant observation

Participant observation is when the researcher participates in the context of a natural scene being studied (Yin, 2011; Merriam, 2014), and in this case, it allows me to collect detailed information about young students' interactions as well as teachers' pedagogical practices with digital technologies. According to Yin (2011) and Merriam (2014), during an observation, the researcher may bring her own judgments and perceptions as a participant during the periods of observation. To reduce the influence of my personal perspectives when observing classroom practices, I applied a "moderate participation" observation method during classroom observation. This moderate participation allows me to shift between a non-participant observer and participant observer. I did not participate in teaching any mainstream learning activities, but interacted with students when they requested assistance with their iPads' and learning problems on a few occasions. I also had a few conversations with the teachers when they were free from teaching and assisted them in arranging learning and teaching materials in the classroom. This may provide deeper insight into different perspectives of participants and assist in future data analysis.

Field notes

I took descriptive field notes during classroom observations, recording settings, participants, activities and conversations (Gordon et al., 2007; Robson, 2011). Yin (2016) recommend taking brief notes initially and writing up detailed research notes to create a more systematic and comprehensive record, after the observations. In addition to field notes, as noted earlier, I photographed the screenshots from Smart TVs, iPads and Smartboards as a means to capture information accurately. As a result, individual and group interactions with digital technologies during or after the instructions were recorded, documented, examined, analysed and evaluated.

I am aware of the difficulty in writing full field notes during the observation, so I have followed Yin's (2016) recommendation on jotting down notes in the classroom during the observation and then constructing the full field notes immediately after the class based on the jottings and students' digital artefacts using the Word software.

Collection of Artefacts

I collected a number of students' artefacts during classroom observations to provide a fuller picture of how students engaged with their iPads. The students' digital artefacts can provide vivid pictures of what students can do with digital technologies (Yin, 2014). Students' artefacts comprised digital creations and multimodal texts made during the class by children: videos, digital photography, digital posters and eBooks, all collected in the form of screenshot. I also took pictures of websites that teachers used to provide a clear illustration of the learning stories. Teachers' choices of digital materials and their digital teaching materials were also collected, if applicable. The data obtained from artefacts supported the data from the observations and interviews to maximise the trustworthiness of my qualitative data (Yin, 2014).

The students' digital artefacts demonstrate their learning and provide evidence in relation to the achievement standards outlined in the curriculum (DEECD, 2006). Sometimes, the digital documentation can show what is learned and what the students can do with digital technologies. It provides a rich source of information about the learning context and illustrates the learning stories of young students learning with digital technologies in an innovative learning environment.

3.6 The Participants

Students participants

Around one hundred and twenty-four young children participated in this project aged five to eight, from four learning communities (Foundation year in 2016, Year One/Two from 2016 and Year One/Two in 2017). Most of the students from the observed learning communities (about 80%–90%) owned their iPads.

Teachers participants

Eight teachers (see Table 4) participated in this research project and agreed to be observed. Of the eight, five classroom teachers (Amanda, Rose, Jessica, Kate, Lauren) and one specialist teacher (Kelly) consented to be interviewed (see Table 3). All teacher participants owned smartphones and laptops for their personal and pedagogical use. The six teachers who participated in the interviews were in their 20s or 30s, with varying amounts of years (1-5 years) of teaching experience (see Table 4). Amanda was followed for two terms in the school year of 2016. Jessica, Rose, Kate Kelly, and Nicole (Nicole did not participate in the interview) were followed for four terms from 2016 to 2017. Lauren and Maria (Maria did not participate in the interview) participated in the project during the first two terms in 2017. A summary of the teacher participants is in Table 4, and pseudonyms have been allocated for reasons for confidentiality. Table number four summarises the composition of the teacher participants and their context.

Teachers' Codes	Teaching Experiences	Education Background	Interview	Classroom Observation
Amanda	$\leqslant$5 years	Bachelors	Yes	Yes
Jessica	$\leqslant$5 years	Bachelors	Yes	Yes
Rose	$\leqslant$5 years	Bachelors	Yes	Yes
Kate	$\leqslant$5 years	Bachelors	Yes	Yes
Lauren	$\leqslant$5 years	Masters	Yes	Yes
Maria	$\leqslant$5 years	Bachelors (doing Masters)	No	Yes
Kelly	$\geqslant$ 5 years	Bachelors	Yes	Yes
Nicole	$\geqslant$ 5 years	Bachelors	No	Yes

Table 4. A portrait of the participating teachers

3.7 Data Analysis

It is suggested that identifying themes when analysing data, helps the researcher to develop a complex story and provides a deep understanding of individual experience in a certain context (Creswell, 2013). I applied thematic analysis to my data to identify significant themes and patterns (Braun and Clarke, 2013; Cresswell, 2013). The overall process of data analysis involved open coding, sorting or constructing, and theorising (Merriam, 2014). Data analysis was performed continuously throughout the study. The data, including field notes of classroom observations, and researcher's reflections/memos was analysed using NVivo to identify useful segments. Excel was used to categorise the interview data. The students' digital artefacts were not analysed by any programs, but used for providing descriptions for the learning stories. Three main themes emerged from the process of the thematic analysis were I-Ready, I-Practise and I-Create.

The two main sets of data including classroom observation and teachers' interviews were coded separately. Both data used an open coding method from the very beginning. The observational data were further coded and analysed with Learning by Design framework, because it is a powerful tool for unpacking the meaning of learning and teaching behaviours in natural classroom settings (Kalantzis & Cope, 2005). For observation data, I separated data into major activities involving the use of technologies, and then reduced common classroom activities and routines into one theme at every beginning stage of the analysis process. The technology mediated activities were further coded and grouped using an open coding approach, and nearly 100 nodes were developed to describe digital technologies associated skills and learning, such as "digital writing", "digital reading", "digital drawing", "digital photographing" and "digital communication". In the second-round coding process, I iteratively reflected on the already categorised data and continuously linked these codes to the literature and the Learning by Design framework to address the research questions. For instance, in the second round of analysis, when analysing young students' interaction with iPads using the four dimensions of Learning by Design framework (Kalantzis & Cope, 2005) (experiencing, conceptualising, analysing and applying), the focus was on understanding the knowledge processes. Then, I identified several sub-themes including "learning iPads and applications", "using digital technologies safely", "drill and practice", "documenting", "collaboration", "online collaboration" and "creating". These sub-themes in terms of describing the use of digital technologies for learning purposes and then were further coded and grouped into broader themes as, I-Ready, I-Practise and I-Create. NVivo proved a useful data managing tool for labelling and grouping nodes during the process of thematic analysis.

The interview data were coded based on the categories that were used to developing interview questions. Using digital technologies for pedagogical purposes was the strongest theme in the interview data. The teachers' commentaries on the use of digital technologies for their pedagogical purposes reflected what they did in their real teaching practices: assessing, documenting and collaborating. The teachers' interview data were coded into "teachers' skills with digital technologies", "attitudes towards the children's use of digital technologies", "pedagogies regarding digital technologies", and "challenges and concerns". These data segments were weaved into the learning stories in I-Ready, I-Practise and I-Create chapters to provide teachers' explanation for unpacking the meaning behind their teaching practices. I used my photographs of students' digital work to visualise the learning stories to make text interview or field notes vivid, but did not explicitly include them in the analysis process.

Theoretical Framework – 'Learning by Design' model as an analytic lens

As noted earlier, I employed the Learning by Design framework (Kalantzis & Cope, 2005) to analyse the way digital technologies were used in the classroom, with particular attention to: teachers' pedagogical practices and the impact on young students' knowledge process. Kalantzis and Cope's framework identifies four dimensions of knowledge processing: experiencing, conceptualising, analysing and applying (Kalantzis & Cope, 2005; Yelland, Lee, O'Rourke, & Harrison, 2008). It supported my approach for a discussion of the relationship between knowledge generation and the use of digital technology, with particular attention to the strengths and challenges of approaches to implementing digital technologies in different learning contexts (Yelland, Lee, O'Rourke, & Harrison, 2008).

Based on the Learning by Design framework, I examined the knowledge process in each sub-theme of using digital technologies and generated three overarching themes: "I-

Ready", "I-Practise" and "I-Create". Each theme represents the relationship between the knowledge process and digital technology use for eliciting powerful learning. Moreover, the three main themes encapsulate the strategies the teachers used to implement digital technologies in the classroom and the benefits and challenges of using digital technologies with young children for learning purposes.

The I-Ready theme was derived from teachers' interviews, in which they stressed that students needed to be prepared and "ready" with basic digital technology skills, especially, Foundation students. Digital technology skills are basic operating skills such as turning on iPads, and making them work and using applications to complete a learning task. The learning activities and pedagogical practices associated with developing basic operating skills and understandings of digital technologies were grouped into the I-Ready theme referred to experiencing in the Learning by Design framework. This was done because developing operational skills is associated with students' prior knowledge from experiences with digital technologies at home, as well as their new experience of exploring new digital devices and resources at school. Two sub-themes, "learning operational skills" and "learning to use digital technologies safely and appropriately", were included to further explain the students' learning with digital devices, as well as teachers' pedagogical choices in terms of implementing digital technologies.

The I-Practise theme refers to learning activities that involve the use of digital technologies for drill and practice, independent learning and documenting. It was named because the interviewed teachers mentioned the word "practise" frequently. Moreover, learning activities that were grouped in the I-Practise theme were focused on games and repetitive digital tasks for practising students' literacy and numeracy skills such as spelling, phonic awareness and calculating, similar to drill and practice. These types of digital technology mediated learning activities were designed to support students to understand the meaning of terms and concepts and to generalise concepts and theories through drill and practice, which come under the knowledge process of conceptualising in the Learning by Design framework. The sub-themes of "using digital technologies for drill and practice", "Learning independently with digital technologies" and "using digital technologies for documenting" were grouped under this theme.

The last I-Create theme relates to productive and creative learning practices such as designing and creating meaningful digital products and multimodal texts (e.g., eBooks, ePosters, or digital stories) utilising literacy skills, numeracy skills, and digital operational skills with appropriate tools and resources. The sub-theme of "creating digital products" was grouped in the theme of I-Create reflecting the dimension of knowledge process as analysing and applying, where the students were encouraged to apply their learned knowledge to different contexts.

Table 5 illustrates the knowledge process in the theoretical framework and how the three main themes related to this process.

Learning by Design	Three Themes
Experiencing new knowledge based on prior knowledge and experiences.	**I-Ready**: students learn to use various digital devices and applications.
Conceptualising new terms, understanding concepts and theorising.	**I-Practice**: Using digital technologies for learning purposes.
Analysing social and cultural contexts and elevating their own works. **Applying** learnt knowledge to solve new problems in a new context creatively and appropriately	**I-Create**: Applying digital technologies skills and knowledge into new learning areas and produce new digital creations

Table 5 The relationship between the main themes and sub-themes

The Learning by Design framework guided the coding of teaching practices and learning behaviours to illustrate the pedagogical practices underpinning the implementation of digital technologies for supporting young students' learning. The framework acted as a heuristic: providing opportunities for the researcher to ask more questions reflecting about whether the students' were encouraged to move from the knowledge process through the dimensions of experiencing, conceptualising, analysing and applying and in what way teachers designed digital technology mediated learning activities to support young students' learning in these four dimensions (Kalantzis & Cope, 2005).

3.8 Trustworthiness

A key feature of the case study approach is that a range of methods can be combined to investigate different perspectives and/or minimise the limitations of a single data collection technique (Denzin & Lincoln, 2011; Johansson, 2003; Yin, 2013). As described already, multiple data collection approaches from multiple sources were used in this investigation (e.g., teacher interviews, observation, and collection of students' artefacts) to ensure the trustworthiness. According to Cohen et al. (2013), triangulation can be used as a validity measurement method because it has the ability to reduce the subjectivity of the data and limitations of a single format. In this way, multiple data collection approaches in case studies increase credibility and acknowledge participants', and perhaps, any researchers' influence during the process of data collection by collating a variety of experiences and stories (Yin, 2011).

Case study research has some shortcomings, such as limited ability to make generalisations from a single subject (Yin, 2013). For example, the digital technology mediated learning activities documented in this study may be unique to the children in a particular primary school in which the researcher has conducted the study, and may not apply to others. According to Stake (2013), case study is not designed for the purpose of representing universal theories or concepts, because the findings are only valid in a specific context, and furthermore may provide “equivocal evidence” which may impact the final presentation of the finding and conclusions (Yin, 2009).

3.9 Ethical Considerations

Ethics approval was granted by the Victoria University Human Research Ethics Committee (the application number of HRE16-163), and the Victorian Department of Education and Training (DET) before conducting the research because the investigation involved a government school. Permission was sought directly from parents and teachers, as well as the children, because the research was considered a high-risk investigation due to involving the observation of young children aged under 16 years in school settings.

After the ethics application was approved for this study, I contacted the school and potential teachers to explain the brief information about the research project. The school principal, assistant principal, potential teachers from Foundation Year to Year One/Two and other potential participants who might participate teaching activities in these Year levels (e.g., IT staffs, specialist teachers and PE teachers) were asked to express their interest in participating in the project through the face-to-face discussions as well as emails. All the participants were given printed details about the nature of research and possible implications to ensure they were informed consent, including the children, in line with Thomson's (2009) view that children’s permissions should be sought like any other adult participants. Participation in the investigation was voluntary, and a reason for refusal was not required. All participants had an opportunity to ask questions about the research, before signing the consent forms. The teachers explained the research and the role of the researcher in the classroom briefly, in plain language, to the young children the major subjects of data collection. This helped students understand their roles and responsibilities in the research process. The children were informed that they had the right to withdraw from the classroom observation at any time. Any data related to the participant who decided withdrawing from my study will be deleted.

The identity of all the participants, including the school, is protected in the reporting of the results of this study through the use of pseudonyms to ensure anonymity and confidentiality. Any non-consent children were excluded during the data collection stage. In addition, the data is stored securely and carefully according to university policy, with access only to the researcher and research supervisors.

The ethical considerations may impact on the data collection, because some children and their parents did not grant their consent to participate in the project. Any non-consent children was excluded during the data collection stage. Any data related to the participant who decided withdrawing from my study was deleted. Removing usable and unique sets of data of these non-consent children may affect the final report, because the valuable amount of information is reduced.

3.10 Limitations of the Study

The findings of this research are important and have the potential to inform the development of educational policy, practice, and theory. However, the results cannot be easily generalised from the data, and research finding would not be derived due to the following reasons. The research only included participants from one school, although different grades and learning communities were involved in data collection (Foundation, Year One/Two learning communities). In addition, there are limitations related to the participant sample used since unequal numbers of students from Foundation year and Year One/Two took part in this research. More digital technology mediated learning activities from Year One/Two may be recorded compared to the learning activities in Foundation Year learning communities in general. However, this limitation could be removed by using multiple sites instead of one school, and the same classes from each grade if possible.

In addition, due to time constraints and the need to maintain the manageability of the research data, the small-scale designed single case study was conducted. Such research design with a limited period of time and small scope of participants did not allow the researcher to investigate the impact of digital technologies across all year levels in primary schools, or conduct a longitudinal study on the impact on young students' learning.

The observation sessions were always arranged in the morning on particular days (Wednesday or Thursday) in the week, so the observed lessons may not have been typical, and some key learning sessions may have been missed, thus my research may not have generated a full or representative picture of the projects or unit learning designs. This might have influenced the authenticity of the results.

Finally, the participant children in the case study classrooms were aged 5 to 8 years old. I did not include younger children in the early childcare settings whose ages were under 5, and thus could not provide a complete picture of young children's use of digital technologies in early childhood settings in Australia. Moreover, the children's experiences with digital technologies from off school settings (e.g., their home or community) were not included in the data collection. Therefore, interviewing parents on their children's use of digital technologies, observing children's informal use of them, or extending classroom observation to a longer period may be helpful for the researcher to catch a fuller picture of using of digital technologies in primary school and gain a deeper understanding of young people's everyday activities related to digital technologies.

3.11 Chapter Summary

This chapter provides an account of the methodological approach utilised in my investigation. The research was located within a constructivist paradigm. I employed a qualitative case study approach to investigate the implementation of digital technologies in a primary school from the western metropolitan region of Melbourne. Data about teacher perspectives and pedagogical practices collected through interviews and classroom observation in Foundation and Year One/Two classes was analysed alongside information about student classroom behaviours and artefacts collected during four terms over 2016 to 2017. Ethics permission from the University and the Victorian Education Department was obtained, and pseudonyms were used to ensure privacy and confidentiality. The Learning by Design theoretical framework of Kalantzis & Cope (2005) was used as a lens to analyse the observation data into different themes, using NVivo. The next three chapters provide detailed results related of the themes that address my main research questions: I-Ready, I-Practise, and I-Create.

CHAPTER 4

I-Ready

This chapter describes the findings connected to the I-Ready theme. They were generated from three data sources: interviews with Foundation Year teachers (two classroom teachers and one specialist teacher), classroom observations (a Foundation Year learning community involving three participants teachers) and work samples of students from one Foundation learning community. The semi-structured interviews with Foundation Year teachers focused on their pedagogical understanding and approaches in using digital technologies to equip their students with basic operational skills such as identifying icons, logging in to Seesaw and AirPlaying iPads in their daily teaching practices. The observational data is presented through learning stories which are observation and documentation of children's learning that is written in a narrative story format with adults' interpretations (Carr & Lee, 2012). My analysis of students' learning stories illustrates how Foundation Year students interact with the various digital tools and resources in the I-Ready theme.

Learning stories from the I-Ready theme are presented to show how teachers and students interacted with digital technologies, especially iPads and educational applications. The learning activities in the I-Ready theme mainly involve young students in the dimension of experiencing from the Learning by Design framework. This dimension articulates the aim of introducing students and immersing them in the new functions and features of iPads and applications, with consideration of drawing on their prior knowledge of and experience with digital technologies (Cope & Kalantzis, 2015).

Digital technology-mediated learning activities in the I-Ready theme allow young students to experience the various operational functions and features of iPads, to become familiar with applications such as Seesaw and Literacy Planet and digital resources such as YouTube videos and QR codes, and use iPads safely (e.g., hold them with both hands, put them away after use, and use them for learning purposes). In summary, the I-Ready theme facilitates the development of students' digital operational skills and acquisition of knowledge about using iPads and digital resources safely and appropriately. Table 6 below presents the three main categorises of digital technology-mediated learning activities in relation to the Learning by Design framework with the I-Ready theme highlighted.

I-Ready	I-Practice	I- Create
Experiencing: Developing operational skills and awareness of using digital technology appropriately and safely.	**Conceptualising:** Developing an understanding of terms, theories and concepts and practising skills with digital technology.	**Analysing & Applying:** Applying digital technology skills and knowledge into new learning areas and producing new digital creations.

Table 6 The I-Ready theme within the Learning by Design framework (Cope & Kalantzis, 2015)

In order to provide a comprehensive picture of the use of digital technologies in the I-Ready theme, in this chapter, I present teachers' pedagogical choices and students' interactions with digital technology in the form of learning stories analysed through the Learning by Design framework.

4.1 Defining I-Ready

As noted in chapter 3, the term "I-Ready" was developed from analysis of the Foundation Year teachers' interviews. It emphasised that they needed to prepare their students to be ready to use iPads and applications successfully and appropriately in their first year of schooling. These Foundation Year teachers designed learning activities that encouraged the students to explore and experience digital drawing, uploading and photography functions on the Seesaw interface which involved their students in the experiencing dimension (see Appendix H). “Experiencing” in the Learning by Design framework refers to immersing the students in new knowledge and experiencing new features and functions of iPads and applications such as Seesaw, Literacy Planet and the AirPlay function. For instance, the Foundation Year teachers attempted to explain and model the functions and features to show young students how the Airplay function or Seesaw work. “Experiencing” also refers to recruiting students’ prior knowledge and experiences with digital technologies at home and making a connection between prior knowledge experiences to learn new features and functions of iPads and applications in school.

The learning practices in the I-Ready theme were frequently observed in the Foundation Year learning community from West Primary School. However, in the observed Year One/Two learning communities, I-Ready practices took place when new digital devices, new applications or new iPads’ functions were introduced to the class for preparing students with basic operational skills.

I will now focus on the teachers’ reflections on their implementation strategies of digital technologies with young students. Interpretation of and discussion about the I-Ready practices follow each learning story.

4.2 Learning Stories in the I-Ready Theme

This section illustrates how digital technologies were implemented in the first year of school. It presents an analysis of learning stories and data from the teachers' interviews about equipping students with basic operational skills, developing students' awareness of using iPads appropriately and promoting collaboration.

4.2.1 Implementing Digital Technologies for Developing Digital Operational Skills

According to the classroom observations as well as the interview data, at first, schooling digital technologies were mainly implemented for building up young students' digital skills, including how to operate iPads, Seesaw and managing online portfolios. Foundation Year teachers considered building young students' basic digital operational skills to be an important strategy in the successful implementation of digital technologies. Foundation Year teachers reported that Foundation Year students needed to learn digital operational skills before they could use iPads and educational applications successfully for complex learning tasks such as creating multimodal texts. This was because the teachers considered that young students' use of digital technologies was based on their cognitive development level (Chaudron et al., 2015; Plowman & McPake, 2013). This accords with Piaget's (1994) contention that most young students from aged 2–7 are in the pre-operational stage, meaning they find it difficult to understand complex and abstract thoughts and ideas. Moreover, a recent study conducted by Chaudron et al.

(2015), reported that children's critical thinking, reading, and writing, problem-solving and creative skills are still developing, and that this "bound" their way of using digital technologies.

Learning to use iPads to take photos

The following learning activity of using iPads to take high-quality photos was recorded in Kelly's (the art teacher) class during Term 2 in the school year 2016 in the Foundation Year learning community.

Teachers' pedagogical practices	Students' learning practices
Kelly held an iPad and asked the students to share their experience of taking photos on iPads by posing many questions, then she showed the correct way to take a good quality photo. She explained, "*You need to hold the iPad firmly, and make sure the item you are going to take is in the centre of the screen."* She demonstrated how to hold the iPad firmly and angled the iPad to have the item in the middle of the screen. She said:	Two girls (Emily & Ava) worked collaboratively. They first decided to use the sky as the background. Then, Ava held her artefact (paper smashed fish) up, and Emily held the iPad with both hands. Emily: "*Are you ready*?" Ava: "*Yes, I am trying to get the fish in the middle of the screen.*" Emily: "*Then, I will hold it. Remember, do not take the sun in, we just want the sky colour as the background.*"

"*Tapping on the camera button, and hold the iPad for three seconds, like counting one, two, three, and then you can move your iPads and go back to see the picture. Do not move your hands after tapping the camera button, as iPads need time to process camera function to give you a clear picture, that's why we count up to three.*" She then asked the students to take their iPads and go outside to take photos of their artefact.	Ava angled the iPad a few times and then tapped the camera button, and held the iPad still while counting up to three. Emily kept holding up the fish until Ava said she had finished taking the photo. Both girls had looked at the taken photo and then showed it to their teacher.

The observational data collected in the art class showed strong evidence that Foundation Year students' digital skills in operating an iPad as a camera were practised: they acquired skills in operating the iPads to take a clear photo. Ava followed her teachers' instructions centring the item in the screen and holding the iPad for three minutes after pressing the action button. Their photo had the paper fish that they had made from previous class in the middle of the screen. This learning activity showed the evidence that after following their teacher's instructions and modelling on how to use the camera function on the iPad, Ava developed digital operational skills including identifying the camera icon and focusing the item while taking photos.

Kelly, the art teacher, considered it was important to teach first-year students digital operation skills like taking photos, because she found that her students' photos were often blurred and unfocused due to poor photo taking skills. She said, "*Learning to use the camera function on an iPad will help them to think about how to take good pictures".* Therefore, Kelly used an explicit teaching approach to deliver clear and logical instructions and descriptions along with physical modelling such as holding the iPad with both hands, pointing to the camera icon and pressing the action button to take the photo. Kelly applied a direct instruction approach providing explicit information on the procedure of taking high-quality photos which involved the students in "experiencing" the new knowledge of using the iPad appropriately. Both teacher's interview data and students' observational data indicated that young students need time, explicit instructions and scaffolding to learn how to operate digital devices and applications in school settings.

In addition, Kelly invited the students to share their known knowledge about iPads photography. Recruiting students' prior knowledge and experiences of taking random photos to the learning activity of taking good-quality photos made necessary connections between their lifeworld and the classroom, again involving the students in the dimension of "experiencing" from the Learning by Design framework (Cope & Kalantzis, 2015). Kelly showed that she considered the students' home experiences with digital technologies as important prior knowledge to be included in her class. She acknowledged that young children gain rich experience with digital technologies before they start school, and reported most of her students had more knowledge about digital technology than she did. Kelly said:

> *They know much more than me about iPads like they know where to get apps, where to search YouTube, and how to take pictures on iPads ……Certainly, they are practising these iPad skills at home. They even taught me how to use a particular app called iMovie. We should use these skills for their learning.*

Kelly's comments indicated that she utilised her students' prior knowledge and experience about digital technologies pedagogically and shared it with other students for more effective art learning. For example, Kelly invited one of her students to teach the class how to operate the application called iMovie.

Acknowledging students' digital abilities and valuing their prior knowledge about digital technologies indicates that the participating teachers' pedagogical approaches were aligned with constructivist perspectives towards teaching and learning. Building up students' digital operational skills based on their prior knowledge and experience of iPads like taking pictures and operating iMovie in hands-on learning activities might be effective teaching strategies for implementing digital technologies in the I-Ready theme. Previous research shows that students learn better when their needs, interests and prior knowledge are valued and emphasised (Wen, Hui, & Kay, 2011).

Learning to use Seesaw

This learning story was recorded in the third Term in 2016 in the morning session in Jessica's class. In this numeracy learning activity, the students were asked to take photos of their 100 counters and then upload them into their Seesaw account.

Teachers' pedagogical practices	Students' learning practices
Jessica showed the QR code to the class and explained: "*We need to scan the code to log in to our Seesaw*". She borrowed one iPad from her student and modelled the procedure of logging in the Seesaw account. *"……so this is the Scan App; open the App, and take a picture of the code, the App will automatically read the code and bring you into your Seesaw account."* Then she showed the students the interface inside the Seesaw App and tapped different	Mia, firstly, counted the 100 counters and then arranged it into the heart shape. When the teachers reminded the class to take a photo of their work with the iPad, Mia turned on the iPad by pressing the home button. She could not log in to her Seesaw account, so she sought my help, because the teacher was occupied with other students. I pointed to the QR code beside the Smart TV and said: "*You need to scan the QR code*." She did this and logged into her Seesaw account. She used the camera function from the Seesaw interface to take

icons to show their functions on the interface. "……*for example, if we want to take pictures…. umm… tap on the camera icon*", she said and pressed on the camera icon. "*Now, we can take a picture just like using iPad camera function*." She then showed quickly how to upload the photo into a Seesaw account. "Y*ou are going to count a hundred counters, and then take the picture of your 100 counter and then upload it to your Seesaw account. Does everyone understand that?*"	the photo of her heart shaped 100 counters. She found it was quite hard to take the picture through Seesaw, because the camera stopped processing the shooting function when she moved the iPad. Then she quit using the iPad, but continued to play with the counters on the floor.

The Seesaw application is a social and online archiving program that allows different parties to access, share and document digital materials and resources on an internet-enabled online platform (see Appendix H), and was used through Foundation Year to Year Six in the case study school. The application allows each student to create their own account and establish their digital portfolio by uploading their work and learning materials created during the class. The application also provides multimedia tools such as a video recorder, eBook designer, digital drawing tools and cameras. These multimedia tools allow students to create innovative digital products and publish their multimodal tasks online.

