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Digital technologies integration in three primary schools in Hong Kong: A cultural historical activity study

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Abstract

This dissertation explores the adoption of a digital-technology-based policy-driven initiative in three primary schools in Hong Kong. According to policy publications, the Hong Kong Government anticipated a significant change in education using digital technologies in schools. The government appeared to expect that learning would not be limited by textbooks and school timetables, nor would it be restricted to the classroom. However, the government appeared to want to exercise firm and centralised control over the textbook-based curriculum.

This dissertation draws upon Cultural Historical Activity Theory (CHAT) to examine teachers' activities that were situated in a collective cultural, social, historical, and educational context. Furthermore, it aims to investigate the integration of digital technologies in three Hong Kong primary schools at the classroom, school, and policy levels.

Data were collected from semi-structured interviews with teachers and principals from three primary schools, supported by the government's education-reform policy documents, classroom observations, school annual reports, and websites from the three schools. Thematic and dialectic analyses were employed to examine the adoption of digital technologies in the three primary schools. As a result of the analysis, themes and contradictions were identified. First, based on the teachers' reflections, students participated more actively in technology-mediated classes than in classes where digital technologies were not used. Second, it was found that the constraints in using technology-mediated tools in the classroom were not isolated but socially bound. Third, it was found that the teachers' level of trust and the division of labour was related to leadership, school culture, and tradition. Finally, government education reform policies were found to be constrained by socio-cultural influence.

Acknowledgements

I have long been inspired to study theories related to systems. I am attracted by how components work together to form a system entirely different from the original components. Before I knew what I was getting into, I began my dissertation on the cultural history of human behaviour in a social context. Not until my dissertation's completion did everything connect, and I was transformed.

It was not easy for me to study for a doctoral degree in the social sciences as my background is in Computer Science. Writing in a computer programme for me is more straightforward than writing a dissertation in English. Thus, a hearty thanks go to my supervisor, Prof. Susan Timmis, who transformed my understanding from a techno-centric person to a social constructionist one. The outcome of my dissertation is credited to my supervisor, Sue, who constantly told me my writing was not critical enough. I have had numerous meetings with Sue over the past six years, and I am grateful that Sue did not give up on me. So, I appreciate Sue's continuous encouragement. I would also like to thank my second supervisor, Prof. Jennifer Rowsell, who spent extra time reviewing my dissertation draft at last-minute notice.

Finally, I owe a great debt to my family, especially my wife, Eugena, who put up with me foregoing yearly vacations while I completed the doctoral degree. She also reviewed the chapters of my dissertation, pointing out many shortcomings. I also thank my daughter, Rebecca, who edited my dissertation and gave me much good advice.

I also would like to thank Dr. John Leung and Miss Mandy Tseng, my close friends and classmates, for being supportive and giving me advice on my dissertation.

Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree* Programmes and that it has not been submitted for any other academic award. Except where indicated by specific references in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: [redacted] DATE: 30 September 2021

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List of Abbreviations

BYOD	Bring Your Own Device
CHAT	Cultural Historical Activity Theory
e-learning	electronic learning used in Hong Kong Government policy documents
e-textbook	the electronic textbook used in Hong Kong Government policy documents
HK	Hong Kong
HKCEE	Hong Kong Certificate of Education Examination
HKDSE	Hong Kong Diploma of Secondary Education
HKSAR	Hong Kong Special Administrative Region
ICT	Information and Communication Technology
IEA	International Association for the Evaluation of Educational Achievement
IT	Information Technology
seed teacher	Seed teacher is the term used in School C, referring to the subject teachers responsible for collecting and consolidating the school's digital learning resources.
SITES-M1	Second Information Technology in Education Study Module 1
SITES-M2	Second Information Technology in Education Study Module 2
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WiFi	wireless fidelity for wireless devices connecting to the Internet

List of Pseudonyms

	School A	School B	School C
Principals	---	Samuel	Theresa
Lead Teachers	Fisher	Sandra	Tom
Subject Teachers	Frank, Faye	Sarah	Terry, Tad

Chapter 1: Setting the Stage

1.1 Introduction

It is generally agreed that digital technologies have changed educational practices both in terms of curriculum and pedagogy, and such change is related to "the heart of education reform in the 21st century" (Noor-Ul-Amin, 2013, p. 8). However, Fu (2013) argued that ICT, as “a powerful tool for educational change and reform,” will only improve “educational quality" if educators rethink and reassess how we learn and teach with ICT as a tool (p. 113). In addition, the Hong Kong Government became aware of the critical role of digital technology in educational reform among secondary and primary schools in the late 1990s (Kong, Chan, Huang, and Cheah, 2014).

The impetus of the present study originated when a dispute arose between the Hong Kong Government and local textbook publishers for primary and secondary schools from 2008 to 2012 when the government attempted to reduce the high price of school textbooks (Education Bureau, 2012; Kennedy, 2013). In 2008, the Secretary for Education, Michael Suen Ming-Yeung, set up a working group to replace printed school textbooks with electronic ones (SCMP, 2008). The “WiFi 100” initiative established in 2014 was the result of continuous efforts of the original “E-Textbook Market Development Scheme” (EMADS) launched by the government in 2012 to encourage local commercial and tertiary organisations to produce e-textbooks (HK Education Bureau, 2012, 2014b). This study aims to explore this issue by investigating educational practices in Hong Kong primary schools, focusing on school and classroom levels and how they are influenced by the government’s reform policy initiatives (see section 1.3.2 for the related policies) and the integration of digital technologies more broadly.

Fu (2013) identified the internal and external factors that influence the success of integrating digital technology in schools. Internal factors refer to teachers' beliefs and their technical ability to use digital technology. In contrast, external factors refer to the availability of digital equipment, technical support, the school curriculum, and school culture. Fu (2013) observed that among these internal and external factors, the most important one is the school culture which includes "the vision, plans, norms, and values that are shared by school members" (p. 120). Pelgrum and Law (2003) argued along the same lines that the success of ICT integration is highly influenced by the leadership’s vision and not the technical skills of teachers. Also,

Law et al. (2003) noted that the availability of hardware and infrastructure is no guarantee of successfully integrating digital technology in education.

Underwood (2014) elaborated three possible strategies for dealing with the complex issue of digital-technologies integration in education: "(1) Minimise the use of technology which just maintains the status quo; (2) Use technology to support the current practice that removes the role of catalyst for change; and (3) Merge and evolve digital technology that necessarily requires us to reassess how learners learn and teachers teach" (p. 8).

The following sections discuss technology integration within the international and Hong Kong contexts, followed by the study rationale. Then, the aims and the research questions are proposed. Finally, my interest in the research and organisation of the chapters will be addressed.

1.2 International context

Over the past 100 years, technology has advanced over time. Technology has always been a significant part of education, such as the introduction of radio, television, and films in a previous era (Buck, 2006). With digital technology, such as microcomputers in the 1970s and the rise of the Internet in the 1990s, technology became a more significant part of education (Betker, Fernando, and Whalen, 1997; W. Ng, 2015). Governments worldwide began developing policies related to using digital technology in education (UNESCO/IITE1, 2011). Research groups appeared related to integrating digital technology in education, such as the International Association for the Evaluation of Educational Achievement (IEA) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

Selwyn (2011) observed that the integration of digital technology "is now a key feature of schools and schooling around the world" (Preface). Selwyn (2011) noted that "with the rise of micro-electronics" in the 1980s, governments and politicians from countries such as the UK and USA launched national and local level "educational technology policies" to demonstrate that they had done "something about new information technologies" (p. 55). Selwyn (2011) claimed that "educational technology gained a heightened importance with the emergence in the mid-1990s of the internet into mainstream societal use," and this trend "attracted the sustained attention of policy-makers, figuring ever more prominently in the education policy agendas of countries around the world" (p. 55). Selwyn (2011) gave a detailed account of the development of educational technology policies around the world in the past thirty years:

> The 1990s and 2000s witnessed a relentless development of ambitious national educational technology policy drives – initiated by the Clinton–Gore administration's National Information Infrastructure in 1993 and soon replicated by governments the world over. … Policy drives during the late 1990s such as the UK National Grid for Learning, German Schulen a Netz and the Singaporean ICT Masterplan for Schools saw nationwide programmes of teacher training … Whereas state policymaking during the 1980s and 1990s took place mainly in (over)developed countries such as the UK, USA, Germany, Japan, Korea, Singapore, Australia, and New Zealand. (p. 58)

From the above description, developed countries initiated educational technology policies. The trend then continued for other "countries in the world – regardless of geopolitical, economic or social circumstance – formulat[ing] and implement[ing] an educational technology strategy" (Selwyn, 2011, p. 58).

According to Selwyn (2011), educational technology policy provides the basis for the use of digital technology in schools, connecting "the interests of the state, economy, industry and other economic stakeholders" (p. 66). Further, the author claimed that these interests are related to the global economy and the need for knowledge workers in the labour market. Educational technology policy has focused more on social, political, and economic issues than educational ones (Robertson, 2003). In this respect, my study examines the impact of educational technology policy on educational practices and its relationship with social, political, and economic issues.

International educational groups, such as IEA, conducted several projects in the 1990s related to using ICT in teaching and learning. A set of reports were produced by IEA, including SITES-M1 and SITES-M2 (Law, Pelgrum, and Plomp, 2008), showing that school- and government-related constraints can contribute to the success or failure of digital technology integration into schools (Law et al., 2008). The studies specifically pinpointed that the vision and support from school leaders and the curriculum policies from the government can influence how successful implementing digital technology in teaching and learning is over time (Law et al., 2008).

Another organisation, UNESCO, performed a series of studies on "ICT in Primary Education" worldwide between 2012 to 2014 (UNESCO/IITE1, 2011; UNESCO/IITE2, 2014; UNESCO/IITE3, 2014) reporting that governments need to take an active role in instituting various national-level policies to remove obstacles to integrate ICT in teaching and learning successfully. The UNESCO 2011 report (UNESCO/IITE1, 2011) also argued that educational leaders worldwide did not want to be led by technology. Instead, they want to take an active

position to “harness the benefits and the power of ICT to transform education for economic, social, and cultural advancement" (UNESCO/IITE1, 2011, p. 67).

In sum, it is not enough for governments to institute educational policies by simply allocating financial resources to the education sector for implementing digital technology in schools to tackle social, political, and economic issues. It also requires the active role of the government to guide the way by instituting national and local policies to remove the obstacles experienced by schools (UNESCO/IITE1, 2011).

The following section covers Hong Kong's educational policies related to the use of digital technology in education.

1.3 The Hong Kong education context

This section begins by explaining the background of the Hong Kong education system, highlighting the need for educational reform. Then I explain the development of digital technology education amid Hong Kong’s educational reforms and how e-textbook entered digital technology education in Hong Kong. The promotion of e-textbooks associated with the E-Textbook Market Development Scheme (EMADS) in 2012 (see section 1.3.2 for the detailed EMADS information) and the launch of the WiFi 100 initiative in 2014 are the backdrops of this study. This section ends with a discussion of the e-learning Policy and the change in the government’s position toward the use of e-textbooks.

1.3.1 Hong Kong educational reform

Hong Kong's education system can be divided into two significant periods – the colonial and post-colonial periods (Forestier, Adamson, Han, and Morris, 2016; Kennedy, 2013). Colonial-period education was mainly characterised by the British grammar school curriculum (Forestier et al., 2016; Kennedy, 2013). The education system focused on preparing students for public examinations such as the GCE Ordinary and Advanced Levels. Textbooks were mainly imported from UK publishers (Forestier et al., 2016). The local traditional culture influenced the colonial period's strong examination culture based on memorisation and rote learning practice and the British colonial filtering system in selecting local elites for public servant positions (Kennedy, 2013).

After Hong Kong’s handover to China in 1997, there was a need for the Hong Kong Government to make changes to move away from the colonial style of education and to align

with the requirements of the knowledge-based or "high-tech" economy (Kennedy, 2013; Yu and Lee, 2020). Such changes would meet the needs of the global economy and local political needs (Forestier et al., 2016). Thus, by 2000, the Hong Kong Government began educational reforms, including curriculum and assessment reform (Kennedy, 2013; Yu and Lee, 2020). The Education Commission stated clearly in the reform policy document:

> The world is undergoing unprecedented changes, and Hong Kong is no exception. We see substantial changes in the economic structure and the knowledge-based economy is here to stay. Hong Kong is also facing tremendous challenges posed by a globalized economy. (Education Commission, 2000, p. 3)

There was a need for a large skilled labour force in Hong Kong to meet the challenge of the global economy instead of a small number of elite government workers in the colonial era (Kennedy, 2013). Kennedy (2013) noted that the knowledge-based economy requires knowledge workers who possess creativity, innovation, problem-solving and critical thinking skills.

The Hong Kong Government made radical reforms in the education system to meet such requirements. The educational reform can be summarised by the two titles of the Education Bureau policy documents: “Learning for life – learning through life” (HK Education Commission, 2000) and “Learning to learn: The Way Forward in Curriculum Development” (HK Council Curriculum Development, 2001). In essence, these two documents highlighted the need for life-long learning and the skills to learn independently, including the use of digital technology in the knowledge-based economy.

The curriculum and assessment reform included in the two policy documents drastically changed how teachers teach and students learn. For example, the curriculum reform provided "a more flexible, diversified curriculum to cater better for learners’ varied interests, needs and capabilities" (Carless and Harfitt, 2013, p. 172). In addition, the assessment reform was geared toward formative feedback rather than summative assessment (Kennedy, 2013). Since the assessment reform emphasises "assessment for learning" rather than assessment for examination, teachers are required to provide continuous feedback to individual students for the benefit of the learners (Curriculum Development Council, 2002). Such changes contradict Hong Kong's traditional examination culture (Carless and Harfitt, 2013). Also, The Education Commission (2000) suggested reducing drilling while increasing a teaching mode of learning that encourages higher levels of thinking. However, since the reform launched in the year 2000, which was not too far away from pre-1997 colonial educational culture, such an “inquiry-

oriented or student-centred" mode of teaching and learning encountered resistance from both teachers and students since such an approach deviated from the local strong examination tradition (Carless and Harfitt, 2013, p. 174).

1.3.2 Digital technologies and Hong Kong educational reform

Fung and Pun (2001) reported that it was not until the 1980s that a subject studying information technology[1] (IT) was made available in secondary schools, but this was still not made available in primary schools. In essence, the IT infrastructure and equipment were not ready for primary schools to conduct IT-related lessons. According to Fung and Pun (2001), the Internet existed only for highly skilled technicians in the 1980s and was not installed on primary and secondary school campuses. Fung and Pun (2001) claimed that by 1997, the use of IT in the education sector was confined to the technological level. There was no long-term plan and no IT-related educational policy. Fung and Pun (2001) observed that Hong Kong started late instituting strategies and policies in using information and communication technology[2] (ICT) in education. In the 1997 policy address by the first Hong Kong Special Administrative Region (HKSAR) Chief Executive Officer, Mr. Tung, he announced a concrete five-year plan, namely, "Information Technology for Learning in a New Era: Five-year Strategy 1998/99 to 2002/03" (HK Education and Manpower Bureau, 1998). At this point, Hong Kong regarded digital technologies as a critical part of educational reform (Kong et al., 2014). Thus, "Information Technology for Interactive Learning" became one of the essential areas addressed in curriculum development (HK Council Curriculum Development, 2001).

Subsequently, three more strategic IT-related educational policy documents were announced in 2004, 2008, and 2014. The titles of these documents were: "Empowering Learning and Teaching with Information Technology" in 2004, "Right Technology at the Right Time for the Right Task" in 2008, and "The Fourth Strategy on Information Technology in Education:

[1] The study of digital technologies in education is referred to by other research studies as IT or ICT in education. In this study, when related to the sources of the research studies, IT or ICT is used to keep the originality.

[2] The terms IT, ICT, and e-learning have been used in the literature and government documents. All these terms are collectively addressed as digital technologies in this dissertation.

Realising IT Potential, Unleashing Learning Power" in 2014 (HK Education and Manpower Bureau, 2004; HK Education Bureau, 2008, 2014b).

The 2004 educational policy document addressed information literacy as the appropriate and ethical use of digital technology (HK Education and Manpower Bureau, 2004). The 2008 policy document concerned providing digital resources for primary and secondary schools (HK Education Bureau, 2008). In the meantime, the Hong Kong Government initiated the E-Textbook Market Development Scheme (EMADS) in 2012 as the first phase and 2013 as the second phase (HK Education Bureau, 2012) of the e-textbook project. The Hong Kong Government worked with local publishers and non-profit organisations to produce e-textbooks bundled with built-in interactive features (HK Education Bureau, 2012). The aim of the EMADS was to establish e-textbook resources with the intent to replace printed textbooks in the future.

In 2014, the Fourth IT Policy focusing on the provision of IT infrastructure was released. This policy document mentioned that WiFi would be installed in all public sectors, including primary and secondary campuses (HK Education Bureau, 2014b). In addition, the Fourth IT Policy document specifically stated that:

> The E-Textbook Market Development Scheme (EMADS), implemented in 2012 with a non-recurrent commitment of $50 million, facilitates the development of e-textbooks for use starting from the 2014/15 school year. The Support Scheme on e-Learning in Schools, with another non-recurrent commitment of $50 million, was launched in January 2014 to enhance the IT infrastructure of 100 schools. These schools will have WiFi access in all classrooms and acquire sufficient mobile computing devices for using e-textbooks and e-learning resources. (Education Bureau, 2014, paragraph 7)

The WiFi 100 initiative, namely, "Support Scheme for e-Learning in Schools", was launched based on the Fourth IT Policy document supporting the e-textbook scheme, EMADS, executed in 2012 and 2013. It selected 100 pilot schools, including 53 primary schools, 42 secondary schools, and five special schools (HK Education Bureau, 2014d). The WiFi 100 pilot study covered three school years from 2014/15 to 2016/17. The WiFi 100 initiative explicitly supported the "E-Textbook Market Development Scheme" (EMADS) instituted in 2012. The build-up of WiFi infrastructure was intended for using e-textbooks in the classroom using WiFi-enabled devices such as tablets. Besides using e-textbooks in the classroom mentioned in the document, e-learning resource access was designed to be another benefit of the WiFi infrastructure. However, the WiFi 100 initiative funding only covered Internet connections,

wireless hardware components, and wireless computing devices (HK Education Bureau, 2014b). The document did not specify the e-learning resources in detail, and no additional funding allocation was mentioned in the Fourth IT Policy document. In fact, the government only provided funding to schools covering wireless computers, while the "internet-connection infrastructure [was] less significant" (Gil-Flores, Rodríguez-Santero, and Torres-Gordillo, 2017, p. 441); therefore, the transformative nature of digital technology in learning may not have been utilised (Rubagiza, Were, and Sutherland, 2011). Pelgrum (2001) suggested that the government should provide more than just the hardware and the infrastructure in the process of educational reform to transform students into "productive knowledge workers" in a knowledge-based economy (p. 163).

1.3.3 The spirit of the government's policy in education

The vision of the government regarding its IT strategy was stated clearly in the "First Five-Year Strategy" document published in 1997 with three learning objectives: "(a) to arouse and maintain our students' motivation to learn; (b) to broaden our students' horizons, to enrich their learning experience and facilitate the development of a creative mind; and (c) to encourage independent lifelong learning and instill team spirit." (Education and Manpower Bureau, 1998, paragraph 2). These learning objectives acknowledge the general IT learning goals with the rest of the world, which changes how people use digital technology (Avidov-Ungar, 2018; Fu, 2013; León-Jariego, Rodríguez-Miranda, and Pozuelos-Estrada, 2020; Macgilchrist, Allert, and Bruch, 2020; Rana, Greenwood, and Fox-Turnbull, 2020).

Furthermore, the Government's "First Five-Year IT Strategy" document also expounds on the idea of educational change in learning:

> To realise the benefits of IT in education, there has to be a paradigm shift in the way school education is conducted - from a largely textbook-based teacher-centred approach to a more interactive and learner-centred approach. Teachers will need to assume the role of a "facilitator" rather than an "instructor" to guide the students to play a more active role in learning. A change of mindset and culture among teachers, parents, and students is key to our strategy. We will also need to mobilise the involvement and participation of the private sector and the entire community in our strategy. (Education and Manpower Bureau, 1998, paragraph 4)

From the above, the expected changes were to go from "a largely textbook-based teacher-centred" way of learning to "a more interactive and learner-centred" learning, a change of role from "instructor" to "facilitator." More importantly, the policy suggested a critical shift in mindset and culture for teachers, parents, and students. Finally, the initiative expected the

involvement of the private sector and the community. These were the essential changes in using IT in education by the government in 1998. These changes differed from the prevailing classroom practices in Hong Kong, where teachers did most of the talking, and students were the receivers of the content rather than contributors without actively participating in learning (Kong, 2011).

1.4 The rationale of the study

In 1998, the Hong Kong Government enacted a significant change in educational practice when they replaced textbook-based learning with ICT-based education (HK Education and Manpower Bureau, 1998). The 2014 government policy provided funding to install WiFi infrastructure in schools to support the use of e-textbooks in the classroom (HK Education Bureau, 2014b). However, instead of adjusting the prevailing curriculum from textbook-based learning to more interactive IT learning, the government stressed the importance of developing a curriculum based on e-textbooks with government-prescribed contents, i.e., the "Recommended Textbook List for e-textbooks (e-RTL)" (Fok, Au Yeung, and Chiu, 2017, p. 1).

Based on the Fourth IT Policy document, the government assumed the role of teachers, with the teachers having to follow the curriculum prescribed in the e-textbook book list (Fok et al., 2017). As the private sector partners established all four IT policy documents, the interpretation of the curriculum was based on the commercial e-textbook publishers and non-profit organisations (HK Council Curriculum Development, 2001; HK Education and Manpower Bureau, 2004; HK Education Bureau, 2008, 2014b). Although the government expected a change in education by integrating WiFi infrastructure in schools, they also imposed the prescribed e-textbook for the school to follow. According to Marsh, Morris, and Lo (2014), the HKSAR government's school-based curriculum strategy was to hand over the operation to external partners such as textbook publishers. However, the list of approved textbooks/e-textbooks had to be from the government. In other words, the government centrally controlled the development of the curriculum.

Various research studies noted that successful integration of digital technology in schools occurs not only through technology, funding, and the technical efficacy of the teachers but also through broader socio-cultural and historical influences that contribute to the outcome of the integration (Al-Huneini et al., 2020; Albirini, 2006; Pulkkinen, 2007; Ra, Chin, and Lim, 2016;

Song and Kim, 2016). Therefore, digital technology integration in education relies on the support of multiple contributing factors that do not exist in isolation. Factors such as leadership style, the historical and cultural traditions of a school, curriculum and pedagogical practice, support of members from the school's community such as students and parents, publishers, and government policy support are also essential (Fu, 2013).

Therefore, it is essential to investigate the social interactions, activities, and practices between teachers and students to understand digital technologies are used in the classroom as part of the social and cultural context. Furthermore, the influence of leadership at the school level in implementing technology-based initiatives and the strategies and teamwork organised among teachers and principals can significantly influence the school culture regarding digital technologies and associated outcomes. Therefore, the micro, meso, and macro levels (see Chan, 2011) are employed in the present study to organise and map the data onto classroom, teacher activities, school, and government policies (see section 4.6.2).

1.5 Research aims and research questions

This study aimed to investigate how digital technologies were integrated at multiple levels in three Hong Kong primary schools based on the implementation of government policy initiatives. These levels include school leadership influences and classroom activities. The study is guided by one main research question:

How do three Hong Kong primary schools integrate digital technologies at the school and classroom levels?

Four sub-questions underpin the main research question as follows:

RQ1: What were the activities teachers and students engaged in, in the process of using digital technologies in the classrooms of three Hong Kong primary schools?

RQ2: How was the division of labour organised among teachers to facilitate the use of digital technologies for teaching and learning?

RQ3: How did school leadership and school culture influence the integration of digital technologies into the three schools?

RQ4: What contradictions between government policies on digital technologies and classroom practice can be identified? How did these contradictions influence the implementation of digital technologies in teaching and learning and school leadership in the three Hong Kong primary schools?

1.6 My interest in this research

As a software practitioner, I have spent a large part of my career in software development in Boston and Hong Kong since the early 1980s. As a result, I have been involved in many innovative software development projects. For example, my former company, DEC [3], collaborated with MIT[4] . I was involved in a project implementing the Unix X Window System display server in the Microsoft Windows system in 1988 in Boston. Another exciting project I initiated was migrating an embedded DOS[5]-based real-time high, precision semi-conductor production system to a Windows-based system for my other former company, ASM[6], in Hong Kong in 2002. This project was technically challenging, and international companies like Motorola, Hewlett-Packard, and Siemens, were using the new production system. Therefore, I have strong technical knowledge of digital technologies and broad exposure to the business environment.