Seesaw is complex for young students to use and does require time to be learned, practised and to be mastered. Jessica the Foundation Year teacher said, *"Preps still found it was hard to use educational Apps such as Seesaw, and sometimes they failed to use iPads in appropriate ways".* She further explained that she found it difficult to implement digital technologies in the Foundation year for extending students' learning such as using iPads for producing multimodal texts, because she had to help her students to use Seesaw and iPads operationally first:

> *With Prep students, you do not really do that much with ICT stuff for learning. I am only teaching them how to use iPads and Seesaw. With Preps, it is just hard because they are still developing an understanding of digital technologies.*

Amanda, another Foundation Year teacher, reported that she had spent a whole year on getting students to learn and use this new application in Foundation Year in her interview.

> *I found it is really tricky with Preps with regards to including ICT, especially, at the beginning of the year. My students struggle with iPads and Seesaw. And they do not know how to use these school apps.*

Amanda further suggested, *"Teachers need to consider their students' digital abilities while implementing digital technologies and to design simple and easy digital tasks based on students' digital abilities."* These comments indicate that the students' cognitive development stages need to be considered, because they might affect the students' abilities in using iPads and educational applications in early primary school settings. She asserted that young children would eventually achieve the goal of using digital technologies as learning tools to produce creative and high-quality digital works only after being equipped with basic digital operational skills.

Foundation Year teachers acknowledged that the first-year students were very dependent on adults' assistance using iPads, because they were still developing digital operational skills and digital competence and needed consistent adults' support and scaffolding when they performed digital tasks. The observation data also showed that young students found it difficult to use complex programs like Seesaw, in line with previous research reporting that young children were not digital natives (Thomas, 2011), who could use various digital devices and resources intuitively (Prensky, 2001). As noted earlier, their digital skills and competencies are closely related to their cognitive development stages (Chaudron et al., 2015). Therefore, according to the Foundation Year teachers' interview data, it was important to teach Foundation Year students digital skills and knowledge on how to operate applications correctly for them to be ready for more complex and productive digital technology mediated learning activities in themes of I-Practise and I-Create.

To ensure Foundation Year students learned how to use Seesaw for uploading digital images, Jessica the Foundation Year teacher provided clear and explicit instructions about how to upload pictures in Seesaw including oral instructions and physical modelling. After assigning the task, she tried her best to engage the students in a digital task of uploading the images by providing one-on-one support while she walked around the class. However, there were still some students who found it difficult to use the camera and the uploading functions on Seesaw and sought Jessica's assistance. For instance, as noted earlier, Mia could not remember to scan the QR code for logging into Seesaw, or the procedures of uploading photographs to her teacher's folder. I observed Jessica busily helping these students to set up the camera on iPads, log into the Seesaw, and help students to hold their iPads firmly (a functional requirement for high-quality photographs). The observational data indicated that young students needed capable peers and adults consistently supporting them to develop digital operational skills and to improve their abilities. This finding echoed Ching-Ting et al.'s (2014) argument that adults' scaffolding and consistent support are considered as an important aspect to enable students to effectively interact with digital technologies in early childhood and primary school settings.

The overall engagement with iPads was reasonably high in this learning activity of uploading the photo on Seesaw. The observational data show that young students were interested in using iPads generally for taking photos, however, they also showed that the engagement level might relate to young students' digital skills. Some Foundation Year students lost interest in using the iPads when they failed to operate Seesaw to upload their photos of the counters. For instance, Mia discontinued the digital task when she could not log into Seesaw, and continued playing with the counters on the floor. Mia's observational data indicated that some young students might show low engagement in digital mediated learning activities due to their poor operational skills. This indicates that the development of young students' digital operational skills is important for promoting engagement and motivation towards the task including iPads.

In summary, Foundation Year students need time to play with and experience different features and functions of iPads to develop their skills of operating Seesaw. A high level of teacher scaffolding and support was required during young students' interaction with iPads and other types of digital devices to ensure their success in using Seesaw. In addition, developing young students' digital operational skills might increase students' engagement towards learning when iPad and educational applications were included.

Learning to use the AirPlay function

According to Amanda, it was important to teach Foundation Year students how to connect their iPads to other digital devices, because "*they are going to use AirPlay skills quite a lot when they move to Year One/Two, so we need to get them ready with this skill.*" Mirroring the iPad's screen to other displaying devices was performed frequently for sharing students' digital artefacts with the whole class. This learning story describes a learning activity in Amanda's class (Foundation learning community) during Term 4 in 2016.

Teachers' pedagogical practices	Students' learning practices
Amanda borrowed an iPad from a student and held it up to the class to show where to find the AirPlay button, and gave oral instructions. *She said: "…just slide up from the bottom of the iPad's screen. You will see the hidden menus. It will pop up like this. AirPlay is on this menu looking like a small screen. Can everyone see it?"* After pressing the AirPlay icon, a list appeared up, and Amanda scrolled up and down explained: "*This is a list of names of digital devices from different classrooms. What is the name of our classroom?*" Amanda pointed to a student who gave the answer "*Monkey*".	There was only time for two students to practise the skills in this learning activity during the lesson. One student (James) was asked to mirror the iPad screen to Apple TV. James stood up and held his iPad with both hands. He tapped on the bottom edge of the iPad's screen to bring up the hidden menu. He found AirPlay and tapped on it. When the list of device names popped up, he became confused and asked Amanda which one to select. The students (sitting on the floor) helped him by yelling: "*The Monkey one!*" James quickly scrolled through the list and found the correct name of the device and tapped on it.

"*All right, so I am going to choose Monkey*", said Amanda. The students all cheered when they saw the iPad's screen brought up on the Apple TV. "*And we do exactly the same to disconnect it from the iPad.*" Amanda then brought up the hidden list and tapped on the AirPlay icon to disconnect the iPad from Apple TV.	He then followed the same procedure to disconnect his iPad from the classroom's Apple TV.

Amanda taught the procedure of mirroring her iPad's screen to the classroom's Smart TV using the AirPlay function which scaffolded the Foundation Year students to gain knowledge of AirPlay through oral language and visual images on smart TVs. Amanda reported that she found it challenging to fully unpack the potential of digital technologies or supporting students' literacy and numeracy learning when the teaching intention was on equipping young students with basic digital operational skills. "*It is not very productive. And are not used for learning very much. That is really challenging in a Prep class."* Amanda said. She further explained:

> *……so at the beginning of the year, my students would not solve any technical problems such as Wi-Fi connection and AirPlaying. After assigning the task, I had half of the class lined up for me to fix their iPads. I felt I was just helping them fix the iPads instead of using iPads for learning.*

When teaching the Airplay function of iPads, Amanda applied teacher-centred and teacher-led pedagogical approaches. This was apparent in both her interview data and my observations: Amanda chose to provide direct instruction as she knew that many students might have difficulty in using Airplay function. So she took away students' agency by doing the task for them. The majority of students were (unavoidably) not given an opportunity to engage in hands-on learning activities to experience the new AirPlay function (see Figure 5), acting as information receivers. It was difficult to tell if these students had learned the skill of AirPlaying their iPad screen and could perform it on their iPads independently. Amanda reflected in her second-round interview that if the time allowed, she could have all students experience the AirPlay function through a hands-on learning activity to develop a better understanding of how to use it. My data suggests that those students need instructions as well as hands-on activities to develop operational skills in the I-Ready theme.

Figure 5 The picture of students mirroring their iPads to the Smart TV

The interview and observational data indicate that equipping students with basic digital skills, especially the students from early childhood to early primary school settings, is an important strategy to ensure young students can use digital devices and programs successfully and independently for their learning. The teachers of the Year One/Two learning communities confirmed that it was important and necessary to teach digital operational skills with young students, because then they were able to implement digital technologies in more effective and productive ways. Rose and Kate the Year One/Two teachers noticed that their students who had well-developed digital skills and understanding by the time they had entered Year One/Two could use iPads and applications in more productive ways, such as creating eBooks and digital stories, reducing the time to teach and instruct their classes on how to use iPads and applications. Kate explained that Year One/Two students who had obtained basic digital skills from their Foundation year learning and home practices. She said:

> *I think the Preps have done that. So, in Year One/Two, I do not even spend more than five minutes on instructing how to use iPads and Apps, I just show them how to do the task on iPads quickly… They just get it, because they have learned it in Prep years, and also used it at home. So, I feel like they have got a lot of knowledge about ICT from the Prep years. I can engage my students in more creative learning activities, such as making eBooks or PPT (PowerPoint). We can have lots of fun stuff with iPads*

Kate's comments confirm that well-developed digital skills in Year One/Two students ensure the effective implementation of digital technologies in an early primary school setting because she believed that young students can quickly overcome technical difficulties and use digital technologies for new knowledge creation. The comments from the Year One/Two teachers confirm that young students need time and adult scaffolding for developing better operational skills before they can apply these digital skills in their learning. This represents a formed rationale for teachers to design I-Ready learning activities to ensure the students learn and develop basic digital operational skills first in their learning journey.

To conclude this section, teaching students how iPads and applications work and how to use them through learning activities in the I-Ready theme is considered as important for equipping young students with basic digital operational skills. This is because young students are still developing their digital skills in their first year of schooling, and they still need intensive adult instructions and scaffolding to master iPads and applications for their future learning (using iPads and applications for drill and practice, documenting teachers’ notes on Seesaw and creating multimodal texts).

4.2.2 Implementing Digital Technologies for Developing Awareness of “Using iPads Appropriately”

In the case study school, educating students to use digital technologies appropriately and safely was considered an important teaching point for ensuring the students’ interaction with digital technologies in early childhood to primary school sectors. Teachers educate young students to use iPads appropriately and safely, including how to physically hold and manipulate their iPads, and worked to develop their understanding of the concept of using iPads for learning through group discussion and hands-on activities. It has been argued that students should learn how to use digital devices with appropriate etiquette, including maintaining digital devices within good condition and operating digital devices with the correct gestures. (Mishna, Cook, Saini, Wu, & MacFadden, 2011). The Victorian Government (2019) also listed the responsible use of digital technologies as an important teaching aspect of implementing digital technology in the school system.

Teachers’ pedagogical practices	Students’ learning practices
Amanda asked the students what the rules were in regard to using iPads in the classroom. One student put up a hand and answered: “*Use both hands to hold the iPad!*” Jessica praised the student and asked if anyone remembered any other rules that they had discussed before. They listed few points, such as “*Do not play with iPads while walking”*; “*Charge iPads when you get home”*; “*Do not leave the iPads on the floor when we move to the next activity”*; and “A*lways keep the protection cover on”*. Amanda wrote down these suggestions on the board and said she was going to take photos of students who demonstrated these good behaviours using iPads during the independent reading session.	The students practised rules and principles of handling iPads in a safe manner when they did literacy activities with iPads during an independent reading session. Jack held his iPad with both hands when he brought it into the classroom. He sat down with crossed legs and started to select eBooks he wanted to read. When he finished reading, he put his iPad back in his bag.

This learning story was recorded from Amanda's Foundation Year learning community in Term 3, 2016. Amanda organised a group discussion and a hands-on learning activity to engage the students in experiencing iPad safety rules and principles (see Figure 6). She applied inquiry teaching strategies to bring students' prior knowledge to the class, posing various open-ended questions about types of behaviour associated with using digital technologies and if they were appropriate or inappropriate in a school context. In this way, the students were engaged in the dimension of "experiencing" by sharing their prior knowledge and experience of rules of using iPads at home.

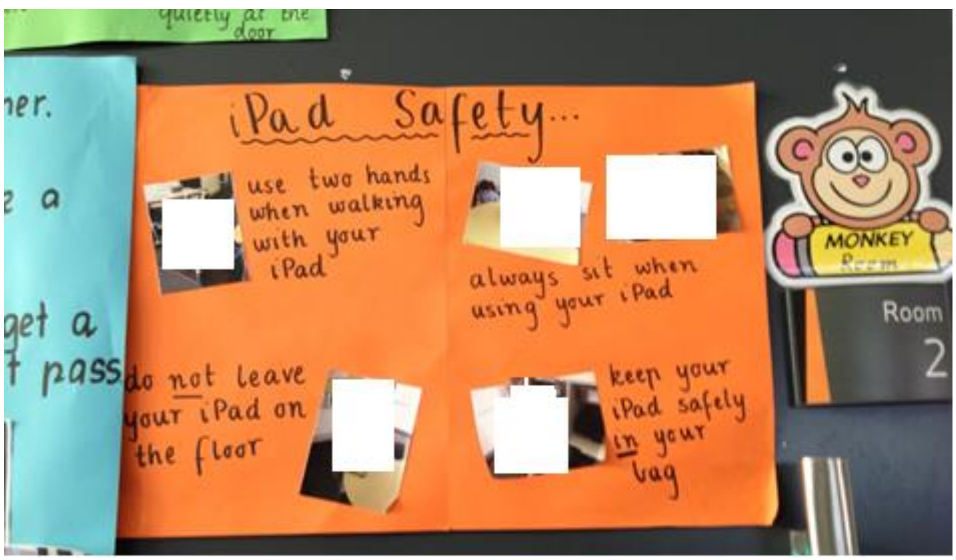


Figure 6 The iPad safety poster

From this activity, Amanda's students developed an understanding of holding iPads safely, maintaining their iPads in good condition, and using iPads for learning in the school context. Using iPads in safe and appropriate ways required young students to develop and apply their gross motor skills like the way they develop perceptual-motor skills including controlling hands and fingers to hold a pen appropriately for writing. According to VEYLDF (State Government of Victoria, 2009), children from birth to eight years do continually acquire, refine and consolidate their motor functions and skills. The observed Foundation Year students were still in an early stage of muscle growth and muscle development, and many found it difficult to manipulate digital devices with a single hand. Therefore, it is important to develop young students' motor skills in operating iPads in safe and appropriate ways. Teaching Foundation Year students to hold iPads with both hands while walking and taking a photo and sitting down with both hands to operate iPads allowed them to devote more strength in manipulating digital equipment.

Amanda noticed that young students had difficulties in managing iPads physically because their motor skills--such as pincer and grip movement--were still developing, and there was a need to teach them to avoid dropping and smashing their equipment. She said, "*For younger kids, iPads are still heavy. And it is so easy for them to be broken, like dropping or smashing if the kids are not told to look after their iPads carefully*." Teaching young students to operate their iPads in safe ways ensured their full access to the functions of these digital devices during class time—an important factor for the full implementation of digital technologies. It has been claimed that learning can be extended when students have full access to digital devices, because they can use digital tools and resources to investigate learning tasks and to carry out deep learning tasks (Fullan & Langworthy, 2014). Accordingly, Amanda explained that she spent nearly a whole term teaching Foundation Year students to use iPads and applications in safe and appropriate ways. *"We introduced the iPads from Prep year. It is just about how to use iPads safely. Even in the second term, it is more just getting iPads out and practising keeping them safe and stuff like that,"* she said.

Furthermore, Kate from Year One/Two explained,

> *So, I feel like they have got a lot of knowledge about ICT from the Prep years. So, I can engage my students into more creative learning activities, such as making e-books or PPT. We can have lots of fun stuff with iPads.*

Teaching young students to operate iPads appropriately and safely through discussing and experiencing rules and principles of using iPads at school contexts improved their use of iPads for more complex and cognitive related learning tasks.

Alongside developing young students' motor skills on operating iPads safely and appropriately, the Foundation Year teachers emphasised that they taught them the concept of "using iPads for learning" which meant that the focus should always be on educational applications in the school context. Foundation Year teachers indicated that educating students to use their iPads appropriately and safely was important for preparing the students to use digital technologies in productive and creative ways. This teaching approach ensured young students' appropriate interactions with iPads and applications, preventing digital technology related misbehaviours. Jessica, the Foundation Year teacher, commented that young students might wish to use iPads for entertainment purposes such as playing games or watching videos; therefore, she designed a learning session in which she and the students discussed appropriate behaviours for using iPads in class. "*We need to get them to know that they are using iPads for learning, not for playing games in the class. It works well as fewer off-task behaviours are captured in my class*," said Jessica. The above comments showed Jessica considered developing students' understanding of the concept of "using iPad for learning" as an important teaching point for implementing digital technologies in her class. I expected that there would be many cases of iPads related misbehaviours during the observation time. However, there were only four cases of students using iPads for playing games without teachers' permissions recorded. Both observation and interview data showed that reinforcing awareness of the principle of "using iPads for learning" might have close relationship in reducing the iPads related misbehaviours.

The Year One/Two teachers confirmed that teaching students to use iPads safely and appropriately ensured the full and effective implementation of digital technologies in the class as less time would be spent on managing the classroom for digital technologies related misbehaviours. They reported that they rarely observed iPad-related misbehaviours, because most Year One/Two students had developed a sound understanding that iPads were for learning purposes. Kate, the Year One/Two teacher, mentioned that her students "*were always on the task*". And she suggested that it was because *"they were taught to do so when they were in Prep*." Lauren, the Year One/Two teacher, also explained that "*the students have been taught well on using iPads with* *appropriate etiquette, especially using them for learning purposes in Prep*." These comments indicated that the participating teachers considered that fostering an awareness of using iPads in appropriate and safe ways was an important teaching goal in the process of implementing digital technologies in early childhood to early primary school settings. Therefore, when implementing digital technologies, it is important to include iPads' safety education.

In summary, my observations of both Foundation Year and Year One/Two learning communities revealed no physical damage to the iPads and no more than four occasions of off-task behaviours indicating that a positive impact of iPad safety education on students' use of technologies. Young students had continuous access to their iPads and interacted with them mainly for learning purposes. These learning activities prepared young students to be ready to use digital technologies and resources successfully for further learning.

4.2.3 Implementing Digital Technologies for Collaboration

"Pairing up", which means students working together and sharing their iPads with their peers, is common in Foundation Year learning communities. In the case study school, some Foundation Year students did not have full access to iPads for many reasons, such as the parents did not purchase an iPad for their children, the students forgot to bring their iPads to school, or they forgot to charge their iPads. Therefore, Foundation Year teachers used a pairing up approach with the aim of supporting young students with less experience with iPads (normally those who did not own an iPad) and applications to develop operational skills and competency with capable peers' (the iPads students) assistance.

Teachers' pedagogical practices	Students' learning practices
Amanda instructed the students to bring their iPads out and then explained that they were going to use Literacy Planet to explore and navigate eBooks and literacy games. She then asked the group of students who did not have iPads to stand up, and paired those without iPads with the students who had them. .	Two girls sat together with a shared iPad. Zoey who owned the iPad showed Lily which icon to press to enter Literacy Planet. Zoey suggested reading E-books from Literacy Planet and demonstrated to Lily where to find the digital index on the Literacy Planet interface. Zoey then handed the iPad to her and helped Lily to bring up the reading list by pressing letters from the index menu. "*You can tap on the book cover that you want to read,*" Zoey explained. Lily then pressed the icon that showed duck images on the book cover. Lily was impressed when the iPad presented the eBook and read it to them.

This learning story was recorded in a morning session in Term 4, 2016 in Amanda's Foundation Year class. Two classes from different Foundation learning communities were combined for this learning activity.

Amanda used the approach of pairing up in this learning activity to ensure all the students gain access to iPads and opportunities to experience the features and functions of Literacy Planet. The approach of paring up promoted collaboration between young students when they were interacting with iPads, allowing students with rich digital experience to share their knowledge of and skills in using iPads and Literary Planet with others. Applying the approach of pairing up to support young students to develop digital operational skills with the assistance of capable peers indicated that Amanda had attached great importance to the role of collaborative learning in young students' learning with and through the use of the iPads. According to Evans and Moore (2013), digital technologies should be used to improve the interactions between students, as peer tutoring and scaffolding have a positive impact on facilitating students to solve technical problems effectively and achieve better learning outcomes.

My observation shows that the observed Foundation Year students benefited from using iPads in pairs. Zoey and Lily developed better digital operational skills through the process of one teaching the other how to log into the application and finding an eBook to read. Zoey taught Lily how to use iPads and applications by giving Lily advice and instructions on how to enter in the application, access the menu and find an eBook on Literacy Planet and modelled the procedures by tapping and dragging icons on her iPads. The observation data showed that Lily developed her operational skills with the help of a capable peer.

Amanda reported that she always attempted to pair the students with iPads up with none-iPads students to maximise access to iPads reading or independent learning activities to develop their digital operational skills. She said,

> *I always asked the students who had iPads to work with those students who did not. So that the no iPads students could always get a chance to use iPads and learn from their classmates. They will not miss out on any learning opportunities*.

The above comment indicates that the "pairing up" approach ensured equal access to digital resources, and that students without iPads could learn digital operational skills from their more experienced classmates. The approach promoted peer tutoring which encouraged the students to exchange their learning experiences and help each other to accomplish digital tasks successfully (Niemi & Multisilta, 2016).

Jessica the Foundation Year teacher explained similarly:

> *I like to have them work in pairs, especially when iPads are used, as they can help each other, such as to solve a technical problem, to sort out the spelling and so on. So, many digital issues will be solved by their peers before coming to me.*

Jessica's comments aligned with the findings of research showing that pairing students up had beneficial effects on students' learning with digital technologies (Bahle et al., 2017) because the approach supported them to develop their digital operational skills better with help and support from other capable students. These comments on promoting collaboration while using digital technologies reflected these teachers' constructivist pedagogical belief that learning may occur when students interact with other people and their surroundings (Harel & Papert, 1991; Vygotsky, 1978).

In terms of literacy development, two observed students gained a better understanding of eBooks when they read together with iPads. For example, after selecting an eBook (with ducks on the cover), Lily shared her prior experience and knowledge of farm animals with Zoey, including her experiences on her grandmother's farm and her knowledge about ducks, which elicited further communication between the girls. Discussion of the characters of animals in the book and how they related to Lily's personal life was evidence that she actively responded to the use of images and texts and, understood the meaning of them. In addition, the eBook contained some new vocabulary items, such as "farmyard" and "animal" which Lily found challenging to pronounce. Lily repeated these words, following Zoey's pronunciation, and finally achieved reading the text fluently. Meaningful learning occurred in this learning activity with both Zoey and Lily scaffolding and supporting each other to accomplish the reading task in terms of understanding and responding to the literature and context of the book, building vocabulary, and developing fluency. This learning story is evidence—similar to Niemi and Multisilta's (2016) findings—that digital technologies have the potential for facilitating students' collaborative learning, especially when students share digital devices.

The observed students' digital operational skills (including operating Literacy Planet) and literacy skills (including fluency, vocabulary and reading comprehension) were enhanced through collaborative learning practices with capable peers' supports and scaffolding. This learning activity reinforced young students' digital operational skills and was categorised in the I-Ready theme. In addition, the students were mainly involved in experiencing new and learned knowledge about features and functions of Literacy Planet such as logging into the application, finding an eBook and getting into literacy games.

4.3 Chapter Summary

The observed I-Ready practices and teacher interview data revealed teachers' pedagogical intention to equip young students with basic digital skills and competency. Learning practices and group discussions on using iPads and applications safely and appropriately were also emphasized throughout the Foundation Year and included in the I-Ready theme. The data from the I-Ready theme show that the Foundation Year students needed teachers' explicit instructions, explanation and modelling on learning basic digital operational skills (such as logging into applications, selecting eBooks, and

AirPlaying) so they could use iPads and educational applications such as Seesaw and Literacy Planet successfully. These learning activities were mainly recorded from Foundation Year learning communities.

In terms of the Learning by Design framework, the students were involved in "experiencing" as the teachers attempted to bring in their prior knowledge and experience of iPads such as taking photos and playing games. Moreover, they were encouraged to develop new operational skills such as scanning QR codes, logging into Seesaw, uploading photos and AirPlaying thought experiencing and exploring new features and functions of iPads and applications in hands-on learning activities. The Foundation Year teachers valued the students' prior knowledge and experience with digital technologies at home and attempted to recruit these valuable experiencing in classroom learning by including iPads in their classrooms. They also engaged their students in group discussions and hands-on activities about applying the rules and principles of using and managing iPads and applications in a safe and appropriate way, such as holding iPads with both hands, using school applications, and using iPads for learning.

Participating teachers considered it important teaching students' basic and operational skills to support young students' learning in early childhood settings. This aligns with research showing that young students' digital abilities are associated with their cognitive development, and that their critical thinking, reading, and writing and problem-solving skills are still developing in their first year of schooling (Chaudron et al., 2015).

Foundation Year teachers also considered it important to teach their students to use iPads safely and appropriately. Since educating young students with knowledge of "iPads safety" may foster students' positive attitudes towards using digital technologies and prevent physical damage to equipment and unsanctioned use of them for gaming and video watching. My results show that young students need teachers' instructions and support on how to operate digital devices and applications appropriately to ensures they use iPads and applications successfully in learning.

Finally, the data is strong evidence of the Foundation Year teachers' constructivist pedagogical understanding of implementing digital technologies that assists in promoting classroom collaboration by pairing up students to support their development of operational skills collaboratively. This was because they promoted classroom collaboration by pairing up students to support their development of operational skills collaboratively. The approach of "paring up" encouraged young students to exchange and share their ideas and experiences about using iPads and applications including Seesaw and Literacy Planet. The students benefited from these pairing up learning activities with capable peers' scaffolding. They gained digital operational skills and literacy knowledge that helped them to solve technical issues and expand their vocabularies.

The next chapter presents the learning and pedagogical practices under the I-Practise theme. I describe the feature and issues of learning activities under this theme in a rich and detailed context using narrative learning stories.

CHAPTER 5

I-Practise

In the previous chapter, the discussion related to the I-Ready theme. The teachers' pedagogical practices with respect to using digital technologies reinforced students' digital operational skills and awareness of using digital technologies safely and appropriately. The I-Ready practices reflected the experiencing dimension of the knowledge process in the Learning by Design framework, in which the students were encouraged to experience operating iPads and applications to develop new knowledge.

The chapter illustrates the features and characteristics of the second theme named I-Practise. Evidence and examples are presented in the form of learning stories, incorporating participants' quotes and observations of their behaviours, to provide rich and in-depth accounts of learning and pedagogical practices with iPads and digital resources in an Australian primary school setting. The I-Practise theme was interpreted as implementing digital technologies in the form of drill and practice and documenting activities. Students were mainly involved in the "conceptualizing" dimension of the Learning by Design framework (Cope & Kalantzis, 2015). In line with the school's literacy and numeracy curriculum, students were encouraged to gain explicit knowledge of concepts in numeracy and literacy such as "size", "text feature" and "environment" and skills such as hand-writing and measuring through teachers' explicit instructions and repetitive small tasks (see Table 7).

The I-Practise theme covers three main groups of learning practices that supported young students to gain knowledge and understating of theories, terms, and concepts: literacy learning, numeracy learning and using digital technologies for documenting. Students used iPads and applications for literacy learning (e.g., handwriting, digital reading, practising alphabet and grammar knowledge), numeracy learning (e.g., measuring and comparing), and documenting (e.g., teachers' notes and students' learning evidence). Their learning activities and their teachers' pedagogical practises were analysed and discussed in this chapter.

I-Ready	**I-Practice**	**I- Create**
Experiencing: Developing operational skills and awareness of using digital technology appropriately and safely.	**Conceptualising:** Developing an understanding of terms, theories and concepts and practising skills with digital technology.	**Analysing & Applying:** Applying digital technology skills and knowledge into new learning areas and producing new digital creations

Table 7 The I-Practise theme within the Learning by Design framework (Cope & Kalantzis, 2015)

5.1 Defining I-Practise

The learning activities categorised in the I-Practise theme were mainly observed in Year One/Two learning communities. The Year One/Two teachers applied a didactic teaching approach for instruction and designed drill and practice learning activities to engage the students in the knowledge process of conceptualising (Cope & Kalantzis, 2015). The learning activities that the students undertook with iPads were classified under the I-Practise theme.