I have worked as an educator in my second career[7] since the mid-1990s and am currently teaching Computer Science courses at a tertiary institution in Hong Kong. I have about 35 years of experience as a professional software developer and about 25 years of teaching experience as an educator at the tertiary level. However, I was not exposed to the primary school culture and the working environment. According to Al-Huneini, Walker, and Badger (2020), a primary school can be "an unlikely setting for innovation" (p. 1). Therefore, I was curious to learn how digital technologies are applied in primary school teaching and learning since digital technologies may require creativity and innovation to be effective.

I am curious to understand how digital technology can impact education since I have in-depth technical knowledge and many years of teaching experience. I was interested in combining both technical and teaching experience in my study. Being deeply involved in technology, I

[3] Digital Equipment Corporation (DEC) headquartered in Maynard, Massachusetts.
[4] Massachusetts Institute of Technology
[5] Disk Operating System
[6] ASM Pacific Technology is a worldwide semi-conductor packaging equipment provider
[7] The second career refers to the career developed after I have my first career as a software developer.

noted the missing link for me is the socio-cultural perspective of technology as a social artefact. Thus, the present research offers me a different view of technology.

1.7 Organisation of the chapters in this study

This dissertation includes nine chapters. Chapter 1 introduces the study and provides the background of the study, including the Hong Kong educational reform and the rationale of the study. Next, the aim and research questions organised in multiple levels are presented. Finally, a summary of each chapter is included.

Chapter 2 is the review of literature. It begins with a brief historical development about applying technologies in education. This chapter examines different socio-cultural factors related to implementing digital technologies in primary schools, including leadership and school culture. The role of EdTech companies in implementing digital technologies in education is discussed at the end of the chapter.

Chapter 3 explores and discusses Cultural Historical Activity Theory (CHAT), the guiding framework of the study. The tradition of CHAT research explores the impact of figures such as Vygotsky, Leont'ev, and Engeström. The concept of contradiction as the driving force in identifying the interactions and relationships among the elements in an activity system is explored here.

Chapter 4 sets out the research design, data collection, and analysis methodology. This study uses a qualitative design – semi-structured interviews with the primary school subject teachers, lead teachers, and principals, classroom observations, and a review of school documents to triangulate the data collected from the interview sessions. In addition, thematic analysis and dialectic analysis were performed on the qualitative data. I also consider the study's trustworthiness and the ethical and data protection issues in this chapter.

Chapter 5 presents the social and cultural contexts of the three participating schools. Each school was regarded as a unique activity system within the CHAT framework. Different components of the activity systems are covered in detail. The context of the individual schools' traditions, values, and leadership styles are identified. Activity system as the unit of analysis was employed in analysing individual schools.

Chapter 6 is the first chapter of two, explaining the finding based on the contexts laid out in Chapter 5. Thematic and dialectic analysis of the qualitative data was conducted, providing

detailed information regarding the three participating schools' classrooms and teaching activities. Contradictions were identified related to both the micro (classroom)- and meso (teacher)-levels.

Chapter 7 is the second findings chapter based on the contexts laid out in Chapter 5. Finally, contradictions were identified at the macro (school)-level regarding school leadership and the Hong Kong Government's educational reform.

Chapter 8 is the discussion chapter that brings findings from Chapters 6 and 7 together and discusses and interprets the results from the lens of CHAT. The discussion is also organised into micro, meso, and macro levels.

Chapter 9 is the concluding chapter summarising key findings, contributions to knowledge, the limitations, and strengths of the study.

Chapter 2: The use of digital technologies in education

2.1 Introduction

This chapter traces the history of technologies such as radio, television, and computers used in education. Similarities in using these technologies in education will be drawn to argue that technology alone may not transform education over time. The present study investigates the issues and challenges surrounding the implementation of the Hong Kong Government's WiFi 100 policy-driven initiative in primary schools and explores the role of primary school teachers and principals in the application of the WiFi 100 initiative in the classroom. Therefore, in addition to the technological view, socio-cultural perspectives, such as school leadership, values, norms, and the division of labour in using digital technology in education, are considered in this study.

This chapter presents literature regarding the use of digital technologies in primary education and the challenges of implementing technology in education. The relationship between the government's education policy and commercial EdTech companies' practices is also examined. EdTech companies are one of the significant sources of technology, leading the partnership between government agencies and educational institutions.

2.2 The continuous challenges in the use of technologies in education

This section briefly describes the history of the use of technologies in education from the 1920s to the present. The use of technologies in education is divided into two distinct periods: the first period, from the 1920s to the 1980s, when analog[8] technology, such as radio, television, motion pictures, and early microcomputers, was used in education; the second period went from 1989 to 2020 – the years when digital technologies and the Internet in primary education were used.

[8] Here, analog is opposed to digital technology. Analog signals are based on the level electric current rather than the one and zero signal used in digital technology.

2.2.1 Technology introduced to education since the 1920s

The use of technologies in the classroom can be dated back to the 1920s. As film and motion pictures became widely available, in 1922, Thomas Edison, the world-famous inventor, claimed that "the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely the use of textbooks" (Cuban, 1986, p. 9). Likewise, Saettler (1990), citing Thomas Edison in 1913, predicted that "books will soon be obsolete … It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed in ten years" (p. 98). Thus, beginning over a century ago, electronic technology in education became a trend worldwide for government agencies and educators to improve the quality of learning.

According to Cuban (1986), radio broadcast technology was introduced to primary and secondary schools in the 1920s in the US. Cuban (1986) claimed that in 1932, Benjamin Darrow, who advocated using radio in the classroom, proclaimed that radio would "expand the child's universe" and "the central and dominant aim of education by radio is to bring the world to the classroom ... the radio may come as a vibrant and challenging textbook of the air" (Cuban, 1986, p. 19). Finally, Cuban (1986) wrote that William Levenson, the successor of Darrow in 1945, envisioned that "the time may come when a portable radio receiver will be as common in the classroom as the blackboard. Radio instruction will be integrated into school life as an accepted educational medium" (Cuban, 1986, p. 19).

The use of motion pictures and the portable radio in the classroom did not deliver the "educational transformation" that technology promised (Hinrichs, 2004, p. 6). New technology did not eliminate the use of chalkboards and textbooks in teaching and learning. The chalk-and-talk approach remained mainstream in teaching in the 1920s despite the advent of the film (Cuban, 1986). In sum, motion pictures did not replace textbooks, as predicted by Edison, nor did radio get integrated into school life. Thus, new technologies made a "modest" impact on education during the early stages of electronic technologies (Tamim, Bernard, Borokhovski, Abrami, and Schmid, 2011, p. 4).

2.2.2 The milestone in digital technologies in education 1970s

To understand the development of digital technologies in the 1990s, it is necessary to return to the invention of the microprocessor in the 1970s, which marked a milestone in both business and education communities (Betker, Fernando, and Whalen, 1997; Gleason, 1981).

Microprocessor technology made microcomputers affordable to small businesses, household users, and schools (Gleason, 1981). For example, the educational system, Logo Turtle, was implemented using microcomputers in the early 1980s (Gillespie, 2004). Microcomputers' use in schools proliferated in the 1970s (Gleason, 1981). However, educational software ran on standalone microcomputers and mainly provided drill-and-practice repetitive learning in the 1970s (Inan, Lowther, Ross, and Strahl, 2010). The use of technology in education migrated from using motion pictures and radio broadcasts in the 1920s to microcomputers in the 1970s and early 1980s; however, it did not revolutionise classroom teaching and learning (Cuban, 2017; Higgins, 2003).

2.2.3 More recent years of digital technology in education (1989 – 2020)

When the use of technologies in education is considered, they are referred to as "digital technologies," such as the Internet, personal computers, and wireless tablets that people use daily (Ng, 2015). In addition, the availability of the World Wide Web attracted educators to explore the possibility of new approaches to teaching and learning, such as collaborative learning, interactive learning, and project-based learning (Enochsson, 2005; Lee and Tsai, 2010).

With the available digital technologies, educators began accessing them and attempting to apply them to their teaching and learning environment because they believed that new technology associated with new pedagogies would improve educational quality, bring reform and changes to education, and fix problems related to the educational system (Fu, 2013; Sancho-Gil, Rivera-Vargas, and Miño-Puigcercós, 2020; Sutherland et al., 2004). Besides the factors mentioned above driving educators to adapt technology in schools, the knowledge-based economy is also the main reason for the change in education (Hargreaves, 2003). Regardless of the reasons for adopting technology in education, Zhao, Pugh, Sheldon, and Byers (2002) observed that educators and teachers alike "need to know the affordances and constraints of various technologies and how specific technologies might support their teaching practices and curricular goals" to integrate technologies into teaching and learning successfully (p. 511).

Electronic technologies have evolved and developed rapidly since the use of radio in the classroom. Emerging technologies are changing quickly, which does not allow teachers, schools, and educators to establish best practices and keep them in the classroom (Moss, 2006).

Advancing technology presents an unstable teaching and learning environment for teachers and students (Selwyn, 2011). Consequently, students and teachers often need to focus on learning new technology rather than educational matters. Similar to their analog predecessors, digital technologies' benefits on educational improvement were still debatable in the 1980s (Tamim et al., 2011).

Despite the problems encountered using digital technologies in education, Tamim et al. (2011) concluded that after 40 years of research from the 1960s to 2000s regarding the use of technology in education, researchers have recognised the "transformative properties" of technologies in education (p. 5). On the other hand, Durff and Carter (2019) argue that despite the possible contribution of technology to students' improvement in learning, the use of technology in school is still not widespread. Durff and Carter (2019) further claim that "attitudinal, socio-cultural, and pedagogical barriers" can prevent teachers from realising the potential of technology in teaching and learning (p. 246).

In sum, this section presents the historical trends, issues, and barriers to using technology in education. The following section reviews research studies on technology in education from the perspectives of teachers' attitudes, schools' socio-cultural environment, and pedagogical practices.

2.3 Teachers' attitudes toward using technology

This section presents human factors based on individual teachers' perspectives on using digital technology in school. When teachers and students use digital technology as new mediated teaching and learning tools, changes "in teaching and learning practices with ICT in schools" are expected (Rubagiza et al. 2011, p. 37). Rubagiza et al. (2011) claimed that "the potential of ICT will not be realised by the mere introduction of computers and ICT infrastructure in schools" (p. 37). Instead, amid the changes, one requires continuous learning and understanding of the essence of technology for both educators and teachers alike (Fullan, 2007).

Technology promised to revolutionise education, but it still presents challenges (Cuban, 2001; Hinrichs, 2004; Player-Koro, 2014). This has triggered researchers to investigate the difficulties impeding the integration of digital technologies into teaching and learning (Tamim et al., 2011). The following two sub-sections consider the internal and external factors that influence teachers' attitudes when using technology for teaching and learning.

2.3.1 Internal factors influencing teachers' attitudes

Studies have reported internal factors such as teachers' lack of technical competence and teachers' beliefs and attitudes in using technology in teaching and learning hampering the integration of technology (Durff and Carter, 2019; Gil-Flores, Rodríguez-Santero, and Torres-Gordillo, 2017; Pongsakdi, Kortelainen, and Veermans, 2021; Sang, Valcke, van Braak, Tondeur, and Zhu, 2011). These studies claim that the availability of technology is a necessary but insufficient condition for the success of digital technology integration. However, teachers' internal factors do not directly influence pedagogical practice (Law et al., 2008). Instead, Law et al. (2008) argued that teachers' pedagogical approach could influence how digital technology is used in teaching and learning.

Fu (2013) provided a comprehensive list of teachers' internal and external challenges preventing the integration of technology in schools:

Table 2.1 List of ICT integration barriers (Fu, 2013, p. 115)

Internal Factors:
Low teacher expectations and a lack of clear goals for ICT use in schools
A lack of teacher collaboration and pedagogical support
Insufficient time to master new software
Insufficient skills for managing teaching materials
Low software competence and habitual ways of conceptualizing what and how students should learn
Limited knowledge and experience of ICT in teaching contexts
A lack of specific knowledge about technology and how to combine it with the existing Pedagogy
External Factors:
Excessive focus on teaching technical or operational skills rather than course content
The pressure to improve scores on national examinations
A lack of recognition and encouragement of the timely and effective use of ICT
A lack of in-service training on the use of ICT
Technical problems in the classroom
Classroom management with large class sizes
A lack of motivation and technical and financial support,
Uncertainty about the possible benefits of using ICT in the classroom
Lack of specific ideas about how integrating technology into instruction

Table 2.1 shows teachers' internal factors, such as software competence, limited ICT knowledge in teaching, uncertain benefits of using ICT in education, and lack of motivation, related to teachers' beliefs and attitudes. However, these viewpoints are limited to individual teachers' conceptions of using digital technology in teaching and learning and are challenged by researchers with socio-cultural points of view. For example, Ertmer and Ottenbreit-Leftwich

(2010) observed that teachers' internal beliefs and attitudes could change to match their school's culture and leadership vision. Similarly, Durff and Carter (2019) asserted that school administrators' values could positively help teachers overcome internal barriers, suggesting that school leadership, values, and norms can influence teachers' beliefs about integrating digital technologies. Such viewpoints align with the socio-cultural Vygotskian perspective that internal factors are initially generated from external cultural influence (Roth and Lee, 2007).

2.3.2 External factors influencing teachers' attitudes

Besides these internal factors, Fu (2013) recognised the external factors that influence teaching practices, such as having no clear school vision and lacking ambiguous goals and planning; these include pressure to improve school scores in public examinations, insufficient time, and a lack of recognition, and encouragement from school management. These external factors, i.e., how the school's culture influences the implementation of technology, are related to leadership (Fullan, 2007). Fu (2013) observed that beyond teachers' internal barriers, a school's culture and leadership exert a more significant influence over the success of digital technology integration. Fu (2013) stated that the role of school leadership is to establish "the vision, plans, norms, and values that school members share" (Fu, 2013, p. 120). As a result, school leadership services are the central privy that connects all school members. Pohio (2016) also pinpointed school culture as one of the CHAT research community's ignored research areas. However, Pohio (2016) argued that the school culture brings lasting effects on school improvement (p. 164). Based on the claims from Pohio (2016) and Fu (2013), there is a possible gap identified in CHAT research, i.e., that school culture and leadership are essential.

Pelgrum and Law (2003) argued that leadership for integrating digital technology into schools is more important than the computer skills of individual teachers. Furthermore, Chai, Hong, and Teo (2008) asserted that school culture can improve teachers' pedagogical practices, beliefs, and attitudes about using digital technologies. Therefore, school culture is a critical factor in successfully integrating digital technologies (Tezci, 2011). Investigating the support of school leadership and culture is related to meso- and macro-levels in research questions 2 and 3, respectively.

2.4 Holistic approaches to understanding educational change

In the previous section, I established many factors besides teachers' personal internal factors. However, external factors such as shared values, vision, and leadership need to be considered

when integrating digital technology into teaching and learning to fully implement digital technology in education (Pelgrum, 2008). Lim (2002) contended that the use of digital technology cannot "be studied in isolation; it must be studied within the broader context in which it is situated" (p.411). Lim (2002) argued that "a more holistic approach to studying ICT in schools by adopting a socio-cultural perspective" is needed (p. 411). Lim (2002) suggested that "research studies in ICT need to shift their attention towards the whole configuration of events, activities, contents, and interpersonal processes taking place in the context that ICT is used" (p. 411).

Ra, Chin, and Lim (2016) argued that despite the vast investment in digital technology for education, its potential to transform education has not been fully exploited. Ra et al. (2016) called for a holistic approach to drive the integration of digital technology at the system level: "ICT in education may be driven and supported at the system level to take up the opportunities of ICT for the transformation of teaching, learning, and management practices in schools" (p. 69).

To illustrate the holistic approach to education, there are 10 socio-cultural and system areas that need to be acknowledged in the "report regarding the status of ICT integration in education in Southeast Asian countries" (Maftuh, 2011, p. 2):

> (1) National ICT in education vision; (2) National ICT in education plans and policies; (3) Complementary national ICT and education policies; (4) Access to ICT infrastructure and resources; (5) Professional development for teachers and education leaders; (6) Partnerships; (7) ICT in the national curriculum; (8) Teaching and learning pedagogies; (9) Assessment; and (10) Evaluation and research. (Maftuh, 2011, p. 2)

From these areas, the background context, such as areas (1), (2), (3), (4), (7), and (9), focus on the system-level integration that is covered in Chapter 1. Thus, I will adopt areas (5) professional development and education leaders, (6) partnership, and (8) pedagogical practice as the guide to frame my literature review.

2.4.1 Professional development for teachers and education leaders

This section discusses the need for professional development for teachers as agents of change. The relationship between leadership and professional development is illustrated to show that leadership needs to establish a shared vision. The components of digital technology are required to be part of the shared vision to develop a school culture of "good teaching" (Ertmer

and Ottenbreit-Leftwich, 2010, p. 275). Leadership is an important factor in integrating digital technology into teaching and learning (Ertmer and Ottenbreit-Leftwich, 2010). Essentially, when the term leadership is used, it refers to the school principals. In contrast, the term education leaders refer to administrators, curriculum leaders, digital technology leaders, or subject leaders. Therefore, professional development discussed in this section covers both school leaders and teachers.

2.4.1.1 Professional development for teachers as change agents

Integrating digital technology into schools brings about pedagogical and curricular changes (Noor-Ul-Amin, 2013). Teachers are the central focus when using digital technology in the classroom (Saxena, 2017). As agents of change, teachers must acquire knowledge and skills (Ertmer and Ottenbreit-Leftwich, 2010). However, Ertmer and Ottenbreit-Leftwich (2010) argued that it is not enough for teachers to possess digital knowledge and skills to empower them to use digital technology to achieve the teaching and learning objectives of student-centred learning. The use of digital technologies in teaching and learning demands that teachers extend their pedagogical practice to include innovative digital elements (Ertmer and Ottenbreit-Leftwich, 2010).

Digital technology can make teaching "quicker or easier" without changing pedagogical practices, which is the "routine way" (Lawless and Pellegrino, 2007, p. 581), similar to one of the strategies mentioned by Underwood (2014), i.e., "using technology to support the current practice that removes the role of catalyst for change" (Underwood, 2014, p. 8). However, Lawless and Pellegrino (2007) claim that the use of digital technology can be used "to adopt new and arguably better approaches to instruction and/or change the content or context of learning" (p. 581). This matches another strategy from Underwood (2014), i.e., "merging and evolving digital technology that necessarily requires us to reassess how learners learn and teachers teach" (p. 8). It is the "merge and evolve" (Underwood, 2014, p. 8) of the current non-digital pedagogical practice that "the majority of today's teachers find most challenging, perhaps because they require the most amount of change" (Ertmer and Ottenbreit-Leftwich, 2010, p. 257).

Such innovative changes require the support of schools and teachers working together because teachers do not act in isolation and "teachers are not 'free agents' and their use of ICT for teaching and learning depends on interlocking cultural, social, and organizational contexts in which they live and work" (Somekh, 2008, p. 450). According to Zhao and Frank (2003),

teachers are mainly influenced by the school cultural environment where they are working. Therefore, in order to facilitate teachers' pedagogical change in teaching, school leadership plays an integral part in creating "a shared vision for technology use" (Ertmer and Ottenbreit-Leftwich, 2010, p. 275). A shared vision should be incorporated into teachers' professional development.

Based on this discussion, the following sections cover the various aspects of teachers' professional development and the role of leadership in facilitating and creating a culture of good teaching using digital technology for teaching and learning.

2.4.1.2 Professional development mindset for teachers in using digital technologies

According to various surveys, professional development has shifted from learning technological knowledge and skills to using technology to support teaching (Ertmer and Ottenbreit-Leftwich, 2010). However, even though some teachers may think that their pedagogical practice has changed from teacher-centred learning to student-centred constructivist learning, in reality, the way teachers use technology for teaching is not innovative but actually similar to the traditional way of teaching (Hermans, Tondeur, van Braak, and Valcke, 2008). The problem is that the design of pedagogical practices in education with technology has not mapped student learning outcomes (Lawless and Pellegrino, 2007).

Professional development is required to help teachers understand the transformative capacity of digital technology to empower students to construct knowledge that can be applied to their daily lives (Lai, 2008; Law, 2008). Ertmer and Ottenbreit-Leftwich (2010) argued that it is time for professional development planners and teachers to "shift their mindsets away from the notion that technology provides a supplemental teaching tool and assume ... that technology is essential to the successful performance of student learning outcomes. Effective teaching requires effective technology use" (P. 256). In other words, successful teaching and learning require technology to be interweaved with pedagogical practice. Technology is not playing a supportive role in teaching and learning anymore. Instead, pedagogical approaches and digital technology are interdependent for achieving meaningful learning outcomes. Therefore, according to Guskey (2000), professional development exists not only to reinforce the current pedagogical practice but also to "redesign educational structures and culture" by using digital technology (p. 16).

In designing professional development programmes, the constructivist approach of internalising knowledge empowers students to take an active role in the "construction and reconstruction of knowledge" accompanied by digital technology in their learning (Ra et al., 2016, p. 11). Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2010) suggested that the idea of empowering students to develop their understanding through the construction of knowledge can be put into practice by providing professional development programmes that help teachers change their practices and mindset. However, the authors claimed that conventional professional development might not provide the constructivist shift teachers need for their pedagogical practices using digital technologies. Therefore, teachers' professional development programmes need to change how they are structured regarding the integration of digital technology.

As Ertmer and Ottenbreit-Leftwich (2010) suggest, "school leadership is a critical factor in facilitating teacher change and a shared vision for technology use … The shared vision should include technology as part of the definition of 'good teaching' in professional development" (p. 275). In the next section, literature related to the socio-cultural and leadership perspectives is presented.

2.4.1.3 The role of leadership

As school leaders, principals play a critical role in adopting digital technology (Tondeur, Cooper, and Newhouse, 2010). Studies have demonstrated the vital role of school leaders regarding the integration of digital technology into teaching and learning (Berrett, Murphy, and Sullivan, 2012; Dexter, 2011; Mingaine, 2013; Yuen, Law, and Wong, 2003)

Dexter (2011) observed that school principals must thoroughly understand the potential of digital technology in teaching and learning at different levels to provide leadership for restructuring their schools' use of digital technology. For example, Leithwood, Harris, and Strauss (2010) contended that school principals must keep track of students' learning related to digital technologies and continue assessing the digital technology policies implemented in their schools. In other words, a school principal should drive different areas, such as the formation of shared culture, introducing changes to professional development programmes, monitoring the effect of school policies related to the use digital technology, and the usage of digital technology among teachers and students.

Thus, the principal plays a critical role in responsibility for the success of integrating digital technology (Berrett et al., 2012). However, it would be reasonable for principals to delegate responsibilities to other school members to share the load and increase the chances of successfully implementing digital technology in their schools. In other words, schools need leadership in different areas when integrating digital technology, which is related to studies on distributed leadership. The following section presents the literature related to distributed leadership.

2.4.1.4 The role of distributed leadership

Smylie, Conley, and Marks (2002) defined distributed leadership as deviating from the conventional idea of leadership based on a single person to a collective leadership role based on specific school areas. Studies have revealed that distributed leadership contributes to the transformation of schools in different ways (Harris, 2012; Ng and Ho, 2012; Wahab, Hamid, Zainal, and Rafik, 2013). Hargreaves and Fink (2004) asserted that all school members should be leaders in different aspects. This notion aligns with Spillane's (2006) view that all members of the school community, besides the principal, such as the head of a curriculum, heads of different subjects, digital technology coordinators, administrators, teachers, parents, and students, can be leaders who contribute to school reform.

Ng and Ho (2012) showed that implementing digital technology in schools requires leaders with different abilities to develop and transform teachers' mindsets. Other studies have revealed that teacher leaders can share the principal's workload, encourage other teachers to contribute to school reform, and support collaboration among other school members (Ghamrawi, 2013; Spillane, 2006).

Danielson (2006) characterised a teacher leader as one who “teach[es] students but also [has] influence that extends beyond their classroom to others within their school and elsewhere” (p. 12). Therefore, professional development success is also driven by teacher leaders who open up new approaches to teaching and learning for other teachers beyond their own classrooms. Conway, Hibbard, Albert, and Hourigan (2005) argued that building a distributed leadership community is essential but must be linked to student learning outcomes.

Here, the role of distributed leadership is presented. A school needs to develop distributed leadership among teachers to successfully implement digital technology. The following section covers case studies related to distributed leadership in schools.

2.4.1.5 Leadership case studies of digital technology implementation

Avidov-Ungar (2018) studied a group of 24 school-teacher leaders selected as candidates for an Information and Communications Technology (ICT) Leadership award by the Minister of Education in Israel in 2014. The author discussed the critical difference between traditional leadership and the new concept of ICT leadership. The traditional leader focuses on an individual (Harris, 2005; Yuen et al., 2003), such as the principal shaping the school culture; however, a new concept of leadership is one where leadership is distributed among individuals throughout an organisation, which makes changes to the organisation's culture (Leithwood and Duke, 1999). Such leadership can involve a person, a group, an organisation, or a community. According to Avidov-Ungar (2018), a selected group of teacher leaders is a new type of leader who plays the leadership role and is the agent of change or the driving force. Therefore, these teacher leaders are not individual traditional leaders but a new type of leader who is part of the community; in Avidov-Ungar's study, they changed Israel's national ICT project implementation.

Another study in Spain by León-Jariego, Rodríguez-Miranda, and Pozuelos-Estrada (2020) found conflicting roles as a teacher and an ICT coordinator with limited time available; an ICT coordinator needs to adjust their job priorities when performing their duties to avoid role conflict. The authors also observed that ICT coordinator constructs their job priorities in practice and cannot follow instructions identified by the Education Administration.

León-Jariego et al. (2020) concluded that a clearly defined role and a shared vision of roles within a school are essential in successfully implementing ICT. They recommend building a team of ICT coordinators, and "this team must have a shared vision of ICT school integration and should be relatively stable" (p. 848).

In Hong Kong, in the context of the present study, Yuen et al. (2003) conducted multiple case studies on implementing digital technology in primary and secondary schools based on the Hong Kong Government's five-year initiative from 1998. The study found three implementation models showing that leadership is the key to influencing and shaping the translation of the government's digital technology initiative into the school's policy, planning, and action. According to the study: 'Model A: the technological adoption model; Model B: the catalytic integration model; and Model C: cultural innovation model' (Yuen et al., 2003, p.165).

Yuen et al. (2003) claimed that in Model A, the use of digital technology is limited to the interpretation of the curriculum, and the principals bear a short-term view, while Model B extends the integration of digital technology into pedagogical practice and activities in the classroom, including problem-solving and project-oriented tasks. This way, pedagogical practice exercises "social-constructivist approaches" (Yuen et al., 2003, p. 166). Finally, the critical difference between Models A and B and Model C is that the principals' school mission and vision statements are clear in Model C. According to the authors, such clear mission and vision statements provide a strong cultural environment and free teachers from confusion. The authors claim that teachers can apply different pedagogical approaches using digital technology and are not afraid of making mistakes.

The study showed that Model A is the initial stage of integrating digital technology, where leadership has not yet established a culture for change management. Model B and C are more ready for change because the leaders are involved in the evolution and set clear directions for their schools. Yuen et al. (2003) contend that an individual holds leadership, i.e., the school principal, and briefly mentions other school leaders. The contribution of teacher leaders was not considered in Yuen's study.

A more recent study by Li et al. (2010) holds a similar view to Yuen et al. (2003), i.e., that other than the supportive factors, such as strong collegiality, trust among teaching members, and receptivity to innovations, strong principal leadership is a determining factor for successfully implementing digital technology.

2.4.2 Teaching and learning pedagogies

In addition to the needed change in pedagogical practices in using digital technology (Rubagiza et al. 2011), Lim and Oakley (2013) claim that "having ICT in the primary curriculum and classroom does not guarantee enhanced learning" (p. 1). Barnes and Sutherland (2010) showed that change in educational practices comes from social learning activities using digital technology rather than individual teachers acting in isolation. The authors argued that learning occurs when there is an interaction between tools, cultural artefacts, and people. This section presents the cultural dimensions of interacting with digital technology from the top-down: broad social and national cultural influence, and from the bottom-up: individual practices among teachers and students.

Researchers from the InterActive Education Project[9] asserted that "ICT alone does not enhance learning" and "how ICT is incorporated into learning activities is what is important" (Sutherland et al., 2004, p. 413). In other words, it is not the use of the 'new' technology that comes with the 'new' pedagogies that will transform teaching and learning (Sutherland et al., 2004, p. 413). According to the authors, the interaction process involved in the learning activities brings about dynamic change and exchanges, including the out-of-school use of digital technology by students and teachers and the culture of the tools being used. The authors argue that "any technological tool has been developed within a particular socio-cultural setting and carries with it the provenance of this culture" (Sutherland et al., 2004, p. 415).

Top-down and bottom-up cultural dimensions influence each other in the interaction process. Top-down cultural influence includes "school culture, subject culture, the National Curriculum, and the national assessment structure that are being influenced by more global factors" (Sutherland et al., 2004, p. 415). The bottom-up culture dimension comes from both students' and teachers' out-of-school personal learning experiences. Thus, the transformation of learning involves interweaving cultural influences from participants, social environments, and the community.

In the next section, I cover the involvement of EdTech companies that have influenced the interpretation of Hong Kong Government education policies, curriculums, and pedagogical practices.

2.4.3 The role of education technology companies in education

In this section, I describe EdTech companies' role in using digital technology in education. It is essential to understand their role because EdTech companies are the sources and suppliers of digital technology as commercial products to the education sector. As a result, digital

[9] The InterActive Education Project was funded by the ESRC (Economic and Social Research Council) Teaching and Learning Research Programme. The project teams were from the Graduate School of Education, University of Bristol.

technology companies and their products directly influence the curriculum and pedagogical practices in the classroom.

2.4.3.1 The education technology market

In the process of searching recent literature with keywords terms such as "EdTech market" and "commercialisation of EdTech" using WorldCat and Google Scholar databases, the following terms consistently appeared: innovation, entrepreneur, government funding, start-up EdTech firm, and venture capital. A further search with the term “EdTech Companies,” some mainstream publishers and technology companies such as Pearson and Edison Learning, Facebook, Apple, IBM, Google, and Blackboard.

Means and Saltman (2019) claimed that "currently, the global education marketplace has been valued at approximately $5 trillion a year" (p. 6). attracting “global edu-corporations, such as Pearson and Edison Learning, Silicon Valley giants, such as Facebook and Microsoft, and financial institutions such as Goldman Sachs, through contracts for for-profit schooling, packaged curriculum, textbooks and classroom materials, testing services, technology platforms” (p.6). In addition, they argue that “within this emerging view of education as a private service, knowledge is conceived as a deliverable private commodity rather than a public good – something that can be standardized, mass-produced, measured, transmitted, and delivered efficiently and profitably” (p. 6). As a result, educational technology startup firms have sprung up in the Edtech market in the past 10 years to lure such a profitable business (Delgado, Wardlow, McKnight, and O’Malley, 2015).

2.4.3.2 Types of EdTech firms

Several studies related to the investigation of EdTech firms are relevant to my research. For example, Mattsson and Andersson (2019) conducted a case study on a privately owned EdTech Swedish startup firm, Sensavis, that entered the EdTech market in 2013. The study investigated tensions generated by the firm and the public service sector interactions.

Mattsson and Andersson (2019) noted that when Sensavis worked with public schools, it started with the involvement of a few enthusiastic teachers and gradually engaged the headmasters and technical staff from the information and communication unit in the decision-making process of developing digital teaching material because of the complexity of digital teaching materials and software. Therefore, according to the authors, Sensavis needed to adjust

its business focus according to the different expectations of teachers, principals, and technical staff.

Mattsson and Andersson (2019) observed that the procurement strategy from the municipality office influenced Sensavis' business operation. Sensavis was obliged to develop a solution for a new iPad model acquired by the municipality office. The Swedish National Agency also controlled Sensavis' business for Education. Sensavis needed to modify the current product to integrate with the new policy when the agency implemented a new policy to develop a nationwide learning platform. A small private EdTech firm like Sensavis in Sweden was driven by the changes in market demand from the public sector customers. However, unfortunately, such demand creates tension between private and public entities.

Ramiel (2020) conducted a case study on a government-owned EdTech research and development unit in Israel named, MindCET (The Centre for Education Technology), a subsidiary of the Ministry of Education. The purpose of the study was to investigate the policy decision-making process under the influence of the private EdTech sector. MindCET is a publicly owned Edtech organisation but operates as a private EdTech startup firm in Israel, together with Silicon Valley [10] high-tech companies' disruptive culture and intervening technological philosophy, according to Ramiel (2020). MindCET provides EdTech products, conducts professional teacher training, and organises international and local EdTech conferences and events (Ramiel, 2020). As a result, MindCET established a network of educators, educational technology entrepreneurs, and business practitioners (Ramiel, 2020). In essence, "MindCET seeks to influence public education policy not by promoting systemic change, but by initiating activities that foster connections, ideas, possibilities, and experiences" from the private sector (Ramiel, 2020, p. 1).

MindCET was a mediator between different actors from the education, business, and technological communities. New ideas generated from these communities are captured by

[10] Silicon Valley is not only a geographical location but also represents an ideology of disrupting routines (or improving routines) through new technology (Leary, 2018).

MindCET and fed back to policymakers (Ramiel, 2020). The author noted that MindCET became a critical agent in coordinating activities between the public and private sectors. Thus, MindCET is "a broker of ideas" (Ramiel, 2020, p. 10).

2.4.3.3 The influence of EdTech companies on Silicon Valley value

A study by Williamson (2019) related EdTech startup firms to Silicon Valley and, in his writing, enforced the Israeli MindCET project idea of intervention and disruption based on Silicon Valley culture. According to Williamson (2019), Silicon Valley's organisational culture takes the stance that public education is conservative and not meeting the needs of a technologically oriented society. So instead, Silicon Valley technology companies took the matter into their own hands and actively invested capital in EdTech startup firms and startup schools[11] to lead educational reform:

> Silicon Valley technology companies, entrepreneurs, investors, and philanthropists are currently engaging in education with considerable enthusiasm. Global technology companies, including Facebook and Google, have launched major technological platforms for education and begun investing financial resources in other startup firms. Silicon Valley has become the centre for a "startup school" movement, which has seen entrepreneurs associated with social media and web companies creating their private schools as competitive alternatives to state schooling and models for the reinvention of public education on a massive scale. (Williamson, 2019, p. 283)

By establishing EdTech firms and startup schools, Silicon Valley technology companies attempt "to speed up education policy" (Williamson, 2019, p. 283). As a result, Williamson (2019) noted that Silicon Valley has become "a major centre of technology-driven global education reform" (p. 283). Silicon Valley aspires to be the "techno-political centre of global education reform" (Williamson, 2019, p. 284) and the startup EdTech firms and schools are the manifestation of such a mentality (Williamson, 2019). The author described this approach to redefining public education as involving significant investments and innovative state-of-the-art technology. Williamson (2019) also noted that Silicon Valley technology companies'

[11] Example of startup schools are AltSchool, Summit Public Schools, Khan Lab School, and XQ Super School Project (Williamson, 2019).

educational reform is partly inspired by the for-profit and return of investment mindset related to opportunities generated from education reform.

Saltman (2016) warned that the "restructuring of public education by economic and political elites" has "succeeded in strategically advancing privatization and market-based school reforms to transform public education into a private industry while also hijacking public governance over educational policy" (p. 107). In other words, Silicon Valley only focuses on using a commercial-technical approach in education and ignores the area of socio-economic issues addressed by the government education policy.

2.5 Chapter summary

This chapter began by describing historical trends in the use of technology in education, such as motion pictures, portable radios, and television, to the current use of technology, such as the Internet, microcomputers, and tablets, and how it is disrupting the conventional way of teaching, including the use of printed textbooks and the chalk and talk mode of instruction. Tamim et al. (2011) claim that after 40 years of educational research regarding the use of technology, researchers have endorsed the transformative values of technology in teaching and learning. However, Durff and Carter (2019) argue that the use of technology in school is still not widespread regardless of the recognised value of technology in education. Sutherland et al. (2004) contended that technology alone would not transform education. Law et al. (2008) also noted that technology is necessary but insufficient for integrating digital technology into schools. Rather, educators need to understand the affordances and limitations of technology in education (Zhao et al., 2002).

Teachers are the agents of change in education, driving educational reform by integrating technology into teaching and learning. Teachers' internal factors, such as beliefs and conceptions of digital technologies, affect teachers' use of technology in teaching and learning. However, teachers' external environment, such as school values, culture, shared visions, and leadership towards technology use can influence internal factors. Therefore, there is a call for a more holistic approach to understanding technology integration into schools (Lim, 2002; Ra et al., 2016).

According to Pohio (2016), in her concluding note on the research trend related to CHAT, "Organisational culture has been highlighted in this article as a tool that can have a powerful influence on the success of an organisation, and yet it is rarely the focus of AT research" (p.

163). “Organisational culture” is a critical success factor for school improvement, which has a lasting effect (p. 164). Lim (2002) claimed the holistic point of view considers the “whole configuration of events … that takes place in context” (p. 411). Thus, school culture, teachers’ professional development and school leadership, pedagogical practice, and the role of EdTech companies and government education policies are essential. As a result, the gaps identified in the present study are the socio-cultural influences on the implementation of digital technology in schools and the government curriculum policy being interpreted and implemented in schools.

Chapter 3: The theoretical framework

3.1 Introduction

In Chapter 2, I argued that understanding digital technologies in education should not be confined to the technology-driven point of view. Instead, a broader scope of socio-cultural and historical premises can strengthen and deepen our understanding. Thus, in my study, I employed the Cultural Historical Activity Theory (CHAT) to investigate the use of digital technology activities in three primary schools.

In this chapter, the literature related to the historical development of CHAT is described, first by explaining the ontological assumption and principles of CHAT, such as the use and development of tools, the role of human agency connected to historical and socio-cultural factors, and the discussion of object-oriented activities linked to the three generations of theory based on the work of Vygotsky, Leont'ev and Engeström (Nussbaumer, 2012). Finally, the chapter ends with a discussion and evaluation of the use of the theory as the methodological framework for this study.

3.2 The study of human practices and activities in education

Engeström (2000a) stated that activity theory[12] was introduced to the West as a theory in psychology presenting an unconventional "cultural and mediational" viewpoint in the discipline of psychology (p. 301). However, according to Engeström (2000a), the deeper meaning of the socio-cultural "epistemological stance of activity theory" was not thoroughly examined (p. 301). In other words, in Engeström's opinion, the socio-cultural stance can be applied to other disciplines beyond psychology, such as organisational studies, education, science, and art. Engeström considered "three activity types as practical lineages leading to the

[12] Activity Theory (AT) is used in some research while CHAT emphasises the cultural historical aspects of Activity Theory. CHAT will be used throughout this dissertation. The term Activity Theory will only be used when cited from the original text.

formation of learning activity. These three are the activity of going together, the activity of work, and the activities of science and art" (Engeström, 2015, p. 75). Engeström (2000a) concluded that such a viewpoint is not only advantageous in the field of psychology but also can provide a new avenue into the study of the "social construction of knowledge" (p. 301).

Therefore, educational research has become one of the disciplines to embrace activity theory. As Nussbaumer (2012) noted, a keyword search using "cultural, historical or activity theory and education" between the years 1990 to 2000 generated 1,577 journal articles (p. 40). Nussbaumer (2012) argued that the high level of CHAT acceptance in educational research highlights the importance of social learning instead of learning individually. Similarly, Roth (2004) expounded on the idea that educational researchers have discovered the potential of CHAT for examining societal changes. Hence, applying CHAT in educational research provides insights into life transformation situations in educational activities (Roth, 2004). Accordingly, my study uses CHAT as the theoretical framework to investigate the transformation and changes among teachers, students, and schools in adopting digital technology in educational practices. The principles of CHAT, the idea of expansive learning, and the concept of activity are discussed in the following sections.

3.3 The development of activity and activity systems in CHAT

This section describes the chronicled development of activity and the activity system underpinning CHAT. The relationships between activity, action, and operation are illustrated, and the cultural artefacts and mediated acts are covered.

3.3.1 The conceptualisation of activity in CHAT

CHAT primarily refers to human activities performed with purposeful objects (Kaptelinin, 2005; Nardi, 2009). Therefore, this section covers individual, culturally mediated activity first explained by Vygotsky, followed by Leon'tev's development of the collective activity.

3.3.1.1 Individual culturally mediated activity

Lev Vygotsky was a Russian psychologist who originally developed the cultural-historical approach to child learning in developmental psychology in the 1920s and 1930s (Engeström, Miettinen, and Punamäki-Gitai, 1999; Vygotsky, 1978). Vygotsky's cultural-historical approach was further developed by his students Alexander Luria and Aleksei Leont'ev after his death in the mid-1930s (Leont'ev and Cole, 2009; Leont'ev, 1978). Vygotsky's

psychological approach was influenced by the classic German historical and philosophical tradition from Kant to Marx and Engels and the French cultural psychology tradition under Pierre Janet (Kozulin, 1986). Vygotsky argued that human actions are mediated by cultural artefacts that can be physical or mental, such as machines, signs, language, and laws, to accomplish the object of the action (Kozulin, 1986). The following figure illustrates Vygotsky's idea of mediation:

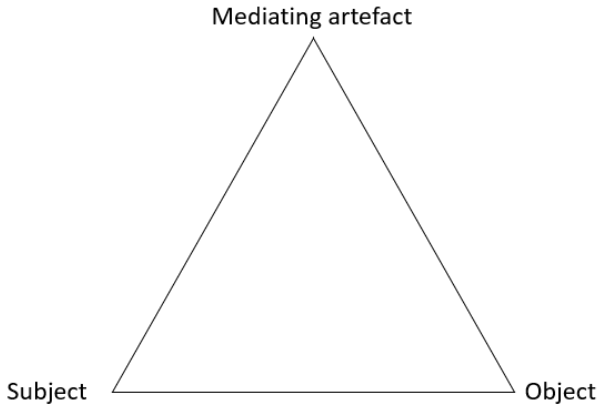

Figure 3.1 Vygotsky's mediated act

(adapted from Engeström, 2001, p. 134)

Vygotsky's idea of cultural mediation is depicted in the form of a triangle of action (Figure 3.1). The triangle consists of a subject, object, and mediating artefact. The subject represents a person or persons performing an activity. The mediating artefact includes physical tools such as machines or mental tools such as signs and languages. Engeström explained that the mediating artefact facilitates the study of an individual's mind and thoughts via cultural means. Thus, society is better understood by individuals using and producing these cultural means (Engeström, 2001).

Two of Vygotsky's books related to the concept of culturally mediated activity were translated into English and published in 1962 and 1978, respectively, *Thought and Language*, and *Mind in Society* (Glick, 2004). Glick noted that:

> Something obviously happened between 1962 and 1978, something that effected an interest in and a fascination with Vygotsky's ideas, or at least what were taken to be Vygotsky's ideas. In 1962, the publication of *Thought and Language* seemed a one-time event. In 1978 *Mind in Society* spawned a generation of scholarship. (Glick, 2004, p. 349)

Vygotsky's socio-cultural school of thought and social learning has a long-lasting impact on the academic community based on his publication, *Mind in Society.*

3.3.1.2 Object of Activity: the transformation of subject

Vygotsky (1978) claimed "activity" operated at the individual level within the socio-cultural context, while Leont'ev (1981) extended activity from the individual to the collective level within Vygotsky's socio-cultural tradition. Leont'ev, a student and colleague of Vygotsky, initially introduced and published the activity concept in Russian. Leont'ev wrote two books in Russian to explain the concept of activity, namely, *The Problems of the Development of Mind*. The initial edition was published in 1959 and later translated into English in 1981 by Victor Kaptelinin, and the other book was entitled *Activity, Consciousness, and Personality*. The first edition was published in 1975 and later translated into English in 1978 (Kaptelinin, 2005). Thus, Kaptelinin explained the conceptual framework of CHAT which proposed studying the mind from a biological perspective showing how it progressed to an advanced stage of consciousness. Kaptelinin stated that such a historical study of the mind and the proposal of activity was the main contribution of Leont'ev. Subsequently, together with the concept of activity, he proposed the notion of "object of activity," which became the key concept in CHAT (Kaptelinin, 2005). Here, Leont'ev (1978) explains object of activity:

> A basic or, as is sometimes said, a constituting characteristic of activity is its objectivity. Properly, the concept of its object (Gegenstand) is already implicitly contained in the very concept of activity. The expression "objectless activity" is devoid of any meaning. Thus, the object of activity is twofold: first, in its independent existence as subordinating to itself and transforming the activity of the subject; second, as an image of the object, as a product of its property of psychological reflection that is realized as an activity of the subject and cannot exist otherwise. (Leont'ev, 1978, p. 86)

Thus, the meaning of the object of activity is two-dimensional. The object's existence is independent of the subject; however, it can be a psychological image of the subject or a reflection of the mind. In both cases, the object is responsible for the transformation of the subject who performs the activity. Consequently, the objective and subjective views of the object are one entity with two facets. As Kaptelinin asserted, "the object of activity has dual status; it is both projection of the human mind onto the objective world and a projection of the world onto the human mind" (Kaptelinin, 2005, p. 5). Kaptelinin (2005) summarised the essence of the object of activity as follows:

> The object of activity can be considered the "ultimate reason" behind various behaviors of individuals, groups, or organizations. In other words, the object of activity can be defined as "the sense-maker," which gives meaning to and determines values of various entities and phenomena. (Kaptelinin, 2005, p. 5)

Therefore, object of activity is the meaning given to the activity that drives the subject to participate and contribute to the activity. The dual meaning of the object of activity can be traced back to the original meaning of two Russian words: *objekt* and *predmet*. Objekt refers to the physical object humans can act upon, while predmet means the motive that drives the activity forward (Kaptelinin, 2005).

3.3.1.3 Activity of subject: mutual transformation of subject and object

According to Kaptelinin and Nardi (2006), "in activity theory, any activity is an activity of a subject, … the interaction is initiated and carried out by the subject to fulfill its needs" (Kaptelinin and Nardi, 2006, p. 32). In other words, activity is driven by motives to achieve the needs, regarded as the goals or the objects of the subject. Kaptelinin and Nardi (2006) also noted that:

> "in activity theory, no properties of the subject and object exist before and beyond activities. … Hence, activity is considered the key source of development of both the object and the subject. … In other words, activity is proposed as the basic unit of analysis providing a way to understand both subjects and objects, and understanding that cannot be achieved by focusing on the subject or the object separately" (Kaptelinin and Nardi, 2006, p. 31-32).

In this case, the activity provides a connection between the subject and the object; hence, activity, subject, and object must be studied as one unified entity. The authors observed, "activity is not only human activity, but the activity of any subject, [and] is understood as a purposeful interaction of the subject in the world, a process in which mutual transformations between the poles of 'subject-object' are accomplished" (Kaptelinin and Nardi, 2006, p. 31). From the above description, the keywords are "purposeful interaction" so that in my study, the focus is about the "mutual transformation" or reciprocal influence of human activity between the subject, i.e., the teachers, and the object, which is the implementation of the WiFi 100 initiative through purposeful interactions with teachers' socio-cultural context. In sum, mutual transformation may occur during purposeful interactions.

3.3.1.4 Subject and environment: one unit

In addition to the concept of object transformation of the subject who performs the activity, the subject and its cultural environment are one unit; according to Yamagata-Lynch, Vygotsky "used Marx's political theory regarding collective exchanges and material production to examine the organism and the environment as a single unit of analysis" (Yamagata-Lynch, 2010, p. 15). Similarly, the book, *The Cambridge Companion* states that:

> Vygotsky argued that the individual and the environment mutually constitute each other; “the environment” cannot be specified independently of the organism (in this case, person) who lives in and through that environment, changing it even as he (in this case, Vygotsky) interprets and acts on it. (Daniels, Cole, and Wertsch, 2007, p. 4)

From the above, we can envision the connection and the similarity in conceptual thinking between Vygotsky and Leont’ev: the subject and the cultural environment are inseparable; activity and object are inseparable since the objectless activity is meaningless (Leont’ev, 1978), and the subjective and objective aspects of the object are inseparable. In other words, we must consider the cultural environment and the object of the activity when we study human activity. Similarly, when we study human activities, the situated cultural context, the embedded objects, and the subjective and objective aspects of the objects must be considered. According to Kaptelinin and Nardi (2006), it is crucial to understand each activity providing answers to the subject's needs and the driving force as the object of the activity.

3.3.2 Cultural artefact mediation and the mediated act

Activity in CHAT primarily focuses on the physically mediated labour activity with cultural artefacts originating from the Russian word *dejatel'nost* (Vygotsky, 1978). However, the meaning of activity was later extended to mental activities, referring to the Russian word, *aktivnost*, such as thinking, remembering, and memorising (Leont’ev, 1978).

Vygotsky asserted that human activity could not be broken down into the stimulus-response (S-R) model rooted in the American psychology research tradition of the 1900s (Kozulin, 1986). Furthermore, he disagreed that the study of human activity can draw conclusive results from animal experiments conducted by behaviourists (Kozulin, 1986). Instead, he focused on the argument that human activity is driven by the object resulting from human activity and consciousness. Therefore, animal actions cannot establish such a relationship (Nardi, 1996).