Digital technologies were implemented mainly for drill and practice, documenting practices and independent learning, with the purpose of reinforcing students' numeracy and literacy knowledge and relevant skills such as spelling, phonic awareness, and sentence structuring. Drill and practice learning activities rely on a learning concept developed from behaviourism, which holds that learning is achieved through practising skills repetitively to master these skills at a lower cognitive stage (Okoli & Onyeagba, 2018). In the case study school, these drill and practice activities were moved from print-based learning media to iPad's platform using Seesaw, and Literacy Planet applications. iPads were used like computers for computer structured drill and practice and documentation tools to support the students to gain explicit knowledge of grammar rules and calculating principles and to master skills such as counting, handwriting, and spelling. Using iPads and Seesaw for documenting purposes, including taking pictures of teachers' teaching notes and uploading students' own learning evidence to Seesaw, showed how digital documentation practices supported young students' learning and teachers' assessing practices. Smart TVs and Smartboards were often used as modelling and displaying tools to play video clips to guide the students through the activities.

The Year One/Two teachers attempted to use formal language to accurately define the terms and abstract concepts from the literacy and numeracy curriculum in their classes. According to Cope (2015), a primary teaching focus is educating students to understand abstract concepts, definitions, and rules and discipline knowledge such as the concept of size, grammar and calculation principles. It is important to engage young students in the dimension of conceptualising so that they can name terms and develop an understanding of concepts and theories from the literacy and numeracy curriculum.

5.2 Learning Stories in the I-Practice Theme

I captured the following learning stories and teachers' quotations in Year One/Two learning communities between 2016 and 2017. These learning stories illustrate the ways digital technologies, especially iPads, Smart TVs, YouTube instructional videos and educational applications, including Seesaw, Literacy Planet and Reading Eggs, are used for supporting students' literacy and numeracy learning through drill and practice, documenting and independent learning activities.

To provide a better understanding of the context of each learning story, I categorised educational applications used in the case study school for drill and practice into two groups. I called the first group of educational applications which included Seesaw, Book-creator and Picolage (see Appendix H, E, and G) as “open-ended applications”. These open-ended applications and programs allow the students to create their own content or digital artefacts which are also used frequently for learning activities under the I-Create theme. However, open-ended applications do not provide immediate feedback and inbuilt instructions and require teachers’ assessment and feedback on students’ work. In the I-Practise theme, Seesaw is used in literacy and numeracy learning activities as an easy editing platform for drill and practice and can be done with traditional learning tools (i.e., pen and paper). Year One/Two students can perform small repetitive tasks, like correcting sentences and comparing objects on iPads, to learn about grammar and direct measurement.

I categorised educational applications such as Literacy Planet, Ready Eggs, Mathletics, and Skoolbo Aussie into closed-ended applications (see Appendices A and F), because these applications do not provide students with tools and functions to create digital content. However, closed-ended applications provide embedded instructions (e.g., sounding out and showing the meaning of a word) and tasks in a game scenario with immediate feedback, such as the answers to multiple-choice and blank filling questions. These programs give immediate feedback that enable students to check their accuracy. The digital tasks on closed-ended applications looked like close-ended questions including matching words to their sounds, arranging words in alphabetical order, or reading comprehension. And closed-ended applications also provided fixed answers to these tasks. Both types of educational applications were utilised by Year One/Two teachers for facilitating their students' literacy and numeracy learning through independent drill and practice activities.

5.2.1 Implementing Digital Technologies for Literacy Learning

Using YouTube videos for practising handwriting skills

Although digital communication is commonplace in education and working sectors, written language is still required (Mackenzie & Spokes, 2018). According to State Government of Victoria (2019), handwriting remains an important literacy skill in the 21^{st}-century, citizens still need to create or complete handwritten texts when taking notes, providing signatures, and communicating by mail.

The following learning story was taken from Term 2, 2017 in Lauren's Year One/Two learning community. It illustrated how she used YouTube videos to reinforce young students' handwriting skills. Smart TV and YouTube videos were used in this learning activity for the instructional purpose and guiding students to practise hand-writing skills.

Teachers' pedagogical practices	Students' learning practices
Lauren explained that they were going to practise writing the letters 'g, h, I and j' with a hand-writing cat. She drew lines on the board and drew a cat on the left end of the lines. She wrote four letters in lower case and an upper case on the line while referring to the guided cat (a writing tool that helps students to write on the dotted third). She asked her students to bring out their writing books and prepare to do handwriting practice. When the students went to get their handwriting books, she turned on the Smart TV and presented a YouTube video demonstrating how to write the four letters. Lauren then walked around the classroom and provided individual support and scaffolding to the students who could not write the letters correctly. .	The students watched the video and followed the instructions and, wrote the letters on their lined sheets. The students were able to follow the instructions from the YouTube writing video to construct their letters.

Engagement in this learning activity was high, as the observed students concentrated on watching the YouTube video and following the instructions to write the letters on their worksheets. Lauren, the Year One/Two teacher, suggested that using a YouTube instructional video to facilitate young students' learning of handwriting skills was a good way to implement digital technologies, because students concentrated on following the instructions on the Smart TV and were highly motivated to write more letters. "*They are very engaged in handwriting when YouTube videos are on. It is a good tool.*" Lauren said. The observation data also showed that the students were motivated to do more tasks. For instance, when the first round of the video finished, the students waited and urged their teachers to play the video again for more practices. The data showed that most young students were interested in watching YouTube videos, similar to Chaudron's report (2015) that young children were enthusiastic about digital devices and multimodal materials. Implementing YouTube videos for guided writing seems an effective strategy to support young students' literacy learning because it enhances their engagement and their motivation towards learning to write letters (Multisilta, Suominen, & Östman, 2012; Niemi & Multisilta, 2016).

YouTube instructional videos (see Figure 7) facilitated the Year One/Two students' development of handwriting skills. The observational data confirmed that students gained knowledge of how to construct lower and upper case letters on dotted thirds. The students were involved in conceptualising by learning the principles of writing letters with both the teacher's instructions and video demonstrations of drawing loops, straight lines, and tails on the correct place in dotted thirds.

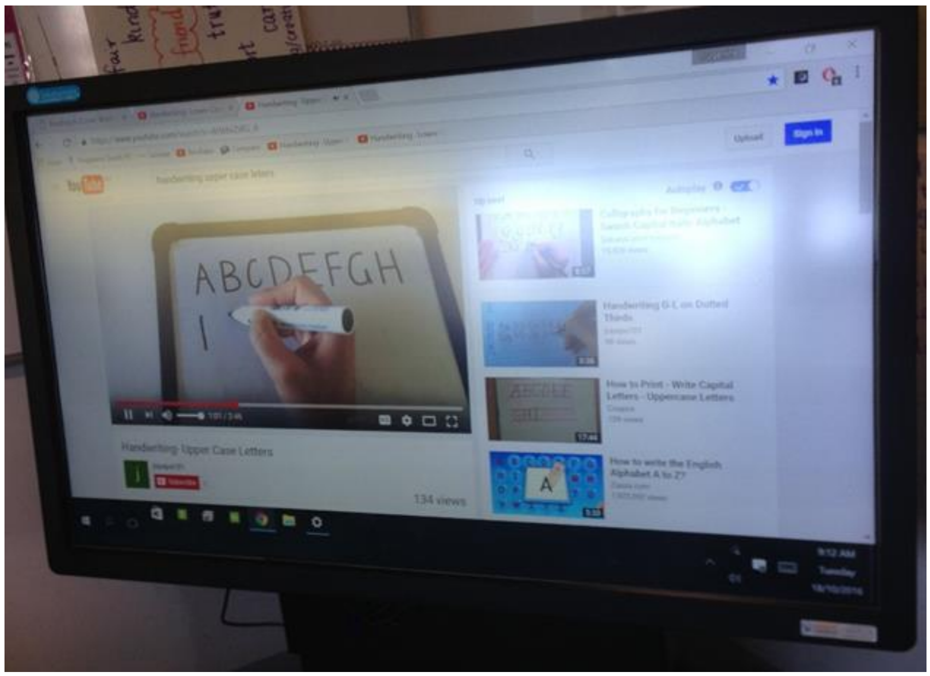


Figure 7 Using a YouTube video to guide the students to practise handwriting skills

This drill and practice suggested that YouTube videos are an effective instructional medium for early primary school classrooms (Isiaka, 2007). The students benefited from using YouTube videos because they gained knowledge and skills about writing letters which improved their literacy skills. However, Smart TV was mainly used for displaying learning material and videos, which was criticised as not effective implementation of digital technologies. Kerckaert (2015) has argued that using digital technologies merely for displaying and modelling purposes does not engage students in deep learning.

Using eBooks for reading

I often observed iPads and educational applications and YouTube videos being used to enhance young students' reading experiences in the Year One/Two learning communities. The following learning story was recorded in Term 4, 2016 in Kate's Year One/Two class. The students were assigned to read silently using the literacy application Reading Eggs (see Appendix A). Reading Eggs offers many digital books and reading comprehension tasks, allowing the students to build vocabulary and enhance reading comprehension.

Teachers' pedagogical practices	Students' learning practices
While the students were reading on their iPads, Kate walked around the classroom and assisted the students with a lower reading level.	The students were excited to bring out their iPads for this silent reading activity. One boy (Oliver) turned on Reading Eggs and scrolled up and down to choose the book he wanted to read. "*Look, I am the only one in the class at this level*!" he pointed to the top roll on the interface to show his reading level indicator to the researcher. He was in level 4, while the majority of students in his class were in 2 or 3.

	"*Oh, look at that, the spaceman is so cool! Wow, I like that spaceship!*" he said to the researcher and pressed on the icon for that book. He put on the earphones and pressed the play button on the cover page. The application read aloud word by word to him. The book page flipped automatically, and Oliver stopped a few times and pressed on the words he did not know, such as "astronaut", and the iPad read it out to him with the meaning in a floating box. He repeated the word with the iPad. At the end of the book, there were comprehension tasks for students to self-assess if they understood the meaning of the story. He got most of the answers right. He went back to recheck the paragraphs when the feedback indicated he should do so.

Kelly, the art teacher, remarked that her students could use iPads to access information from the internet and the online library or the digital learning materials on Seesaw, which "*broadens their knowledge*". The students could learn new vocabulary, text features and organisation through reading a wide range of digital books. The Year One/Two teachers noted that digital libraries and digital resources on Seesaw allowed young students to access information via browsing webpages, reading eBooks and watching videos and reports which, in turn, enhanced their literacy skills in terms of acquiring new vocabulary, learning sentences styles and developing fluency. Other researchers agree that the internet and online libraries provide rich language resources for young children which enhance their general literacy skills (Flewitt et al., 2014).

iPads engaged young students in reading practices by providing multimedia features such as sound, interactive illustrations, and reading comprehension tasks in eBooks. The implementation of Literary Eggs for silent reading practice increased the young students' reading enjoyment through the addition of sounds, cartoon characters, and hyperlinks. Oliver, the Year One/Two student mentioned above, was amused when he tapped on new words to have the iPad read them out to him. Oliver also showed great interest in the wiggling cartoon spaceman on the side of the text. Other students from Kate's class enjoyed interacting with these multimedia features from the eBook, and were motivated to read eBooks and eStories again, which indicated that the technology was enhancing young students' reading experiences. Other research has indicated young students are motivated to read more when they are provided with familiar and interesting tools and resources (Infante et al., 2010).

I observed that the in-application instructions, reading comprehension tasks and feedback in Reading Eggs supported the Year One/Two students to learn independently. For instance, during reading comprehension tasks, Oliver showed that he understood the Spaceman story when he correctly identified what the astronaut did in the story. This observational data indicated that the in-application instructions and feedback enhanced Oliver's independent learning experience by facilitating learning of new vocabulary, reading fluency and understanding the content of the book. The extra support such as sounding out words, showing the meaning of the word and providing self-assessment tasks enhanced his reading experience which contributed to his literacy development.

Kate, the Year One/Two teacher, agreed that reading applications like Reading Eggs and Literacy Planet supported the students' literacy development by providing extra support such as reading/sounding out the word, showing the meaning of the word and hyperlinking the word to pictures and cartoons so that students could learn effectively while reading in multimodal ways independently. She said:

> *They can tap on the word they do not know, and iPad will read the word to them which is really good. They learn new words in this way. Moreover, they can self-assess their understanding as there are small tasks after each story which helps them to reflect on what they have learned from the story*.

Kate's comments echoed Kervin's (2016) statement that iPads can support young children's literacy learning by providing in-built instructions, multimodal assistance, and feedback such as sound, meaning, and illustrations about new words and reading comprehension tasks. Moreover, the other Year One/Two teacher, Rose, explained that iPads and educational applications allowed young students to "*direct their own learning*" with inbuilt instructions and to "*self-pace their reading in educational apps"* rather than relying on teachers' instructions. The teachers' comments aligned with recent studies' findings that digital drill and practice activities enhance students' independent learning experiences, because students can decide when to learn and what tasks they are interested in undertaking with their familiar digital tools (Nicholas, McKenzie, & Wells, 2017; Okoli & Onyeagba, 2018).

I often observed the use of digital books in drill and practice form to reinforce young students' literacy skills in Year One/Two learning communities. It has been claimed that educational applications/programs with inbuilt instructions and feedback motivate young students to complete more tasks, as well as to accomplish learning tasks independently (Siraj-Blatchford & Whitebread, 2003). The learning story outlined above is evidence that iPads can support young students' literacy development and enhance their independent learning experiences through offering a wide range of reading materials, multimodal support and assistance with in-program instructions and feedback.

Using literacy games for practising alphabet knowledge

Literacy games from Literacy Planet were implemented as a form of digital drill and practice for enhancing young students' literacy learning. The following learning story described how students developed their alphabet knowledge through playing the "Monster" game in Literacy Planet. According to the State Government of Victoria (2019), learning alphabetical knowledge contributes to one's understanding of print concepts, which are considered important for reading and writing in English learning. This is because the development of alphabet knowledge is an important predictor of early reading and writing success (State Government of Victoria, 2009).

This learning story was recorded in Kate and Rose's classroom during Term 4, 2016.

Teachers' pedagogical practices	Students' learning practices
Kate instructed the students that they could play any games from the Literacy Planet App. She gave no more instructions or guidance. Rose then asked the students to be quiet and informed them of the time they could spend on this leaning activity.	Two girls (Anna & Ella) turned on their iPads and selected the Literacy Planet app. There are many small games in this application, so it took a while for the girls to decide which one to play. Then Ella randomly selected one with a Monster character on the icon, and Anna showed great interest in it and decided to play this

	game as well. They started the game without reading the instructions. There was a list of words on the left, and one cartoon monster on the right side of the screen. In the beginning, the two girls just randomly pressed and dragged the items on the screen. Then Anna found that she could drag the letters, and when she dragged the word towards the monster, the monster would open its mouth. Sometimes, the monster made an "Ouch" sound, and the word went back to the left side; sometimes, the word went into the monster's mouth, and the monster ate it. Then I asked them what the rules were for this game. Anna then went back to the information page, and read the instructions out aloud together with Ella. Then Anna explained to me and Ella that they needed to feed the monster with the word in alphabetic order. They started to read the word list first to find out the order

	of the words. They sang the alphabet song together, matched the words and then dragged it into the monster's mouth correctly. "*Yes! We got it right! Let's play it again!*" said Anna when they finished dragging all the words. Both girls enjoyed the game, which they kept playing until the time was up.

The game scenario engaged the two observed Year One/Two students in practising their alphabet knowledge. For instance, Ella dragged "apple" and then "big" from the word list on the left into the monster's mouth on the right (see Figure 8). The students were amused when the monster made sounds, and played the game several times. During the second and third time playing the game, they quickly rearranged the words based on their initial letters in alphabetical order, which showed strong evidence that their metalinguistic awareness of knowing the difference between a "word" and a "letter" was developed. Anna and Ella's literacy learning experiences were enhanced through playing the game on Literacy Planet due to its colour, sound and interactive cartoon effects. From this example, it can be seen that literacy games could be considered as effective tools for supporting young students' literacy learning.

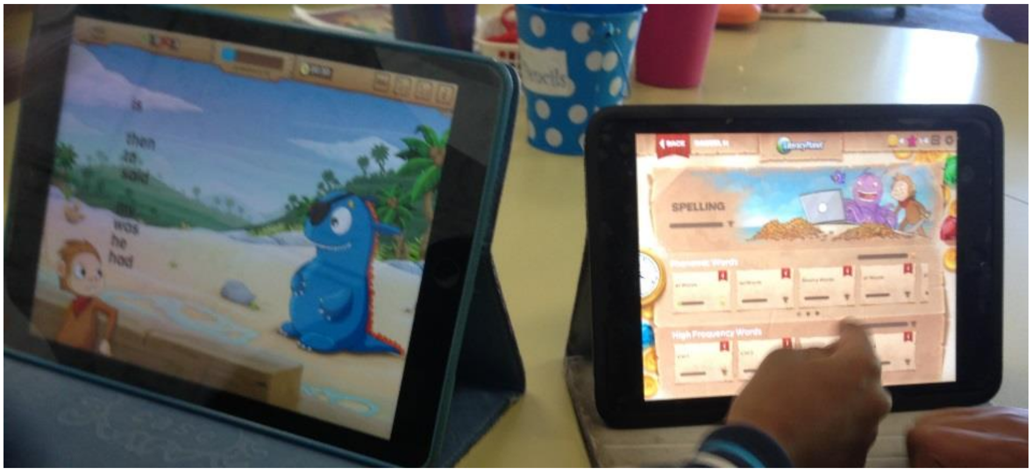


Figure 8 Two girls were playing the “Monster” game in the “Literacy Planet” application

However, in the beginning, Anna and Ella did not read the instructions and played the game just for fun, and they were amused when the monster made “ouch” sounds. The feedback from the game was immediate, but not constructive, because the students did not understand why the monster spat out the words. I then suggested the girls read the instruction page again to see how to play the game. If no adult had intervened, they would have played the game to see the monster eating the words rather than practising their phonetic knowledge. Learning occurred when the girls worked out the rules behind the game and referred to the alphabet order rhyme shown on the Literacy Planet instruction interface and put the correct words to the monster’s mouth orderly.

This learning story indicated how iPads and literacy games could enhance young students’ literacy learning by offering games featuring drill and practice activities. However, lacking capable adult supports and scaffolding might lead to their ineffective use.

Teachers' further detailed constructive feedback and instructions were required for these drill and practices activities on iPads, so that the students would make use of the iPads more effectively for learning purposes. To conclude, the students still needed adults' scaffolding in doing digital drill and practice learning activities for their literacy learning. Kate, the Year One/Two teacher, reflected that she needed to encourage the students to share what they played and what they have learned from playing the games after each independent learning activity. In this way, other students could learn how to play these games effectively for learning. Kate's reflections in her second-round interview indicated that it was important to allow students to interact with digital technologies and shared their experiences and understanding with others for meaningful learning (Liu & Matthews, 2005; Vygotsky, 1978; 1980).

Using Seesaw for practising grammar knowledge

The following learning activity illustrated how iPads and Seesaw were used to facilitate constructing sentences and applying grammar knowledge. Acquiring knowledge of text features, including punctuation being a feature of written text, and capital letters signalling the beginning of sentences, mainly engaged young students in the Learning by Design's conceptualising learning process (Cope & Kalantzis, 2015). The students were asked to use Seesaw (see Appendix H) to take photos of sentences that contained errors and to correct them.

This learning story was captured in Term 1, 2017 in Jessica's Year One/Two classroom.

Teachers' pedagogical practices	Students' learning practices
Jessica spent most of the time explaining the principle of constructing correct sentences.	Connor was observed using Seesaw to take a picture of the sentence first.
She then used one student's iPad to do the task together with the whole classroom. She showed one sentence with some grammatical mistakes that had been printed on a paper strip, and used the iPads to take the picture of the sentence. She then discussed with the students if they found anything wrong in the sentence by showing the digital copy of the Smart TV. The students actively put up their hands and pointed out the grammatical and punctuation mistakes in the sentence.	He put the paper strip away and read the sentence a few times. He circled the comma at the end of the sentence, and used his finger to draw a full stop on top of it. He could not find the rest of the grammatical mistakes. Then I suggested he read the sentence carefully to see if there was any wrong use of capital letters. He circled one misuse of lower case, but he was unsure about his correction, so he erased it and uploaded the online digital task to the folder with his teacher's name.
Jessica circled the error and then inserted	

the correction beside it using the digital drawing function on the iPad. Then she grouped students into fives and gave each paper strips printed with errors.	

Seesaw provided an easy editing interface, with multimodal tools such as digital drawing, text inserting and digital erasers. Jessica explained after assigning this task, "*using iPads makes this task a bit easier for them to do, as they can digitally edit and re-edit their answers*". Easy editing functions made Jessica's students more motivated to work on correcting sentences than with using pen and paper. The observed students showed high motivation in doing the drill and practice of correcting sentences on iPads, because they enjoyed using the camera and digital drawing functions. For example, Conner showed a great interest in taking pictures of sentences and correcting four more sentences. Other students I observed in Kate's class also showed a high level of motivation to practise their grammatical knowledge, as they attempted to finish all the sample sentences and shared their sentence pictures with corrections on Seesaw. This data indicates that iPads had the potential to sustain students' engagement and motivation in literacy drill and practice learning activities. This finding aligns with previous findings that digital technologies have a positive impact on students' motivation and enthusiasm toward learning (Multisilta et al., 2012; Niemi, 2016).

With four sample sentences, Conner identified the punctuation errors to use a full stop to end a sentence in the first example sentence that shown in Figure 9. He erased the circle and drew ‘J’ on top of the word “*john*” to show that the word should be written in capital. He corrected two errors that were associated with capital letter issues, one was using a capital letter at the beginning in the second and third sentences, and the other one was to use the capital letter in a name in the fourth sentence. The learning evidence showed that Seesaw helped Conner develop his literacy knowledge of text structure and organisation by identifying the wrong use of punctuation and capital letters in a sentence.

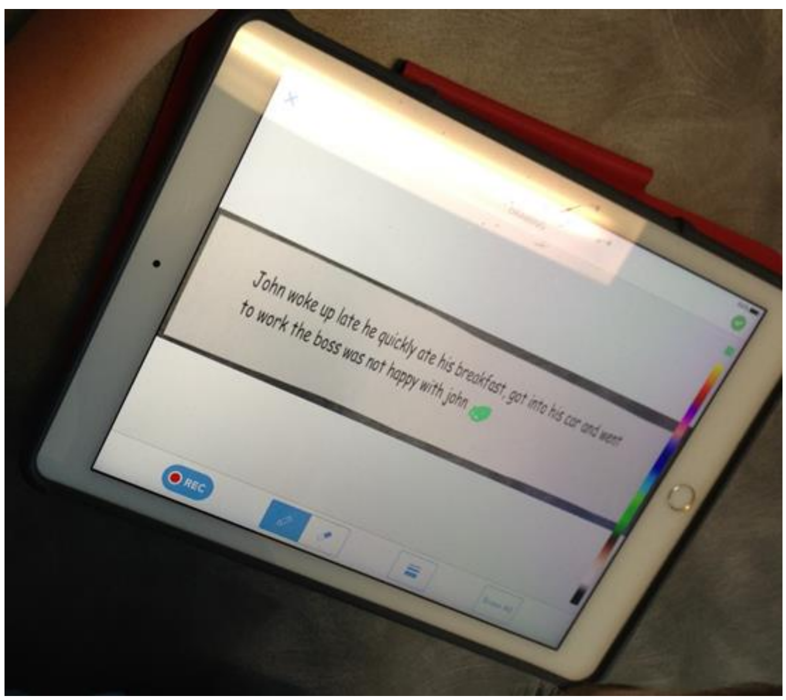


Figure 9 Using Seesaw to correct a sentence

Despite its usefulness, Seesaw (open-ended application) does not provide immediate feedback. For instance, Connor could not correct the sentences by using a full stop to separate two independent sentences, and capitalised the first letter in the second half sentences in "*John woke up late he quickly ate his breakfast.*" After most of the students had finished their sentences, Kate displayed Conner's sentence pictures on the Smart TV, pointed out the remaining grammatical errors in Conner's first sentences, and explained how to correct the errors that he missed. Thus, the student still needed the teachers' scaffolding in terms of reconstructing his knowledge of text features including using punctuation and capital letters when digital technologies were included for drill and practice learning activities. The observation data indicated that teachers' constructive feedback was important in this digital learning activity in terms of guiding and scaffolding the students to successfully accomplish the task like finding all the grammar mistakes and then re-composing the sentences appropriately. According to Kucirkova (2014) and Terreni (2010), teachers' roles as scaffolders and supporters are considered important because students need consistent instructions, scaffolding, and constructive feedback to gain new knowledge and develop new skills in using digital technologies.

These learning stories (i.e., reading eBooks, guided handwriting, correcting sentences) show that digital technology played important roles in young students' literacy learning, especially, in supporting and extending learning by providing rich reading materials, games and learning tools. Implementing digital technologies for literacy drill and practice seemed to contribute to increasing students' engagement and motivation towards learning and enhanced young students' literacy learning experience with in-built instructions and feedback from some close-ended educational applications.

5.2.2 Implementing Digital Technologies for Numeracy Learning

iPads and applications were used for supporting students' numeracy learning across four learning communities in the form of drill and practice activities. The following learning story was recorded from Term 4, 2016 in Rose's Year One/Two class. This hands-on activity occurred after Rose's gave explicit instructions about the concepts of Size and Volume.

Teachers' pedagogical practices	Students' learning practices
After providing explicit information about the concepts of Size and Volume and physical modelling using counters to measure the size of the container, Rose assigned the task. Rose used the different sizes of containers to hold counters to show students that the bigger container held more counters than the smaller container. She then explained that the	The students sat on the floor with two containers in front of them. They skilfully turned on the iPads and logged into Seesaw to take photos of the two containers. A student called David placed two containers side by side to make a comparison. Then he pointed to the bigger one and pressed on the drawing icon and selected the colour to draw a circle around it. After drawing, he

marks on the containers indicated the size/volume of the container as well, which would tell the students how big the container was. She further explained that the students needed to find out which of two randomly chosen containers held more. Then she gave very brief instructions on the procedure of using iPads and the Seesaw App, such as "*log in to Seesaw first, then take the photo of two containers, and circle out the one that holds more.*" There was no modelling or physical demonstrating of using the iPads.	found the recording button (REC), and he pressed and recorded his response as "*this container holds more*". After uploading the picture with the digital drawing and audio recording, the boy quickly went to the container box to collect two new containers and repeated what he had done in the previous task.

To ensure that students gain knowledge of measurement and the skill of comparing, Rose, the Year One/Two teacher, spent roughly 20 minutes explaining the concepts of comparison and then used the units to measure the capacity of containers with explicit instructions and modelling teaching approaches. The students were mainly involved in the conceptualising dimension from the Learning by Design framework (Cope & Kalantzis, 2015). The teacher taught the abstract knowledge of naming and defining size, volume and capacity and the concept of' measuring through direct comparison, and then encouraged them to explain the concept of measuring using plain language such as “this container holds more”.

The learning intention was to reinforce students’ understanding of the concepts of volume and size, aligned with the subject of measurement in the numeracy curriculum (State Government of Victoria, 2019). David, the Year One/Two student, was offered various multimedia options to practise measuring capacities of the two containers on Seesaw rather than writing down his responses in sentences to explain what he learned. He compared the two containers by matching one container against the other container side by side, which implied that he could distinguish capacity from other attributes, like shapes. After circling the bigger container (see Figure 10), he used Seesaw’s recording function to note “*this one holds more*”, indicating that he could use everyday language to explain and describe the numeracy knowledge of measurement. David was involved in “conceptualising” the concept of measuring through learning the definitions of the terms such as “size”, “volume” and “capability” and generalised them using everyday language. The iPads and Seesaw were implemented in this learning activity to develop young students’ measurement skills using multimedia features such as digital photography taking, digital drawing, and audio recording.