Vygotsky’s mediated act was misinterpreted during the 1930s to 1950s as the extension of the S-R model into S-X-R, where X is the “mediating link” (Vygotsky, 1978, p. 13). However, he contended that actions are always mediated and not just a matter of stimulus and response:

> Vygotsky was not a stimulus-response learning theorist and did not intend his idea of mediated behavior to be thought of in this context. What he did intend to convey by this notion was that in higher forms of human behavior, the individual actively modifies the stimulus situation as a part of the process of responding to it. It was the entire structure of this activity which produced the behavior that Vygotsky attempted to denote by the term "mediating." (Vygotsky, 1978, p. 14)

Vygotsky demonstrated how a mediated act is different from an unmediated one. Based on the triadic relationship between subject, object, and mediating artefact (Figure 3.1), the higher order of mental function is the product of the mediated act with the cultural artefact denoted by linking the artefact from subject to object. In contrast, the lower elementary cognitive function is the product of the unmediated act indicated by the direct link between subject and object (Vygotsky, 1978).

Mediated artefacts can be characterised as psychological tools related to the human "mind and behaviour" and technical tools operating in the physical world (Vygotsky, 1978, p. 87). Psychological tools bring changes to human behaviour, while technical tools bring changes to the "object itself" (Vygotsky, 1978, p. 87). In other words, a psychological tool is directed to mental activities such as language, signs, and software programmes. In contrast, the technical tool is directed to physical activities such as a keyboard, mouse, chopsticks, fork, and knife. Wertsch (1998) explained that the interaction of the subject with the psychological tool contributes to the transformation of mental functions (Wertsch, 1998, p. 79). As a result, tools mediate activities with the social context, while activities mediate the tools being used. Such two-way mediation enables the tools to evolve and capture the culture, history, and knowledge developed within the social context. The mediated tools were further categorised into three types by Wartofsky (1979), namely, primary tools (physical), secondary tools (mental), and tertiary tools (context, community, culture, and vision) (Wartofsky, 1979). Engeström (1990) noted that tertiary tools impact the mode, direction, and identity of the activity system (Engeström, 1990, p. 174).

Because of the two-way mediation, the activity system is dynamic and changes over time. Kuutti (1995) pinpointed the essential role of mediating artefacts during the dynamic interaction in an activity:

> Thus the (reciprocal) relationship between the subject and the object of activity is mediated by a tool, into which the historical development of the relationship between subject and object thus far is condensed. The tool is at the same time both enabling and limiting: it empowers the subject in the transformation process with the historically collected experience and skill 'crystalized' to it, but it also restricts the interaction to be from the perspective of that particular tool or instrument only; other potential features of an object remain 'invisible to the subject. (Kuutti, 1995, p. 27)

Kuutti argued that because mediated artefacts are the cultural and historical carriers of the socio-cultural context, the mediating artefact can play a critical role in "enabling and limiting" the transformation of the activity system (Kuutti, 1995, p. 27).

3.3.3 The relationship between activity, action, and operation

Leont'ev delineated the differences between collective activity, individual actions, and operations. However, he did not develop the concept into a graphical representation. Thus, Figure 3.2 from Wilson (2006) depicts the relationship between activity, actions, and operations:

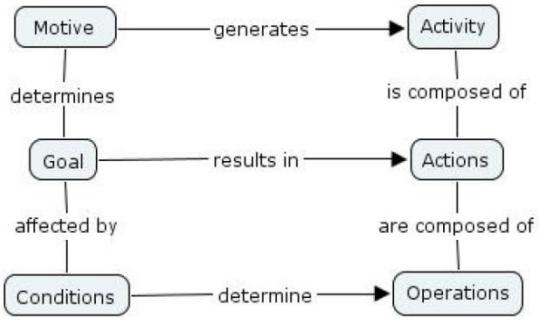

Figure 3.2 Activity, actions, and operations

(adapted from Wilson, 2006, P. 8)

Activity is collective and has long-term endurance, while its object cannot be realised into an outcome in a short time (Kuutti, 1995). Therefore, activity needs to be broken down into smaller stages in order to accomplish the object, and shorter-term actions or a series of related actions emerge as the intermediate steps (Kuutti, 1995). In these terms, the smaller action steps can be further broken down into more specific operations and all stages, such as actions and operations, which contribute to the overall activity (Kuutti, 1995). Finally, interactions and exchanges between these three levels – activity, actions, and operations – cannot be separated from one another. Therefore, activity is accomplished by individual subjects performing actions and operations (Leont'ev, 1981). Activity composed of group goal-oriented actions associated with individual subjects contributes to the activity's collective object (Engeström, 1999). Leont'ev was criticised for his activity structure because it remained at the individual subject level (Engeström, 1999).

3.3.4 The concept of an activity System

Engeström (2015) consolidated both Vygotsky's and Leont'ev's concepts of mediated action and collective activity into the new understanding of CHAT as a system. The activity system (Figure 3.3) was published in the first edition of the book, "*Learning by Expanding"* in 1987 and later updated in the second edition in 2015:

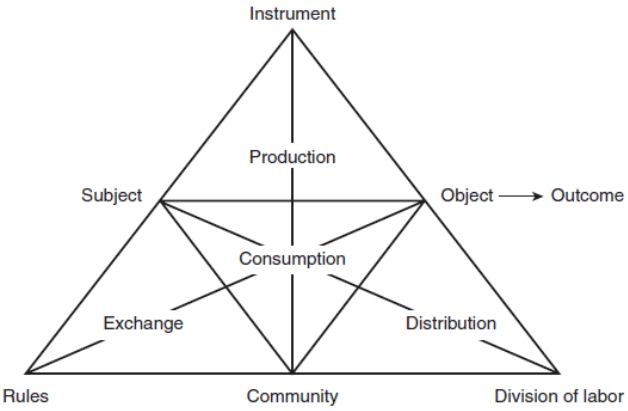

Figure 3.3 Activity system as the structure of human activity

(adapted from Engeström, 2015, p. 63)

Engeström defined an activity system as an "object-oriented, collective, and culturally mediated" historical and social context (Engeström, 1999, p. 9). The components involved in an activity system (Figure 3.3) are subject, object, mediated tools such as signs and computers, rules, community, and division of labour; Engeström attributed this configuration as "the structure of human activity" (Engeström, 2015, p. 63).

In Engeström's conception, based on Leont'ev's, activity is regarded as a social and collective behaviour that extends to considering human interaction within a cultural and historical social context. Such consideration can be applied to educational research in the school context related to my study. Engeström characterised an activity system as "heterogeneous," "disruptive," and "innovative" in nature (Engeström, 1999, p. 7-9). Engeström further illustrated the character of an activity system as follows:

> The most well-planned and streamlined actions involve failures, disruptions, and unexpected innovations. These are very difficult to explain if one stays at the level of actions. (Engeström, 1999, p. 32)

Here, Engeström notes the importance of studying and understanding an activity system at the collective activity level instead of at the individual activity level, confined by the rigid structure of "well-planned" actions (Engeström, 1999, p. 32).

When analysing the activity level, the "interaction of heterogeneous and contradictory elements" within the scope of an activity system can be scrutinised (Engeström et al., 1999, p. 317). As the subject interacts with various elements in the activity system, negotiation and re-negotiation constantly occur in the co-construction of both the subject and object (Engeström, 1999).

Transformation may arise due to the "tense interaction between heterogeneous and contradictory elements" (Engeström et al., 1999, p. 316). The following section delineates the relationship between contradiction, expansive learning, and transformation.

3.4 Contradiction, expansive learning, and principles of CHAT

This section presents three related areas, contradiction, expansive learning, and the CHAT principles applicable to my study.

3.4.1 Contradiction

Contradiction found its root in Marx and Engels' philosophy of dialectical materialism, with the activity system being dialectic in nature (Kaptelinin, 2005). However, the early 20th-century contradiction was not allowed to be discussed openly in the Soviet Union (Engeström, 2001). Engeström claimed that it was not until the 1970s that Western researchers were exposed to the tradition and began exploring the concept of contradiction.

Engeström integrated the concept of contradiction into CHAT to identify tensions in a socio-cultural context embedded in an activity system (Figure 3.3). Such contradictions could be useful in understanding the aggregated historical fundamental systemic relations and conflicts within and between activity systems (Engeström, 2001; Roth, 2004). As a result, contradictions are considered the seeds for change and the possibility for transformation and improvement of the activity system (Engeström, 2015). Ultimately, they lead to innovation in a new way of thinking and doing things differently in the activity systems (Engeström, 2001, 2015).

The concept of contradiction in Activity Theory is widely used by researchers in the workplace, urban development, law enforcement, product usability, human-computer interaction, and education (Nussbaumer, 2012). Contradiction is the study of human actions in the socio-cultural environment with the goal of seeking improvements in the activity system (Engeström, 2007). In this present study, CHAT is applied to identify and explore contradictions in using digital technologies as tools in the educational environment in Hong Kong.

3.4.2 Types of contradictions

Engeström and Sannino (2011) define four types of contradictions for contradiction analysis:

Dilemmas: "A dilemma is an expression or exchange of incompatible evaluations, either between people or within the discourse of a single person. A dilemma is typically

reproduced rather than resolved, often with the help of denial or reformulation." (Engeström and Sannino, 2011, p. 373).

Conflicts: A conflict takes "the form of resistance, disagreement, argument, and criticism. … The resolution of conflicts typically happens by means of finding a compromise or submitting to authority or majority." (Engeström and Sannino, 2011, p. 373-374).

Critical conflicts: "Critical conflicts are situations in which people face inner doubts that paralyze them in front of contradictory motives unsolvable by the subject alone. … The resolution of critical conflicts involves finding new personal sense and negotiating a new meaning for the initial situation." (Engeström and Sannino, 2011, p. 374)

Double binds: "Double binds are processes in which actors repeatedly face pressing and equally unacceptable alternatives in their activity system, seemingly no way out. … The resolution of a double bind requires practical transformative and collective action that goes beyond words but is often accompanied by expressions such as "let us do that" and "we will make it." (Engeström and Sannino, 2011, p. 374)

Engeström and Sannino (2011) also noted that "critical conflicts and double binds were found to be particularly effective lenses on systemic contradictions." (p. 368)

3.4.3 Expansive learning

Engeström's expansive learning theory is unique in that it is unconventional compared to the current learning practice. Expansive learning focuses on the learning of new knowledge as it is created. Furthermore, expansive learning is the contradiction that allows members of the activity system to challenge current practices, question systemic conflicts, and drop some current practices (Engeström, 2010).

First, expansive learning is not concerned with well-formed and well-known knowledge to educational organisations. Engeström claimed:

> Standard theories of learning are focused on processes where a subject (traditionally an individual, more recently possibly an organization) acquires some identifiable knowledge or skills in such a way that a corresponding, relatively lasting change in the behavior of the subject may be observed. It is a self-evident presupposition that the knowledge or skill to be acquired is itself stable and reasonably well defined. There is a competent 'teacher' who knows what is to be learned.
>
> The problem is that much of the most intriguing kinds of learning in work organizations violates this presupposition. People and organizations are all the time learning something that is not stable, not even defined or understood ahead of time. In important transformations of our personal lives and organizational practices, we must learn new forms of activity which are not yet there. They are literally learned as they are being created. There is no competent teacher. Standard learning theories have little to offer if one wants to understand these processes. (Engeström, 2001, p. 137-138)

Second, expansive learning is interested in transforming activity at the collective community level instead of the individual level. Individuals contribute to the change, but the transformation is the collective activity system:

> The object of expansive learning activity is the entire activity system in which the learners are engaged. Expansive learning activity produces culturally new patterns of activity. Expansive learning at work produces new forms of work activity. (Engeström, 2001, p. 139)

> Third, from Engeström's point of view, expansive learning should attend to the horizontal development of knowledge instead of vertical development:

> We habitually tend to depict learning and development as vertical processes, aimed at elevating humans upward, to higher levels of competence. Rather than merely denounce this view as an outdated relic of enlightenment, I suggest that we focus on constructing a complementary perspective, namely that of horizontal or sideways learning and development. Both dimensions are involved in expansion. (Engeström, 2000b, p. 533)

My research focuses on expansive learning related to the three primary schools' activity systems. Expansive learning occurs in a common workplace such as an educational institution (Engeström, 2001).

3.4.4 Principles of CHAT

It is essential to outline the five principles of CHAT that Engeström summarised to form a framework of study for my research. These five principles are summarised as follows:

> First principle (unit of analysis): "A collective, artifact-mediated and object-oriented activity system, seen in its network relations to other activity systems, is taken as the prime unit of analysis" (Engeström, 2001, p. 136).

> Second principle (multi-voicedness): "An activity system is always a community of multiple points of view, traditions and interests" (Engeström, 2001, p. 136).

> Third principle (historicity): "Activity systems take shape and get transformed over lengthy periods of time. Their problems and potentials can only be understood against their own history" (Engeström, 2001, p. 136).

> Fourth principle (contradictions): "…the central role of contradictions as sources of change and development. Contradictions are not the same as problems or conflicts. Contradictions are historically accumulating structural tensions within and between activity systems." (Engeström, 2001, p. 137).

> Fifth principle (expansive transformation): "An expansive transformation is accomplished when the object and motive of the activity are reconceptualized to

> embrace a radically wider horizon of possibilities than in the previous mode of activity" (Engeström, 2001, p. 137).

From the above, an activity system as the primary unit of analysis is used to formulate the three participating schools. Each of the schools is considered a unique activity system for analysis. My research will use multi-voicedness to review the teachers, principals, and schools' multiple perspectives, cultures, and interests. The historicity of each school is considered for its unique historical development that influenced the use of digital technology. Contradiction will be the main effort in Chapter 7 to identify the systemic and structural tensions in the activity systems.

3.5 The evolving research tradition of CHAT

CHAT is a collective term and an evolving research tradition conceived from the culture and history of Russian psychology in the late 1880s (Kaptelinin and Nardi, 2006). According to Engeström, Activity Theory is "the best kept secret of academia" (Engeström, 1993, p. 64). CHAT is not a model in conventional science nor a theory that is capable of predicting the behaviour of a system by inputting appropriate data and outputting results (Kaptelinin, 2014; Kuutti, 1995). Instead, Kaptelinin (2014) argued that it is being used as a frame of reference that guides and directs researchers looking for important indicators to identify the main problems that occur in a complex real-world situation.

Kuutti (1995) stated that activity theory originated from the Soviet cultural-historical research tradition, and the English translation has lost the essence of the tradition. The English word "activity" does not cover the critical meaning of the German and Russian words: "Tätigkeit" and "dejatel'nost", respectively. The German and Russian words mean "doing in order to transform something," referring to physical labour. The English word, activity, does not bear such a connotation (Kaptelinin, 2005; Kuutti, 1995). The term "theory" refers to either the early tradition from Vygotsky (1978) and Leont'ev (1978) since the 1920s or the current research community initiated by Engeström (1987) (Kuutti, 1995).

There are three generations of CHAT, and the primary contributors are Vygotsky, Leont'ev, and Engeström (Nussbaumer, 2012). The word "generation" does not imply that the later generation is better than the earlier ones, but the three generations are connected. They shared some common ground but bared their uniqueness in their generations. In the following sections, the development of the CHAT's three generations is explained.

3.5.1 First generation

The first generation is Vygotsky's concept of artefact mediation of human interaction with the socio-cultural environment (Vygotsky, 1978). Vygotsky established the simple triadic relationship of subject, object, and the mediated artefact. Leont'ev, a student of Vygotsky, built upon the idea of the cultural, historical mediated activity and introduced the structure of activity and the concept of the object of activity. Leont'ev differentiates activity from action and operation and builds a hierarchy of activity discussed in section 3.3.3. However, both Vygotsky and Leont'ev limit the cultural artefact mediation to individual activities. Thus, the centre of the first generation of CHAT is the approach of artefact mediation and the mediation act discussed in section 3.3.2.

3.5.2 Second generation

In the second generation, Engeström enriched Vygotsky and Leont'ev individualistic model into a collective model of multi-vociedness and multi-views. A group of individuals interacts and relates to each other within their cultural and historical social context attributed as an activity system (see Figure 3.3). He extended the framework of subject, mediated tool, and object triadic relationship (see Figure 3.1) founded by Vygotsky and Leont'ev into a six components framework (see Figure 3.3), with the addition of rules, community, and division of labour, which has become an essential tool in researching a wide range of disciplines, including education (Nussbaumer, 2012). Engeström extended individual-mediated activity as the unit of analysis from the first generation into a collective activity system. As a result, a more holistic view of an activity system guides researchers in studying human socio-cultural mediated activities with a social context and history.

3.5.3 Third generation

Engeström is the key figure in instituting the third generation of CHAT. Engeström migrated his focus from a single activity system to an interacting network of activity systems with different cultural traditions (Engeström, 2001). Such a shift in focus allows Engeström to study shared objects and the restructuring within and among activity systems (Daniels, 2001). Engeström also summarised the third generation of CHAT into five main principles in CHAT (discussed in section 3.4.3): unit of analysis based on object-oriented activity systems, multi-voicedness providing a different point of view, historicity, and contradictions that are the systemic tension accumulated throughout history; finally, positive changes may occur due to

the expansive learning and transformations of the activity systems. (Engeström, 2001). Expansive learning is also discussed in section 3.4.3.

3.6 CHAT as a framework for educational research

According to Timmis (2014), the framework of CHAT is dialectic in nature, and it has the potential to study "contradictions and tensions" that arise from the activity system (p. 7). Such contradictions and tensions are the seed for improvement from an expansive learning standpoint (Engeström, 2001). The structure of the CHAT-related human activity framework provided me with a rich conceptual framework for my research in understanding the changes in using digital technology (mediated tools) in the primary school environment. This framework allowed me to investigate various objects as the results of different activities carried out by the subjects (teachers) within the context of a primary school community which is the historical-cultural environment influencing activities. The relationship between individual subjects and the community allowed me to investigate rules to govern the interactions between people (teachers) and the division of labour related to the interacting process in achieving the object. The principles of CHAT such as historicity and multi-voicedness also provided me insight upon analysing the systemic and structural contradictions of the activity system.

3.7 Chapter summary

In this chapter, I have described the essential aspects of CHAT, such as the cultural artefact mediation of the first generation, the dialectic relationship of the elements in the activity system of the second generation, the systemic contradiction and tension as the root of the system transformation, and how to improve the expansive learning of the third generation. As mentioned, different aspects of CHAT form important pillars for my study. For example, the context of a school's cultural environment is inseparable from the activity of adopting technology in teaching and learning to afford a holistic approach to the study. Finally, the dynamic of the mutual transformation or reciprocal influence of human activity between the subject and the object within the socio-cultural context is another essential aspect of CHAT for my study.

Chapter 4: Methodology

4.1 Introduction

This thesis aims to explore the practice of introducing and using digital technologies for teaching and learning in three primary schools in Hong Kong, employing a qualitative approach guided by the four research questions:

RQ1: What were the activities teachers and students engaged in, in the process of using digital technologies in the classrooms of three Hong Kong primary schools?

RQ2: How was the division of labour organised among teachers to facilitate the use of digital technologies for teaching and learning?

RQ3: How did school leadership and school culture influence the integration of digital technologies into the three schools?

RQ4: What contradictions between government policies on digital technologies and classroom practice can be identified? How did these contradictions influence the implementation of digital technologies in teaching and learning and school leadership in the three Hong Kong primary schools?

This chapter begins with a discussion of the research paradigm, theoretical framework, and research design. The research design includes the sampling of participants, data collection, and data analysis, followed by a discussion of trustworthiness, ethical considerations, strengths, and finally, the limitations of the methodology.

4.2 Social constructionist inquiry

Social constructionism concerns knowledge being socially co-constructed through the interactions between people as opposed to knowledge being discovered (Schwandt, 2003). I conducted semi-structured qualitative interviews in implementing an interpretative inquiry. This qualitative design aligns with the social constructionist approach of studying human interaction, events, and actions. Interpretative inquiry focuses on meaning-making in a context appropriate for a social constructionist stance. The instrument of the study is the researcher, who interprets and constructs meaning with the interviewee. Educational research is often socially oriented, and the meaning and reality are socially constructed (Scott and Usher, 1996). Such socially constructed meaning and reality must be supported and validated by the methodological contexts of educational research and practice (Scott and Usher, 1996, p. 1). Therefore, adopting social constructionism, I took the inductive reasoning approach in which knowledge is derived from social interactions based on the cultural and historical context

(Crotty, 1998). In this study, CHAT provides the framework that meets the social constructionist stance criteria.

4.3 Theoretical framework

The educational practices among the three primary schools are investigated through the lens of CHAT. CHAT emphasises the collective object of activity of human interaction under the influence of the history and culture of the context under investigation, which means the object of the activities is constructed based on the data collected with the help of CHAT (Hashim and Jones, 2007; Kaptelinin, 2005). According to Hashim and Jones (2007):

> Activity Theory is a theoretical framework for analyzing and understanding human interaction through their use of tools and artifacts. Activity Theory offers a holistic and contextual method of discovery that can be used to support qualitative and interpretative research. Activity Theory is particularly relevant in situations that have a significant historical and cultural context and where the participants, their purposes, and their tools are in a process of rapid and constant change. (p. 408)

Since CHAT has often been used for studying human behaviour in various disciplines, such as psychology, education, management, and information systems, it is an appropriate analytical framework for this educational research. Engeström's activity system separates an activity into different components: subject, object, instruction, rules, division of labor, community, and outcome (Engeström, 2001). This analytical process is based on the dialectical relationship between these components (Hashim and Jones, 2007).

4.4 Research design

This section describes the sampling procedures and how participating schools and teachers have been selected.

4.4.1 Case study

This research adopted a case study design. The fundamental goal of a case study is to understand a social phenomenon in detail and depth (Punch, 2009; Stake, 2010). A case can be referred to as an individual, a small group, an organization, or a community (Punch, 2009). This research is a case study of an educational practice using digital technologies in schools with funding from the Hong Kong Government's WiFi 100 initiative in three local primary schools. The case provides an opportunity to examine the uniqueness of each school's experience and how digital technologies are integrated into schools for teaching and learning.

The three primary schools participated in the Hong Kong EDB WiFi 100 initiative (see section 1.3.2 for details). According to Stake (2006):

> Whether leaning toward standardization or diversity, almost every educational or social service program will be far from uniform across its different situations. Therefore, it is often useful to look carefully at persons and operations at several locations to understand complex programs. (p. v).

To summarise, according to Stake (2006), there are differences and similarities in the implementation of an educational service programme such as WiFi 100 in different school environments. Therefore, studying three schools instead of one allows the researcher to collect data from different sources. Accordingly, this approach facilitates the study of multi-voicedness in CHAT (Engeström, 2001).

Yin (2009) argued that a case study is one of many qualitative research methods. According to Yin (2009), a case study is a research strategy that collects data from the actual social setting: an organization, a small social group, or individuals. My study took place between 2015 to 2017 when EDB implemented the WiFi 100 initiative. Data collection instruments were interviews with teachers and principals, school reports publicly available on the three schools' websites, and classroom observations.

4.4.2 Sampling and selection of participants

I employed non-probability sampling, a normal practice in qualitative research (Ritchie, Lewis, and Elam, 2003). The selection of non-probability samples meets the criteria and features of the sample population to answer the research questions and accommodate the purpose of the study (Morehouse, 2012). Unlike probability sampling, social research does not attempt to achieve broad population coverage, and sometimes a "sampling frame may not exist" for a social research population (Seale, 2012, p. 144). Instead, I established the criterion to select primary schools participating in the WiFi 100 scheme. The snowball sampling approach was used in this study to identify potential participating schools (Ritchie et al., 2003; Seale, 2012).

I established three criteria for sampling: First, schools selected had to be WiFi 100 participants. Second, the schools selected were from three districts (not named to retain anonymity). Third, various school sizes were required, i.e., more than 1000 students; between 1000 to 600; and below 600 student body. According to Yin (2016), "the goal or purpose for selecting the specific instances is to have those that will yield the most relevant and plentiful data" in purposive sampling (p. 93). Therefore, selecting schools from different districts and of different

sizes helped provide a heterogeneous context for this study. My study used purposive sampling because the WiFi 100 participating schools were relevant to my research. I identified and selected potential WiFi 100 schools through one of my Bristol classmates who worked in the Education Bureau and my other personal contacts. One of the WiFi 100 schools also referred me to another WiFi 100 school. Thus, I utilised snowball sampling for my sample schools; however, my snowball sampling was "purposeful and not done out of convenience" (Yin, 2016, P. 95).

According to Yin (2016), "there is no formula for defining the desired number of instances (or sample size) for each broader or narrower unit of data collection in a qualitative study" (P. 95) as long as the sample provides "relevant" data (Yin, 2016, P. 93). As a result, I narrowed the number of schools down to six WiFi 100 schools. Three of these six schools agreed to participate in my research; one other school agreed only to be my pilot study school, while two declined to participate. The remaining three participating schools met my purposive sample criteria in representing schools from different districts with different school sizes. Since these three WiFi 100 schools met my purposive sampling requirements, I proceeded with my research based on these three schools. The following table presents the three schools' profiles:

Table 4.1 School profiles of the three participating schools

(Data extracted from school websites and annual reports)

	School A	**School B**	**School C**
Number of Students	1000	700	550
Number of Teachers	65	50	40
Number of Classes	36	25	18
Year Established	1930s	1980s	1950s

Table 4.1 shows School A is the biggest and the oldest school. The school sizes and years established may represent resources and cultural differences among the three schools. School A is more resourceful and the oldest but relatively open-minded because it accepted e-textbooks 10 years ago. School B is a medium size school and the youngest of the three schools. It does not have as many resources as School A and has a tightly controlled leadership style. The use of digital technologies is not only for teaching and learning but also for the school's

image. School C is the smallest school and has fewer resources than School A. It is a conservative school with a Catholic tradition; teachers were not exposed to digital technologies before the WiFi 100 initiative. (See Chapter 5 for details of cultural differences for each school).

Although I aimed to study the integration of digital technologies, I could not interview all teachers using digital technologies in each school because of time limitations. According to Stake (2006), "qualitative samples are usually small in size. … if the data are properly analysed, very little new evidence is obtained from additional fieldwork unit." (p. 83). Therefore, I worked with the school principals to sample a gender-balanced group of teachers actively using digital technologies in their teaching. I covered a range of subject specialisms and years of experience (see Chapter 5 Table 5.1). Such a selected group of teachers can be considered purposeful sampling (Seale, 2012).

I interviewed eight teachers and two principals (profiles in Chapter 5, Table 5.1). Twelve interviews were proposed: three teachers and one principal from each school. However, the principal from school A was not available, and only two teachers were available instead of three for the interview from school B.

In reviewing the literature regarding the sample size appropriate for qualitative research, Yin (2016) argued that there is no fixed rule to determine the sample size for a qualitative study, while Patton (2002) also claimed that "there are no rules for sample size in the qualitative inquiry" (p. 203). Morse (2000) proposed the idea of data saturation in considering different factors to determine the number of participants. Hence, Morse recommended that it is safe to overestimate the sample size (Morse, 2000). Yin (2009) and Nissen (2005) presented case studies but did not explain the sample size selected and how data saturation is researched. On the other hand, Boddy (2016) argued that "sample sizes involving one single case can be highly informative and meaningful … research using a single sample or case but involving new areas or findings that are potentially highly relevant" (p. 426). Boddy continued:

> Theoretical saturation can also be helpful as a guide in designing qualitative research, with practical research illustrating that samples of 12 may be cases where data saturation occurs among a relatively homogeneous population. (p. 426)

In my study, the three primary schools were heterogeneous, which justifies the small sample size, and diverse enough, based on the school history, the number of students and teachers, to provide diversity (Marshall, Cardon, Poddar, and Fontenot, 2013).

4.5 Data collection process

CHAT research emphasises a holistic approach to understanding the historical and cultural development of the context, which requires the collection of various types of data (Yamagata-Lynch, 2010). Therefore, the dataset in this research involves primary data such as semi-structured interviews, classroom observation data, and secondary data such as school annual reports and government education reform documents[13].

The semi-structured interviews [14] were undertaken in June and July 2016. Classroom observations were carried out in the school year 2016-17. Interviews facilitated the exploration of teachers' experience using digital technologies for teaching and learning and multi-voicedness related to the source of contradiction (Murphy and Rodriguez-Manzanares, 2013). Classroom observations provided first-hand details about integrating digital technologies. Such first-hand information cannot be replaced by interviews and the review of school documents (Merriam and Tisdell, 2016). I took a detached observer role by sitting at the back of the classroom without disturbing the regular operation of the class. I observed and noted the interactions between the teacher and the students, including the teacher and students' actions using the digital tools. I also observed and noted the non-digital tools integrated in the digital lessons and the classroom arrangements.

4.5.1 Primary data from interviews and classroom observations

The primary data collection process started with multiple school visits and discussions with the teaching staff to arrange the pilot study, the actual interviews, and classroom observations. These visits and discussions helped to refine the interview questions and facilitated the classroom observation sessions (Gay, Airasian, and Mills, 2012).

The following table summarises the data collection time frame:

[13] Government documents cover four documents in 1997, 2004, 2008, and 2014 (see section 1.3.2 for details)
[14] Semi-structured interview is interchangeable with the term interview for convenience.

Table 4.2 Overview of Data Collection Activities

Data Collection Activities	Time Frame
Initial contact and school visits	Summer of 2015
Pilot study	4th February 2016
Actual interviews	June and July 2016
Interview data transcription	September 2016 to August 2017
Classroom observations	School A and C: September 2016 School B: December 2016

The following sections give details of the data collection process, including the pilot study, semi-structured interviews, and classroom observations.

4.5.1.1 Pilot study

A pilot study helps examine the scope of the research and provides practice before the actual research is conducted (Yin, 2016). Therefore, the study's "procedures and results and insights from the pilot study that will affect the research itself" (Mertens, 2014, p. 544) should be documented. The pilot study was performed to identify the appropriateness of my research methods and explore areas in using digital technologies in schools where I could frame my study (Yin, 2016). This pilot study school was one of the WiFi 100 schools I contacted. However, the school agreed to participate only in my pilot study, not my full study. Therefore, on the 4th of February 2016, semi-structured interviews were conducted with four teachers responsible for the digital technology lessons.

The participant teachers were asked for feedback after the interview. Several issues were raised and integrated into my research data collection process. First, the interview length, limited to one hour, was preferable. Second, the participants noted that some of the questions were too focused on the technological aspects of digital technologies. In addition, they were in favour of increasing the number of open-ended questions to have the opportunity to share their opinions. Finally, I learned that the introduction of my research was essential and needed to be more detailed and specific so that the participants would understand the context and reasons for my questions. In addition, I found that the questions I prepared were not well structured, and the content was not always focused on activities and the teacher's view. There was too

much emphasis on technical tools in use. As a result, I learned from the pilot study that ensuring the participants felt comfortable in the interview was necessary. Therefore, my questions were revised and refocused. I also adopted the suggestion that the scope of the interview questions be more open-ended while limiting the interview time to one hour.

4.5.1.2 Semi-structured interviews

Semi-structured interviews were carried out in June and July of 2016. It was approaching the end of the school year, and teachers were less busy. Therefore, I conducted the interviews after school or during lesson breaks. The interview questions and the consent form were sent to the participating schools a week before the interviews, which allowed the principals and teachers to understand the questions ahead of time and gave them a transparent view of the interview.

According to (Wilson, 2013), a semi-structured interview involves a set of questions prepared beforehand with open-ended follow-up questions during the interview. Participants are welcome to contribute their ideas related to the research subject during semi-structured interviews (Efron and Ravid, 2013). The advantage of the interviewer's follow-up questions is to allow the participants to go deeper with their responses (Pope and Mays, 2013). Furthermore, the face-to-face semi-structured interview enables the interviewer to clarify points made by the participants and gain more understanding associated with the research topic (Patton, 2002).

In my interview plans, I designed two sets of questions (see Appendix D): one for principals and the other for teachers. The questions for principals focused on administration aspects, while the questions for teachers concentrated on the daily operation in using digital technologies. First, I began the interview with a conversation to create a friendly atmosphere. Next, I presented the purpose of my study in detail, including what I learned from my pilot study to help the participants present their viewpoints more relevant to my research. Next, the consent statement was covered, and the interviewee was invited to sign the consent form before the actual interview began. After that, I asked the prepared questions and followed up with exploratory questions for more insights from the participants (Legard, Keegan, and Ward, 2003). Most interviews were conducted within the agreed time limit of 30 to 40 minutes.

The recorded interview data were transcribed fully into Chinese first since the teachers and principals spoke Cantonese. I then translated the Chinese scripts into English. The transcription and translation process took about 12 months, from September 2016 to August 2017, on a part-

time basis to finish. Data interpretation and analysis took another 24 months, from September 2017 to August 2019.

4.5.1.3 Classroom observations

My classroom observations focused on the digital technologies used in the classroom. Classroom observations provide the researcher with first-hand information about classroom practice and the details of teaching and learning activities (Merriam, 1998). There are two main elements in observation: what is observed and how data is recorded (Wilkinson and Birmingham, 2003). Similarly, Foster (2006) asserted that "there are two further distinctive features of observation in research: first, the way it is organized and, secondly, the way observations are recorded, interpreted and used" (p. 58). According to Foster (2006), there are two types of observations, namely, "structured or systematic observation for testing hypotheses and less-structured or qualitative observation for exploring the framework" (p. 57). Foster (2006) claimed that observation could be used "to supplement or provide a check on data collected in interviews" (p. 58). One of the advantages of observation is that "the observer may be able to 'see' what participants cannot. ... observation can provide information on the environment and behaviour of those who cannot speak for themselves and therefore cannot take part in interviews" (p. 59). More importantly, observation provides the social context for understanding human behaviour in the classroom setting. The classroom operation cannot be understood when it departs from the context (Connell, Ashenden, Kessler, & Dowsett, 1982)

There is a range of roles a researcher can play in an observation situation, such as a “complete observer” who is “invisible” to the environment, “an observer-as-participant, participant-as-observer, and complete participant” (Mertens, 2014, p. 446). In this study, I took a complete observer role and located myself at the back of the classroom in my situation. As a result, the classroom could operate relatively normally. Classroom observations were video recorded for about 35 minutes each (based on timetabled class time) on my smartphone. Immediately afterward, I audio-recorded the field notes on my smartphone. The way teachers and students used digital devices as mediating tools in teaching and learning, and the details of interactions between teachers and students and among students were carefully recorded. In addition, the non-digital tools and the classroom settings and classroom organisation were also noted in my observations. The following table summarises the number of interviews and the number of class observations I conducted:

Table 4.3 Summary of Data Collection Process

	School A	School B	School C
Number of Interviews	3	3	4
Number of Classroom Observations	2	1	1

4.5.2 Secondary data from school documents and government

The school annual and planning reports covering the 2015-16 school year were downloaded from the three schools' websites in March 2017. These reports were the source material for understanding the individual school's historical and cultural background. Specifically, they reported the progress of the WiFi 100 project. Such documentary data expedites my understanding of the use of digital technologies in teaching and learning. The school documents were the historical artefacts that provided additional information not available in the semi-structured interviews. Similarly, the government education reform documents also provided the historical and social context of the participating primary schools (see section 1.3.2 for the four documents used in this research).

The following section explains the data analysis.

4.6 Data analysis process

I initially took a bottom-up approach using the thematic analysis method to identify emerging themes from the dataset and further define the theoretically informed categories based on CHAT. This helped me answer the research questions. The emerging themes within the activity system denoted the relationships that facilitated a dialectic analysis of tensions and contradictions among different elements in the activity system (Timmis, 2014). Roth and Lee (2007) suggested combining other methods, such as thematic analysis, with CHAT to determine the emerging themes from the dataset for dialectic analysis to avoid the risk of examining the elements in separation.

The following sections discuss data analysis based on CHAT and thematic analysis.

4.6.1 CHAT dialectic analysis

Along with the thematic analysis, CHAT was used to explore the historical and cultural influence of integrating digital technologies in the three schools and their classroom contexts.

Delineating an activity system's elements is the initial stage in CHAT analysis. Next, dialectic analysis in CHAT is used to identify contradictions and tensions that emerge between two interacting elements in the activity system (Timmis, 2014). According to Timmis (2014), contradiction analysis identifies opposing dialectical forces among an activity system's elements. For example, Figure 6.2 in Chapter 6 shows the opposing forces that emerge between the teachers who conduct digital lessons and the classroom rules, such as the classroom culture, class time, and class size, which prohibits teachers from integrating digital technologies successfully. As a result, the contradictions provide insights into the possibilities for future improvement. Therefore, the activity system is the basis and the unit of analysis in my analysis of the three Hong Kong primary schools (see Chapter 5 for the details of activity systems related to these three schools).

4.6.2 Thematic analysis

According to Maguire and Delahunt (2017), the benefit of using thematic analysis is that,

> A thematic analysis aims to identify themes, i.e., patterns in the data that are important or interesting, and use these themes to address the research or say something about an issue. This is much more than simply summarising the data; an excellent thematic analysis interprets and makes sense of it. (p. 3353)

Similarly, Braun and Clarke (2013) noted that thematic analysis is "a method for identifying themes and patterns of meaning across a dataset in relation to a research question" (p. 174). Therefore, the thematic analysis followed the guidelines suggested by Braun and Clarke (2013) and was applied to the interview dataset surrounding the four research questions (see Appendices H and I for themes and codes identified from the interview). The thematic analysis covered six steps, including becoming familiar with the data, coding the data, grouping codes into themes, developing top-level global themes, and summarising and interpreting the themes (Braun and Clarke, 2013).

In order to understand the multi-levels of this study, I found that it was helpful to organise the thematic analysis across three different levels as suggested by Chan (2011). Three levels of "knowledge building innovation" in education are: "macro-level related to educational policies and reform, meso-level related to a network of teachers, and micro-level related to individuals and groups in the classroom" (Chan, 2011, p. 152). These three levels can be mapped onto the four research questions. In addition, four global levels emerged from the thematic analysis: classroom interaction, teacher activities including individual and teamwork, and school

leadership and community. The relationship between these three levels of analysis is shown in Table 4.4.

Table 4.4 The mapping of research questions with top-level themes

Research Questions	Levels of Analysis	Top-level themes Identified
RQ1: What were the activities teachers and students engaged in, in the process of using digital technologies in the classrooms of three Hong Kong primary schools?	micro-level	The historicity of classroom activities The outcome of digital-mediated classroom activities
RQ2: How was the division of labour organised among teachers to facilitate the use of digital technologies for teaching and learning?	meso-level	Rules and division of labour Rules and internal and external collaborations.
RQ3: How did school leadership and school culture influence the integration of digital technologies into the three schools?	macro-level	School leadership management style Learn co-planning policy
RQ4: What contradictions between government policies on digital technologies and classroom practice can be identified? How did these contradictions influence the implementation of digital technologies in teaching and learning and school leadership in the three Hong Kong primary schools?	macro-level	Government policies and socio-cultural context of schools Principals' dilemma

For a detailed theme listing, and the mapping of levels of analysis, see Appendix H. Table 4.5 summarises the stages of the analysis process combining the themes and dialectic relationships at different levels of analysis.

Table 4.5 Stages involved in the data analysis process

Stages	Area of focus	CHAT analysis	Dataset
Initial	Dwelling the dataset	Review all datasets	Interview transcripts Class observation notes School annual reports Policy documents
Micro-level stage	Delineation based on elements of the activity system	Thematic analysis: Tools, subject, object, rules	Interview transcripts Class observation notes
Meso-level stage	Identify and explore teachers' activities	Thematic analysis: Division of labour, community, subject, object, rules.	Interview transcripts School annual reports
Macro-level stage	Dialectic analysis	Thematic analysis: Contradiction analysis	Interview transcripts Policy documents

In each stage, the dataset, including interview transcripts, school annual reports, classroom observations, and government education reform documents, was analysed to produce initial themes that were repeatedly reviewed with the activity systems as the unit of analysis. The following sections provide a description of each stage.

4.6.3 The combination of themes and CHAT analysis

From Table 4.5, CHAT analysis was performed at all stages: micro-level, meso-level, and macro-level. The themes and sub-themes outlined in Appendix H guided the CHAT analysis in each stage.

Micro-level analysis guided by classroom activity themes to delineate relationships of elements in the activity system, such as:

- Subject
- Object
- Tools
- Rules

Figure 4.1 Theoretical informed classroom activity themes based on CHAT

In addition to the elements in Figure 4.1, the dialectic relationships between elements in the activity system, such as subject-object, tool-object, and object-rules relationships, were analysed to understand the classroom interaction at the micro-level. Themes were used to guide the above dialectic analysis.

Meso-level analysis guided by teacher activity themes to explore elements of the activity system such as:

- Division of labour
- Community
- Subject
- Object
- Rules

Figure 4.2 Theoretical informed teacher activity themes based on CHAT

Similarly, Figure 4.2 shows the meso-level analysis involved individual teacher activities and teamwork among teachers. The elements of the activity system, such as division of labour, community, subject, object, and rules, were investigated at this stage.

Macro-level analysis guided by school leadership and government policies related themes and the type of contradictions provided by Engeström and Sannino (2011):

- Dilemmas
- Conflicts
- Critical conflicts
- Double binds

Figure 4.3 Theoretical informed leadership and government policy themes based on CHAT

Finally, Figure 4.3 shows the macro-level analysis and the different types of contradictions (dilemmas, conflicts, critical conflicts, and double binds), which were fully explained in Chapter 3, section 3.4.2. which were employed to investigate the contradictions in leadership and government education reform initiatives

4.7 Ethical considerations

The School of Education (GSoE) research ethics procedures were observed, and the application for research ethics approval was submitted on 20 April 2016 (see Appendix A). The procedure involved revising my research proposal after discussing potential ethical issues with my supervisor and my doctoral classmates. The Research Ethics Form was produced as a result of these procedures and submitted for approval. This research project was approved and signed off on 19 May 2016, with project number 32982.

The researcher is accountable for the research data protection, data confidentiality, identity, and anonymity of the participants. Therefore, participants were informed of the purpose of the study and understood their right to withdraw from the research when they did not feel comfortable with the research (BERA, 2018). An information sheet (see Appendix C) was emailed to the schools a week before the interviews. In addition, prior to the interviews, a consent form (see Appendix B) was made available for the participant to sign as a mutual agreement of informed consent (BERA, 2018).

The participants also had the opportunity to ask questions before or during the interview regarding the protection of interview data. A concern consistently raised among the principals and the lead teachers was, “will the research expose sensitive issues about the school and the teachers?” The school did not want any internal information exposed to the outside world. Such information could be misused and affect the school’s reputation. Hence, the information sheet and consent form were essential for the participants to understand the purpose of the research and establish mutual trust and understanding during the data collection process.

I transcribed and translated the interview and lesson observation data. This was to ensure school the collected data would not be released outside this research. Both the names of schools and teachers' names were hidden using pseudonyms, and the gender of the pseudonyms was randomly assigned. Demographic information, such as age and years of participant experience, was kept to a minimum to protect a teacher’s identity (Punch, 2009). Information related to the schools was also kept to a minimum. For example, no physical location of the school is mentioned. In addition, I ensured that teachers’ and students’ faces were not recorded in the video recording session or the picture taking. All the data collected in this research will be destroyed at the end of the study. This further protects the privacy of the participating schools, teachers, and students.

4.8 Trustworthiness and triangulation of the research

Qualitative research needs to establish the trustworthiness of the study. According to Lincoln and Guba (1994), areas such as credibility, transferability, dependability, and confirmability of the study require consideration. The areas of credibility and confirmability are the main concerns of this research. The method of collecting data is related to credibility, while data triangulation is related to the confirmability of this study.

To establish the study's credibility, I was considered an outsider to the schools involved and did not have a working relationship with the schools before this research. However, the data collected could be influenced by my position as an information technology professional. Such bias may diminish this study's credibility and affect the teachers' responses to the interview questions. In order to minimize the potential of such bias, I established a mutual understanding atmosphere that would avoid having the participants respond to the questions in technical terms (Yin, 2009). Such protocol is essential for obtaining a genuine response from the participants.

Triangulation also relates to the issue of the trustworthiness of the research. Different triangulations minimize the biases inherited from the researcher's position (Keeves and Sowden, 1997). There are different types of triangulation, namely, theory triangulation, methodological triangulation, investigator triangulation, and data triangulation. In this research, data triangulation was employed. Different data sources were collected for data triangulation, including semi-structured interviews, lesson observations, a review of the school's annual report, and planning documents (Olsen, 2004). Data triangulation also involves duplication of data collection at different locations with different participants. For example, data collected from the three primary schools involved the same interview questions. Therefore, the answers from these teachers could be triangulated as they were from different schools.

4.9 Chapter summary

In this chapter, I explained the research methodology. The research design was appropriate for the CHAT theoretical framework that required contradiction analysis within the dialectic relationship in an activity system. The collected data allowed me to perform a bottom-up study based on the context of the three participating schools. Next, Chapter 5 covers the backgrounds of the three schools, while Chapters 6, and 7, are the findings chapters.

Chapter 5: The historical and cultural context of the three schools

5.1 Introduction

This chapter presents the contexts of the three participating schools based on the CHAT framework of the activity system. The three primary schools that participated are unique culturally and historically. Therefore, each school context is regarded as a separate and unique social environment represented by an activity system as the unit of analysis. In this study, the activities carried out in an activity system refer to the use of digital technologies in teaching and learning in primary school. Hence, a school encompasses the physical infrastructure, such as the WiFi hardware and the classrooms. People involved, such as students, administration staff, technical support staff, and other teachers who are observers, are part of the activity system but not the whole activity system. In this way, the activity system is the unit of analysis in CHAT, and it extends from the individual to the collective social context, the school context.

History, culture, rules and regulations, internal and external policies, and the division of labour within the school are also essential parts of the activity system. Therefore, in addition to presenting each school's background information, individual elements of an activity system will be described in detail. The description of the elements is unique to the school based on the interviews, classroom observations, the school's website, and annual reports.

Accordingly, this chapter begins by presenting each school's historical and cultural background. Then, reviewing each school's annual reports covering the school year 2015-16 enriches the data set. Sample extracts of these reports related to e-learning can be found in Appendix E. In this chapter, I focus on analysing the interactions between the elements in the activity systems of the three schools. Table 5.1 shows participants' profiles covering each participant's position, subject(s) teaching, and years of teaching experience.

Table 5.1 Participants' profiles of the three primary schools

	School A	School B	School C
Principals	Not available	**Samuel**	**Theresa**
Lead Teachers	**Fisher**	**Sandra**	**Tom**
Subject	IT	Chinese	English
Years of experience	Over 20	Over 20	Over 20
Subject Teachers 1	**Frank**	**Sarah**	**Terry**
Subject	General Studies	Mathematics General Studies	Music and IT
Years of experience	Seven years	Four	Fifteen
Subject Teachers 2	**Faye**		**Tad**
Subject	Mathematics	Not available	Mathematics
Years of experience	Five		Ten

From the participants' profiles, Table 5.1 shows that all the lead teachers from the three schools were e-learning team leaders with over 20 years of experience. The subject teachers from School A, Frank and Faye, were young, having teaching experience of fewer than 10 years. For School B, Sarah was young, having teaching experience of fewer than five years. Subject teachers, Terry and Tad from School C, taught for over 10 years.

Fisher, the lead teacher from School A, was an Information Technology teacher. The lead teacher, Sandra, from School B, was a Chinese Language teacher, while Tom, the lead teacher from School C, was an English teacher. Frank and Faye, the subject teachers from School A, were teaching General Studies and Mathematics, respectively. Sarah, from School B, was a Mathematics and General Studies subject teacher. The subject teacher from School C, Terry, was a Music and Information Technology teacher while Tad was a Mathematics teacher.

5.2 Historical and cultural background and description of the activity system for School A

This section presents School A's historical and cultural background with a detailed description of the uniqueness of the elements in the activity system.

5.2.1 Historical and cultural background of School A

The school annual report from School A mentioned that it was established in the 1930s and has over 80 years of history (School A Document, 2016). In 2015, it had about 36 classes and a student body of slightly over 1,000 with about 65 teaching staff. The school maintained a relatively young teaching staff with about 21% having between five to nine years of teaching experience and 22% under four years in 2015-16.

From the website and annual reports available from School A, the aims of school A were:

> *to develop students' independent thinking ability, provide a good learning environment, and develop students' creative capability (School A Document, 2016).*

These educational aims guide the school's pedagogical practice and curriculum development. The aims also suggest a strong vision of nurturing students' creativity.

Given the above school vision, Fisher, the head teacher, conferred that School A had a long history of running e-learning[15] classes. School A started using e-textbooks 10 years ago, exposing digital technologies to teachers and students. The use of digital technologies was aligned with the school's vision.

The use of e-textbook was related to Hong Kong's education reform initiated by the Hong Kong Government in 2000 (HK Education Commission, 2000) (see Chapter 1, section 1.3). About five years earlier, the school conducted technology-mediated lessons using the online interactive whiteboard. WiFi also partially covered the school premises. Students had been using laptop computers in the classroom for technology-mediated lessons for five years. The school obtained funding from the WiFi 100 initiative in 2014. As a result, the school began to upgrade its WiFi infrastructure and acquired tablets and iPads for technology-mediated classes.