Figure 10 The student using Seesaw to do the task of identifying the “bigger container”

The multimodal tools and functions increased the students’ motivation and interest in this repetitive mathematical task, and enhanced their numeracy learning. For instance, David enjoyed using the camera function to take pictures of two containers and was motivated to do more tasks. This agrees with the claim that digital technologies hold children's interest and attention in mathematical learning activities, thereby motivating young children towards numeracy learning (Huang, Huang, & Wu, 2014; Lui & Lee, 2013; Spencer, 2013).

iPads and Seesaw enhanced Year One/Two students' numeracy learning by providing multimodal tools including the audio recorder, digital marker and camera, which supported their ability to express understanding of size and volume. In addition, Kate, the Year One/Two teacher, noted that iPads assisted students with different abilities and interests to learn. For instance, the students would record their answers and responses to a mathematical problem using the audio recorder if they were not capable of writing them down with traditional learning tools in numeracy learning practices. She said:

> *….So for me, the role (of the iPads) is to extend their learning, not through just books or paper tests, but also through the use of media, and through the use of the internet…If a child isn't able to write terms and sentences, as they are not at that level, they have got the apps to do the tasks, like they can voice record their answers. iPads allow them to learn in different ways. So, it is a really good tool. Especially, in the twenty-first century kind of learning environment.*

Kate's perspective was similar to Niemi and Multisilta (2016)'s research findings. They reported digital technologies could provide various digital tools and resources catering for young students' diverse learning needs and interests to support them to learn more effectively.

In addition, Rose, the Year One/Two teacher, also implied that young students' numeracy skills, such as adding and counting, were improved using iPads and educational applications (closed-ended applications), which provided many numeracy tasks and games for students to work with. She said:

> *Digital technologies are good for supporting students' learning, in many ways, like numeracy skills. They have got hundreds of maths games on their iPads.*

They learn to count, calculate, the value of numbers and number order knowledge and so on when they play these games. It is fun and my students like these games.

Rose's comments reflect previous research findings that students are motivated to do the numeracy task by the inclusion of gaming scenarios with colourful and animated graphics (Chen & Hwang, 2014). Chen and Hwang (2014) have reported that using educational games for drill and practice reduces the boring side of repetitive tasks due to their multimedia and gaming features, which traditional learning tools lack. Both Year One/Two teachers mentioned that their students were amused by iPad games from the Mathletics application, and were encouraged to play more numeracy games because they were fun and attractive. Therefore, using numeracy games for drill and practice increased young students' motivation and engagement in numeracy learning.

In summary, iPads and Seesaw were used to support young students' numeracy learning. The ease in use of multimodal functions, including photography, digital drawing, and audio recording encouraged students' agency in using digital tools, which greatly increased their engagement in and motivation toward numeracy learning. In addition, these multimodal functions removed learning barriers associated with traditional learning tools and allowed the students to express their learning more easily like using an audio recording for responses. The use of multimodal functions made this numeracy learning activity less like drill and practice, because the students tended to create digital artefacts with multiple modes (one of the features of the I-Create theme). This indicated that the teachers attempted to extend the learning activities from the theme of I-Practise to the I-Create theme by allowing students to use digital tools and resources for making meaning and expressing ideas. The features of the theme of I-Create were emerging from the learning activities from the theme of I-Practise.

5.2.3 Implementing Digital Technologies for Documenting

Documenting practices observed in the Year One/Two learning communities included recording and saving photos, video and audio and uploading these digital media files into Seesaw. According to Given et al. (2009), documenting activities can be defined "as the practice of observing, recording, interpreting, and sharing the processes and products of learning through a variety of media in order to deepen learning" (p. 38). The teachers from the case study school promoted documentation practices—revisiting their digital work and words and reflecting on what they have archived to inform future learning—as a way of engaging the young students in active learning. Using digital technologies for documenting purposes can support students' learning. Moreover, documentation practices may deepen students' understanding of their own learning through reconstructing their prior knowledge by adding and re-editing information on their documented learning media files (Watson, 2015).

Students benefit from documenting teachers' notes online

The following learning story illustrates an event in which the teacher assisted the students to document teaching notes about stick insects on the whiteboard. It was recorded in Term 3, 2016 in the One/Two science class. This learning story showed how digital technologies were used for documenting purposes for One/Two students' learning about "*spiny stick insects*" in a science class.

Teachers' pedagogical practices	Students' learning practices
Nicole, the science teacher, asked the students to review what they had learned about insects from the last class. She had asked the students to take photos of the insects and make some notes about it. She encouraged the students to go back to their Seesaw online space to look at their previous posts in the science folder. She then had a discussion with the students on what they have known already about spiny stick insects (body size, colour, living environment, food and lifespan).	Students all actively responded to these questions, especially when they were able to refer to their previous posts in the Seesaw online learning space. James held up his iPad with the Seesaw app. He logged into the folder and found the note he had saved from last week's science class. He read through the note on the iPad, and then quickly put up his hand to respond to the science teacher's questions.

In this learning story, the Year One/Two students used Seesaw and the camera to capture notes about spiny stick insects from Nicole's science class and recalled the information during the following classes. Encouraging students to use iPads to document teachers' notes allowed them to record their own learning in the following class in an easy way. Nicole reported that using iPads and Seesaw allowed students to capture teachers' notes in a fast and easy way in a busy classroom. An additional benefit was easier editorial changes on digital notes, increasing the students' ability to improve and extend their work through digital technologies (Nicolaidou, 2013). Nicole further explained:

> *For those Year One/Two students, it is hard for them to write and remember some long science terms, as these words are not for their level. There is no need to copy these terms down, but it would be good for them to keep the information for their future study*.

As demonstrated in this story, Billington (2016) reported similar findings that digital technologies remove the learning barriers to spelling and writing down words and sentences using traditional learning tools which may support young students to learn more.

James, the observed Year One/Two student, was engaged in deep learning during the process of revising his documented teachers' notes about spiny stick insects. He accessed his science folder to find images and text information saved from a previous science class to recall the facts about spiny stick insects (see Figure 11). The images and text information that James documented from the previous lesson provided vivid pictures for him to recall the knowledge about spiny stick insects which enabled him to quickly respond to the teacher's questions. He was involved in conceptualising as he refreshed his memory about spiny stick insects and the definition of terms such as "phasmids", "life cycle", "habitat" and "breeding" in relation to spiny stick insects. Using iPads to record the teacher's notes was an important part of the learning process, because it provided the students with visual information that was deemed necessary for the new lesson. It is claimed that using digital technologies for documenting engages young students in meaningful learning as they can reflect on their previous knowledge and learning experience by evaluating these learning evidence after revisiting their documented files (Meyer, Abrami, Wade, Aslan, & Deault, 2010).

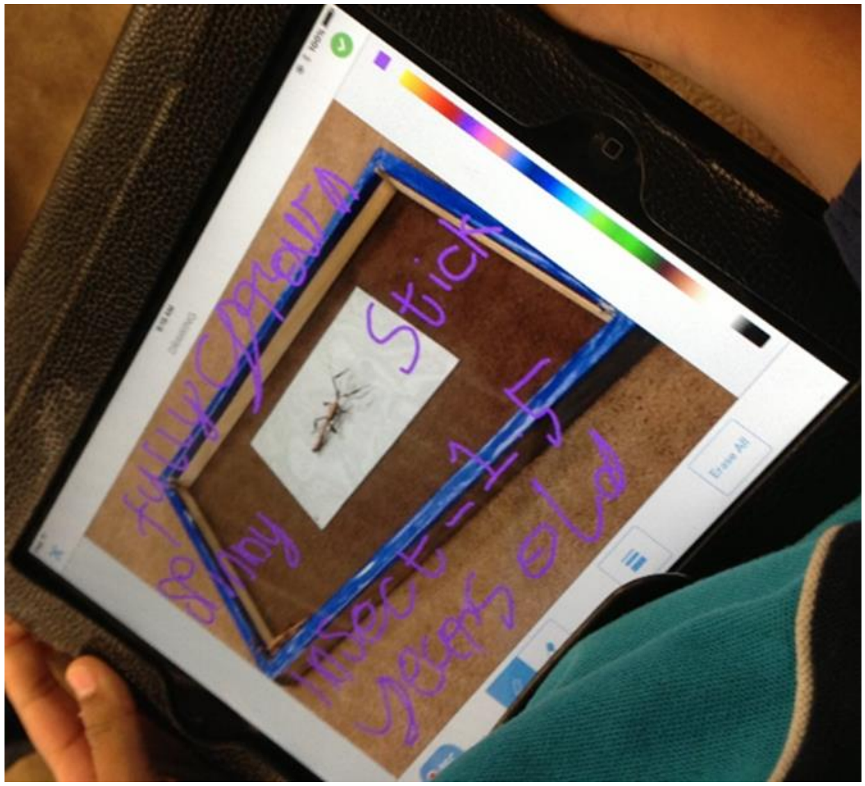


Figure 11 A student used the iPad to document his learning from a science class

Despite the positive outcomes reported above, using digital technologies for documenting purposes has been criticised. Plowman et al. (2012) reported that implementing digital technologies merely for documenting purposes may not engage the students in deep learning, this might be because the teachers used digital technologies to document their students' learning evidence. However, in my study, the young students controlled the iPads and were positive participants in documenting their teachers' notes as well as their own learning evidence. Using digital technologies for documenting purposes enable students to actively keep and manage their own learning (Meyer, Abrami, Wade, Aslan, & Deault, 2010). Research suggests that when students are actively engaged in this process, they gain increased ownership of their learning which enables them to learn more effectively (Given et al., 2009).

Teachers benefit from assessing students' learning online

The Year One/Two teachers reported that they benefited from using digital technologies for documenting young students' own learning as they could assess learning more effectively online. The Year One/Two teachers implied that they could better understand students' learning processes by capturing "the events, questions, conversations and acts that provoke and advance learning over time" (Ritchhart, Church, & Morrison, 2011, p. 18). The learning evidence including photos, multimodal text and videos uploaded on Seesaw, which served as visual archives of students' learning. The documentation showed the teachers what students have learned, and what students have not learned, so that they were able to design learning activities that addressed their students' learning needs more effectively (Ritchhart, Church, & Morrison, 2011).

The Year One/Two teachers reported that they benefited from collecting digital creations from Seesaw to identify their students' learning needs in terms of literacy and numeracy learning. By assessing students' digital tasks on Seesaw, the teachers could identify what learning activities were most likely to support children's learning, for instance, if the students needed more drill and practice to improve their hand-writing skills, the teachers might arrange guided handwriting practice using YouTube videos. Moreover, they gained a better understanding of their students' learning processes by assessing student's digital drill and practice tasks on Seesaw. Lauren, the Year One/Two teacher, said:

> *……They are able to talk through their ideas or show their learning through their digital works. The documented learning evidence can show me more information on what they have learned, what they were good at, and what they have been interested in. So, I find that iPads are really helpful for me to target their learning needs. I find that digital technologies are really helpful for me to assess their learning.*

Lauren further explained, "*As iPads could capture the authentic data and show me what the students have learned as well as what they have misunderstood, so I can analyse these data to evaluate my teaching plans and make it more targeted.*" These comments indicate that using digital technologies to document students' learning helped the teachers to assess their own teaching to see if their approaches were effective, or if they needed to focus on a particular student who needed more support or learning topics that needed further explanation in the next cycle of teaching.

Kate, the Year One/Two teacher, agreed that iPads allowed her to collect authentic data on her students' literacy and numeracy learning activities. She explained that the use of Seesaw could capture many types of learning evidence from her students, including writing responses, oral/video answers or pictures to show how they find answers. The teacher was able to assess the students' learning and understanding about the learning topics by watching, listening and reading the students' digital artefacts on Seesaw. Kate said:

> *We really love Seesaw. One is because it documents their learning. If it is comprehension, answering the questions, retelling, summarising, or clarifying the words; Seesaw can capture all these learning results for me. I can check their learning online and say yes, they can do it or no they can't.*

Besides capturing and documenting students' learning, Kate further explained that she could assess her students' work at home on Seesaw, which made assessment easier and more effective than traditional assessment methods like marking papers and workbooks. *"So, Seesaw is really good to use for assessment because when I go home, I am going online, and I know exactly what they have done. It is a really good assessment tool",* she said.

Overall, using digital technologies for assessment purposes was addressed as the main pedagogical purposes by participating One/Two teachers. They reported that iPads and Seesaw could capture different types of students' learning and evidence such as oral responding, written language and video recordings, which allowed them to understand better what their students were interests in, what their students had learned, and what their students needed to learn.

5.3 Chapter Summary

The activities categorised in the I-Practice theme share features with drill and practice which aim to support the students to learn about concepts such as measuring, the natural environment, and text features and organisations. The studied teachers applied teaching strategies, including explicit and direct instructions and modelling methods and explanation approach, to deliver the learning content. The students were placed in the Learning by Design's conceptualising dimension in which they gained knowledge of particular terms or rules by naming terms and using the rules functionally with digital tools and resources (Cope & Kalantzis, 2015).

Moreover, digital technologies were found to provide multimodal tools and rich learning resources for young students to learn and interact with during drill and practice. Literacy and mathematical games were used commonly during class time to increase students' engagement and motivation towards learning. Using digital technologies for drill and practice also promoted independent learning through in-application instructions and feedback.

In addition, digital technologies (e.g., iPads and Seesaw) allowed students to document their teacher's teaching notes as well as their own learning evidence. Year One/Two students could consistently reflect on their prior knowledge by accessing their teacher's teaching notes and their own learning outcomes and reconstructed their prior knowledge by adding new knowledge.

However, some students were observed using applications incorrectly or performing digital tasks in unexpected ways such as not knowing the rules of games which may hinder learning. iPads were sometimes used for play or entertainment rather than learning. Therefore, scaffolding and adults' instructions while young students are working with iPads are needed to promote the effective use of digital technologies. In general, digital technology mediated learning activities are not designed to help the students to participate in the knowledge process of creating, in other words, Learning by Design's applying dimension is not reached in the I-Practise theme.

CHAPTER 6

I-Create

Chapter 4 described digital technology mediated learning activities within the I-Ready theme, which were designed to equip young students with operational skills and develop their awareness of using iPads and applications safely and appropriately. Chapter 5 described learning activities within the I-Practise theme, highlighting digital technologies implemented for promoting drill and practice and documenting practices for reinforcing print-based learning skills such as spelling, phonic awareness, and measuring skills.

This chapter presents Year One/Two students' learning activities and their teachers' pedagogical practices for the application of digital technologies under the I-Create theme. These learning activities mainly involve the students in creating and producing multimedia texts including eBooks, ePosters, digital presentations, and digital graphs. They involve young students in developing higher-order learning skills such as problem-solving, critical thinking and creating which require the application of learned knowledge and skills to new contexts or to generate new knowledge (Cope & Kalantzis, 2015; Dong, 2016; Hill, 2004). These concepts related to the analysing and applying dimensions from the Learning by Design framework (Cope & Kalantzis, 2015) (see Table 8.).

I-Ready	I-Practice	I- Create
Experiencing: Learning operational skills and appropriate manners to manage the devices	**Conceptualising:** Developing an understanding of theories and concepts by practising them with digital technology.	**Analysing & Applying:** Applying digital technology skills and knowledge into new learning areas and producing new digital creations

Table 8 The I-Create theme within the Learning by Design framework (Cope & Kalantzis, 2015)

6.1 Defining I-Create

In the I-Create theme, students apply their learned knowledge and skills in new contexts using digital technologies to solve new problems and make meaning. They do this by creating multimodal texts such as digital books, digital stories, e-Posters and audio/video presentations. Most of the observed Year One/Two students were skilled in using digital technologies, including iPads and school applications for creating and producing purposes. For instance, they used their iPads and Seesaw to create a digital story ("A Fluffy Dog") incorporating digital photos, body performance, and textual monologue. According to Cope and Kalantzis (2015), when students are involved in the process of applying, they may be involved in synthesising disparate ideas or applying what they have learned in new contexts innovatively. This definition links the I-Create theme to the dimension of applying in the Learning by Design framework (Cope & Kalantzis, 2015).

The Year One/Two students I observed mainly involved in the knowledge process of analysing when they participated in learning activities related to the I-Create theme. On one hand, they could use iPads and applications in critical ways by analysing the task, and then selecting the most suitable tools and resources either digital or traditional to complete the task (such as using Book Creator for creating books, Keynotes for digital presentations and Seesaw for stories). On the other hand, they actively participated in online collaboration and communication on Seesaw, which allowed them to see other students' work and comments and evaluate their own digital creations with consideration critically. According to Cope and Kalantzis (2015), in the knowledge process of analysing, the students are encouraged to consider the use of any knowledge, action, learning tools and media appropriately and critically. Therefore, the digital technology mediated learning activities in the I-Create theme can be linked to this knowledge process (analysing).

Digital technologies are thought to have a greater impact on learning when they are used for creating and producing digital artefacts (Higgins et al, 2012). This is because deep learning can be promoted when digital technologies are implemented to support students to produce new knowledge and solve new problems (Fullan & Langworthy, 2014; Yelland, 2015a). Moreover, it is claimed that using digital devices for symbolic and innovative activity promotes students' social interactions, fosters critical thinking and problem-solving, and lays the foundations for literacy learning (Wood, 2013). Therefore, I-Create learning activities may unpack the potential and possibilities of digital technologies for meaningful learning. This study showed strong evidence that students benefited from I-Create learning activities because their various learning skills—including literacy, numeracy, creating, and collaboration skills—were enhanced through the process of creating and producing digital artefacts.

6.2 Learning Stories in the Theme of I-Create

I captured several learning stories and teachers' viewpoints in Year One/Two learning communities during 2016—2017 that illustrated the ways digital technologies were used for supporting students' literacy and numeracy learning through creating multimodal texts such as digital stories, eBooks and digital graphs. In addition, they demonstrate how digital technologies promote collaboration online (e.g., Seesaw), in classrooms and within the wider community. I also explained the Year One/Two teachers' pedagogical practices and perspectives for promoting deep learning and collaboration with digital technologies using these learning stories.

6.2.1 Implementing Digital Technologies for Literacy Learning

The students from the observed Year One/Two learning communities used digital technologies, including iPads, Seesaw, Book Creator and Keynotes to create digital books, digital stories, and digital slides. Their literacy learning, including writing, knowledge of text features, and organisational features, and skills of combining various modes for meaning-making was enhanced through creating multimodal texts.

Transforming print-based knowledge into digital format

This learning story was captured in Term 3, 2016, in Rose's Year One/Two class. The activity involved creating a digital recipe book based on a printed-recipe book. The focus was on teaching students about text structure and organisation (State Government of Victoria, 2019).

Teachers' pedagogical practices	Students' learning practices
Rose used a webpage to introduce a recipe book to the classroom. She also used the print material to show students how a recipe book looked. She pointed out each element, such as the cover page, book	Sarah selected Book Creator to create the digital recipe book. She started a new eBook page and named it "The book", and then typed the title.

title, content pages, ingredient information, and procedures. She then wrote a simple recipe book together with the students on the whiteboard. Rose asked the students to get out their iPads and create a recipe book and gave suggestions for making the recipe book look fun and interesting.	She then highlighted the title to change the colour (red), size (16) and font (bold) of the texts. She explained that red was her favorite colour and that was why she used it. However, she found red text was uncomfortable to read on the white page, so she chose black as the background colour. After typing the text, she switched to Safari and searched for the image of ingredients using Google Images. She copied a picture from the website and pasted it beside the ingredient text on the second page. She resized the picture and arranged it in the appropriate place next to the text. After finishing the book, she inserted the page numbers as “cover”, “page 2” and “page 3” to ensure that her digital book included all the book elements. Finally, she saved the file in her digital folder on Book Creator.

This learning story showed how students applied and transformed knowledge (writing a recipe book in print media) to a new context (creating a recipe book in digital media). This is considered an important part of the knowledge process, representing students' active engagement in deep learning (Cope & Kalantzis, 2015; Kalantzis & Cope, 2005).

Creating a digital recipe book encouraged the students' deep learning and enhanced their literacy learning experience. Sarah, the Year One/Two student, developed her understanding of text features and organisation of a recipe book with the scaffolding of her teacher through various pedagogical approaches. She applied her print-based knowledge of text features, using simple words and short phrases in a list format to describe the ingredients, tools, and steps needed in making her "potion". Sarah transformed her knowledge of text organisation of print-based books (a cover page, content page, a book title, and page numbers, and organising reading order from left to right) to create her own recipe book in Book Creator. In addition, she selected multimodal elements like digital images from the internet to illustrate each ingredient and tool for meaning-making more effectively. Developing students' understanding on concept that the organization and feature of text and images can impact audience's feeling and understanding of the content of the book is an important standard in literacy curriculum (State Government of Victoria, 2019). This evidence (see Figure 12) showed that creating a digital recipe book enhanced young students' literacy learning experience.

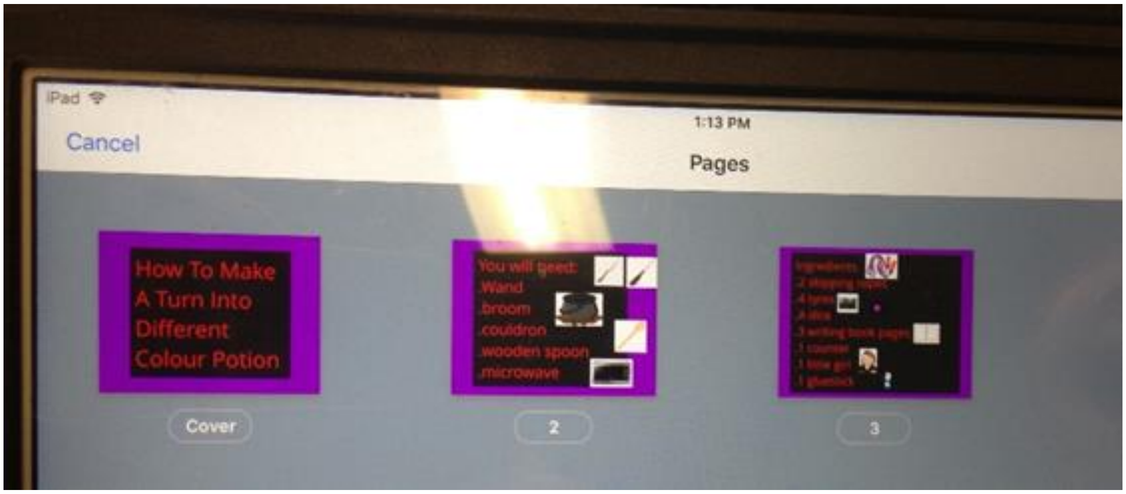


Figure 12 Sarah's digital recipe book

The Year One/Two teachers acknowledged that students' literacy skills were enhanced while creating digital books. Kate, the Year One/Two, teacher reported that her students' literacy skills were improved through the process of creating multimodal texts. She said, "*Their spelling skill is improved too, as they are typing keywords for searching information online while composing the eBooks.*" For example, Sarah, the Year One/Two student, showed that her spelling skills were enhanced while creating her digital recipe book, because she could type words such as "how", "ward" and "colour" fluently in upper and lower case letters and was able to construct short phrases using the keyboard on the iPad's screen. This is in line with Neumann (2016) who has reported that young students in his study perform better in literacy learning such as spelling, sound-letter recognition, and print knowledge when they use tablets for writing, typing and mark making.

In addition, Rose, the Year One/Two teacher, reported that she highly valued the role of digital technologies for encouraging her students to create e-Books. This was because young students could showcase their learning and express their knowledge about learning topics (inducing text feature and organisation) using multimodal functions and tools from iPads and applications. Rose said:

> *It is important to use iPads, as iPads allow them to use many options to publish their ideas. My students get a better understanding of ICT stuff, and they know that they have these options to showcase their ideas digitally. Some kids use online images to showcase their understanding of words while creating digital books which is really good. I always ask them to use these digital functions for creating digital books to show what they have learned today.*

This learning story showed that encouraging young students to create digital books supported their literacy learning. Students' literacy skills, including spelling, sentence construction, and applying knowledge of text features and organisation, were improved. Moreover, their teachers confirmed that this deepened their understanding of the learning topic (recipe writing in the process of applying print-based literacy knowledge) meaning the students were actively engaged in deep learning.

Using digital technologies for narrative writing

Digital technologies, especially iPads, were often used to engage the observed Year One/Two students in story-telling for improving their narrative writing skills. The students create their own digital stories based on teachers' brief instructions using visual, textural, oral language and performance and digital tools including a camera, digital drawing functions, and comic book templates. Digital technology provides rich language resources and learning tools for students to interact and utilise for meaning-making which contribute to their literacy skills (Flewitt et al., 2014), such as drawing, writing, performance and digital forms experimenting with characters, settings and events (State Government of Victoria, 2019).

The following learning story was captured in Term 4, 2016 in a Year One/Two learning community. An online program called Story Starters was used to provide main ideas like characters, events, and plots and guide the students to compose a short narrative text (e.g., digital stories). Rose, Kate, and Maria's (Maria did not participate in the interview) directed this community learning activity in turns.

Teachers' pedagogical practices	Students' learning practices
Three teachers (Rose, Kate, and Maria) from Year One/Two learning	The observed group included three students Tan, Jacob and Emma. Tan suggested using the "comic book" style

communities took turns to explain how to create a story including developing characters, settings, plots and an event. Kate introduced the "Story Starters" to the students using a smart TV. Kate pressed the "Spin" button and the "Story Starters" presented the instructions for the digital story as "*draw a picture or write a story for a dog who knows the password to get pass secret a door*". She instructed their students to use the information from "Story Starters" to create their own digital narratives in their literacy groups (three to four students). Rose and Maria helped to manage the students to bring out their iPads and instructed that the students could choose any media or tools to present their stories such as on iPad or on their workbooks.	to create a digital story. Tan acted like the dog, Emma acted as the secret door, and Jacob took a photo of Tan and Emma with his iPad. In the first picture, Tan posed and said "Hi". After Jacob took the photo, the three students gathered together to appraise. Then Tan tapped on the plus icon to bring up a blank dialogue bubble and typed "*Hi My name is Rafa. I am a fluffy dog*!" Then Emma acted like the secret door, and Tan acted like a dog pretending to pass through the doorway. Jacob photographed the scene. Tan then typed "*I know the password to open the secret door, and it is muchi muchi*" In the last scene, Tan, who acted like the dog, passed the door (Emma). Jacob then took the picture. Tan add

	text as "*See I told you, I know the password to open the secret door*."

According to Jewitt (2009), it is important for students to understand how to utilise different modes to convey meaning in their texts, and how to combine multiple different modes across the text to create narrative writing for meaning-making. Creating short narrative writing with multiple modes is an important literacy skill including developing an event, main characters with different media to express ideas effectively (State Government of Victoria, 2019). The observed students from Kate, Rose, and Maria's classrooms created digital stories by discussing the content arranging the sequence of events, taking photos of the performance, and typing the monologue on Seesaw.

Kate, the Year One/Two teacher, suggested that when the students moved from Foundation Year to Year One/Two, "*they were able to use digital technologies in more complicated and productive ways,*" such as creating digital stories using moving or still images, symbols, sound, and video recordings to "*showcase their learning"*. Rose said that Year One/Two students could *"present and use different multiple intelligences they like"* in complex and productive ways, such as including *"including digital drawing, writing, recording, and making movies in their digital works".* These above comments indicated that the teachers understood that students could experiment with and convey meaning through dynamic combinations of various modes across written and spoken language, visual, audio, performance, and spatial semiotic resources with consideration of text feature and organisation.

iPads and Seesaw provided multimodal tools for the students to create their own digital stories, including capturing gestures and creating illustrating a sequence of events. For instance, Emma, Tan, and Jacob decided to use a comic book template from Seesaw to retell the story. Tan performed as the main character (the dog). Emma performed as an object (a secret door), and together they developed three events: “introducing a dog”, “the dog knows a password” and “the dog passes the door”. Jacob took photos of the events as illustrations for constructing their digital story. Tan then wrote short monologues for the main character to accompany each illustration through written language (see Figure 13). Thus, the observed students actively participated in meaningful learning by exploring new ways of creating digital stories using various modes with digital tools. iPads and Seesaw facilitated application and transformation of their digital and writing skills to a new context to represent a story using a combination of modes such as text, images, and performance using iPads creatively and appropriately.