[15] E-learning was the term used by EDB's three policy documents announced in 2004, 2008, and 2014. They referred to the use of electronic textbooks (e-textbooks) in the classroom. Therefore, when e-learning is used, it relates to EDB's electronic learning policies. Otherwise, "digital learning" or "digital technology-mediated learning" will be used throughout this thesis.

Fisher pointed out that there was a common consensus among teachers in accepting the use of digital technologies in the classroom. The use of e-textbooks was available to teachers only in the classroom for the non-BYOD (Bring Your Own Device) classes. Students in the non-BYOD classes were still using printed textbooks. However, they could use an e-textbook when studying at home. The school's open-minded culture towards technology facilitated the participation of the WiFi 100 initiative. According to Fisher, Education Bureau (EDB) recommended the school adopt the BYOD policy since it planned to run daily digital classes for grades 3 and 4. Students were required to carry their iPad to school on regular school days.

According to the 2015 school planning document, School A started with four BYOD classes, two grade 3 and two grade 4, for the first year of the WiFi 100 project in 2014. For the second school year in 2015, the school added two more classes from grades 5 and 6. By the third school year in 2016, one more grade 6 class was added; thus, seven BYOD classes were arranged. When comparing the total number of 36 classes, seven classes represented only 19%. According to head teacher Fisher, School A did not intend to implement BYOD classes for the entire school because some parents did not want their children to participate in digital learning classes. Instead, School A allowed parents to choose between BYOD and non-BYOD classes, which suggests that although teachers in School A were confident in using digital technologies, the management of School A was cautious in implementing the WiFi 100 project. Therefore, the administration took the incremental approach of adding a small number of BYOD digital technology classes each year. In this way, the school could adjust the strategy and accumulate the best practice for future classes joining the BYOD programme.

Having introduced School A's historical and cultural background, the following section details the construction of School A's digital technologies integration activity system. The activity system was constructed based on the data from the school's annual report and in-depth interviews with teachers.

5.2.2 Detailed description of the activity system for School A

This section describes the elements of the activity system for School A. The following figure depicts the activity system for the integration of digital technology into teaching and learning activities for School A teachers:

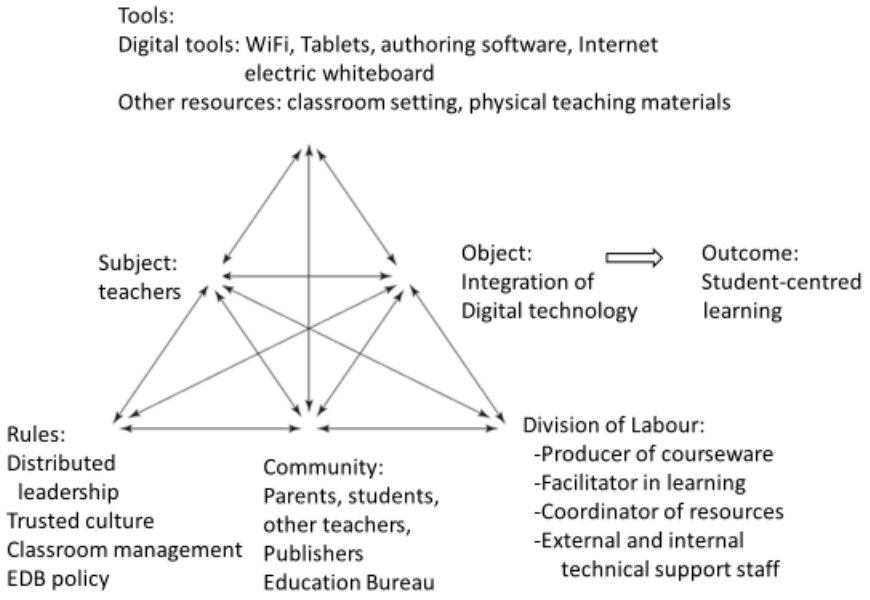

Figure 5.1 Digital technologies integration into teaching and learning activity system for School A

The uniqueness of the elements in School A's activity system is described in the sub-sections from 5.2.2.1 to 5.2.2.5.

5.2.2.1 Subject and object

Teachers were the **subject** in carrying out the activities in facilitating the use of "e-textbook, e-learning resources and relevant pedagogies in their learning and teaching" (Education Bureau, 2014a, p. 1), which was the **stated object** of the WiFi 100 initiative. One head teacher, Fisher, and two subject teachers, Frank and Faye, participated in the interviews from School A. Both subject teachers expressed interest in using digital technologies in teaching and learning. However, each teacher had their personal objects. For example, Frank said that his intention in using digital technologies was to provide a pleasant learning experience for the students. Faye, another subject teacher, stated that she wanted to develop her digital technology skills in her teaching career to enrich her knowledge in teaching and learning.

Fisher recalled that the initial purpose of the e-textbook initiative was to create competition among textbook publishers. The Government intended to pressure the publishers to reduce the cost of textbooks for parents. However, e-textbooks were bundled with printed textbooks by the publishers. As a result, parents needed to pay for the e-textbook and the digital device in

addition to the printed textbook and were paying much more than before. Fisher stated this was a failed initiative from the Government. Because of such understanding, the School A leadership allowed teachers to try different ideas in using digital technologies.

5.2.2.2 Tools

The main **tools** used in the activity system were the WiFi infrastructure, wireless tablets (iPad), the Internet, and authoring software. WiFi and tablets were used primarily in digital lessons, while the teachers used the Internet to search for teaching material inside and outside the classroom. Authoring software was used for courseware creation by teachers. For example, Fisher, the head teacher from School A, mentioned that:

> *We encouraged our teachers to take the initiative to design their digital courseware. We also encouraged teachers to experiment with using tablets in the classroom.*
>
> Fisher, lead teacher, School A, 12/7/2016

Another tool, the electronic whiteboard, was used in the classroom. The school garden was used for General Studies lessons outside the classroom. In one of my lesson observations, students were asked to take pictures of different plants from the school garden in a General Study lesson (Figures 5.2 and 5.3). The students displayed the images on the whiteboard to share and compare the differences among the plants. However, I did not notice whether there were printed textbooks used during my lesson observation. This might imply that the BYOD classes in School A fully utilised the iPad as the medium for teaching and learning. BYOD students were different from non-BYOD students in that non-BYOD were required to use printed textbooks while the BYOD students would only use iPads.

Figure 5.2 A student took a picture of a plant in the school garden.

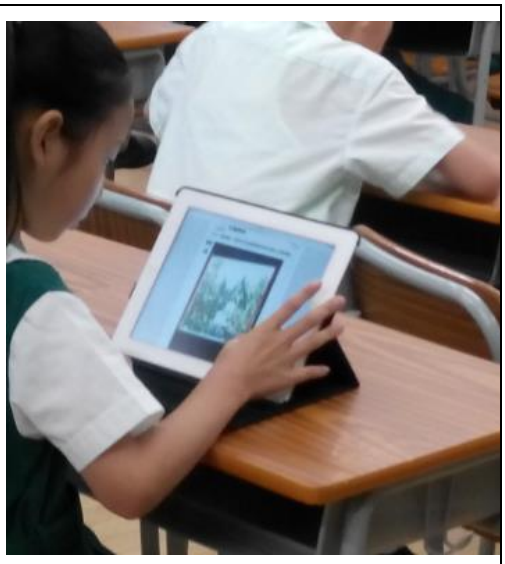

Figure 5.3 Only iPad on student's desk.

BYOD students could carry out creative multimedia learning activities based on their digital devices, as seen in Figures 5.2 and 5.3. However, the student's potential use of digital technologies for collaborative learning and teamwork was missing during my class observation (Selwyn, Potter, & Cranmer, 2009).

5.2.2.3 Rules

Rules are the formal and informal guiding principles that explicitly or implicitly regulate activities. Frank mentioned that teachers had the autonomy to use the digital learning resources provided by the school or create their own digital teaching materials. Fisher also noted that:

> *We allow our teachers to decide whether to use the digital learning materials provided by the school or they will use their digital materials. Therefore, there is no need to be approved by either the principal or the subject lead teacher.*
>
> Fisher, lead teacher, School A, 12/7/2016

Thus, School A's leadership gave room for innovation and creative activities for teachers.

In the WiFi 100 funding requirement, EDB stated that funding was available only for WiFi infrastructure and the Internet connection to use e-textbooks in the classroom (HK Education Bureau, 2014b). Therefore, wireless devices such as iPads and teaching software would not be funded by the WiFi 100 initiative. This constraint presented a contradiction between the EDB

policy (rules) and the object of the initiative the school was required to accomplish. This constraint is discussed in Chapter 7.

5.2.2.4 Community

Community in this activity system involved the interaction of external publishers, parents, students, and teachers who were not part of the WiFi 100 project team. For School A, the collaboration between the external publishers and the internal non-WiFi 100 team teaching members suggests that the implementation of the WiFi 100 project extended the scope to outside the school border and the project group boundary.

Frank spoke from his experience that students were excited and looking forward to digital lessons. According to Frank, this enthusiasm was because the technology allowed students to take an active role in learning. Fisher also mentioned that parents did not mind paying extra for the iPad and other digital learning materials for their children which suggests that students and parents recognised the value of participating in digital lessons.

5.2.2.5 Division of labour

Division of labour facilitates the investigation of the role played by different community members. The following example illustrates how teachers and parents worked together with the BYOD policy.

Parents played an essential role in implementing digital technologies. Frank noted that based on his experience in implementing the WiFi 100 project:

> *I organised a tutorial session during the parental meeting. As a result, both parents and students are learning the same software operations. This way, it will save class time to cover the essentials in my curriculum instead of operating the software programs.*
>
> Frank, subject teacher, School A, 12/7/2016

From the above, it is apparent that parents contributed their time to work with the teachers learning the software with their children. As a result, class time could focus on teaching rather than the operation of the software.

Faye also mentioned the school needed the involvement of the parents in the BYOD program that:

> *Since the students will be learning with iPad in school and at home, parents will be monitoring to guide the students to use the iPad properly at home. Some parents expressed concern that their children may be distracted from schoolwork by using iPad outside the classroom to play electronic games and browse the Internet with unrelated content.*
>
> Faye, subject teacher, School A, 12/7/2016

In addressing parents' concerns, Faye noted that the school established a rule for the students that the BYOD iPad was only for studies and not for games. Faye also said parents needed to help the students maintain the iPad in good condition since the students were under 10 years old. In addition, if the iPad malfunctions, it may harm students' learning progress.

Therefore, the division of labour between teachers and parents was closely related. As a result, the WiFi 100 initiative may not have been successful without parents' participation.

5.2.3 Summary of School A context

In alignment with the school's key educational aims, the school decided to acquire knowledge in using digital technologies for the teachers. On the other hand, the misalignment of teachers' objects and stated objects of the WiFi 100 initiative was also identified.

Although School A began using digital technologies early and teachers' efficacy level was high, the school management did not rush to implement the BYOD program to cover the whole school. Instead, the school modestly implemented the system by adding a small number of classes to the program.

The potential use of digital technologies creatively and collaboratively was not fully utilised by School A. The school only emphasised multimedia-related creativity, but the collaboration area was missing during my class observation. Furthermore, the management gave teachers autonomy in making decisions for innovation and creative activities regarding how pedagogical approaches integrate with the school's curriculum.

As for rules, the school policy did not provide the resources needed for teachers to implement digital technology lessons. Finally, a division of labour between teachers and the involvement of parents in implementing the WiFi 100 project was established in School A. Implementing the WiFi 100 initiative for School A would not have been successful without the participation of parents.

5.3 Historical and cultural background and the description of the activity system for School B

This section provides the historical and cultural background information of School B and a detailed description of the uniqueness of the elements in the activity system for School B.

5.3.1 Historical and cultural background of School B

This section draws upon the historical analysis from interview data, the school's annual report, and the School B website for the 2015-16 school year (School B Document, 2016).

School B was established in the 1980s, and the teaching staff is relatively young. In the 2015-16 school year, there were about 25 classes with a student body of slightly under 700 and about 50 teaching staff 2015-16. Seventeen percent of the teaching staff had five to nine years of teaching experience, and 44% had less than five years (School B Document, 2016). The principal of School B, Samuel, said that his teaching staff should focus on teaching instead of spending time creating digital teaching materials and learning digital technology skills:

> *The school does not expect our teachers to design digital teaching materials since they are not experts in digital technologies.*
>
> Samuel, principal, School B, 10/6/2016

Samuel added that teachers should work with outside parties to obtain or co-construct related teaching materials. Such a stance was also reflected in the school's annual report:

> *We value collaboration with outside organisations, such as EDB, local universities, and local grade schools. We should take advantage of the resources that are available outside our school. (School B Documents, 2016, p. 9).*

From the above excerpt, it might be inferred that School B defined the role of a teacher more as a consumer than a creator of digital teaching materials. This also suggests that the principal did not believe teachers should be creators of digital curricula and digital teaching materials even though the teachers might be capable of introducing innovative ideas in teaching and learning.

According to the school's annual report in 2015-16, School B joined the WiFi 100 initiative in 2014 and formed the "E-learning Development Team" in 2015, and equipped each classroom with an interactive electronic whiteboard, a desktop computer, a projector, and a visualiser to help teachers run technology-mediated lessons (School B Document, 2016). The e-learning

Development Team consisted of a curriculum head teacher, Sandra, as the team leader and four subject teachers covering Mathematics and General Studies for grade 3 and grade 4 classes, a total of five teachers responsible for the implementation of the WiFi 100 project (School B Documents, 2016). In addition, the subject teacher, Sarah, was one of the team members.

5.3.2 Detailed description of the activity system for School B

This section describes the elements of the activity system for School B. The following figure depicts the activity system for the integration of digital technology into teaching and learning activities for School B teachers:

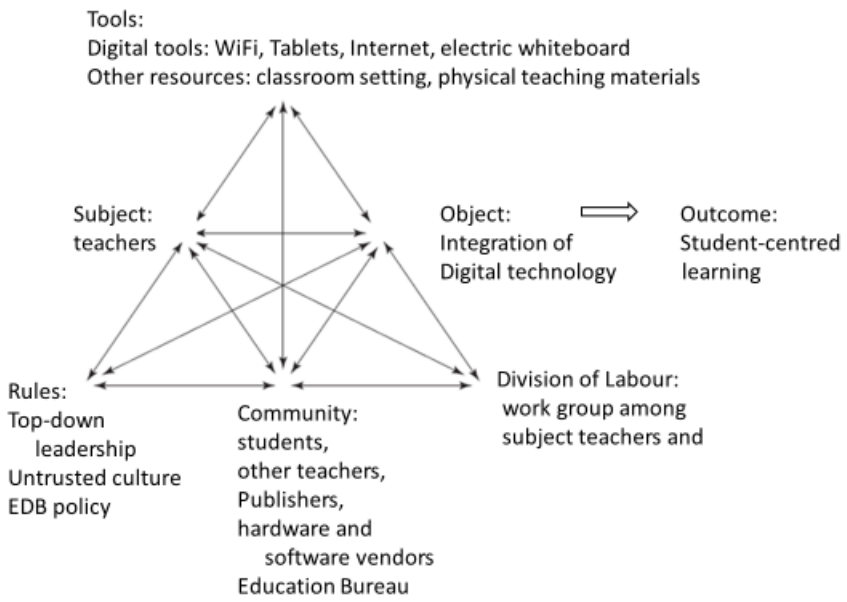

Figure 5.4 Digital technology integration into teaching and learning activity system for School B

The uniqueness of the elements in School B's activity system is described in the sub-sections from 5.3.2.1 to 5.3.2.5.

5.3.2.1 Subject and object

It is essential to relate the school's educational aims to the **object** of the activity system since these aims play an influential role in how **teachers** perform their teaching activities. The school aims were written in the school's annual report in the school year 2016, page 1, as follows:

Teaching by encouragement, nurtures a culture of care and self-discipline, and creates a successful and happy life for the students. (School B Documents, 2016)

The school's aim included formal guidelines and informal norms for teachers to follow in teaching and learning activities within the school context. In addition, one of School B's main educational aims was to provide a pleasant learning environment for the students. However, School B did not mention nurturing students' creativity, which School A did. Consequently, School B did not actively integrate new technology into its curriculum when reviewing its history of using digital technologies (School B Document, 2016). This school culture and historical background influenced the school leadership in interpreting and translating the WiFi 100 initiative into action.

5.3.2.2 Tools

The situation in using **tools** in the classroom in School B differed from School A. School A only used iPads in the classroom (see Figure 5.3 in section 5.2.2.2). In School B, however, students used iPads and physical items, such as rulers, in a mathematics lesson. However, I did not notice the students using a printed textbook during my class observation in School B. Instead, the teacher used a ruler to demonstrate the equal distance in a symmetrical diagram on a projected image; students followed the instructions to measure the space on the image displayed on the iPad with their rulers (Figure 5.5 and Figure 5.6).

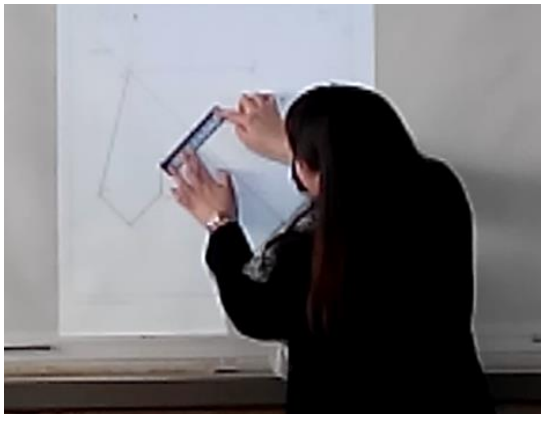

Figure 5.5 Teacher demonstrated the symmetrical nature of a diagram on the projected image.

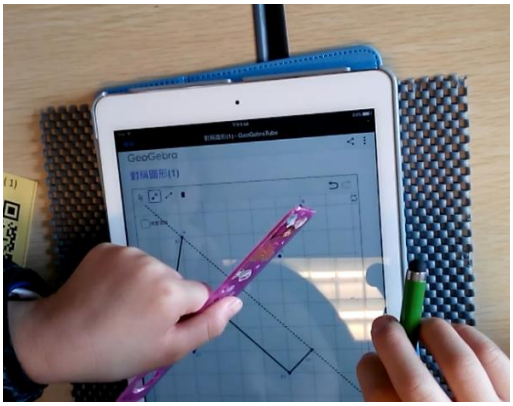

Figure 5.6 A Student followed the instruction to measure the space of the asymmetrical diagram.

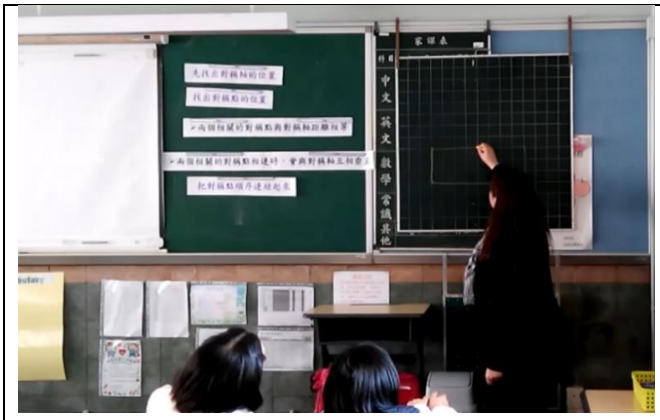

Figure 5.7 Teacher using a physical graph blackboard to clarify the symmetrical concept.

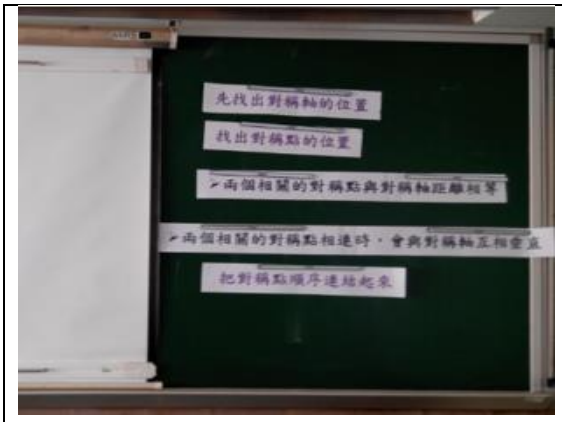

Figure 5.8 Paper-based instruction

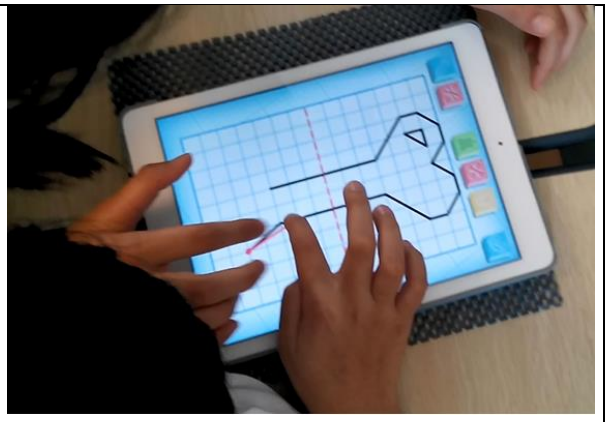

Figure 5.9 Co-construction of an asymmetrical diagram by two students

During my class observation, the mathematics teacher used the projected image to illustrate an asymmetrical diagram's equal distance nature and utilized a blackboard physical graph to clarify the concept (Figure 5.7). In addition, detailed printed paper instructions were displayed in front of the class the entire time (Figure 5.8). Finally, two students shared one iPad and co-constructed a symmetrical diagram in class (Figure 5.9).

This example illustrates that conventional methods and tools could be integrated into the technology-mediated lesson. However, this example also demonstrates that the subject teacher from School B was creative. She combined the available digital courseware with conventional physical teaching tools despite the constraints imposed by the principal discouraging teachers from creating their own digital courseware.

5.3.2.3 Rules

The participating teachers, including the lead teacher, Sandra, and the subject teacher, Sarah, were accountable to the **rules** established by the leader, Samuel because he was in a higher position as the principal in the school hierarchy. In addition, as the E-learning Development Team leader, Sandra understood the constraints and expectations of her upper management, which could lead to the success of the WiFi 100 project. Therefore, Sandra illustrated her point of view:

> *We are a small and not resourceful primary school in a public housing community. We need to survive to attract more students from the neighbourhood. Digital learning projects could attract parents and students from our neighbourhood.*
>
> Sandra, lead teacher, School B, 10/6/2016

This pragmatic view of the rules recognised by Sandra seemingly connects to Samuel's perspective, which demonstrated that rules imposed from the top might directly impact the implementation of the WiFi 100 project carried out by front-line teachers.

5.3.2.4 Community

For School B's social environment, teachers conducted various activities in interacting and collaborating with external partners such as publishers, hardware and software vendors, service providers, tertiary institutions, and government agencies. Such collaborative relationship services were essential resources for School B since Sandra, the E-learning Development Team leader, identified School B as a small primary school in Hong Kong with a short history and weak socio-economic connections:

> *We are a standalone educational organisation with limited resources, unlike other primary schools with a long history and strong economic support from their mother organisations. Therefore, we need to work doubly hard to secure the necessary resources for our school. We received a donation of 70 tablet computers from Samsung by participating in the Samsung Smart School Buddy Programme. We also applied for the EDB Quality Education Fund scheme to obtain an additional budget to support the WiFi 100 project.*
>
> Sandra, lead teacher, School B, 10/6/2016

This comment suggests that the lead teacher, Sandra, took a pragmatic view in interacting with the school's community. The object of the activities in the community for Sandra was to secure more resources to make the WiFi 100 project successful.

5.3.2.5 Division of labour

While the participating teachers, Sandra and Sarah, understood their duties and responsibility in implementing the WiFi 100 project, their actions when carrying it out were directly influenced by the top-down management style. To reduce the pressure from the management, Sandra decided not to work alone. Instead, she included digital lessons in the formal approval process, similar to the non-digital approval. Thus, it seemed that Sandra strategically involved the administrative staff in sharing the responsibility.

The subject teacher, Sarah, also mentioned that the school gave her the responsibility without allocating the necessary preparation hours to carry out her WiFi 100 project responsibilities. Therefore, the subject teachers also decided not to work alone by distributing the workload among the team members.

5.3.3 Summary of School B context

Samuel, the school principal, fulfilled both the stated object of the WiFi 100 initiative from the government and the school's aim stated in the school's annual report. Samuel got the job done as a school principal. However, Samuel exercised a top-down management style with his subordinates, such as Sandra and Sarah, without considering whether there was sufficient support for his staff. As a result, Sandra needed to find additional resources from outside partners to finance the WiFi 100 project, while Sarah was required to devise a strategy to share the risk of the WiFi 100 project.