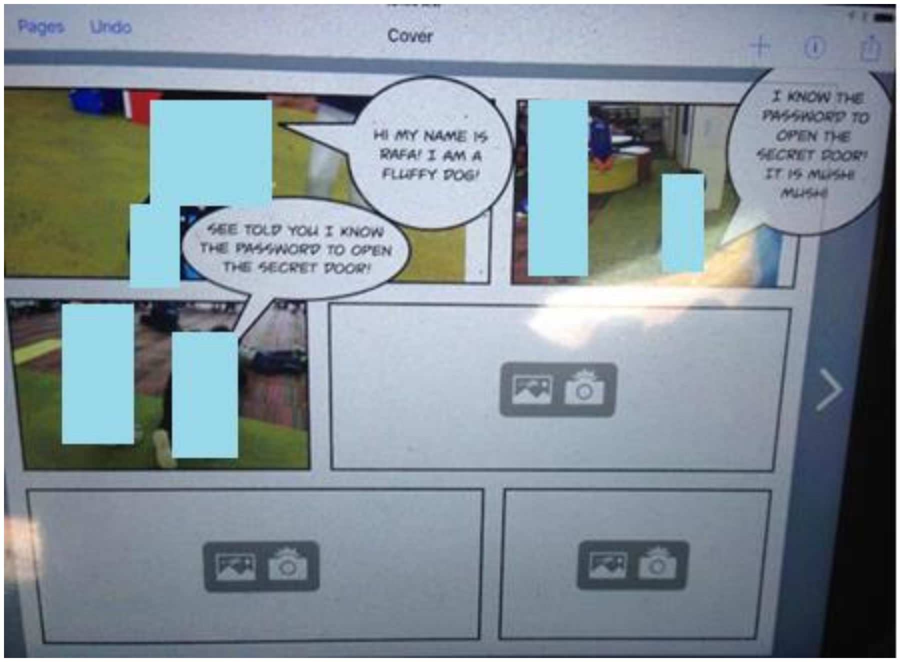


Figure 13 Screenshots of the digital story “A fluffy dog”

This learning activity showed that the observed students could manipulate three modes including gesture, visual and textural modes to create short narrative writing. Silvers, Shorey, and Carfton (2010) reported a similar finding that students’ abilities of meaning-making and expressing themselves could be empowered in multimodal ways with appropriate tools and resources. The learning evidence presented here provides further illustration of how iPads and Seesaw can enhance young students’ literacy learning including writing and combining various modes for meaning-making creatively.

To promote the creative use of digital tools to produce meaningful narrative writing, Kate, the Year One/Two teacher, applied the “free choice” approach, encouraging students to select digital tools and resources based on their interests and learning needs. She said:

> *Their digital works are quite surprising to me, for instance, one of my students used a digital comic book style to retell the story. I have never taught them to create the digital story in that way, so I was quite surprised. I really like that, and I want them to do more…*

The research evidence indicates that teachers' student-led and free choice teaching approaches promote creative learning, enabling students to be active learners creating their own digital stories (Wen, Hui, & Kay, 2011). Kate further explained that giving her students the freedom to choose and apply appropriate applications and digital resources to express their ideas and learning experiences enhanced their literacy skills. She said:

> *…the best way is to get them to choose different apps. Having the freedom to choose the apps, they are able to make the decision if they are going to use the app or not based on their own capacities, interests, and purposes. So, I think literacy skills are developed while they are trying different apps and tools to get their ideas across.*

Kelly, the art teacher, had a similar point of view, saying she preferred to exercise *"not so much control on students' use of digital technologies but conducting the use of digital technologies with more freedom".* The comments from Kate and Kelly showed that they encouraged the students to direct the way of using digital technologies for various learning purposes. Such freedom might enhance students' learning experience as they could be more creative while selecting and trying out the most appropriate digital tools and resources to best represent their ideas and learned knowledge. Kemmis, Wright, and Atkin’s (1977) stated that allowing students to choose tools and resources when participating in creative processes encouraged playful exploration and testing of ideas that enabled them to construct new knowledge. My research showed similar results, iPads and Seesaw encouraged young students to explore multimodal functions and tools to produce their own digital stories in a very creative way.

Using both digital and traditional tools for informational writing

Both digital and traditional tools were implemented to support young students to present their knowledge about the learning topic. My observations indicated that iPads, the internet, and traditional learning tools (e.g., pen and paper) were used effectively for enhancing young students’ literacy learning through composing a piece of informational writing. Kate asked her Year One/Two students to create slides, either in digital or print media, to present information about a famous person, an animal or a place in which they were interested. Creating complex digital slides for purposes of presenting students’ understanding about the learning topic like information writing involves higher-order thinking skills, such as searching for relevant information, designing multimodal texts and critically arranging information in a logical order (Anderson & Sosniak, 1994). The learning activity was recorded in Term 2, 2017 in Kate and Jessica’s classrooms.

Teachers’ pedagogical practices	Students’ learning practices
Kate asked the students to refine their informational writing. She instructed that the students could use any applications for the final presentation, or they could present it in their workbooks. After the students finished their digital presentation towards the end of class, Jessica then helped the students to represent their informational writing on Smart TV.	In the third week, Oliver was asked to create a slide for a formal presentation. On the first page, he put the name of his presentation and his digital drawing of the dinosaur. In the following slide, he inserted text based on his hand-writing from previous classes and pictures he saved from Google Images. He inserted text that he recorded earlier about the Spinosaurus from the workbook. Then he went back to the camera roll to select images. From many saved images, he selected five that he thought conveyed the most important information about this dinosaur. He created five slides on the iPad for presentation. He then thought it would be better to have a video to show how the Spinosaurus was a spectacular and

	unique dinosaur. He searched the YouTube videos about the Spinosaurus, and carefully chose one and explained that the video included a 3D model of the Spinosaurus.

Lauren reported that asking students to write informational texts based on their interests motivated them towards learning and writing. Lauren said, *"If they are really passionate about the topic, they will go a bit further and search it online, and it is good for writing informational texts."* This approach reflected the teacher's student-centred pedagogical understanding. Lauren leveraged her students' prior knowledge and interest to increase the students' motivation towards literacy learning and writing. The above commends showed that the students' engagement towards learning literacy was enhanced when they were allowed to work on the topic that they selected and enjoyed writing.

The observed Year One/Two students gained new knowledge of the Spinosaurus through searching relevant information from the internet. For example, Oliver, the Year One/Two student, found and selected relevant facts about information and images of Spinosaurus, then used these materials for his information writing independently. He learned that the Spinosaurus was the largest carnivorous dinosaur rather than Tyrannosaurus, so reconceptualised his previous knowledge. The process of selecting relevant information and images from internet showed the strong evidence that the observed student’s critical thinking skills were improved because he could analyse and evaluate the information and images to decide which information was useful for his digital presentation. This showed that he was involved in deep learning as he could source relevant information and reconstruct his prior knowledge about Spinosaurus, and echoed Flewitt et al.’s (2014) findings about active learning through searching for, analysing and then representing information digitally.

Oliver used traditional learning tools to reconstruct his draft about digital slides. He wrote down some keywords about Spinosaurus based on the information that he found online and used them as guides to construct the digital slides. Copying down words and phrases from the internet on the workbook supported Oliver’s handwriting skills. In addition, Oliver moved between digital (i.e., iPads and internet) and non-digital (i.e., handwriting and books) modes to translate information and knowledge about Spinosaurus that he had learned from books and internet with his own interpretation (see Figure 14). Using both digital and non-digital tools effectively for composing informational text indicated that he engaged in the knowledge process of applying(Cope & Kalantzis, 2015), because he consistently reflected on the handwriting copies, images, and videos that he had found from the internet to communicate his learning and understanding about Spinosaurus into digital slides.

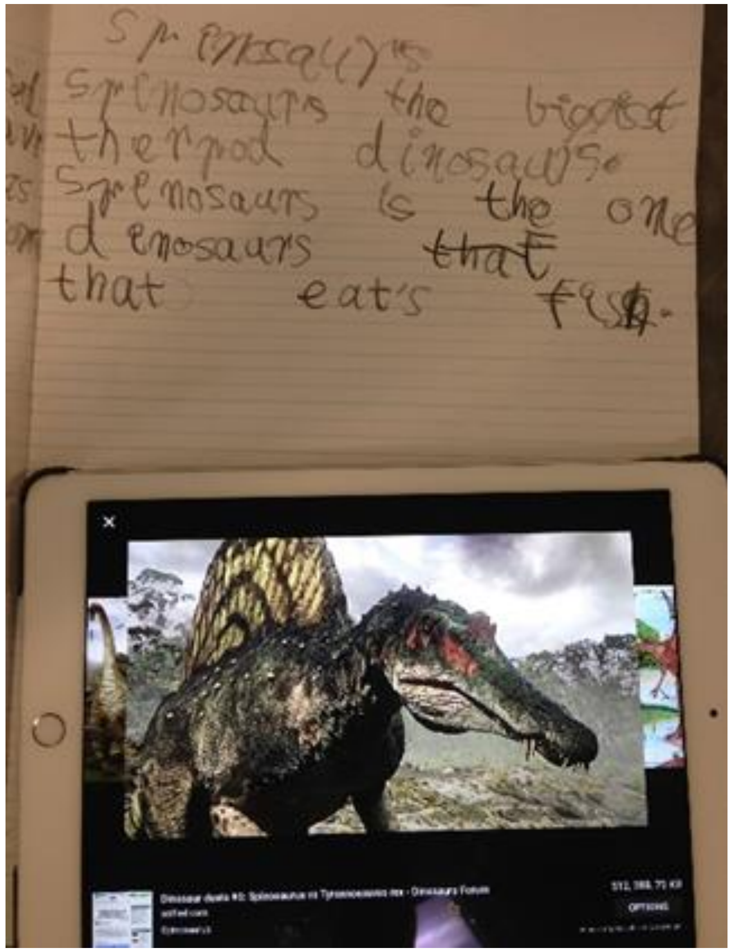


Figure 14 Oliver’s handwriting about Spinosaurus and accompanying digital images

In this learning story, students used both digital and traditional learning tools to write an informational text, Year One/Two teachers explained that they still valued traditional learning tools, and suggested that they and digital technologies should be implemented in a balanced way. The teachers indicated that students had no preferences for choosing print-based or digital media when they were creating or presenting their slides. This is in line with Suoninen's (2013) finding as young children have the same interests in both digital and non-digital learning materials, tools and toys. Kate, the Year One/Two teacher, reported that her students liked to use colourful pencils to draw illustrations and write informational texts to introduce their Barbie dolls on booklet instead of using iPads. Similarly, Kelly, the art teacher, explained: "*my students still enjoy using real materials to make things*." The above comments indicated that teachers from Year One/Two acknowledged that young students were still interested in using traditional learning tools like pens, markers and concrete arts materials for creating new objects.

In addition, the Year One/Two teachers reported that both digital and traditional learning tools were valuable for facilitating young students' literacy learning. Lauren, the Year One/Two teacher, commented in her second-round interview: "*I do not think that we need to use digital technologies for every learning task for creating.*" She still valued traditional learning tools because "*learning and practising with pen and paper is still important as they still need these skills in their work, for instance, handwriting skills are still important today"*. Teachers believed that traditional learning skills such as handwriting, drawing, and weaving were important and should not be replaced completely by digital technologies for engaging students in creative learning activities. According to Fullan and Langworthy (2014) and Nazarenko (2015), teachers need to balance new and traditional learning in the classroom based on students' learning needs and interests.

The final component of Spinosaurus slides was a digital drawing about Spinosaurus on the cover page incorporated digital images (visual), the texts (written language) on each slide, and hyperlinked the video (visual) about 3D Spinosaurus from YouTube in the last slide (see Figure 15). The final digital slide is the strong evidence that Oliver (Year One/Two), critically analysed and evaluated the content of the text and incorporated appropriate images, videos and hyperlinks to convey meaning better. This supports Silvers, Shorey and Carfton's (2010) contention that digital technologies can support the development of critical thinking and creating skills. Niemi and Multisilta (2016) reported a similar finding that students were more critical and creative when they used digital tools to finish their work.

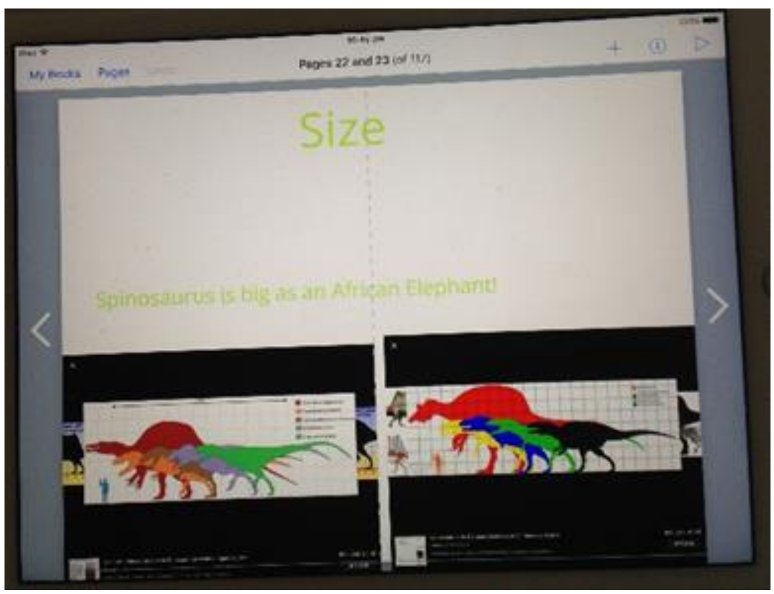


Figure 15 One slide of the student's digital presentation about Spinosaurus

This learning activity about creating informational multimodal texts encouraged young students to apply their knowledge about writing topics, informational writing skills and the digital skills of combining various modes. The students' literacy learning was enhanced by moving between digital and non-digital media and tools for typing and handwriting, searching relevant information online and inserting images and hyperlinks on slides for meaning-making. The Year One/Two teachers considered it important to include both digital and traditional tools to support young students to create digital artefacts for the purpose, so that both traditional and non-traditional learning skills were practised and deepen their students' understanding of learning topics.

6.2.2 Implementing Digital Technologies for Numeracy Learning

The students were encouraged to use digital tools and resources such as Seesaw, calculators, and survey generators to solve mathematical problems. The following numeracy activity demonstrated the students' use of digital tools to create a digital graph which indicated that their digital skills were extended in numeracy learning. This learning story was recorded during Term 2, 2017 from the Year One/Two learning community. Lauren was the classroom teacher. The learning topic was "Chance and Data" (State Government of Victoria, 2019). The Year One/Two students were asked to conduct a small investigation to collect data in categories of the flavour, colour or pets and then present the data in print or digital forms.

Teachers’ pedagogical practices	Students’ learning practices
In this community learning activity, Lauren provided brief instructions on how to do the task, such as how to collect data from classmates by asking questions about their favourite flavours, and then converted the data into a graph. Lauren suggested that the students use Book Creator, Picolage or Seesaw, but did not provide explicit instructions on any particular application for data collection and presentation. The students could choose any applications they thought the best to use.	The students were very excited about this task, because they enjoyed asking their classmates the question like “*what is your favourite flavour?”* The students had the freedom to use the iPads or draw their data charts on paper. Ethan, a Year One/Two student, decided to use an iPad. He typed the question “What is your favourite flavour?’ using Seesaw. He then turned on the digital voice recorder to record his classmates’ answers to the question. After collecting the data, he drew horizontal and vertical lines to create a plain chart on the second page. To present in an easy way, he used coloured dots to indicate categories as well as the value on the x-axis rather than using words. He drew a picture of an ice-cream underneath the x-axis with a different colour to present the different flavours. Then he replayed the interview

	record and placed the associated coloured dots on the chart aligned with the Y-axis to present the bar chart. After analysing the graph, Ethan concluded that most of his classmates liked chocolate flavour.

iPads and Seesaw provided the Year One/Two students a wide range of tools to facilitate them to solve their investigating questions. Ethan's use of an audio recording for data collocation was creative compared to using tally marks, and showed that he understood the functions of Seesaw’s digital tools and selected the appropriate one for collecting the data (see Figure 16). He developed a digital graph by drawing coloured dots with Seesaw. The iPads provided many tools (e.g. audio recorder, table generator, and drawing function) for Ethan to interpret and represent the data, which enhanced his numeracy learning experience. According to Geiger, Goos, and Dole (2015), digital technologies can encourage students to explore new approaches to solve mathematical problems enhancing their mathematical competence.

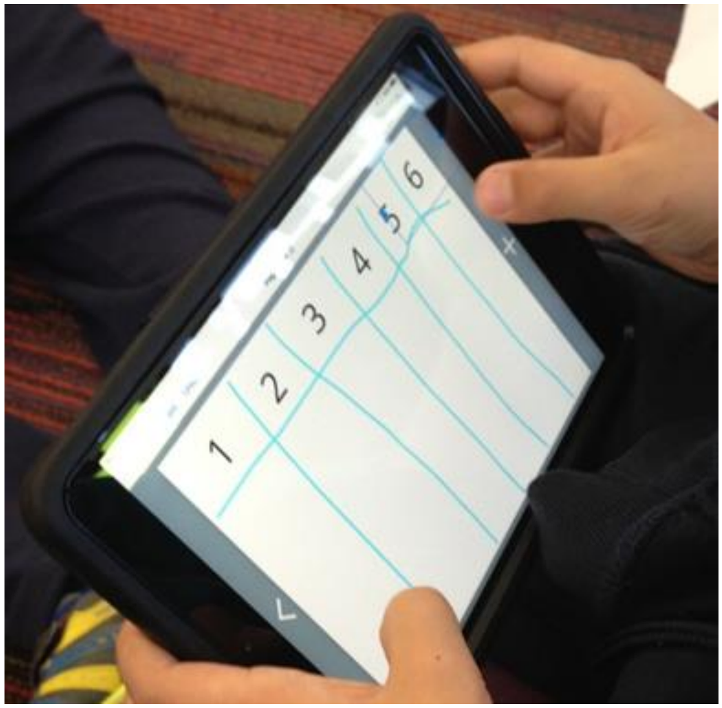


Figure 16 The student used an iPad to collect data for a graph

This learning showed that the observed student's numeracy skills were enhanced; he applied knowledge of chance, data representation and interpretation to determine how many ice-creams flavours were needed in his birthday. His creation of a digital graph by arranging coloured dots on the x-axis showed that he understood the data because he could compare the data among variables. The process of producing the graph demonstrated that Ethan could apply numeracy knowledge of (statistics and probability) critically to solve the ice-cream problem. Anderson and Sosniak (1994) have found that such higher-order thinking skills (e.g., developing an interview question, critically analysing and evaluating data, and creating graphs to form an answer to the investigation question) are promoted when digital tools are used for solving problems.

The Year One/Two teachers reported that students were engaged in meaningful learning when they used digital technologies for solving mathematical problems. Lauren explained that her students' numeracy skills were improved when they used digital tools like audio recorders and digital drawing functions to create a digital graph. She explained that they "*are willing to take risks and try different things when they are coming to use iPads and Apps to solve the problem…Their math skills are getting better*." She spoke about a digital graph showed the strong evidence of an in-depth mathematical understanding of "Chance and Data". The student provided a solution by representing interview data in a coordinate system using a wide range of digital tools.

In summary, digital technologies can enhance young students' numeracy learning experiences through the applications of their various digital tools and functions (e.g., digital recorder, digital drawing) and allow them to apply their knowledge to solve real-life problems. This learning story about creating a digital graph illustrated the pedagogical practice of using iPads to support young students' numeracy learning.

6.2.3 Implementing Digital Technologies for Collaboration

Collaboration is promoted in the I-Create theme, because students can demonstrate their learning to a large community (e.g., family, local schools and libraries) with the connectivity that digital technologies afford (Cope & Kalantzis, 2009b). According to Bahle et al. (2017), collaborating with people or groups with different learning abilities, strengths and culture develops students' ability to accept other perspectives, an essential skill in future work (Kalantzis & Cope, 2012b). Moreover, collaboration promotes deep learning as students interact with other students and teachers, the content of the lessons, and artefacts to construct their prior knowledge more effectively (Niemi & Multisilta, 2016).

Year One/Two teachers suggested that encouraging students to share learning and teaching materials, such as uploading digital artefacts and videos, eBooks and information about the learning topics on Seesaw, was an effective way to implement digital technologies in an early primary school setting.

Collaboration online

The Seesaw online learning space worked like a school-based Facebook page, sharing the students' works, learning evidence, and experiences with classmates, teachers, and parents. Collaboration online in my study refers to a more closed internet network, which means only authorised parties can assess this network (e.g., students' parents, the school teachers and the school IT officers). It is an effective way to implement digital technologies in an early primary school setting because "*it is online and can be accessed at any time at any place*", said Kelly, the art teacher.

Teachers’ pedagogical practices	Students’ learning practices
The students were asked to use their iPads to design a poster that summarised the story they read in the morning session. This task was designed to improve students’ literacy skills and make meaning about their world. While most of the students were busy with this task, Rose selected five students to take part in an informal assessment on reading comprehension. Rose did not provide detailed instructions on which app the students could use or the procedures for using a particular app to do the task. She grouped five students for an informal reading comprehension assessment while other students were designing their digital poster.	When Jane, a Year One/Two student, uploaded her digital poster to the Seesaw online space, Phoebe (another student) came over and asked her how she did it. Phoebe placed a heart emoji and text “*its cool*”on the post to show Jane how much she liked it, saying “*It is so cool! How did you do that?*” Jane returned the compliment by showing Phoebe how to upload her file on Book Creator. The two girls then sat together and browsed other students’ posts on the Seesaw online space, and commented on them.

I observed Rose's students spontaneously participating in online collaboration logging into Seesaw and browsing other students' digital posts without teachers' instructions. After students created their digital posters, the teachers only provided instructions related to online safety, and to be respectful when they commented on their classmates' online posts. Year One/Two students used Seesaw to post their digital work and ideas in the online learning space. For example, in this learning story, students were asked to create a digital poster about their interests and upload it on Seesaw. The students inserted images, cartoon stickers and colourful texts to create ePosters (see Figure 17), then uploaded them to Seesaw.

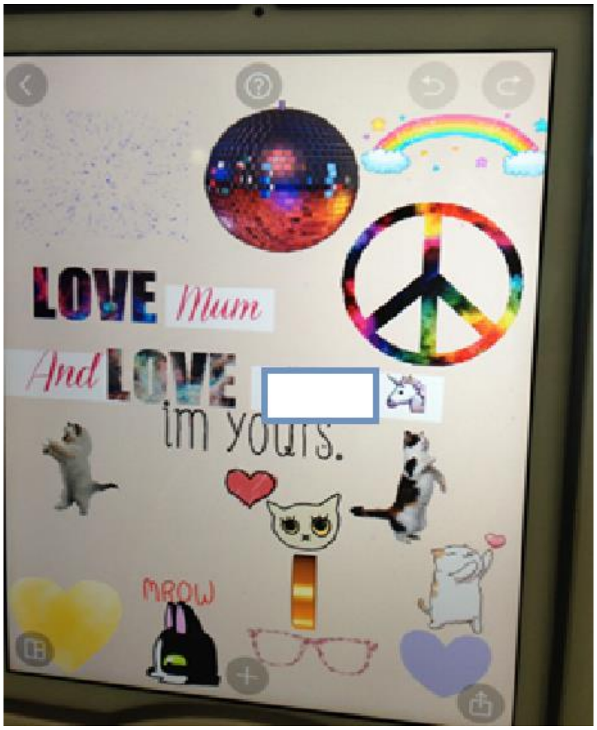


Figure 17 A digital poster produced by a Year One/two student

Working with others provided great opportunities for students to learn new digital skills and improve their own digital artefacts through discussion of the content as well as applications' functions. For instance, Phoebe, the Year One/Two student, showed great interest in browsing others' works on Seesaw, and posted a simple comment like "*its cool*", after seeing Jane's digital poster (see Figure 17). She then sought communication by discussing with Jane for detailed information about how to create moving stickers and insert them into a digital poster. I observed a high level of communication and collaboration in the online space while the students were working and interacting with each other. Phoebe gained new knowledge of how to create a moving sticker and how to insert these stickers in terms of improving the content of her ePoster. Such collaboration practices involved the students in the knowledge process of 'analysing' in which the students were encouraged to criticise their position and evaluate their own learning through sharing, communicating and taking other perspectives and suggestions.

Phoebe and Jane's story showed strong evidence that iPads and Seesaw enhanced students' collaborative learning experiences both online as well as in classroom.

Collaboration with wider communities

Seesaw enabled the students to learn and share knowledge in a bigger community, including exchanging ideas with students from different learning communities.

According to Kate, Year One/Two teachers used Seesaw for online collaboration because it invited parents and students from higher grades to become part of young students' learning journeys. She said, "*Peers from other learning communities, teachers, and parents can access students' learning through reading their online posts*". The students from different classes could see the works created by other students, learn from them and provide feedback. Students could improve their digital artefacts, and gain new knowledge and skills by considering perspectives and suggestions from teachers and more capable students from higher grades.

A good example of utilising digital technologies' connectivity for promoting online communication and collaboration within a wider community was reported by Kelly, the art teacher. All the students in the school were invited to participate in an art learning project about "weaving" for a period of nine weeks. The students from the Foundation Year were asked to develop shoelaces tying skills at the end of the class. While Year One/Two students were asked to weave coloured strips of paper or cut paper plates to weave a lattice. Videos and instructions on how to tie shoelaces or weave paper strips were uploaded on Seesaw for students to read and develop their own learning projects. Some students shared photos of their grandparents' knitting, and others recorded videos showing how their grandparents or aunties knitted. These images and videos were uploaded to their shared art project folder on Seesaw about how to create patterns of weaving.

As a consequence of this project, the students learned about different types of weaving, such as making knots, knitting, and basket weaving. They evaluated and improved their own weaving artworks based on teachers' and peers' comments. Kelly said, *"the idea of having one space [the digital learning space on Seesaw app], is that everyone can contribute, and see the learning process right in front of them."*

Generally, online collaboration on Seesaw enhanced young students' learning experiences because they received support and suggestions from capable students, teachers and their families through online posts and comments. Moreover, young students were motivated towards learning, since they could make their own unique contributions in multimodal ways using collaborative learning practice with digital technologies (Niemi & Multisilta, 2016).

Collaboration in classroom

Collaboration among the Year One/Two students was promoted by the inclusion of digital technologies (e.g., iPads and Seesaw). Digital technologies provided a wide range of digital tools (e.g., drawing function, camera, audio/video recorders, and digital editing interface) enabling students with varied abilities and strengths to work together effectively. Rose, the Year One/Two teacher, suggested that "*students can use their different intelligence to work together on iPads.*"

The learning story about Tan, Jacob, and Emma (see a detailed description of the learning story from pages 228-230) showed a good example of how iPads and Seesaw facilitated a group of Year One/Two students to create a digital story about “a fluffy dog” collaboratively. The group of students decided to use comic book templet and worked out three ways including body actions, photo illustrations and monologue to represent the story. Tan was familiar with using different templets from Seesaw and then suggested to use comic book templet to create short narrative writing. Emma contributed to the storytelling by arranging performance with Tan by acting out three events. Jacob who was passionate about taking photos recorded the performance on iPads and inserted the pictures into the comic book templet. The group members gained opportunities to exchange their ideas, skills, and knowledge to construct the digital story. The collaboration level was high as digital technologies enabled all group members with different learning abilities and interests to contribute to producing creative narrative writing.

Using digital technologies to reinforce the collaborative learning environment, both online and offline, is an effective implementing approach in early primary school classrooms. Collaborative learning allowed the young students to receive more support, suggestions and comments from capable peers and adults to reconstruct their digital, literacy and numeracy knowledge and improve their digital artefacts.

6.3 Chapter Summary

In this chapter, I outlined my research results about digital technology mediated learning activities in the I-Create theme, which mainly engaged the students in the knowledge process of analysing and applying in the Learning by Design framework (Cope & Kalantzis, 2015). The majority of creative learning activities were recorded from Year One/Two learning communities.

The findings showed that creative practices were considered the most challenging learning practices because they required higher-order thinking skills and advanced digital skills and competence were required for this type of learning activity. Digital technologies contributed to students' performance in class and supported their learning skills. The learning activities were complex: students were asked to create digital products and multimodal texts including eBooks, digital stories and digital graphs. Students increased their knowledge by searching for relevant information, developing narrative writing and solving mathematical problems.

In addition, the findings in this chapter showed that digital technologies could support young students' learning (literacy and numeracy) and enhance their collaboration skills while creating digital stories, eBooks and mathematical graphs. The students were critical and creative when they used digital tools and materials to produce digital artefacts based on their personal interests. In general, the students developed a wide range of learning skills, such as problem-solving skills, communication skills, critical thinking skills, and creative skills which were major features of 21^{st}-century learning (4C skills).

The teachers valued digital technologies for the creation and production of new artefacts, and believed them to be effective in engaging the students in meaningful learning. Teachers applied mixed pedagogical approaches—such as providing explicit information about the learning content and brief instructions on the use of digital technologies—to encourage their students to creatively applying their learned knowledge and digital skills to produce digital artefacts. Year One/Two teachers allowed young students to select digital tools and resources based on their interests and learning needs, thereby encouraging their creative experience. At the same time, they promoted online sharing on Seesaw, which established a collaborative learning environment.

In the next chapter, I synthesise and discuss the findings, comparing teachers' perspectives and my observations of using digital technologies for teaching and learning. I revisit and review the data based on my experience and cognitive understanding of the use of digital technologies in a past teaching career and in relation to the literature.

CHAPTER 7

Discussion

Yelland and Masters (2007) argued that rapid changes in digital technology had happened outside schools, but traditional educational practices have not kept pace inside schools. They further suggested that new learning practices and new approaches, that unpacked the possibilities and potentials of digital technologies, were required for preparing 21st-century students. With new skills, they could work flexibly and collaboratively in the information society. These arguments and suggestions guided me to explore students' interactions with digital technologies, as well as teachers' pedagogical perceptions and practices related to implementing digital technologies in a contemporary primary school setting. To answer the main research question–*How are digital technologies implemented in contemporary Australian primary school classrooms to support students' learning?*–the following sections weave together the discussions about how digital technologies were implemented through the three themes and across the curriculum, the benefits that young students gained from using digital technologies, and the factors that might enable such implementation in a formal educational setting. My research showed that students and teachers engaged in meaningful learning practices that utilised a wide range of digital technologies. The learning stories from the case study school illustrated digital technologies' ability to empower students with digital skills and competencies.

Digital technologies (e.g., iPads and educational applications) enhance young students learning experiences and support then to develop various learning skills including digital operational skills, collaboration skills, literacy and numeracy skills and, creative skills, which are all important 21st-century' learning skills.

My qualitative research examined and explored current features and conditions of digital technology implementation in an Australian K-6 primary school, and drew on data resources that were collected through teachers' interviews (five classroom teachers and one art teacher), classroom observations (34 entries) and students' artefacts. Learning stories were developed to illustrate the way young students used digital technologies in their learning of literacy, numeracy, arts and science subjects and to illustrate the teachers' pedagogical practices in implementing digital technologies in primary school classrooms. The digital technology mediated learning activities were categorised into three themes: I-Ready, I-Practise and I-Create. The Learning by Design framework was used to analyse learning stories using four dimensions: experiencing, conceptualising, analysing and applying. My analysis of these learning stories focused on exploring the potential of iPads and educational applications such as Seesaw and Literacy Planet in innovative teaching and learning practices, and I investigated their impacts on students' learning across the primary school curriculum. I concluded that digital technologies were being implemented thoroughly in the curriculum in the case study school, and that students' engagement, collaborative learning experiences, independent learning experiences, and literacy and numeracy learning were being enhanced through digital technology mediated learning activities.

7.1 Research Outcomes and Discussion

Australian governments pursue the goal of fully unpacking the potential of digital technology for learning by encouraging schools and educational sectors to implement digital technologies into and across the curriculum (ACARA, 2012a). The key findings of my study show that digital technologies, especially iPads and educational applications, are widely implemented through literacy, numeracy, arts and science for facilitating young students' learning in the case study school. However, the national and Victorian curriculum guidelines about digital technologies are brief and provide few details about how to implement them. Nevertheless, in the case study school, the teachers designed rich learning activities using iPads, Seesaw and other educational applications and actively engaged young students in activities that fall under the I-Ready, I-Practise and I-Create themes. The teachers used digital technologies (e.g., iPads, Smart TVs, and educational applications) in student-led learning activities including playing literacy games, taking pictures of teachers' notes and creating multimodal texts. The case study teachers recognise the value of digital technologies for learning, in a line with Australian learning frameworks and educational documents (Lynch & Redpath, 2012).

The I-Ready, I-Practise and I-Create themes were identified based on the Learning by Design framework, and were used to illustrate a full picture of the implementation of digital technologies in the case study. The learning stories described within these themes also show that digital technologies have the potential for supporting young students to develop digital skills, literacy and numeracy skills through a collaborative learning environment. In addition, the case study school teachers displayed pedagogies that supported early learning and development through the use of digital technologies with the guidance of the curriculum (e.g., literacy, numeracy, and digital technology). The analysis of data revealed that all three themes of digital technology mediated learning activities are important for fully unpacking the potential of digital technologies in terms of supporting students' literacy and numeracy learning in an early primary school setting.

I found that the case study school teachers were heavily influenced by cognitive developmental theory which emphasises delivering learning content that suits students' digital and cognitive abilities. Both Foundation Year and Year One/Two teachers demonstrated their pedagogical understanding of implementing digital technologies for extending young students' learning through producing and creating digital artefacts in the I-Create theme, which is strongly constructivist. Such pedagogical understanding of implementing digital technologies are also consistent with the Year One/Two teachers' pedagogical practices. However, many of the learning activities with iPads were categorised in I-Practise, which indicates that digital technologies are heavily implemented for supporting traditional classroom practices focused on knowledge transmission, such as engaging young students in drill and practice and documenting activities to gain conceptual literacy and numeracy knowledge.

The results of this study suggest that the case study Australian primary school employed digital technologies across the curriculum for meaningful learning. The pattern of implementation I identified, through the themes of I-Ready, I-Practise and I-Create, represents a useful model for other early childhood educators and primary school teachers to tailor and adapt so that they might be able to fully unpack the potential of digital technologies to support their students' literacy and numeracy learning in their own classrooms.

The following sections build on the nature of young students' interactions with digital technologies by describing and analysing documented learning activities. I used the Learning by Design framework (Kalantzis & Cope, 2005) to illustrate the ways that digital technologies were being implemented in the primary classrooms in which I conducted my research.

7.1.1 Implementing Digital Technologies through I-Ready, I-Practise, and I-Create

I developed Figure 19 to represent the three main themes as a series of overlapping and nested circles. Each circle is part of the other circles. Each circle represents one theme of digital technology use in an early primary school classroom under current implementation conditions.

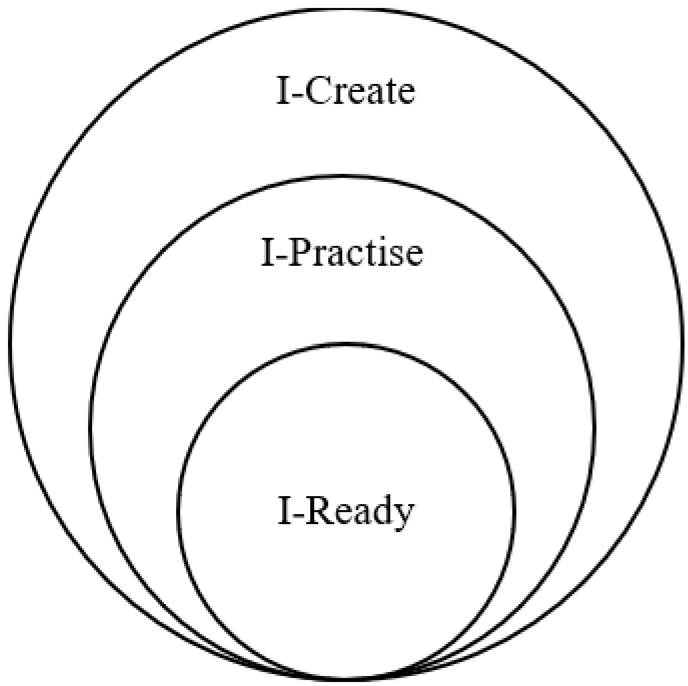


Figure 18 Three main themes of digital technology mediated learning activities

I-Ready

In the I-Ready theme (the smallest circle in Figure 19), digital technologies including iPads, Seesaw and, Literacy Planet support young students to develop basic digital operational skills and competencies, such as identifying icons, logging into Seesaw and using the airplay function. This theme also encompasses using hardware and software safely and appropriately, such as holding iPads with both hands and using their applications for learning. The Foundation Year students were mainly involved in learning activities from this dimension, because they were encouraged to explore, navigate and experience new functions and features of iPads and educational applications (Cope & Kalantzis, 2015).

I-Practise

In the I-Practise theme (the middle circle in Figure 19), digital technologies are commonly implemented in the form of drill and practice and to document practices that reinforce students' literacy and numeracy learning, such as spelling, sentence structuring and measuring. In my study, the Year One/Two students were mainly involved in the Learning by Design framework's conceptualising dimension (Cope & Kalantzis, 2015). Most of the learning activities within the I-Practice theme involve students in learning abstract concepts and terms from the literacy and numeracy curricula. Digital technologies are implemented in repetitive formats to reinforce the students' conceptual and theoretical knowledge of literacy and numeracy.

I-Create

In the Create theme (the largest circle in Figure 19), the digital technology mediated learning activities are designed to enhance creativity. They allow the students to utilise their digital skills, and literacy and numeracy skills, to combine different modes including visual, audio, and spatial modes to create multimodal texts and solve new problems such as creating eBooks, ePosters and digital graphs. Hence, the Year One/Two students were involved in the Learning by Design framework's analysing and applying dimensions (Cope & Kalantzis, 2015). According to Cope and Kalantzis (2015), the applying dimension is the most important element in the framework, because the associated learning activities extend students' learning as they generate new knowledge and solve life-related problems in the process of creating multimodal texts. The students actively participate in the deep learning process as they are developing new ideas from searching relevant information online, applying learned knowledge to solve numeracy problems, creating multimodal texts (e.g., eBooks, digital slides and digital stories), and collaborate and communicate on Seesaw. These digital technology mediated learning activities encourage the students to apply their learning experience and knowledge, the ultimate goal of full implementation of digital technologies in formal educational settings (Bailey & Blagojevic, 2015; Fullan, 2013; Yelland, 2006).

My research shows that the I-Ready, I-Practise and I-Create themes are needed for fully unpacking the potential and possibilities of digital technology in terms of support young students' literacy and numeracy learning. The I-Ready theme is placed within the other two circles, which indicates that being a functional user who can use digital devices, software and programs appropriately is essential (Hill, 2004). This is because the students with basic digital skills can use digital technologies for more complex tasks like creating and producing multimodal texts. First year students' digital operational skills and knowledge such as logging into Seesaw, setting up Wi-Fi and uploading digital files are still emerging. Organising learning activities in the I-Ready theme shows that teachers from the Foundation Year are influenced by developmental theory. They consider young students' digital abilities and development stages and teach developmentally appropriate content for children (Piaget, 1964) in the process of implementing digital technologies. Their pedagogical practices align with major early learning childhood frameworks and policy advice as developmental theory is widely introduced to early learning frameworks and curricula (Fleer, 2011b).

During Foundation Year, the students in the case study school develop basic operational skills, and are able to use digital technologies more effectively for their learning purposes (I-Practise) when they move to Year One/Two. Digital technologies are implemented throughout the literacy and numeracy curriculum in I-Practise, and digital technologies are mainly used for reinforcing traditional classroom practices like drill and practice and documenting learning. Smart TVs display learning content and provide instructions to the students. Seesaw is used for reinforcing young students' understanding of the rules of sentence structure, direct comparison and phonic awareness in repetitive small tasks like correcting sentences digitally (which could be done with pen and paper). The learning activities within I-Practise are still designed to practise traditional learning aspects, such as typing words and editing writing which reinforced the traditional learning skills such as spelling and punctuation. The Year One/Two teachers reported that using digital technologies for drill and practice was not transformative—they were used as "*replacement tools".* Since, these types of learning activities did not promote young students in using digital technologies to produce multimodal texts, generate new knowledge or work out the solution to new problems. Cope and Kalantzis (2015) have also argued that it is important to elevate students to reach the applying dimension (associated with I-Create) rather than remain in the conceptualising dimension (associated with I-Practise) to ensure the students engage in deep learning. Other authors have argued that using digital technologies for drill and practice merely reinforces the taught skills and concepts that might limit students' imagination, curiosity and creativity (Clement, & Sarama, 2003).

Plowman and his team (2012) reported a similar finding that digital technologies were still mainly implemented to replace pen and paper for reinforcing students' conceptual understanding about terms and concepts in literacy and numeracy learning; and were mainly implemented in early childhood setting for reinforcing rote learning skills such as handwriting, documenting, editing and calculating. Kerckaert and his team (2015) also found that the current implementation of digital technologies in early childhood and primary school settings were considered as less effective as digital technologies were mainly used for lower-order tasks such as practising drill and practice, documenting and word processing. And less learning activities with digital technologies were designed to promote deep learning that engaged the students in deep learning processes such as problem-solving, critical thinking and creating (Billington, 2016; Plowman & Stephen, 2006; Yelland, 2015b).

Although I expected that the majority of digital technology mediated learning activities would fall into the I-Ready and I-Practise themes, I observed many I-Create learning activities in Year One/Two learning communities. This indicates that the Year One/Two teachers are attempting to implement digital technologies to extend students learning rather than reinforce traditional classroom practices. The learning activities within I-Create theme enable the students to shift from digital customers to digital producers. They utilise the internet-enabled features on iPads to extend their learning and share it with a wider community in the process of producing new artefacts (i.e., digital stories about “a fluffy dog” or, the eBook about “the magic recipe”). Such use of digital technologies is innovative and creative, because the teachers reported that these learning activities are rarely done with traditional learning tools (e.g., pen and paper). These activities allow the students to apply their skills and knowledge about digital technology, literacy and numeracy, which recent research promotes as a goal of the full implementation of digital technologies (Bailey & Blagojevic, 2015; Fullan, 2013; Yelland, 2006).

Many researchers have urged teachers to fully integrate digital technologies into their pedagogical practices to perform learning activities in the I-Create theme (Burnett, 2016; Cope & Kalantzis, 2015; Keane, Keane, & Blicblau, 2016), but digital technology mediated learning activities from the I-Ready theme are also important. Preparing young learners to be ready with solid digital skills and relevant knowledge for their future learning is an important teaching strategy for implementing digital technologies. Due to young students' nascent cognitive development and limited digital abilities, it would be too ambitious to recommend that Foundation Year teachers seek to mould students into creative digital producers. In the national curriculum, teaching students how common digital systems work and can be used for different purposes is a core assessment criterion (ACARA, 2012a). When students have already become proficient about digital technologies, teachers should consider extending their digital skills to other learning areas and design learning activities in the theme of I-Create rather than simply applying digital technologies for I-Practise learning activities in form of drill and practice reinforcing rote learning. In the case study school, the participate teachers' pedagogical practice of implementing digital technologies through the themes of I-Ready, I-Practise and I-Create is highly consistent with the ideology and principles embedded in the Australian National curriculum.

Teaching approaches for implementing digital technologies

My research revealed various approaches used in the case study school for implementing digital technologies through the themes of I-Ready, I-Practise and I-Create.

The Foundation Year teachers tended to provide direct and explicit instructions using a modelling approach to teach digital operational skills while organising learning activities within the I-Ready theme. Arthur et al. (2012) viewed direct or explicit instruction as the most appropriate strategies for teachers to introduce new concepts or skills. For instance, Amanda, the Foundation Year teacher, explained and modelled the procedure of mirroring an iPads' screen to a Smart TV using the Airplay function including identifying the Airplay icon, pulling up the hidden menu and selecting the correct name of the device to her students. According to Vygotsky (1980), explicit and instructional teaching approaches lead the students' potential development as it scaffolds the students to process ahead of their current development stage. Accordingly, the Foundation Year students learned how to operate some advanced iPad functions (e.g., Airplay function) and complex applications (e.g., Seesaw and Literacy Planet) with the scaffolding of their teachers through oral instructions and physical demonstrations. However, direct and explicit instructions might restrict students' agency in terms of using iPads and Seesaw, and provide less time for students to interact with iPads and application by themselves.

Year One/Two teachers applied a free choice approach, involving providing relatively few instructions on how to operate iPads and their applications and allowing freedom for the students to select digital tools and resources based on their interests and learning needs in the I-Create theme. For instance, Kate and Rose, the Year One/Two teachers, provided no suggestions on the applications or tools to use in the learning activity of creating digital narratives (i.e., a fluffy dog). This approach promotes the students' creative skills and critical thinking skills, because students have to consider functions and features of digital tools and application critically and judge on which one would work best for their tasks such as eBooks, ePoster or digital stories. It has been claimed that students engage in meaningful learning when they create their own digital products using familiar digital tools and resources (Robin, 2008). In this way, I observed that digital technologies were often used to engage Year One/Two students in learning and extend their current knowledge to a wider context instead of merely displaying learning and teaching materials. The teachers sought to build students' understanding of and capability to use digital technologies for their own learning needs to ensure that digital technology stimulated meaningful learning.

However, after analysing learning activities within the I-Practise and I-Create themes, I found that Year One/Two teachers neglected their roles as scaffolders on some occasions. They tended to provide little scaffolding and supporting while students used iPads and applications in the learning activities from the themes of I-Practise and I-Create. This might because Year One/Two teachers are influenced by the play-based pedagogical perspective embedded in Australian's early learning frameworks and curriculum (Department of Education and Training, 2015). Play-based learning activities can help young students to develop their learning strategies, and gain knowledge of language and literacy through interacting with information from digital technologies, with capable adults' support and scaffolding (Qian & Clark, 2016). According to Rosen and Jaruszewicz (2009), this is the most effective way to integrate digital technologies into the early childhood setting. Therefore, teachers' instructions and scaffolding are always important to ensure meaningful learning while young students are encouraged to explore with iPads and educational applications.

In summary, I found that Foundation Year and Year One/Two teachers' pedagogical approaches to implementing digital technologies were associated with their constructivism pedagogical philosophy. The teachers from the case study school applied a wide range of pedagogical approaches, including providing explicit instruction, modelling, explaining and free choice in terms of implementing digital technologies. Teachers' scaffolding and assistance are always required to ensure the successful use of digital technologies for learning purposes. A wide range of pedagogical methods are required to ensure teachers switch between being an instructor, scaffolder, and facilitator when promoting meaningful learning with digital technologies (Cope & Kalantzis, 2015).

7.1.2 Implementing Digital Technologies Across the Curriculum

My observational data indicated that digital technologies were widely integrated into many learning areas of the curriculum in the case study school. Rosen and Jaruszewicz (2009) argued that teachers should apply both technologies and pedagogy knowledge to map out the digital technologies throughout the curriculum. The case study school stressed the importance of developing literacy and numeracy and this clearly influenced the teachers' use of digital tools and resources with young students. iPads, and literacy and numeracy resources including eBooks, literacy and numeracy games and YouTube videos were applied intensively in most of the classes for supporting young students' literacy and numeracy learning.

Enhancing literacy learning

My findings indicate that digital technologies offer a wide range of learning resources such as eBooks, video stories from YouTube, and educational games from Literacy Planet and Reading Eggs which enhance young students' literacy skills such as fluency, reading comprehension and matching phonemes and graphemes. They echo previous researchers' arguments that spelling, writing, and communicating skills can be improved in the process of manipulating digital devices and resources for literacy learning tasks (Niemi et al., 2014).

The observational data shows that iPads and literacy applications enhance the students' literacy skills by offering numerous literacy and language resources such as eBooks, videos and interactive reading tasks which contributed to building up their vocabulary, reading comprehension, and phonic awareness. This finding echoes Flewitt's report (2014) that digital technology offers countless language resources for students to interact with to broaden their knowledge about the world. My study shows that young students' fluency, the knowledge of phonics and graphics and knowledge of text feature and organisation are improved and enhanced through reading materials based on their interests and suited to their reading abilities. For instance, a Year One/Two student (Oliver) learned the word astronaut through reading an eBook (Spaceman) in the silent reading activity. Two Foundation Year students wrote the informational text to provide facts about floods after watching its ABC video report on iPads. Both Foundation Year and Year One/Two teachers explained that their students' literacy skills were improved because the students could read digital books and watched news reports on iPads which contribute to building up their vocabulary and reading comprehension. Needless to say, digital technologies have the potential of improving young students' literacy skills by providing rich literacy learning resources.

My research also shows that digital technologies, especially, iPads, offer multimodal tools and resources such as cameras, digital drawing, and audio and video recording, which allow young students to make meaning effectively through the process of composing multimodal texts. Binder and Kotsopoulos' (2011) research with Canadian children (aged under five years) developed multimodal narratives in an early learning centre confirmed that utilising the visual arts for literacy teaching and learning could be a means for students to express ideas and understanding more effectively. The research applied a similar method but with much younger learners compared to my research. Their research showed that young children could use multimodal literacy narratives to explore and express their understanding of what was important to them and consider how they fit in as a member of a classroom literacy community (Binder, & Kotsopoulos, 2011). They have assumed that by enacting multimodal expressions of understanding, young students would feel validated and empowered which allows them to reconstruct and reconceptualise their understanding and knowledge better about the world. In this way, "multiple forms of literacy broaden, extend and transform the traditional use of literacy" (p. 341). Similarly, in my research, the students' literacy skills improved because iPads offered affordable learning tools and resources (e.g., Seesaw, and Book Creator) allowing the creation of eBooks, digital stories and digital posters to express their learning and understanding about the learning topics in a flexible learning environment. The process of creating multimodal texts with digital tools and resources allows students to practise literacy skills and gain literacy knowledge better (Flewitt et al., 2015). In addition, Wood (2013) suggested that the multimodal narrative could be a means for a student to express their ideas and understanding and promote their literacy learning by enabling them to think critically in terms of using different digital tools and modes to compose the multimodal texts.

Research conducted in Australian pre-schools has shown similar results that implementing digital technologies in literacy learning activities supports young children to develop literacy skills such as letter and word recognition and talk around play through photographing, storytelling, drawing, and audio recording (Dezuanni, Dooley, Gattenhof, & Knight, 2015). The research indicated that using digital technologies to assist students to develop early literacy skills is a reliable approach. This method enhances the level of communication and learners' confidence. The students were offered multiple tools to express their thinking and understanding, such as digital images, video tools, and audio tools to represent meaning in multimodal ways. Students' literacy skills such as spelling, and speaking are practised and improved through consistently drawing, typing, and recording when they communicate and present their ideas using familiar modes (Chun-

Ming, Hwang, & Huang, 2012; Niemi et al., 2014). Similarly, my data indicates that students' literacy skills are improved through typing, spelling, playing letter recognition games and creating digital storytelling.

In conclusion, digital technologies have the potential to enhance primary students' literacy skills by providing multimedia options, digital learning resources, and multimodal tools. Moreover, students' literacy skills such as reading, writing, and speaking are improved when they use digital tools for digital storytelling, eBooks and videos to express their thinking and understanding.

Enhancing numeracy learning

My research shows strong evidence that digital technologies improve students' numeracy learning. The students' numeracy skills—such as counting, operation, and data analysing and representing—developed when they were learning with their iPads. Digital technologies provide learning tools and resources for young students to utilise to explore new ways to solve life-related mathematical problems.

Huang (2014) and his team found that Year Two students from Taiwan experienced better learning outcomes when using digital technologies in numeracy learning because game features and in-built instructions eliminated students' fears and frustrations when they did mathematical tasks. The students appeared to enjoy and feel motivated towards learning and practising numeracy skills and knowledge. My data from teachers' interviews confirmed that students could interact effectively with iPads, when working on Mathletics. They received support and guidance such as in-built instructions and immediate feedback from the program. This enabled them to consistently reflect on their learned mathematical theories and concepts such as the principles of number orders, number values, and calculation (Neumann & Neumann, 2015). Therefore, it can be concluded that multimodal functions and educational numeracy games increase students' motivation and interest in doing mathematics tasks, which improves their students' mathematical comprehension and application (Huang, Huang, & Wu, 2014).

My research shows that digital technologies provide students with a wide range of tools and resources, which encourage them to explore new approaches and methods to solve mathematical problems. The learning story about creating digital graphs, in which Year One/Two students used iPads and Seesaw to study their classmates' favourite ice-cream flavours is an excellent example. iPads and Seesaw provided multimedia tools that enabled the Year One/Two student to use the audio recorder to collect the data, digital calculator and table generator to interpret data and create a digital graph to represent data to address his investigation question. Geiger, Goos, and Dole (2015) found similar results from their research across primary schools and middle schools in South Australia to investigate the ways that digital technologies could be implemented to support students' numeracy learning. They reported that digital technologies supported the student to gain numeracy knowledge such as numbers, geometry, algebra, and calculus within life-related contexts (Geiger, Goos, and Dole, 2015). My research findings present similar results as the iPads and their multimedia tools enable young students to solve a new problem within life-related contexts.

In general, digital technologies, especially iPads, provide a wide range of learning resources and tools to enhance young students' numeracy learning experiences (Papadakis et al., 2016). iPad offers multimodal functions, inbuilt feedback and instructions, and sound and visual effects in numeracy tasks which increase students' interest in and motivation towards numeracy learning. These features allow young students to gain an easy understanding of the mathematical task and problems and motivates them to use different methods to solve mathematical problems which in return improve their numeracy knowledge and skills.

7.1.3 Young students Benefit from the Implementation of Digital Technologies

Engagement

My research shows that iPads and Smart TVs and other digital resources are employed to engage students in learning activities, and that the level of students' engagement is high in general. Students in both Foundation and Year One/Two learning communities were frequently engaged in learning activities with digital technologies classifiable within the I-Ready, I-Practise and I-Create themes. This finding aligns with the current educational policy that teachers design learning activities that involve various methods and tools to engage students' interests in multimodal learning and teaching materials (DEECD, 2018).

The participating teachers reported that the students' engagement was quite high when digital technologies such as iPads, Smart TVs and applications were employed. For instance, Jessica, the Foundation Year teacher, noted that her students showed high willingness to use iPads, and they concentrated for a longer time in such activities than they did when using print materials. The observational data also indicated that students from both Foundation and Year One/Two showed great attention to the screens of the iPads, Smart TVs and Smartboards when they were learning, and their engagement levels were high when they used iPads for creating, communicating and sharing purposes. Most of young students stayed on task for a longer period of time on their iPads according to Kate, because sound, moving images and an interactive interface held their attention. Likewise, Spatariu, Bell, Peach, and Winsor (2011) suggested that digital technologies could support young students' learning by increasing their motivation and engagement on learning tasks. Niemi and Multisilta (2016) confirmed that students (aged from 10-12 years) from three countries (Finland, Greece, and California) were more engaged when digital technologies were applied in the classroom. Their research reported that the students were interested in and enjoyed using computers, digital recorders, and MoViE software to construct and create digital stories as video clips (Niemi, & Multisilta, 2016).