School B has the shortest history compared to the other two primary schools in this study. In addition, it is a standalone school with weaker socio-economic support than the other schools. However, the E-learning Development Team Leader, Sandra, found unique ways to finance the WiFi 100 project by mobilising resources from community members.

The rules observed by Sandra were a pragmatic approach connected to the direction of upper management. Also, regarding the division of labour, Sandra and Sarah involved administration staff and other e-learning team members in sharing the responsibility of the WiFi 100 project.

5.4 Historical and cultural background and the description of the activity system for School C

This section covers School C's historical and cultural background and a detailed description of the uniqueness of elements in their activity system.

5.4.1 Historical and cultural background of School C

According to the annual reports and website available for School C, the school was established in the 1950s with over 60 years of history (School C Document, 2016). There were about 550 students with slightly under 40 teaching staff covering 18 classes in the school year 2015-16. It was the smallest primary school in terms of students and teachers compared to the other two schools. About 70% of the teaching staff had over 10 years of experience, the highest ratio among the three schools in the 2015-16 school year. The number of teachers with five to nine years of teaching experience was slightly above 10%, and under four years under 20%. This indicated that School C had a high proportion of experienced teaching staff. Since these experienced teachers were more mature individuals, they might have had different concerns regarding the introduction of digital technologies in school, according to the School C principal, Theresa:

> *We are an old primary school with a conservative Catholic tradition. As a result, our experienced teachers' IT knowledge is outdated. Teachers with 15 to 20 years of experience lack basic knowledge in operating the current digital tools.*
>
> Theresa, principal, School C, 14/7/2016

Theresa claimed that these mature teachers might doubt using digital technologies in teaching and learning and some may feel threatened by the introduction of the WiFi 100 project.

According to Theresa, School C did not participate in the e-textbook reform scheme initiated by the government in 2000 (HK Education Commission, 2000). The school was not interested in new technology being introduced to the school. Therefore, School C did not institute a digital learning program. This was the time before Theresa was the principal.

As the principal, Theresa initiated the WiFi 100 project in 2014, and she started running digital lessons in 2015 (School C Document, 2016).

5.4.2 Detailed description of the activity system for School C

This section describes the elements of the activity system for School C. Figure 5.10 depicts the activity system for the integration of digital technology into teaching and learning activities for School C teachers.

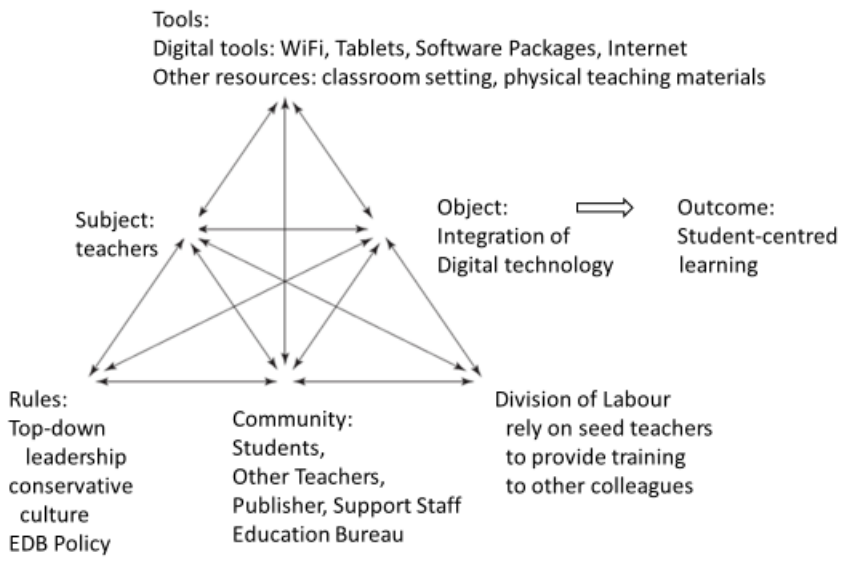

Figure 5.10 Digital technology integration into teaching and learning activity system for School C

The uniqueness of the elements in School C's activity system is described in the sub-sections from 5.4.2.1 to 5.4.2.5.

5.4.2.1 Object and subject

School C is a Catholic primary school, and one of the school's aims was to spread the Gospel mentioned in the school's 2015-16 annual report, page 3:

> *The spreading of the Gospel is the priority of the school's education aim. The realisation of such educational philosophy is to provide our students with a balanced life and a lifelong learning environment. As a result, our students will be contributing members of society (School C Document, 2016).*

This education philosophy was the mainstream culture of School C in teaching and learning in its 60 years of history. Furthermore, Theresa, the principal, claimed the parents endorsed such a culture:

> *Parents choose our school because of our education philosophy, not because we use the latest technology in teaching and learning.*
>
> Theresa, principal, School C, 14/7/2016

Theresa also recognised the contrast between the school's education-dominant philosophy and the use of digital technologies in the WiFi 100 project. She stated that teachers who had been with the school for over 15 to 20 years had questions about the WiFi 100 project in school:

> *Will technology in school distract us from our Catholic school tradition? Is the purpose of the WiFi 100 project to reduce the number of teaching staff? Will we, the teachers, be forced to early retirement who cannot use digital technologies in the classroom.?*
>
> Theresa, principal, School C, 14/7/2016

There was resistance among the experienced teachers, so Theresa did not require them to use digital technologies in the classroom in the first year of the WiFi 100 project. Instead, she stated that she would communicate with these teachers and convince them of the need to use digital technology in teaching and learning in our knowledge-based economic society. Theresa noted that these experienced teachers were gradually convinced that there was no conflict in using technology with a Catholic school tradition and that teachers would not be replaced because of the WiFi 100 project. Theresa gave herself one year to overcome the historical differences between digital technology and Catholic traditions. According to Kuutti (1996), any tools in the form of artefacts that may be physical, such as digital technologies, or mental, such as Catholic tradition, will enhance or restrict the process of transformation based on the inherent historical collective behaviour. In our case, Theresa, as the subject, attempted to strike a balance between the two traditions.

Theresa's stance aligned with the school's education philosophy in preparing students to become contributing members of society while maintaining the school's Catholic tradition. However, the experienced teachers agreed there was a need to integrate digital technologies into the school curriculum but did not agree with the project implementation arrangement that Theresa initiated. The difference and the contradiction will be discussed in section 7.2.1 on School C leadership contradiction.

In sum, there were different objects perceived between the experienced teachers and the principal. While Theresa wanted to introduce digital technologies to the school based on societal and economic needs, the experienced teachers perceived a potential negative impact on their careers

5.4.2.2 Tools

From my School C digital lesson observations, multimedia and animation were the main features used in the classroom. They were universally used across different subjects, including Language, Mathematics, and General Studies lessons. Multimedia, such as video clips, provided a real-world scenario that allowed for an active discussion among students in the classroom. For example, during my class observations in a General Studies lesson, a one-minute car accident video clip was presented, followed by a class discussion on what to do when this situation happens. The question and immediate feedback sessions were also delivered using the online feature of the learning software (Figure 5.11).

Figure 5.11 Group discussion with teacher scaffolding students

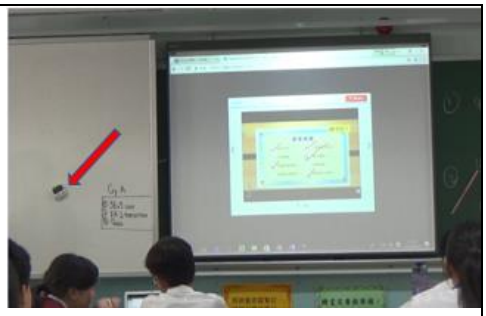

Figure 5.12 Use of a kitchen clock in classroom

This was a good use of multimedia in which students could easily understand the car accident. According to Higgins (2003), the key issue is that teachers need to find innovative ways to use digital tools. It is more important for teachers to think about extending digital tools with learning in mind. This viewpoint was not mentioned during the interview sessions with the teachers from School C but was evident during class observation sessions.

Another tool, a digital kitchen clock, was used by the teacher to keep track of the time being used in different segments of the digital lesson (the red arrow in Figure 5.12). However, the teacher seemed very cautious about how time was allocated to the digital lesson.

5.4.2.3 Rules

The WiFi 100 project was organised hierarchically in School C. Principal Theresa appointed six seed [16] teachers responsible for the six main subjects, namely, English, Chinese, Mathematics, Social Studies, Music, and Visual Arts, to implement the WiFi 100 project. This suggests that the management style was also top-down similar to School B's management style. However, unlike School B, Theresa gave clear directions when distributing the responsibilities among the six seed teachers. She entrusted them to drive the WiFi 100 project in their subject areas. As a result, there may be a possible managerial contradiction between the principal and teachers. The discussion of such tensions is covered in section 6.3.1 on rules and division of labour.

5.4.2.4 Community

Many parties were involved in School C's community, including students, parents, publishers, and teachers from other schools in the neighbourhood.

Theresa explicitly stated that the goal of integrating digital technologies into teaching and learning was not to improve the school's image and student enrolment:

> *Digital learning has little impact on student enrolment. Parents put moral education for the school in higher priority than digital technology in learning*
>
> Theresa, principal, School C, 14/7/2016

In other words, School C was a well-established school with its education philosophy being known and endorsed by the parents. Theresa stated in her interview that participating in the WiFi 100 initiative was to prepare students for our knowledge-based society. Theresa also indicated that parents were supportive of her introduction of digital technologies.

[16] Seed teacher was the term used by School C principal, Theresa. A seed teacher was a focal personal who responsible for consolidating resources for a subject area and became an expert in that subject area.

As far as students' learning was concerned, Tom, the lead teacher, and the English subject teacher stated that digital learning software did help with students' learning.

As for using teaching materials from publishers, Tom pointed out that sometimes the English exercises provided by the publishers were too simple and not appropriate for the level of his students. Therefore, he needed to create exercises for his students.

Tad, the Mathematics subject teacher, described how he conducted his mathematics classes:

> *I only occasionally use e-textbooks from publishers. I mainly use math software programmes downloaded from the Internet.*
>
> Tom, lead teacher, School C, 14/7/2016

Thus, teachers from School C did not solely rely on publishers' teaching materials. Instead, they obtained online teaching materials or created their own exercises and activities.

5.4.2.5 Division of labour

Theresa, the School C principal, delegated six seed teachers, with each seed teacher covering specific subject areas. According to Tad, the Mathematics seed teacher was the focal person in digital learning resources related to Mathematics:

> *Seed teachers are required to share their experiences each school year. Therefore, I need to give a demo of using the application software in a sharing session.*
>
> Tad, subject teacher, School C, 14/7/2016

Therefore, seed teachers are knowledgeable in digital technologies for their pedagogical practices and willing to consolidate and share their respective subject areas with their colleagues.

Theresa stated that her teaching staff would take turns running teaching demo lessons once each school year. Usually, it would involve one grade and one subject teacher responsible for the session. In addition, other teachers would be invited to the demonstration lesson to learn the operation in a technology-mediated classroom environment.

5.4.3 Summary of School C context

This section identified the discrepancy of objects between the principal and the experienced teachers. Second, the tools related to the pedagogical practice in the technology-mediated

classroom were not limited to using tablets. Tools can also be other mediated artefacts, such as a kitchen clock, to control the class activities' timing.

Third, regarding rules, Theresa, the principal, employed a hierarchical structural and top-down managerial approach with clear responsibility and clear-cut division of labour. However, such a division of labour may have introduced tensions among the teaching staff because of uneven job duties.

Finally, the interactions between teachers and members of the community were covered. Parents were supportive of both the school's Catholic tradition and the newly introduced digital technology approach. However, both the English teacher and the mathematics teacher were not satisfied with the digital teaching material provided by the publishers, and they decided to find their sources on the Internet or construct their class exercises.

5.5 Chapter summary

This chapter presents the uniqueness of the activity systems of the three schools. Each school is unique in its socio-cultural and historical traditions. As a result, the way teachers interacted with each other differed from one school to the other. In addition, the leadership of the three schools also played an essential role in integrating digital technologies. Principals are the leaders who can be regarded as mediating artefacts. In this case, for teachers interacting with the environment, the mediating artefact is the leader who could facilitate or impede the integration process (Kuutti, 1995). The influence of leadership will be discussed in Chapter 7.

Chapter 6: Classroom and teachers' activities

6.1 Introduction

The previous chapter covered the three schools' social and cultural contexts. This chapter is the first chapter of two chapters on the findings. This chapter analyses themes identified for micro-level classroom activities and themes described for meso-level teacher activities (see Appendix H for the main themes and sub-themes related to the micro- and meso-levels). CHAT dialectic analysis (Timmis, 2014) is employed to examine the constraints and tensions between elements of the classroom learning system and the teachers' working system. The red bidirectional arrows in Figures 6.2 and 6.4 to 6.6 signify the dialectic relationships between two elements in the activity system.

Three primary schools participated in this research, and 10 interviewees were involved. The interview data from these interviewees serve as one of the primary data sources for this research. For the years of teaching experience and subject teaching, refer to the profile Table 5.1 in Chapter 5 about these 10 participants' background information.

6.2 Micro-level classroom activities

This section describes the themes related to classroom activities, i.e., the current and digital-mediated classroom activities. Sub-themes are structured around the CHAT activity system's selected elements, such as tools, rules, subjects, objects, and outcomes.

6.2.1 Historicity and classroom culture

Terry, the IT subject teacher from School C, recalled his experiences 10 years ago as an IT teacher:

> *I often used presentation software such as PowerPoint to manage my teaching materials and conduct my IT classes. For example, I presented PowerPoint materials using a desktop computer with a projector secured on a four-wheel movable AV trolley.*
>
> Terry, subject teacher, School C, 14/7/2016

Terry's comment may reveal that using digital technologies in the classrooms was not a common practice before implementing the WiFi 100 project in schools. Similarly, the principal of School C, Theresa, mentioned the current pedagogical practices in her school:

The use of PowerPoint presentation software in the classroom was still mainly one-way communication. There was no difference compared to 10 years ago, and the interaction with students was limited. PowerPoint presentation lessons are no different from the "chalk and talk" teaching mode. It was merely to convert teaching materials to PowerPoint, which was in digital format.

Theresa, principal, School C, 14/7/2016

Here, Theresa explains her primary school's historical and current pedagogical practices before implementing the WiFi 100 project. Even the use of PowerPoint made very little difference because the teaching mode was mainly teacher-centred.

The historical background of using digital technologies in School C shows there was limited interaction in the classroom. The rest of this section considers historical and cultural factors influencing the use of digital technologies in the three schools.

Frank, the subject teacher from School A, commented on the current classroom activities:

The current classroom is rigid, inflexible, and boring. Also, the pedagogical practices are uninteresting to the students who are not enthusiastic about what they learn. They attend the class to fulfil their obligation as students. The teacher talks in front of the classroom for 35 minutes while the students sit and listen. The job is done for teachers and students when the lesson ends.

Frank, subject teacher, School A, 12/7/2016

Here, Frank seems dissatisfied with the current classroom practice, where he describes the students as passive and inactive in their learning process. The limited interaction and participation suggest that the traditional local culture influences it. For example, students are not encouraged to talk and express themselves in the classroom and must obey the teacher's instructions.

Terry, the subject teacher from School C, echoes Frank's point of view:

The current teaching and learning situation has remained at the skill and knowledge transfer level. Teachers are obligated to finish the curriculum within the very limited class time. As a result, students were not encouraged to ask questions while teachers competed with limited time to cover the curriculum.

Terry, subject teacher, School C, 14/7/2016

Based on the above extracts from Frank and Terry, class interactions in Schools A and C are limited by the traditional local culture and there is insufficient class time to complete the school curriculum requirements.

The principal of School C, Theresa, also pointed out that a technology-mediated lesson needs time to set up tablet computers at the beginning and takes time to turn off and return the tablet computers at the end of class. Thus, the class time, limited to 35 minutes, is too short. The 35-minute class time is a common rule among local government-funded primary schools, as mentioned by participants from Schools A and C

Other historical factors, such as the current classroom physical configuration and class size, also limit classroom interaction. For example, the lead teacher, Tom, an English teacher from School C, said the current classroom configuration and class size restrained him from interacting with all the students:

> *I can only selectively ask a few students for feedback and move on with the lesson since I have many students in one class. I can only get input from one or two enthusiastic students sitting in the front row or ask some shy students seated at the back of the classroom. I do not have a good idea of how the other students learn.*
>
> Tom, lead teacher, School C, 14/7/2016

Tom reveals the interaction with students and student feedback is limited by the classroom configuration and the class size since most of the current classrooms in Hong Kong primary schools are arranged in rows and columns. In addition, the current class size in Hong Kong is around 25 to 30 students. Therefore, a teacher may have difficulty paying attention to all students.

The logistics explained here are typical in Hong Kong government-funded primary schools and not unique to the three schools. These socially bounded conditions refer to the contexts of different local government-funded primary schools that are socially connected within the Hong Kong education system even though they are physically apart. The local government-funded primary schools share common social and historical characteristics such as class time and class size that conform to rules and policies imposed by the government. In addition, classroom configuration is standard among the three school classrooms (Figure 6.1).

Figure 6.1 depicts the classroom configuration from my classroom observation in School B, where students were arranged in rows and columns in a technology-mediated lesson. The

teacher gave instructions in front of the class while students listened before reaching for their iPads. During my classroom observation, group discussion was limited to two students sitting beside each other. Therefore, row and column arrangements limit the students' mobility and interaction. In all three schools I visited, the classroom configuration was similar.

Figure 6.1 Classroom configuration in School B

The classroom rules, such as the classroom culture, class time, class size, and classroom configuration, limit interaction and hamper the use of digital technologies in the three schools. Figure 6.2 illustrates the contradiction between teachers' object of integrating digital technologies and the current classroom rules.

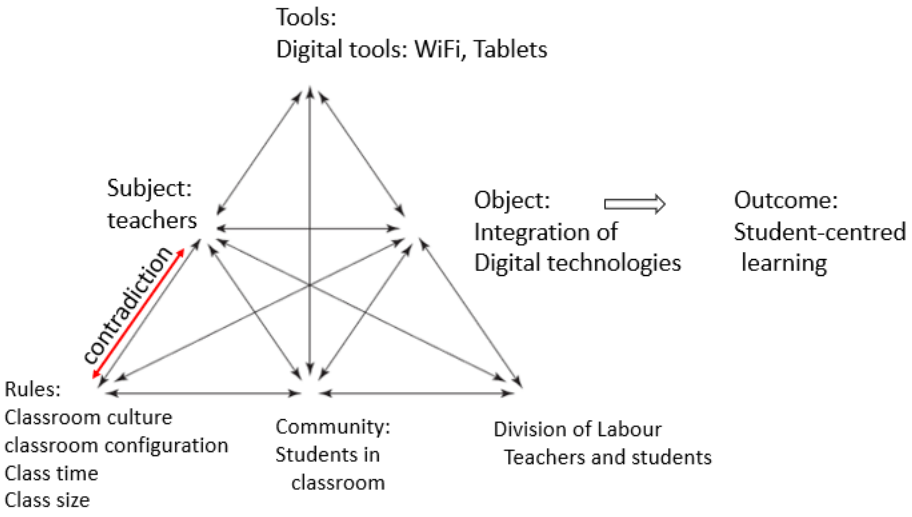

Figure 6.2 Contradiction exists among teachers with the current classroom configuration, culture, class time, and size for all three schools.

The following section covers interactions brought to the classroom by introducing digital technologies despite classroom constraints.

6.2.2 The outcome of digital mediated classroom activities

This section concerns how teachers utilised digital technologies to conduct learning activities in the three schools, including teachers' reported observations of students using digital technologies independently and the outcomes of student-teacher interactions and student-centred learning. The contradicting objects between schools, parents expected outcomes, and the actual teachers' outcomes from integrating digital technologies in Schools A, B, and C are also reported.

Sarah from School B, a subject teacher teaching Mathematics and General Studies, agreed that using digital technologies allows students to widen their scope of learning by using the Internet search function to access websites for information. Sarah commented on the use of the Internet in the classroom as follows:

> *ICT tools give our young students the space to think, express, and learn in a different mode. This is one step forward compared to memorising and reciting the printed textbook material in our current teaching and learning approach. In addition, the ICT tool motivates the students to take an active role in learning and searching for their own answers rather than relying on their teachers to tell them the answer.*
>
> Sarah, subject teacher, School B, 10/6/2016

Here, Sarah recognised the benefits of digital lessons that students were engaged in using digital technologies in their learning activities.

Tad, a Mathematics teacher from School C, also agreed that digital technologies could make learning more meaningful, vivid, and engaging. Tad observed that:

> *Students take a more active role in learning. For example, when I covered the topic of three-dimensional (3D) geometric diagrams and special geometric relationships, my students could participate in manipulating and rotating the three-dimensional geometric objects on their own tablets. Students personally interact with 3D objects and visualise the change of spaces relative to the object's environment. The learning process was under my students' control.*
>
> Tad, subject teacher, School C, 14/7/2016

According to Theresa, using digital technologies in learning motivates school children to learn. For example, from her observation, an SEN (Special Educational Needs) child was happier to learn when she could control her learning pace. Theresa commented:

> *For example, an SEN child could follow stroke by stroke when learning to write Chinese characters using teaching software. A similar situation applies to normal children without SEN.*
>
> Theresa, principal, School C, 14/7/2016

From these instances, Sarah, Tad, and Theresa realised the importance of students' learning modes to become active and control their learning pace using digital tools and resources. Students appeared to be more engaged in learning when they could control what and how they learned. Digital technologies provide the capacity for students to manage their learning.

Tom, the English subject teacher from School C, also reported the change in students' behaviour in his English lesson. He agreed that technology-mediated lessons contributed to higher participation by using online learning platforms, such as Socrative and Nearpod. He noted that:

> *The online learning platform provides interactive learning activities and immediate feedback and enables full participation in the classroom. For example, when I posted a short question or a short quiz through the online learning platform, the whole class was required to answer the question. The software learning platform would instantly show the result of the answers without delay.*
>
> Tom, lead teacher, School C, 14/7/2016

Tom noticed the impact of immediate feedback on students' learning behaviour which immersed them in their learning:

> *The immediate feedback is beneficial both to the students and me. The software helps me visualise how well the students understand what I just covered in class. Students can also correct their mistakes during class while their memory is still fresh.*
>
> Tom, lead teacher, School C, 14/7/2016

Terry from School C had a similar experience:

> *An online learning platform like Nearpod will automatically mark the standard answer. The result of individual students will be available immediately during class time. As a result, my*

students did not need to wait for a week to get feedback from the classroom exercise and were more enthusiastic about learning.

Terry, subject teacher, School C, 14/7/2016

These experiences suggest that immediate feedback is a preferred learning mode for students.

Frank from School A described his intention to run technology-mediated classes to provide a pleasant learning experience for his students.

Initially, I intended to provide a pleasant learning experience for my students. However, the students were new to the technology-mediated classroom and were looking forward to experiencing the new approach.

Frank, subject teacher, School A, 12/7/2016

According to Frank, students were excited to learn new computer skills and apply them to their daily activities outside the classroom. This suggests that computer skills and knowledge inside and outside the classroom are essential for students. Frank continued:

The students take a more active role in learning in the technology-mediated class because they want to try new things. In addition, since an iPad can take pictures, videos, and audio recordings, students can integrate such multimedia features into classroom activities and take-home exercises. As a result, it makes learning more enjoyable.

Frank, subject teacher, School A, 12/7/2016

Here, Frank observes that the classroom activities transformed from a "chalk and talk" mode to a more interactive mode that allowed students to control their learning. Frank's expectation of a technology-mediated classroom is similar to the description by Beatty and Feldman (2012) that teachers no longer stand in front of the class, and the students sit behind their desks and listen to the teacher. In addition, the class activities can be extended out of the classroom. For example, Frank recalled that in his Social Studies class, students were asked to do a multimedia homework assignment:

When I covered the environmental hygiene lesson, I asked the students to visit their neighbourhood to take some short videos on problems and issues related to environmental hygiene. They needed to make interview clips with their neighbours to expose the different points of view on a given issue—this multimedia project facilitated and aroused their interest in learning. As a result, I hoped learning with digital technology would improve students' sense of accomplishment. They can show off their schoolwork at home to their parents.

Frank, subject teacher, School A, 12/7/2016

We can see that with new tools, such as an iPad, students enjoy the multimedia capabilities of digital technology. For example, students could extend their social contacts to their neighbours outside the classroom with the help of an iPad to record their work. Such change in students' behaviour was what Frank, as a teacher, longed for.