Their evidence showed that the use of digital technologies had the potential to increase the students' engagement level and had a positive impact on students' motivation and enthusiasm toward learning which enhanced the students' engagement in classrooms (Multisilta et al., 2012; Niemi & Multisilta, 2016).

My research shows that interactive games allow young students from Year One/Two to develop their literacy and numeracy knowledge and skills in easy and enjoyable ways due to their game scenarios, sound effects, moving characters and colourful backgrounds. Literacy and numeracy games from educational applications increase the students' motivation towards learning as they were amused by multimedia features such as interactive cartoon characters (e.g., the Monster game from Literacy Planet), hyperlinks, and sound while reading eBooks, doing drill and practice and creating multimodal texts. The findings of my research agreed with the literature that reported that students showed greater engagement in numeracy learning activities when iPads were applied in Year Three primary classrooms in Australia (Attard, 2012). The students were enthusiastic when they worked on mathematical games and watched a mathematics video tutorial from the internet in terms of practising mathematical skills and developing the understanding of mathematical concepts. Attard (2012) found that overall engagement was increased due to the multimodal features of digital tasks including sound, images and the interactive interface.

Banaszewski (2005) found that students were more engaged when digital technologies were used in the classroom compared to solely using a textbook for teaching when they participated in storytelling activities. In addition to the learning context, digital aspects, such as videos, digital images, and the internet, engaged students more. His research showed that most of the students were highly engaged with digital tools and resources in the upper primary classrooms (Year 4—12). It is claimed that young students can learn more effectively when digital technologies are included as they create an innovative and attractive learning environment such as including game and cartoon features in tasks that catch the young students' interests and attention and encourage them to do more tasks (Judge, Floyd, & Jeffs, 2015; Lui & Lee, 2013; Neumann & Neumann, 2015; Verenikina & Kervin, 2017).

However, Banaszewki (2005) found that some students showed relatively little interest in using computers for their learning tasks, even though the general engagement was high. He suggested that this might be because they were engaged more with other types of learning tools and resources, such as books, counters and puzzles. Banaszewki's study was based on desktop computers and educational software on creating digital stories which might be difficult for young students to interact with. My research involved more user-friendly iPads, and showed that most students were interested in using traditional learning tools and materials for learning. It seems that students' preferences for and varying interest in traditional and non-traditional learning tools and material influences their engagement with digital technologies. Teachers should acknowledge this and allow students to choose the tools and materials they are comfortable and confident in using rather than pushing them to use iPads for every learning activity.

Pierotti (2006) also reported students who showed less interest in using computers and other types of digital devices, due to their lack of experience with digital technologies. These students had a hard time using computers to perform digital tasks, and many avoided using them (Pierotti, 2006). My research found similar results with iPads, that students who developed fewer digital operational skills had a lower engagement. For instance, Mia, the Foundation Year student, simply quit her iPad when she found it difficult to use Seesaw in the I-Ready learning activity. I observed that engagement was higher when students who obtained well-developed digital skills. Therefore, digital operation skills should be taught to teach to ensure a higher level of engagement. This also indicates that learning activities from the I-Ready theme are important, as these learning activities equip the students with basic operational skills to ensure that students are actively engaged in digital technologies mediated learning activities.

Consequently, digital technologies enhance students' engagement in literacy and numeracy learning practices. Digital technologies encourage students to utilise different senses and modes for learning, such as visual, acoustic and animatic. It could be concluded that digital technologies had advantages of engaging students in learning and increasing students' motivation towards learning (Niemi, Multisilta, 2016).

Collaboration

Collaboration is an important learning skill for 21st-century classrooms. Johnson and Johnson (1986) stated that to reach a higher level of comprehension and thought, as well as conservation of knowledge, collaborative learning is needed compared to individual learning. Collaboration is a crucial skill for young students (Bahle et al., 2017); working in pairs provides opportunities to exchange ideas and experiences and learn by communicating, sharing and constructing knowledge about the use of digital technologies. Roschelle and Teasley (1995) reported that promoting collaborative learning with digital technologies may engage the students in meaningful learning.

I captured various types of collaboration from the four learning communities. Individuals in pairs and groups helped each other to solve technical issues or grammar and spelling problems. I often observed peer tutoring, in which capable students taught others to take photos, spell, construct sentences and use iPads. Online collaboration was observed more commonly in the Year One/Two learning communities; they uploaded their learning evidence including multimodal texts, images, audio and video recordings into Seesaw, and posted comments on other students' work to share their thoughts and ideas.

I observed Seesaw increased collaboration between students as it encouraged the students to upload their digital artefacts and comments for exchanging and sharing their ideas and learning experience online. Kelly, the art teacher, reported that her students were inspired by viewing different learning evidence and ideas and tried to apply others' ideas and comments to improve their own digital artefacts. Vygotsky (1978) pointed out that learning new ideas and perspectives from others helps students to reconstruct their prior knowledge about the learning topic and the world. Kelly's insight echoes VanderArk and Schneider (2012), who suggested that students are inspired by watching and learning from others' work online. They found that digital technologies provide a rich learning environment that promotes collaborative learning. They also claimed that digital technologies have possibilities to improve the level of collaboration via increasing online sharing and communicating which in turn promotes deep learning. In my own research, I observed that uploading one's work into the Seesaw online learning space built up a student's awareness of their contribution. Students develop a strong passion for learning when they feel that they are contributing not only to their own learning progress but also their learning community, which increases their drive to improve and extend their work (Nicolaidou, 2013). In this way, students are not only reaching their goals but helping others to reach theirs.

Collaborative learning on Seesaw allowed the participating students to show their parents and wider communities how they engaged in various aspects of the curriculum in the school. Kelly, the art teacher, reported that the students from different years, teachers from different learning communities and students' parents could be included in Seesaw for knowledge sharing. According to Rosen and Jaruszewicz (2009), the most exciting possibility that digital technologies afford is that all stakeholders are included in the learning process, which makes a stronger connection between school learning and students' personal learning at home. Students learn more effectively when they can share their works and learning experiences from home and to different learning communities, and get support and supervision from their parents, siblings and other members of their communities (Price, 2015).

My research also shows that digital technologies allow people with different abilities and strengths to work together effectively. For instance, Jacob (Year One/Two) took photos to illustrate his digital story “A fluffy dog”, his group member, Tan, who was good at typing and editing, wrote the accompanying text to explain the illustrations. Both students contributed to composing a meaningful digital story using tools and skills that they were good at and familiar with. This confirms Standley’s (2003) conclusion that digital technologies encourage collaboration between students, which in turn leads to the utilisation of students’ various capabilities.

However, Banaszewski (2005) argued that students naturally collaborate with their peers with or without the use of digital technologies. He wrote that using digital technologies did not directly affect collaboration in the classroom, arguing that most digital technology mediated activities focusing on developing students’ digital skills and competence rather than being used for promoting classroom collaboration. Banaszewski examined the use of desktop computers and more complex software in a primary school setting which might show that desktop computers had less effectiveness for promoting classroom collaboration. In contrast, in my research, the iPads' relatively user-friendly design and mobility contributed to classroom collaboration and communication by providing a flexible learning environment and multiple learning tools and resources. Besides providing digital technologies, particular teaching approaches—such as pairing up, promoting online collaboration and project-based learning activities—should be considered essential elements of fostering collaborative learning in educational settings (Banaszewski, 2005; Fullan, 2013)

In summary, my findings show that using digital technologies enhances young students' collaborative learning experiences. The observational data indicate that digital technologies encourage students with different learning abilities to work together more effectively by offering multimodal options such as audio, video and digital images. Online platforms like Seesaw encourage students to exchange and share their idea, knowledge and learning experiences.

Independent learning

My research data show that young students' independent learning experiences are enhanced when digital technologies (e.g., iPads, Smart TVs and educational applications) are included in learning practices. According to Lynch and Redpath (2012), one of the learning objectives of the Australian curriculum is to implement digital technologies for promoting independent learning, because independent learning will have a lasting impact to support students to achieve the objective of education for sustainable futures. My research indicates that digital technologies assist students to learn independently by providing digital tools and resources that cater to students' diverse interests and learning needs, so they are able to learn at their own pace utilising their strengths confidently. In the learning activities from the theme of I-Practise, iPads and closed-ended applications offer inbuilt instructions and immediate feedback, which help students to accomplish the drill and practice tasks independently.

My research findings imply that digital technologies as an effective teaching approach hold a key position in addressing the learning needs from diverse backgrounds and abilities of the students in the case study school. The Year One/Two teachers confirmed that students gained better independent learning experience when using digital technologies. The teachers reported that iPads and digital resources allowed young students to learn at their own pace and level, for instance, reading applications could provide different levels of eBooks and associated literacy tasks like reading comprehension, phonic games and spelling games for students that suited their literary abilities and reading needs. Digital resources from Literacy Planet and Ready Eggs placed the students in their levels to target their personal goals better. For example, the students had their own digital libraries with sets of eBooks matching their literacy abilities. Similarly, numeracy applications such as Mathletics provide numeracy tasks including adding, value placing and shape matching associated with students' numeracy abilities. According to Van Gils (2005), digital technologies promote independent learning by allowing students to learn at their own pace based on their own interests and learning needs. Kalas (2010) also reported that digital technologies offer opportunities to scaffold and support young students with different abilities, learning needs and diverse cultural backgrounds to learn more effectively.

According to Niemi and Multisilta, (2016), digital technologies provide diverse and customised programs and tools to suit students' learning needs, allowing students to accomplish tasks independently. Some closed-end educational applications, such as Literacy Planet, Reading Eggs and Mathletics, allowed the students in my study to learn by themselves, because they were provided timely feedback to check their answers and reflect on their prior knowledge about literacy and numeracy. Year One/Two students were able to self-assess their comprehension and understanding by doing multiple-choices tests, responding to short answer questions, and understanding blank filling tasks after reading eBooks on Literacy Planet. Feedback allows the students to reflect on their prior knowledge and encourages them to consistently reflect on their own learning process. It is claimed young students can learn more effectively as they can develop some basic literacy and numeracy skills from reflecting and evaluating their achievements with assistance and support of instructions and feedback from educational programs and applications (Burnett, 2010; Van Gils, 2005). For senior students, feedback from educational applications supports them to analyse their learning process and develop appropriate strategies for evaluation and improvement for better learning outcomes (Chen et al., 2004; Jeng, Huang, Chen, Shu, & Huang, 2015). Similarly, Lynch and Redpath (2012) reported that students acquire a wide range of knowledge, skills, and values with assistance and extra support such as the immediate feedback and in-app instructions that digital technologies offer, which promotes independent learning.

In summary, digital technologies can enhance students' independent learning experiences, through responding to diverse individual interests, abilities, and providing immediate feedback and in-built instructions. The students benefit from independent learning experiences, acquiring in-depth understandings about learning topics from the curriculum when they are able to direct their own learning based on their learning abilities and needs and with the assistance of in-built instructions, and can reflect on their own learning processes with feedback.

7.1.4 Enabling Factors for Implementing Digital Technologies in a Primary School

Digital resources

This research explored the use of digital technologies resources in an Australian primary school. The case study school was selected as a study site because it had a well-established digital infrastructure learning environment consisting of various new digital devices, high-speed wireless connections, and a BYOD policy to implement digital technologies. Each observed classroom had digital resources such as Smart TVs, Smartboards, interactive surface computers, digital cameras, iPads, educational applications, and an internet connection. The times of each device used were varied when viewed from an individual student's use. For instance, iPads were the most frequently used for both Foundation Year and Year One/Two students. Because the curriculum focused on literacy and numeracy subjects, digital literacy and numeracy materials (e.g., eBooks, video stories, Literacy Planet and Mathletics) were relatively more common and have been infiltrated into the learning environment.

Digital infrastructure and technical support underpin a school's full implementation of digital technologies (DEECD, 2018). It is suggested that a school should provide teachers and students with reliable, available and sustainable digital learning environments including obtaining, resourcing and budgeting for digital hardware as well as software (DEECD, 2018). The statement indicated that high-quality digital tools and infrastructure, and digital resources are needed to allow schools to build such sustainable digital learning environment where both teachers and students could obtain access to a wide range of digital technologies for teaching and learning practices.

The BYOD policy allows students to bring their own tablets computers to school as part of their learning experience which ensures students' access to digital technologies during class time. According to Pedró (2011), guaranteeing access to digital technologies by reducing the ratios of digital devices helps to ensure access to and equitable use of technology; and allows students to gain rich digital experience. For instance, the

Foundation Year students gained more opportunities and longer time working on their own iPads (comparing to sharing one iPad) to develop digital skills during the I-Ready learning activities. Year One/Two students could apply their digital skills and experience to literacy and numeracy learning areas through playing educational games, and documenting teachers' notes and creating multimodal texts. Learning, as Fullan and Langworthy (2014) noted, is extended when students have their own digital devices, because they have full access to digital learning tools and resources to investigate learning tasks and problems which enable them to carry out deep learning tasks individually or within small groups.

However, the full integration of digital technologies in schools requires many other factors such as digital technology, immersed curriculum, well-trained teachers, and continuing professional development for teachers to build up their digital technology implementing pedagogical capacity (Buabeng-Andoh, 2012; Ching-Ting, 2014; Kerckaert, 2015). Sustainable digital resources and infrastructure encourage teachers to include digital technologies in their classes and provide more opportunities for students to develop digital skills and competency. However, providing digital devices and tools does not guarantee meaningful learning. According to Fullan and Langworthy (2014), effective implementation of digital technologies does not mean simple provision of adequate digital tools and resources, but involves using them as part of "learning partnerships and deep learning tasks" (p. 60). Effective implementation plans and pedagogies such as engaging young students through learning activities in the themes of

I-Ready, I-Practise and I-Create, are still needed to ensure deep learning with digital technologies.

A positive vision of using digital technologies with young students

It is suggested that digital technology implementation in the classroom is shaped by teachers' perceptions of children's interest in them (Agyei & Voogt, 2013). In my research, teachers from both Foundation Year and Year One/Two learning communities acknowledged the important role of digital technologies in contemporary students' life. Six teachers demonstrated their awareness that contemporary children grow up in a digital-rich environment. Young children's home digital technologies experience plays an important role in shaping their learning and thinking in class, because their understanding of the world includes interpreting information and meaning from digital media (Yelland & Gilbert, 2011). In addition, teachers were aware of the impacts of technological development on young children who grow up in a society where new technologies have been an integral part of their lives. Notably, Kelly, the art teacher, indicated that her current students obtained more knowledge and information about the world by using iPads to access the internet compared to the same age groups from her previously taught classes. These perspectives reflect a sociocultural view of child development, in which young children develop their knowledge and understanding about the world from intensive interaction with their environments and cultural practices (Dong

& Newman, 2016; Fleer, 2011). This pedagogical understanding of young children's' use of digital technologies aligns with the early childhood curriculum and national curriculum in Australia, which are strongly framed within a sociocultural perspective of learning. Becker (2000) reported that teachers aligned with a sociocultural constructivist pedagogical perspective were more likely to implement digital technologies in their classes. This is because sociocultural approaches support students to learn effectively by linking their learning and experience from their homes and communities to those at school.

The participating teachers believed that students would benefit from using digital technologies in their classrooms, and therefore encouraged their implementation. It is claimed that teachers need to hold positive attitudes and strong beliefs towards young children's use of digital technologies (Blackwell et al., 2014; Ertmer, 1999). Four Year One/Two teachers provided examples showing that students' literacy and numeracy, problem-solving, information searching and creating skills were improved when using digital technologies. Such high value placed on the role of digital technologies ensures that teachers actively implement digital technologies in their daily practices.

Ertmer (1999) has described one barrier that impacted digital technologies effective use in the classroom is relating to teachers' beliefs with digital technologies and perceived values of technologies for their students' learning. Teachers' personal visions and understanding regarding using digital technologies with students, especially, with young children, will impact their daily practices of integrating digital technologies in the classroom (Blackwell et al., 2014). Therefore, teachers' positive attitudes and beliefs are important and direct factors on digital technology implementation in the class.

Collaborative teaching environment

It was apparent in the teachers' interviews and my classroom observations, that a collaboration culture supports teachers to implement digital technologies in their classrooms. Teachers of both Foundation Year and Year One/Two students emphasised the roles of peers and teachers in providing support and scaffolding (e.g., organising pairing up activities and group work tasks) while applying digital technologies in the classroom.

All participating teachers used digital technologies in teaching their learning communities collaboratively. They worked to establish a collaborative learning and teaching environment that allowed them to develop and adopt effective approaches to integrate digital technologies. They observed other teachers' classes and took turns to teach the class. Kate, the Year One/Two teacher, reported that she would like to try new strategies for implementing digital technologies in her classroom that she had learned from her colleagues. Teaching collaboratively exposes teachers to new perspectives and promotes the sharing of ideas, and encourages teachers to take risks and try new ways to use digital technologies (Masoumi, 2015). Many researchers reported similar findings that teaching collaboratively supported teachers to implement digital technologies into their classes (Buabeng-Andoh, 2012; Ruggiero & Mong, 2015). The participants recognised that support from their colleagues and observing others' classes were important and these practices helped them to improve their implementation plans. The evidence indicates a collaborative teaching environment encourages the teachers to share and try new ideas on implementing digital technologies, which prompt the teachers to implement digital technologies and engage young students in deep learning.

7.2 Summary

This chapter presents a discussion of the main findings and contributions of my study. Digital technologies, including iPads and applications, are valuable tools and resources for engaging young students in meaningful learning. I categorised digital technology mediated into three themes: I-Ready, I-Practise and I-Create that illustrate the state of implementation of digital technologies with young students in a formal educational setting. The observational data indicate that learning activities across the I-Ready, I-Practise and I-Create spectrum are important, because young students need operational skills (I-Ready) before they can use digital technologies for more cognitive-related tasks in I-Practise and I-Create themes. However, teachers should always aim to shift young students from being digital consumers to digital producers for better literacy and numeracy learning by organising learning activities in the I-Create theme.

My findings illustrate that digital technologies have the potential in supporting young students to learn more effectively as digital technologies through enhancing students' engagement, collaborative learning experience, literacy and numeracy skills. They promote independent learning by providing multimodal learning resources and tools through internet-enabled platforms. The case study teachers applied various teaching approaches to extend students' digital skills and knowledge to other learning areas (e.g., literacy and numeracy) through organising learning activities to encourage their students in the I-Create theme (e.g., creating digital books, solving mathematical problems and presenting digital slides). My research data suggest that to implement digital technologies successfully, teachers should establish the technology enriched, and constructivist learning environment in which young students have full access to a wide range of digital devices and resources. And they should design learning activities across the themes of I-Ready, I-Practise and I-Create based on their students' digital and learning abilities. Students should be encouraged to use these tools and resources based on their own interests and learning needs.

CHAPTER 8

Conclusion

This final chapter provides an overview of my study on the implementation of digital technologies with young students in an Australian early primary school setting. First, I reflect on the study in terms of its stated purpose and process, then provide a summary of the findings. I discuss the contribution of this study to the literature, as well as its implication for schools, teachers, and policymakers, and end with suggestions for further research.

8.1 Research Questions

My study was guided by the following main research question:

- How are digital technologies implemented in contemporary Australian primary school classrooms to support young students' learning?

To assist in answering this research question, three sub-questions were developed:

1. What are the Australian primary school teachers' pedagogical perceptions of implementing digital technologies with young students?

2. What are the Australian primary school teachers' pedagogical practices with respect to the implementation of digital technologies with young students?
3. How do digital technologies enhance young Australian primary school students' learning?

The following sections provide summarised answers to these questions.

8.2 Reflecting on the Study

I explored teachers' perspectives and practices when incorporating digital technologies for teaching and learning in some Australian early primary school classrooms, and recorded students' interactions with digital technologies. The study also focused on the possibilities of digital technologies—including iPads, Smart TVs and educational applications (e.g., Seesaw, Literacy Planet and Book Creator)—to support young students' literacy and numeracy learning. Findings were organised around learning stories to help understand the roles of teachers, their pedagogical choices, and the rationales in devising activities that incorporated digital technologies. These stories also presented the students' learning processes to show how they benefited from using digital technologies.

I drew on a constructivist paradigm for this qualitative research, because this enabled me to gain deeper insight into teachers' and students' experiences with digital technologies.

Furthermore, the constructivist paradigm is compatible with the sociocultural view of learning that underpins Australian early learning curricula and policies. I established a single case study based on a public primary school in western Melbourne to collect the data. Semi-structured individual interviews with teachers enabled me to hear their voices and accounts of their experiences with digital technologies. Observing and documenting learning stories enabled me to reveal the patterns and features of the teachers' pedagogical practices and student's learning behaviours with digital technologies. Students' digital artefacts demonstrated the depth of their learning, and this evidence enabled me to analyse how they developed literacy and numeracy skills and constructed knowledge when incorporating digital technologies into their learning.

The Leaning by Design framework (Kalantzis & Cope, 2015) was used as a lens to develop the themes of I-Ready, I-Practise and I-Create to present practical examples on fully unpacking the potential of digital technologies for supporting young students' literacy and numeracy learning. In the I-Ready theme, young students were mainly equipped with digital operational skills to use digital technologies appropriately and safely. In the I-Practise theme, digital devices and resources were used for repetitive learning practices, facilitating young students to develop an understanding of abstract concepts, theories, and terms from the literacy and numeracy curricula. In the I-Create theme, students were encouraged to produce and create digital multimodal texts. Each theme was important. Young students needed I-Ready practices to develop solid digital operational skills. Once they obtained such skills, they applied them in more cognitively involved tasks such as drill and practice tasks, documenting tasks and creating tasks in the I-Practise and I-Creative themes.

Digital technology mediated learning practices in the themes of I-Ready and I-Practise were common in the learning communities I studied. Thus, I concluded that the current implementation of digital technologies still focused on reinforcing digital operational skills and traditional classroom practices including drill and practice and documenting practices. To fully unpack the potential of digital technologies required teachers to support young students to become digital producers, meaning actively applying their literacy or numeracy skills to generate new knowledge and solve new problems using digital technologies (Hill, 2004; Kalantzis & Cope, 2005). I recorded several learning activities that could be classified from the I-Create theme, indicating that the teachers from the case study school encouraged students to take agency and create their own digital stories, slides, and eBooks to promote them into the dimension of applying. This makes the case study school's implementation of digital technologies a good example of how they can be mapped into the curriculum for meaningful learning.

In general, this research was successful in revealing teachers' perspectives towards implementing digital technologies in primary school settings. There was no significant difference in the perspectives of the six interviewed teachers regarding using digital technologies. All the teachers from the case study school had positive perspectives toward using digital technologies for facilitating young students' learning in their classrooms. They voiced the belief that digital technologies were beneficial for young Australian students because they supported young students' literacy and numeracy learning. In particular, the teachers regarded educational applications and online resources as useful tools for young students' independent learning. They acknowledged many advantages of digital technologies for teaching and regarded them as useful tools for teaching collaboratively. Positive perspectives towards digital technologies encouraged teachers to embrace their application of digital technologies in and through the curriculum.

My research found that the participating teachers held constructivist perspectives and actively employed various teaching approaches to incorporate digital technologies into their classroom for facilitating young students' learning. They were aware of the impacts of social and technological development on young students growing up in the information society because they tried to include iPads into each learning activities as much as possible. In addition, they valued the role of capable peers and promoted collaboration, both online and in classroom. The teachers organised learning activities based on students' abilities and learning needs which indicated they were also influenced by cognitive development theory. These results showed that the teachers' main purpose in implementing digital technologies was to extend young students' learning, rather than to impact basic operational skills or keep students busy in the classroom. The teachers turned brief implementation instructions from the digital technology curriculum into meaningful and diverse learning activities in the I-Ready, I-Practise and I-Create themes.

I discovered that the teachers applied various teaching approaches, including direct instruction, modelling, pairing up, group work, and free choice options to support and scaffold young students' learning with digital technologies. In the I-Ready theme, Foundation Year teachers' classroom practices were characterised by strong teacher-centred instructions and involved considerable direct physical and oral instructions. With direct instructions, the teachers assigned the task, taught operational skills, and assisted students to solve digital problems. In the I-Practise theme, explicit instructions were applied to help young students to gain conceptualised knowledge about literacy and numeracy concepts and theories. In the I-Create theme, the students were allowed to select their learning topics and tools for creative purposes. Within these teaching approaches, the teachers fulfilled the roles of instructor, facilitator and scaffolder when they implemented digital technologies. In general, these teachers' classroom practices were student-centred; they encouraged their students to use iPads for multiple learning purposes with support and scaffolding from their peers. The teachers used a repertoire of teaching and learning strategies (Kalantzis & Cope, 2005) to support the higher-order skills that children need for further success including creativity, problem-solving and co-construction of new knowledge.

Young students had excellent access to digital technologies and I observed many instances of hands-on exploration with them in the classroom. The students' use of iPads was mainly self-directed, they were encouraged to source digital devices and resources based on their own interests and learning needs. In general, the students were enthusiastic, joyful and curious when they participated in digital technology mediated learning activities. Although the duration of usage varied depending on activity design, most students had many opportunities to play with their iPads and design their own digital artefacts for meaningful learning.

My research illustrated that both Foundation Year and Year One/Two students benefited from using digital technologies in their literacy and numeracy learning. The iPads and digital resources increased the students' engagement and motivation towards literacy and numeracy learning, because they gained a better understanding of the learning tasks and were attracted to the multimedia features such as interactive cartoon characters, hyperlinks, and sound. I observed that digital technologies offered a wide range of learning resources, such as eBooks and educational games, with in-built instructions and feedback that provided opportunities to enhance young students' literacy skills such as fluency, reading comprehension and matching phonemes and graphemes. The digital tools and resources—including numeracy games, tools for drawing, recording, and calculating, and table generators—allowed students to explore ways to solve the life-related mathematical problems which enhanced their numeracy learning. These supports from iPads and applications also enabled young students to learn independently.

In addition, my findings showed that digital technologies seem to enhance young students' collaboration experiences. This was because digital technologies encouraged students with different learning abilities to work together more effectively using multimodal options such as audio, video and digital images. Digital technologies enabled the students to share their ideas, knowledge and learning experiences through the online platforms (e.g., Seesaw), which helped them and other students in learning and solving problems.

Finally, the learning stories framed in the themes of I-Ready, I-Practise and I-Create provided an overview of the current implementation of digital technologies in early primary school classrooms. The Learning by Design framework that I have applied in this study contributes to understanding the knowledge process along with possible pedagogical choices. The I-Ready, I-Practise and I-Create themes contextualise the four dimensions from the framework by providing detailed practical examples of using digital technologies in early primary school settings that remedy the lack of life-related implementation examples in research to date.

8.3 Significance and Contribution

The outcomes of this research may enable both teachers and students to tap into the power of digital technologies more effectively and participate in more engaged teaching and learning through developing digital technology mediated learning activities from the I-Ready, I-Practise and I-Create themes.

One aim of this research study is to elicit more information and provide practical examples of strategies for promoting the integration of digital technologies for deep learning in the primary school setting. The learning stories documented in my study describe teachers' pedagogical choices, the students’ learning, and their digital tasks, and the digital learning content, contributing to a new understanding of ways to unpack the potential of digital technologies, including their connectivity and multimodal features to facilitate young students’ literacy and numeracy learning. The literature review (chapter 2), reveals a gap in the documentation of the practical use of digital technologies, especially, in the Australian context, where the curriculum and learning are heavily influenced by developmental theory and a sociocultural perspective. The learning stories from my study provide rich first-hand evidence and good implementation examples that fill this research gap in the field, and show the factors that might contribute to teachers’ use of digital technologies for better extending young students’ learning in early primary school settings.

It is expected that the new understanding about implementing digital technologies through I-Ready, I-Practise and I-Create themes will inform curriculum design and educational policy on helping teachers to use digital technologies to promote deep learning in their classrooms. The implementation of digital technologies in the case study school shows ways of mapping digital technologies into the curriculum. The learning stories give a clear picture of how digital technologies are implemented in a primary school setting, potentially acting as a guide to other teachers to develop plans for their own students. Teachers could consider the three themes and adopt them in their practical use of digital technologies to extend young students' learning. For instance, if students need to learn how to operate iPads or a particular application or program, then teachers should consider designing learning activities in the I-Ready theme. If students need to develop conceptualised understanding about literacy and numeracy terms and theories, then teachers should encourage their students to undertake I-Practise learning activities. It is also crucial that students participate in I-Create learning activities, because creating their own digital stories, slides, and eBooks leads to deep learning. The learning activities from the I-Practise theme are closely associated with reinforcing students' traditional learning skills based on print-media, which might not fully unpack the potential of digital technologies for deep learning. Therefore, teachers need to always keep in mind to help their students reach the theme of I-Create. My analysis and discussion of learning activities in the I-Ready, I-Practise and I-Create themes from the case study school that is highlighted through the discussions encourages educators, policymakers, and schools to reflect on current implementation strategies and strive for on-going improvement. Policies regarding the implementation of digital technologies should continue to be reviewed and strengthened with explicit guidelines and supplementary materials containing practical examples.

8.4 Recommendations Arising from This Study

One recommendation stemming from my research is that a school should establish digital technology enriched learning environments including hardware and software and the internet, which should lead to more effective implementation of digital technologies for supporting meaningful learning. The availability of and equitable access to digital resources like iPads, Smart TVs, and Smartboards is a critical factor to ensure teachers' implementation of digital technologies in their classrooms. Adequate and equitable access to functioning and reliable digital resources can facilitate teachers to incorporate these in learning programs and create a rich digital technology environment for students to engage in different digital learning tasks (State Government of Victoria, 2019). Primary school students need both resources and opportunities for learning activities and creating their own multimodal texts with digital devices.

In addition, my findings suggest that teachers should embrace a combination of pedagogical approaches to the implementation of digital technology. For instance, in the case study school, the teachers applied direct instruction, modelling and free choice for different learning activities in the themes of I-Ready, I-Practise and I-Create. These approaches enable them to shift between the roles of instructor, classroom manager, facilitator and scaffolder while using digital technologies for eliciting meaningful learning with young students.

8.5 Suggestions for Future Studies

I investigated mobile devices (iPads), display devices (Smart TVs and Smartboards) and various educational applications to understand how they affect teaching and learning in an Australian primary school setting. More focused research with young children and their teachers on the use of a single form of digital technology (e.g., iPads) or a particular application (e.g., Seesaw) is important to explore the potential of digital technologies to support young students' literacy or numeracy learning.

My study covered literary, numeracy, science and arts learning, and showed that digital technologies had positive impacts on young students' learning in these learning areas generally. In future studies, researchers could investigate how digital technologies can be used to support students' learning in specific learning areas such as literacy or numeracy.

In addition, researchers could examine teachers' perspectives and pedagogical practices regarding the use of digital technologies by young children with respect to other contexts and cultural backgrounds. This means that the studies on teachers and young children's use of digital technologies in private schools or schools in suburban and rural areas across Australia should be conducted. My study does not pay attention to the multicultural background of students and the way digital technologies are used to support their learning in formal educational settings. Further research could explore how digital technologies can be implemented to facilitate the learning of students with different cultural backgrounds or with English as a second language to learn more effectively in the early childhood setting as well as the primary school sector. The research literature would benefit from cross-cultural studies of the use of digital technologies for teaching and learning in early childhood settings and primary schools.

8.6 Final Remarks

My research illustrates the use of digital technologies in early primary classrooms in an Australian primary school and teachers' strategies associated with implementing them. The findings confirm that digital technologies are useful tools for engaging young students in meaningful learning. The use of digital technologies in the early years is of great importance in shaping young learners' knowledge, skills, experiences and future learning habits. Three themes of digital technology mediated learning are identified—I-Ready, I-Practise and I-Create—to illustrate the major aspects of successful integration of digital technologies in Australian early primary school classrooms. I argue that it is crucial to move students beyond being digital technology users (the I-Ready theme) and scaffold the students be digital producers (the I-Create theme).

It is time to move forward. Digital technologies have been driving major changes in education, and will continue to do so. The information society, the knowledge economy, and the 21st-century global community, demand that schools de-emphasise old ways of teaching and learning in favour of new and digital capable learning practices.

APPENDIX A

Applications List

iPad App List [Foundation – 2]

Here at [redacted] Primary School, iPads are vital to your child's education. We use them in some aspect in every lesson we teach. It is extremely important that your child comes to school with their iPad fully charged - **<u>every day.</u>**

The following apps are considered core apps and will be used on a daily to weekly basis. These must be installed and updated on your child's iPad:

Seesaw Free	Skoolbo Aussie Free	Mathletics Free	Kids A-Z Free	Reading Eggs Free
Literacy Planet Free	Book Creator $7.99	QR Code Reader Free	iMovie $7.99	Bits Board (AUSLAN) Free
Pocket Scoreboard Free	Bee Bot Free	Nearpod Free	ePlatform Free	Pic Collage Free

The following apps are considered optional apps which may be used but are not required:

The Alien Adventure Free	Scratch Jr Free	Minecraft $10.99

APPENDIX B

Consent Form for Parents of Students

CONSENT FORM – PARENTS OF STUDENTS

Project Title: ***New learning in the 21st century: a case study of digital technology implementation in primary school classes***

Name of Parent/Guardian: ____________________

Name of Child: ____________________

Name of investigator(s): Prof. Nicola Yelland (Chief Investigator), Dr. Kirsten Sadler (Associate Investigator), Lina Zhao (Student Researcher)

1. I consent to my child's participation in this project, the details of which have been explained to me, and I have been provided with a written information sheet that I can keep.

2. I understand that after I sign and return this consent form the researcher will retain it.

3. I understand that my child's participation will involve being observed by the student researcher and that I can request access to the field notes regarding my child. I also understand that my child's works will be collected and used in the research thesis. I agree that the student researcher may use these data as described in the information letter I have been provided.

4. I acknowledge that:

   (a) The possible effects of participating in the project have been explained to my satisfaction;

   (b) I have been informed that I am free to withdraw my child from the project at any time without explanation and to withdraw any unprocessed data my child may have provided;

   (c) The project is for the purposes of research;

   (d) I have been informed that the confidentiality of the information my child provides will be safeguarded;

   (e) My child's name will be referred to by a pseudonym in any publications arising from the research;

   (f) Some of my child's classmates will also be asked to participate in the study, and that none of the participants, or anyone else, will be informed as to who has participated, or about the nature and content of your child's involvement;

   (g) I have been informed that I am able to access the research findings by providing a short summary report or a hard copy shared from the school, should I agree to this.

Parent/Guardian's signature: Date:

APPENDIX C

Consent Form for Students

CONSENT PROCESS–STUDENTS

Project Title: ***New learning in the 21st century: a case study of digital technology implementation in primary school classes***

Name of Child: ______________________________

Name of investigator(s): Prof. Nicola Yelland (Chief Investigator), Dr. Kirsten Sadler (Associate Investigator), Lina Zhao (Student Researcher)

The Participant Child is indicated as dissent, when:

1. He/she has strong opinions on not participate in the research project, such as the verbal expression "I do not like to be watched/observed……" or " I do not want to be part of this."

2. He/she shows an active avoidance when the researcher is in the classroom. For instance, the child tries not to make eye contact with the researcher and keeps moving away when the researcher is nearby.

3. His/her behaviours indicate the feeling of depression and frustration while working with the researcher, such as particularly un-talkative in conversation, write nothing or scrawl over a drawing when the researcher is watching by the side.

This child will be informed that he/she has rights to withdraw the participation anytime, and his/her decision is always respected and granted. The researcher will:

1. Invite the child to join all the activities and discussions, but there is no attempt to convince them to participate in the research project.

2. Stop approaching to the child.

3. Remove any data related to the child.

APPENDIX D

Consent Form for Teachers

CONSENT FORM –TEACHERS

Project Title: ***New learning in the 21st century: a case study of digital technology implementation in primary school classes***

Name of participant:

Name of investigator(s): Prof. Nicola Yelland (Chief Investigator), Dr. Kirsten Sadler (Associate Investigator), Lina Zhao (Student Researcher)

1. I consent to participation in this project, the details of which have been explained to me, and I have been provided with a written plain language statement that I can keep.

2. I understand that after I sign and return this consent form the researcher will retain it.

3. I understand that my participation will involve being observed while teaching, interviews with the student researcher, and collection of teaching materials. I agree that the researchers may use the results as described in the information letter I have been provided with.

4. I acknowledge that:

   (a) The possible effects of participating in observations and interviews have been explained to my satisfaction;

(b) I have been informed that I am free to withdraw from the project at any time without explanation and to withdraw any information I have provided;

(c) The project is for the purposes of research;

(d) I have been informed that the confidentiality of the information I provide will be safeguarded;

(e) My name will be referred to by a pseudonym in any publications arising from the research;

(f) I have been informed that I am able to access the research findings by providing a short summary report or a hard copy shared from the school, should I agree to this.

Participant signature: Date:

APPENDIX E

Educational Apps Information--Book Creator

Book Creator is an open-ended educational application. The application offers many multimedia tools to publish eBooks on the iPad. It is ideal for making all kinds of digital books, including children's picture books, comic books, photo books, journals, textbooks and more. The teachers from the case study school usually ask the students to represent the report, summary and story which is connected to their learning topics on this

application after the learning section. Many teachers said this App was a good learning tool for the students to present their learning and thinking with multiple media. It also removes the learning barriers such as spelling and sentence writing as students can insert their voice and video into Book Creator to publish their digital productions.

APPENDIX F

Educational Apps Information—Literacy Planet

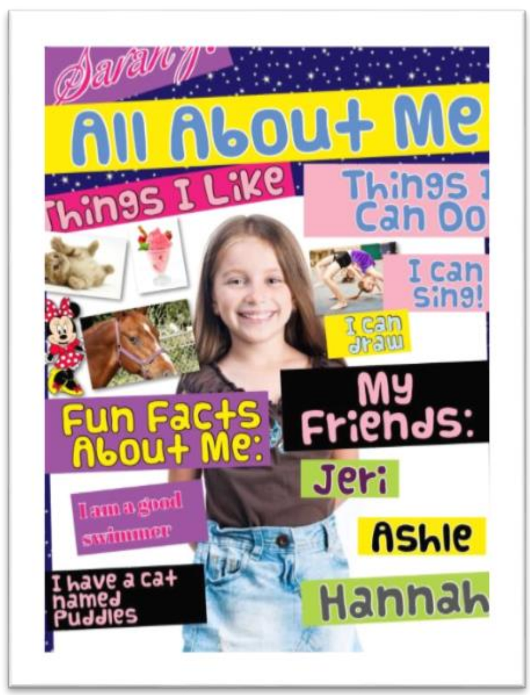
The Literacy Planet offers various versions that can be adopted in different operating systems and devices. The case study school mainly uses the App version on iPads. The Literacy Planet App contains text, scripts, graphics, information, data, pictures, sounds, music, videos, interactive features, user generated information, editorial and other content accessible by Users. With the online function, it offers a learning platform and service where students, teachers, schools, and parents subscribe to the program for supporting students to develop their literacy skills. Students can bring their literacy work back to their home with this online function.

The App is used to help reinforce the high frequency words being taught, and for phonological and phonemic awareness exercise through a range of exercises and games. It is also containing the popular gamified elements such as the prize wheel. The teachers will set up each student's reading level, then the program will generate a digital learning project according to students' learning level, which reflects concepts of personalised and students-directed learning. The App is mainly used in independent reading sections in foundation years and year one and two communities combining with other hands-on reading activities. The students can do their home reading with this App if they could not borrow the physical book from their school library.

APPENDIX G

Educational Apps Information—PicCollage

PicCollage is a multimedia tool for users to create amazing collages and digital cards with photos and stickers. The application lets the user instantly arrange their photos into frames or get creative with freeform collages, cut-outs, filters, borders, stickers, and text like photo-shop with sessional stickers, backgrounds, and templates. The users can add stickers and text, and share these on social media later. It's unsurprising considering that collaging is perhaps the classic activity of teenage creatives outside of journal writing.

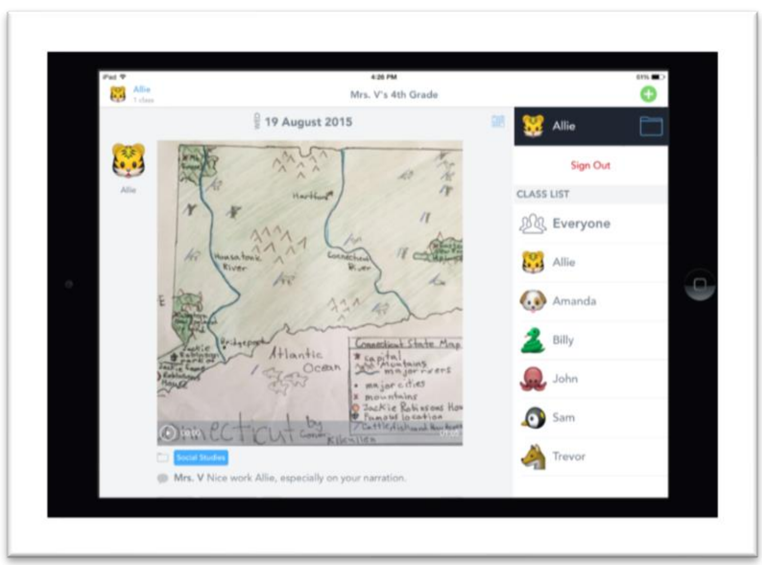


In the case study school, Pic Collage is used along with Seesaw and Book Creator Apps for most of the learning activities related to literacy and numeracy practices. The students can use various text styles, fonts, colours, images, and backgrounds to decorate their digital posters or reports on iPads.

APPENDIX H

Educational Apps Information—Seesaw

Seesaw is one of must have Apps that need to be installed into iPads in the case study school. The App is widely used throughout the whole school and most of the learning activities. The program is described to empower students of any age to independently document what they have learned at school. The most common activities that involve the use of the Seesaw are online publishing and documenting. The students can capture



their learning by taking photos, videos or utilising other tools from the app and then upload their works on Seesaw online space. Teachers can assess students' works and provide feedback from their ends. Students can share their works with classmates, parents and other members by publishing their works into this online space.

APPENDIX I

Information Package—Parents

23/02/2017

Dear Parents,

I am writing to ask your permission to allow your child to take part in the project **New Learning in the 21st century: a case study of digital technology implementation in primary school classes**. This is a PhD research program that is supported by Victoria University and the Department of Education. Your child's school has kindly agreed to cooperate with the project and now we are asking your permission for your child to take part. In 2016, I conducted the research in the Preparatory classrooms at the Primary School as a Master of Education students and I have since upgraded to PhD program.

This research project seeks to find out how students are engaged and stimulated in their learning when using IPads. The ways in which they use IPads in the classrooms will be observed. The PhD study is an extension of the Masters research and extends into the Year 1 and 2 clusters at the school. I will document their work in Year 1 in order to discover the depth of their leaning over the course of the two school years. I will conduct the study with the cooperation of the teachers and will be a participant while observing in the classroom activities.

I will visit your child's classroom, observe your child's learning behaviours and collect work examples on the first term of the Australia school year for five weeks. I will return in the second term for another five weeks to observe and collect the work sample. Your child's work samples and pictures (not showing the front face) will be collected at this stage. At no time will the work be shown or discussed with anyone else except the teacher and my PhD supervisor, Professor Nicola Yelland

The project will be explained in terms that your child can understand, and your child will participate only if he or she is willing to do so. Your decision whether or not to allow your child to participate will not affect the services normally provided to your child by the entity where research is being conducted.

All the information collected will be confidential. You and your child's teacher will be able to have access to the information on your child's progress in learning, which can be used to develop your child's personalised educational program. No information about individual children will be made available to anyone else. At the conclusion of the study, a summary of group results will be made available to all interested parents. You may withdraw from the project at any time.

We would appreciate it if you would permit your child to participate in this project, as we believe it will contribute to furthering our knowledge of how children learn by using new technologies and how to improve teaching strategies to support powerful learning.

The research will be carried out by staff from Victoria University. If you have any questions you would like to ask before replying, please do not hesitate to contact me Lina Zhao on 0423709617 or by emailing lina.zhao@live.com; or my supervisor Professor Nicola Yelland on 0438344139 or by email Nicola.yelland@vu.edu.au .

In order for your child to participate in the project, please complete and return the attached form to your child's class teacher. If at any point you decide to withdraw your child from the project, you can do so without having to provide any explanation.

Thank you in advance for your interest and support of this project.

Sincerely,

Lina Zhao   Professor Nicola Yelland

PhD Candidature, School of Education, VU   Professor of Education,

Victoria University

To be returned to your child's teacher

Title of Project:

New Learning in the 21st century: a case study of digital technology implementation in primary school classes

I acknowledge that all information gathered on this project will be used for research purposes only and will be considered confidential. I am aware that permission may be withdrawn at any time without penalty by advising the researchers.

I realise that this project has been reviewed by and approved by the Research Ethics Review Board at Victoria University and that I may contact this office if I have any comments or concerns about my child's involvement in the study.

If I have any questions about the study I can feel free to call the researchers.

I agree to my child's participation in this study.

I agree to use my child's work samples and pictures for the purpose of research (thesis or journal publishing).

Child’s name: ………………………………………………………………………

Parent signature: ……………………………………………………………………

Date : ………………………………………………………………………………

APPENDIX J

Information Package—Students and Parents

Students and Parents/Guardians

New Learning in the 21st century: a case study of digital technology implementation in primary school classes

You child is invited to participate in this research

Your child is invited to participate in a research project entitled ‘New Learning in the 21st century: a case study of digital technology implementation in primary school classes’.

After reading this information sheet, if you are willing to give your consent for your child to be involved in this research, please read and sign the attached Consent Form and return it to <insert teacher at school contact name> by <insert date>.

Project explanation

This project is being conducted by student researcher Lina Zhao as part of a Master of Education at Victoria University under the supervision of Professor Nicola Yelland from the College of Education.

Schools today are changing with a growing focus on incorporating IPads and other types of smart devices in classrooms to enhance learning. This research project seeks to find out how students are engaged and stimulated in their learning when using IPads. The ways in which they use IPads in the classrooms will be observed.

The research project will be conducted at the Primary School in 216/17 within the year level of Prep Grade, and Grade One/Two.

Your child's school has been chosen because: a) IPads are used in the classroom and now are well integrated into daily learning activities in all grades, and b) new teaching methods are employed for effective learning. All children in your child's classroom will be invited to participate in the study.

What will your child be asked to do?

The research will be conducted in your child's classroom, and children will not be required to do any more than their usual learning activities. Children will be observed and the works they produce will be collected as they engage with IPads and other types of digital devices during daily learning activities. Your child's learning behaviours and the way his/her interacting with IPads will be recorded. The information will be collected for between two to four school terms (Terms 3&4 2016, Terms 1&2 2017) in total.

If you consent, participation will consist of the researcher:

- observing your child's involvement and learning interactions with IPads and other types of digital devices, along with other students and teachers during the daily classroom activities.
- collecting and/or copying (e.g. via screenshot or photograph) your child's work (such as digital drawings and eBooks on IPads, illustrations, and the games themselves) during the class time.

If your child does not consent to be part of this study, information will not be collected about your child. The researcher is keen to ensure your child is comfortable and secure while observing and will treat their responses with sensitivity.

What will my child gain from participating?

This is an opportunity for your child to share his/her thinking about their classroom activities that incorporating with IPads. They will able to share what they like to do and what they learn from using IPads.

How will the information my child gives be used?

The researcher will use the information that is collected about your child as research data to write up a research thesis and a short summary report. The insights shared by your child will help the researcher to formulate a view of how IPads can be used innovatively and what teaching methods are most effective in helping students learn. The intended outcome of the research is to provide others (school staff and researchers) with deep insights into how IPads can be implemented in schools that equip students with 21st-century skills.

The researcher will ensure all the recorded data is de-identified (i.e. there will be no names of parents, students or schools). Any public reporting of the research will not include identifying information about your child.

What are the potential risks of participating in this project?

There is minimal risk to each participating student. There may be a time when a student shares the information which may be sensitive about a peer or their teachers. It is also possible that someone who knows your child well and knows your child participated in this project may recognise your child's identity from a quote in our publications (even though we will give your child a 'fake' name). To address this, participation is entirely voluntary and your child will not be required to divulge any sensitive personal information.

Your child's work will be only used to analyse how well it reflects learning outcomes rather than marking and ranking. Student's names will be removed from his/her work if it is chosen to demonstrate the research findings.

You will also be able to withdraw your child's involvement from the research project at any time. This will not affect your child's school experiences in any way. Children who do not take part in the research will continue with their usual classroom activities.

In the event that research participants become concerned with any aspect of the research, they will be able to consult with Dr Anne Graham, trained psychology. Dr Graham can be emailed at anne.graham@vu.edu.au and contact via telephone on 9919 2159.

How will this project be conducted?

The student researcher will be visiting the school 2-3 days a week across two to four school terms. If you consent, your child's learning interactions and activities during the class time will be observed and documented in the form of handwritten field notes. Observations will be as unobtrusive as possible and will be conducted by the student researcher while your child is engaging in usual classroom activities.

In addition to observing and talking with your child about their experiences with IPads, other students involved in your child's small learning group during class time will also be observed (where permission had also been granted by their parents). This will provide information about how the IPads are used collaboratively and the learning that occurs in interaction with others in the group. It will also provide in-depth information about how IPads can be used in school settings in an effective way.

Who is conducting the study?

The research is being conducted by student researcher Lina Zhao for Masters of Education in the College of Education at Victoria University.

Lina Zhao can be contacted via email on lina.zhao@live.com or via telephone on 0423709617.

Lina's supervisor is Professor Nicola Yelland of the College of Education at Victoria University. Professor Yelland can be contacted via email on Nicola.Yelland@vu.edu.au and via telephone on (03) 9919 4904.

If you have any queries about your child's participation in this project or any further questions about the study, there may be directed to the Researchers listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

APPENDIX K

Information Package—Teachers and School Leaders

Teachers and School Leaders

New Learning in the 21st century: a case study of digital technology implementation in primary school classes

You are invited to participate in this research

You are invited to participate in a research project entitled 'New Learning in the 21st century: a case study of digital technology implementation in primary school classes'

Project explanation

This project is being conducted by student researcher Lina Zhao as part of a Master of Education at Victoria University under the supervision of Professor Nicola Yelland from the College of Education.

Schools today are changing with a growing focus on incorporating IPads and other types of smart devices in classrooms to enhance learning. This research project seeks to find out how students are engaged and stimulated in their learning when using IPads. This research project will be introduced to the children by exploring how they use IPads and learning Apps, and what they learn from them in the classroom. The methods in which teachers incorporate IPads and other types of digital devices into the learning activities will also be observed and recorded.

Your school is chosen because a) the digital technologies (e.g. IPads) are encouraged in the classroom and now well implemented in daily learning activities, and b) the children's diversities and learning needs are well acknowledged by teachers, and c) innovative pedagogies are encouraged for effective learning.

What you will be asked to do?

Participation is voluntary and will consist of:

- Two approx. 20-30 minutes face-to-face interviews held at your school on breaks or completion of the school day.
- Having your involvement and interactions with others in the usual learning activities observed along with other students and teachers, in the time of period of 2-3 days per week for two to four school terms.
- The collection (e.g. via screenshot or photograph) of teaching resources or students' work (such as digital drawings on IPads, educational Apps, eBooks, illustrations, and the games) during the class time.

We are deeply grateful for any time and effort you are able to contribute by participating in this project.

The interviews will not focus on personal issues. The questions will explore the implementation of digital technologies with in the curriculum, and the type of innovative pedagogies that work effectively in your classroom.

Your responses will be treated as confidential, and details of your identity will not be conveyed in the final report.

What will I gain from participating?

This is an opportunity for you to share your thinking and experiences about the role of digital technologies in teaching and learning and pedagogies that could be best to engage and stimulate students' learning. You will be treated as an expert as your cooperation in this research project will also help create new knowledge that will be used to enhance educational outcomes and reform curricula and pedagogies in schools in general.

How will the information I give be used?

The researcher will use the information that is collected from the interviews and observations as research data to write up a research thesis and a short summary report. All information collected for this study will be stored in accordance with Victoria University's Code of Conduct for Research.

The interview may be recorded using a digital audio recorder, if you grant your permission to do so. The audio recording will be stored securely and your privacy will be protected at all times. The researcher will ensure all the recorded data is de-identified (i.e. there will be no names of parents, students or schools). Any public reporting of the research will not include identifying information about you.

What are the potential risks of participating in this project?

There is minimal risk to participating teachers. There may be a time when information is shared that may be sensitive in nature about your colleagues or students. It is also possible that someone who knows you well and knows you participated in this project may recognise your identity from a quote in the research publicans (even though we will give you a 'fake' name). To address this, participation is entirely voluntary and you will not be required to divulge any sensitive personal information. You may choose which questions to answer or not answer.

You are also able to withdraw the interview or being part of the study at any time.

In the event that research participants become concerned with any aspect of the research, they will be able to consult with Dr. Anne Graham, a trained psychologist. Dr. Graham can be emailed at anne.graham@vu.edu.au and contact via telephone on 9919 2159.

How will this project be conducted?

The researcher is visiting the school 2-3 days a week for between two to four school terms and observing up to 3 classrooms. Information will be collected in the form of handwritten field notes. Observations will be as unobtrusive as possible and will be conducted by the researcher while children and their teachers are engaging in classroom activities.

Participating teachers will be invited to complete two interviews (approx. 30 minutes each) about their insights on the way they are implementing digital technologies in their classroom, and what works best for engaging students in classroom learning activities. Participating teachers may be asked to keep the material that they are used for classroom activities over a short period of time for photocopying.

Who is conducting the study?

The research is being conducted by student researcher Lina Zhao as part of Phd of Education in the College of Education at Victoria University.

Lina Zhao can be contacted via email on lina.zhao@live.com or via telephone on 0423709617.

Lina's supervisor is Professor Nicola Yelland of the School of Education at Victoria University. Professor Yelland can be contacted via email on Nicola.Yelland@vu.edu.au and via telephone on (03) 9919 4904.

Any queries about your participation in this project may be directed to the Researchers listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

APPENDIX L

Interview Questions

Project Title:

New Learning in the 21st century: a case study of digital technology implementation in primary school classes

Permission to record:

Copyright waiver:

Interview Questions:

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1. Collection of general demographic data (age, gender, class level, subject area).
2. Describe your approach to teaching and learning.
3. What sort of digital devices do you use at school (for example; planning, teaching, own professional learning)?
4. How do you describe your level of skill in using digital technologies?
5. Describe the sorts of activities you and your students undertake when using digital technologies in your class.
6. Have you noticed any changes in your classroom through implementing digital technologies into teaching and learning?
7. What value do you place on digital devices, and functions in your teaching? Is there a difference between how you are working now and how you worked previously?
8. Are there any pedagogies strategies you have found most successful? What are they?
9. What are your future plans for incorporating digital technologies into your class, how and why?
10. How do you believe technologies should be used in the classroom? Why?
11. Can you describe any successful/unsuccessful teaching and learning moments incorporating technologies in the classroom?
12. Can you identify any of your key beliefs about literacy that underpin your literacy teaching?
13. Can you describe your understanding of what it means to be "multiliteracy"
14. How do you describe the relationship between literacy and technologies, and if you consider technologies in the literacy session, what does it look like?
15. Do you think it is important to incorporate technologies into literacy teaching?

16. What is your belief in innovation pedagogies? How do you describe your teaching strategies regarding innovation? Do you think it is important?
17. What do you think the most important skills for the 21^{st} century?
18. Is there anything else I should know or you would like to add?

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