The following picture illustrates students from Frank's class making multimedia classwork for a General Studies class:

Figure 6.3 Student using an iPad to make multimedia classwork

These findings from Schools A, B, and C show that a certain level of student-centred learning was achieved (see figures 5.1, 5,4, and 5.10, student-centred learning is the common outcome across all three schools). However, since digital technology accomplished the common object, is this a suitable tool for meeting the schools' expectations?

Despite the benefits mentioned above, teachers are still doubtful about conducting digital lessons. Frank said that digital technologies are just a tool and should not be the primary concern of the quality of education:

> *Is digital technology a must in teaching and learning in the classroom? A teacher can still teach without the tablet, and students can still learn without the tablet. A tablet is just a tool. Using the tablet to enhance and enrich students' learning experience is more important than the tool itself.*

Frank, subject teacher, School A, 12/7/2016

In other words, Frank implicitly pinpointed differences between technology-mediated lessons and conventional lessons without technology. Frank did not want to just convert the teaching

contents from textbooks to digital tools without rethinking the differences between the two teaching approaches. Lawless and Pellegrino (2007) stated that technology is an enabler in stimulating new possibilities in instructional strategies, changing learning contents, and the way we assess students. This also demonstrated that Frank's doubt merely using digital technology without rethinking will transform education.

However, the e-learning team leader, Sandra, from School B, held that digital technology is just a supporting tool that helps facilitate teaching and learning more effectively:

> *The tablets and software applications are only tools, not the curriculum's core. We only take advantage of these tools to facilitate teaching and learning.*
>
> Sandra, lead teacher, School B, 10/6/2016

Sandra felt that digital technology is just another teaching tool similar to a whiteboard in the classroom. She pointed out that she would use digital technology only to make her teaching easier and reduce her workload (Ertmer and Ottenbreit-Leftwich, 2013). This viewpoint is consistent with School B's culture that technologies should not side-track teachers

Tad is a Mathematics teacher from School C who agreed that using digital technology could make learning more effective, vivid, and enjoyable, and digital technology might move towards a student-centred learning direction. However, he would only use it when the technology would help him to illustrate his topic and lighten his workload (Ertmer and Ottenbreit-Leftwich, 2013). Tad's conservative viewpoint also aligns with School C's traditional culture.

Frank mentioned that at the school's parent meeting, he told his students' parents that his digital lessons would strengthen their children's digital media skills and broaden their knowledge. However, the skills and knowledge gained may not improve the student's grades on the public examinations implying that Frank recognised the contradiction, i.e., that the current public examination assessment did not assess digital skills.

Thus, I asked: "What are the differences between the digitally mediated and traditional classes?" Tom, the lead teacher from C, answered:

> *The school and the government invested in digital technologies, but the result may not be as expected. For e-learning, the class encourages discussion and expresses an individual opinion. Such practices are related to high-level thinking. On the other hand, the traditional class focuses on rote learning and prepares students for the public examination. In this case,*

the e-learning class may not contribute to the school's expectation of a good public examination outcome.

Tom, lead teacher, School C, 14/7/2016

Even though teachers from schools B, C, Sandra, and Tad recognised the benefit of digital technology, they still had a doubt. They preferred using it in cases where technology will lighten their teaching load. School C and parents from School A also regard digital technology as a tool to improve students' public examination performance.

Frank recognised the incompatible objects between the expected outcome and the digital-technology-integration outcome from School A and Tom from School C. Figure 6.4 depicts a contradiction between the student-centred learning outcome and the school and parents' expected examination outcome.

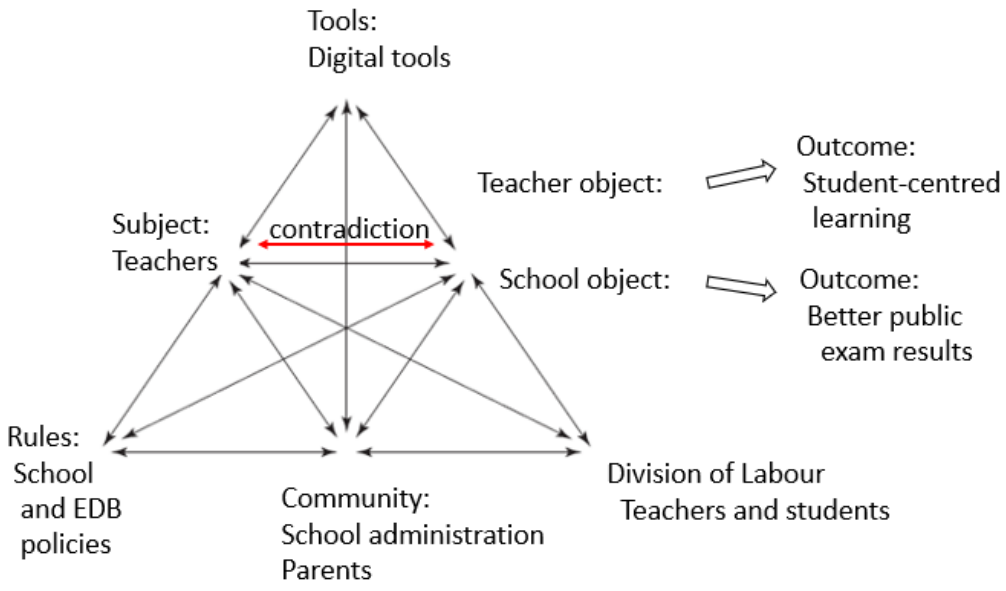

Figure 6.4 The object of the school principal and the actual outcome of digital technologies integration may differ in the cases of Schools A and C.

As for micro-level classroom activities, the current classroom limitations are presented. The local classroom culture, classroom configuration, class time, and class size are factors that prohibit the realisation of the potential benefits of integrating digital technologies in teaching and learning. These classroom limitations are related to the government's education policy and

the historical development of local classroom culture and are shared across the three schools. With digital technologies integrated into the classroom activities, the teachers recognised a certain level of student-centred learning, such as higher engagement in learning, higher level of classroom interaction, and immediate feedback from classroom activities. Each school integrated digital technologies differently. For example, School A emphasised the multimedia benefit of digital technologies while School B mainly utilised the benefit of Internet information search capability. School C focused on using software applications such as Socrative, Nearpod, and Mathematics 3D software. Thus, the contradicting objects between schools and teachers were identified.

6.3 Meso-level division of labour and collaborative activities

This section covers themes related to teachers' teamwork activities, collaboration, and division of labour among teachers to facilitate the integration of digital technologies into teaching and learning.

6.3.1 Rules and division of labour

This section covers the division of labour and the scope of workload in preparing a digital lesson at the three schools.

Frank, the subject teacher from School A, recalled the problems he encountered in preparing a digital lesson a year ago:

> *E-learning tools are evolving, and there is no commonly accepted standard for us to follow. How much preparation is enough is not clear. For traditional teaching, you are only required to deliver the learning materials to the students. Your job is done. However, for e-learning, in addition to covering the learning materials, we must consider how we deliver the learning material with the e-learning tools. What is the outcome we want to achieve? I have no good answer to the question.*
>
> Frank, subject teacher, School A, 12/7/2016

Here, Frank compares the preparation of the conventional non-digital lesson to a digital lesson. Unfortunately, there was no commonly known best practice in preparing a digital lesson that he could follow. In addition, the preparation work involved the knowledge of using the hardware and software, which is time-consuming and more demanding to learn.

Regarding the resource allocation for digital technology lesson preparation and the hardware and software tools available to test ideas, Frank pointed out that the school did not provide support and resources. Instead, he needed to spend money to buy equipment and used his time to prepare and try out new ideas during lesson preparations. This implies that the school had not considered the change of job duty of its teaching staff.

Tom, the subject teacher from School C, also noted a similar situation:

> *Digital lesson preparation takes 2 to 3 times longer than conventional class preparation in terms of the time spent. I need to try the software beforehand. Expect the unexpected during the digital lesson since it is new to us and involves digital hardware and software tools.*
>
> Tom, lead teacher, School C, 14/7/2016

Here, Tom points out the uncertain nature of digital lessons and the required extra precautions and considerations.

Faye and Sarah, the Mathematics and General Studies subject teachers from Schools A and B, agreed that digital lesson preparation is time-consuming. Tad, the Mathematics subject teacher from School C, also claimed that he needs to search, filter, and select the appropriate digital learning material for his class:

> *It is not only taking longer time but also related to the issue of the usefulness of the digital teaching material. I can search the Internet or look for the publisher's learning material. However, not all digital learning material available is appropriate for e-learning. For example, there are over 20 topics from our publisher, and only half are interactive and interesting. The other half just converts the content into digital format.*
>
> Tad, subject teacher, School C, 14/7/2016

Based on these comments and the experiences of various other teachers from all three schools, the preparation work cannot be completed by only one teacher. Because of the complex nature of digital lessons, a division of labour among teachers is necessary. Unfortunately, according to Frank, there was no known standard for sharing preparation tasks. Therefore, it is necessary to investigate how individual schools tackled the issue strategically and differently.

In the case of School A, the division of labour was informal, and teachers worked independently in deciding how to integrate digital classes into the curriculum. As a result, teachers were free to form their working group informally, and there was no direct order from the principal to group teachers into working teams or require teachers to meet specific pre-set

targets (see section 5.2.2.3 for School A's culture). This suggests that the level of trust between the teachers and the principal was high, and the teachers had the autonomy to make decisions about the division of labour. For example, Frank and Faye teamed up to create their digital courseware for their BYOD classes.

In School B, the principal, Samuel, asked the E-learning Development Team members to take turns conducting and preparing digital lessons individually (see section 5.3.1 for School B's top-down management culture). The teachers in the E-learning Development Team had different opinions about the responsibilities and duties given by Samuel. However, the subject teacher, Sarah, one of the E-learning Development Team members, noted that the team members would devise a strategy to deal with their assigned duty. She commented:

> *I will meet with other teachers in the E-learning Development Team after school hours since digital lesson preparation is regarded as an extra task that will not count as regular teaching duty. Therefore, we will split the workload among the team members. This will reduce our workload and risk when preparing and running the digital lessons.*
>
> Sarah, subject teacher, School B, 10/6/2016

This comment suggests that School B did not encourage nor provide sufficient support to the teachers. Teachers from the E-learning Development Team distributed responsibility amongst themselves. As a result, the success or failure implementing the digital lessons depended on a team effort rather than being each individual member's responsibility.

School B's principal enforced teachers' work separately instead of having them work in a team with an organised division of labour among teachers. School B's teachers disagreed and were unhappy about the duty arrangement. So instead, teachers were dividing tasks among themselves privately and arbitrarily.

Theresa, the principal of School C, arranged the division of labour among teachers in a hierarchical fashion. The central focus was the six seed teachers (see sections 5.4.2.3 and 5.4.2.5 seed teachers for the arrangements). The six teachers centralised selected digital learning materials and made them available to the other teachers.

According to School C's Mathematics seed teacher, Tad, the arrangement of the six seed teachers was unbalanced, and the responsibilities were uneven. Out of 40 teaching staff, only six were actively involved in consolidating the digital teaching materials for the other teachers to use. The other non-seed teachers would be inactive or passively involved in sharing teaching

materials for the school. In addition, the seed teachers were already overloaded with their regular job duties. As a result, the division of labour was not well distributed among the teaching staff, and the seed teachers were unhappy about the arrangement, according to Tad.

Figure 6.5 below illustrates the contradiction that occurred in School C because of the unbalanced workload arrangements. Contradiction also occurred in School B because of the top-down management style.

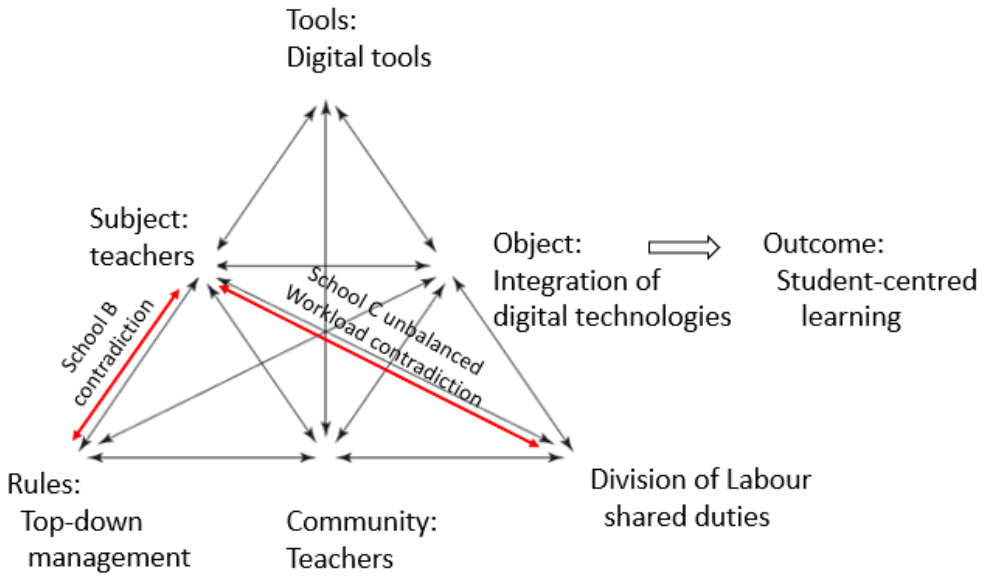

Figure 6.5 Contradiction occurred due to the unbalanced division of labour in School C and the top-down management in School B.

6.3.2 Rules and internal and external collaborations

This section covers various object interpretations at the meso-level and relates to teachers' activities of integrating digital technologies.

The following were the statements made by Frank and Faye, subject teachers from School A, regarding their objects concerning the WiFi 100 project:

> *Initially, I intended to provide a pleasant learning experience for my students because the current class is rigid, inflexible, and boring.*
>
> Frank, subject teacher, School A, 12/7/2016

> *It is because digital tools and software are continuously evolving. Therefore, as an e-learning teacher, I must follow technological trends closely.*

Faye, subject teacher, School A, 12/7/2016

Here, different social factors influenced the object of using digital technologies for Frank and Faye. Frank wanted a change from the current social-cultural and educational practice. In contrast, Faye wanted to enrich her digital technology knowledge for her career. As a result, both teachers' objects deviated from the stated aim in the WiFi 100 initiative document where the Education Bureau officially defined the aim of the WiFi 100 initiative as integrating e-textbooks, e-learning resources, and relevant pedagogies into learning and teaching (HK Education Bureau, 2014a).

I asked Frank and Faye during the interview regarding the details of the WiFi 100 initiative. Frank told me he did not have time to read the documents and simply followed his personal interpretation of the initiative. Similarly, Faye said she did not seem aware of the initiative's stated aim. Instead, Frank and Faye collaborated to create digital courseware for their students without using the e-textbooks required by the WiFi 100 initiative.

As School A's lead teacher and e-learning team leader, Fisher coordinated the external parties and facilitated digital resources for the WiFi 100 project. Internally, Fisher was required to work with the WiFi 100 project team members to increase the awareness of various digital learning resources for teachers. He told me that he was aware of the WiFi 100 funding relating to the use of e-textbook (see section 5.2.1 for the history of School A using e-textbook). However, he was not convinced that using e-textbooks would be successful in Hong Kong. Consequently, Fisher stated that the school allowed teachers to employ different ideas for digital lessons without e-textbooks.

School B reported that it created a digital technology learning environment hoping to allow 100% of the student population to use digital technology for self-learning (School B Document, 2016). This was also confirmed in the interview with the principal, Samuel:

> *In our school, for instance, before the morning assembly time, our students have the opportunity to learn extracurricular knowledge provided by the EDB (Education Bureau) website. Students can use tablets provided by the school connected to the website and learn various topics like Earth Science, Astronomy, Palaeontology, and Hong Kong Economic Environment. Students just pick a topic of their interest and learn more about it. Digital technologies provide such a learning environment for our students.*
>
> Samuel, principal, School B, 10/6/2016

This comment might indicate that the school principal intended to establish a digital learning environment as a showcase to attract students from the neighbourhood to enrol in the school. Meanwhile, the school principal collaborated with external e-learning partners and providers to provide digital learning materials. However, he discouraged teachers from collaborating among themselves and developing their knowledge and skills in digital technologies for pedagogical purposes.

Samuel noted that he established a digital technology learning environment for the students by modernising the school's equipment. From Samuel's perspective, he focused on tangible items. Thus, Samuel first considered the school's aim (see section 5.3.2.1 for School B's aim). Then, he relied on the e-learning partnership with local tertiary institutions and e-textbook publishers to supply digital courseware to the school to align with the WiFi 100 initiative's stated aim. As a result, Samuel met both the WiFi 100 initiative's aim and the school's educational aim fulfilling his duty as the school principal. In the end, he could put his tangible contributions into the school report. However, intangible aspects, such as the teacher's professional development and support, were not mentioned during the interview.

Sandra, the lead teacher and e-learning team leader from School B, stated in her interview:

> *Since our school does not expect our teachers to design their digital teaching materials, we will take every opportunity to get to know external partners, such as e-textbook publishers, hardware and software vendors, and local tertiary institutions. We will partner with them and obtain the needed e-learning resources.*
>
> Sandra, lead teacher, School B, 10/6/2016

In other words, Sandra understood that her success was measured by the extent of collaboration with external e-learning partners and the amount of additional funding she could secure for the WiFi 100 project. These results were measurable and could be put into the school's record as a showcase for recruiting students from the neighbourhood. In this case, the lead teacher, Sandra, matched the principal's object but not the WiFi 100 initiative's aim.

Theresa, principal of School C, mentioned that her object in participating in the WiFi100 initiative was to prepare her students for the future. Theresa also mentioned that mature teachers with 20 years of experience interpret the object of integrating digital technologies in school differently (see section 5.4.1). These mature teachers considered integrating digital technologies in school a threat to their careers.

Tom, the lead teacher and e-learning team leader, indicated that he wanted to renew his knowledge of digital technologies for his teaching career. Tom is also one of the six seed teachers in School C (see section 5.4.2.3 for seed teachers' arrangement in School C). He commented:

> *I will search for the appropriate digital teaching materials and recommend them to other teachers. The seed teachers will share their experiences in teacher meetings. We require teachers to use the materials recommended by the e-learning seed teachers. This is the current school policy.*
>
> Tom, lead teacher, School C, 14/7/2016

Tom's activities as the e-learning team leader were similar to Sandra in that he was aligned with the principal's object but not the WiFi 100 initiative's aim.

Figure 6.6 highlights the misalignment of school objects and the stated WiFi 100 initiative aim. Such a misalignment was allowed in School A since the management understood the WiFi 100 initiative aim was partially unrealistic. Principal Samuel manipulated the WiFi 100 resources for his object. Principal Theresa from School C and her teaching staff also had different interpretations of integrating digital technologies in school. The use of e-textbooks was not considered in all three schools. Therefore, a contradiction occurred between the schools' interpretations and the actual aim of the WiFi 100 initiative.

Figure 6.6 illustrates the contradictory objects at the meso-level regarding teachers' collaborative activities in integrating digital technologies in their schools.

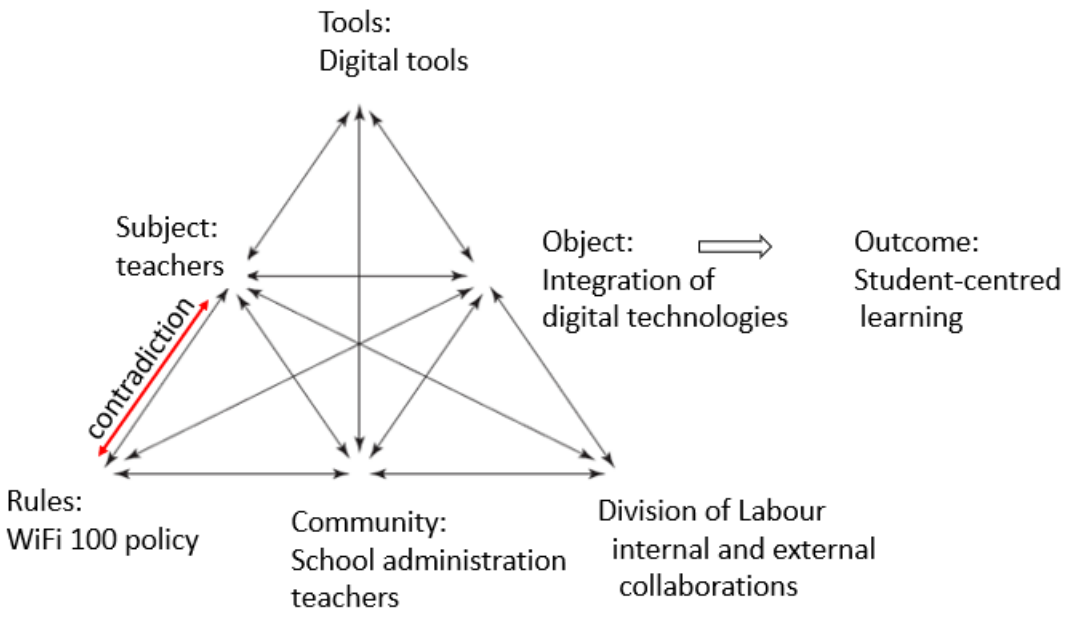

Figure 6.6 Contradiction between teachers' objects and WiFi 100 policy.

The meso-level teachers' activities related to the division of labour were arranged differently among the three schools. School A allowed teachers to informally form their working team. Therefore, there was no contradiction among School A teachers. For School B, there was a contradiction because there was no division of labour among teachers. For School C, a contradiction occurred because the workload focused only on the seed teachers.

The other aspect of the meso-level teachers' collaborative activities was related to the different interpretations of the objects of the integration. School A allowed teachers to make their collaborative decisions, while teachers from B needed to follow the collaborative agenda defined by the principal. School B focused on external collaborative activities, while School C focused on internal collaborative activities. The findings show that the use of e-textbooks was not the primary concern in all three schools.

6.4 Chapter summary

This chapter addresses the micro (classroom) and meso (teacher) level activities. At the micro (classroom) level activities, the findings revealed various factors that prevent the active classroom interaction between student-to-student and student-to-teacher, such as traditional local cultural behaviour in the classroom, tight class time to cover the required curriculum, the classroom structure, and the class size. Digital lessons demonstrated a certain degree of student-

centred learning and active student-teacher interactions despite these classroom barriers, according to the teachers' observations. However, the outcome of digital lessons was not meeting the expectation of parents in School A and the principal in School C.

At the meso (teacher) level activities, findings exposed different divisions of labour related to digital lesson preparation. School A allowed teachers to make their decision. School B decided that the division of labour in digital lesson preparation was unnecessary for the teachers. School C, a structured and rigid division of labour, was established based on six seed teachers. Lastly, different strategies employed by the three schools regarding internal and external collaboration were addressed. The individual school's cultural context influenced the division of labour and collaboration approaches.

Chapter 7: School leadership, policy, and culture

7.1 Introduction

This chapter is the second chapter of the two chapters on findings. In the previous chapter, I discussed themes and the CHAT dialectic analysis related to classroom activities at the micro-level and teachers' activities at the meso-level. This chapter covers the themes at the macro-level and the CHAT contradiction analysis pertaining to the school's leadership, culture, and the influence it may have over the government's reform policy.

Four types of contradictions, i.e., "dilemmas, conflicts, critical conflicts, and double binds" (see Engeström and Sannino, 2011, p. 368), were found by analysing contradictions (see section 3.4.2). The process of dialectical contradiction analysis is explained in section 4.6.1. Two contradictions, namely, "conflict" and "critical conflict" were identified regarding leadership styles, and the "conflict" contradiction was identified as related to the digital lesson co-planning policy. In addition, a "double binds" contradiction was identified related to the influence of education reform policies, and a "dilemma" contradiction was found based on the funding issue.

7.2 Macro-level school's leadership, policy, and culture

This section describes the themes and CHAT contradiction analysis related to the school's leadership, policy, and culture.

7.2.1 School leadership management styles

This section covers school leadership regarding digital technology integration into the three schools. Since the principal of School A was not available for an interview, there was no primary data regarding School A leadership style. Therefore, School A leadership style will be discussed based on the teacher interviews only. School B and C leadership styles will primarily be addressed from principals' interviews with the support of the teacher interviews.

School A leadership style is based on interviews with the lead teacher, Fisher, and subject teachers, Frank and Faye, who offered their impressions of the school principal's leadership style. No apparent leadership contradiction was identified for School A from the interview data. I have included School A to present a complete picture of all leadership styles among the three schools.

The lead teacher from School A, Fisher, stated:

> *Our teachers have total freedom to decide which topic they want to conduct the lesson with the tablets. We allow our teachers to use the school's digital learning materials or their digital materials. There is no need to be approved ahead of time either by the principal.*
>
> Fisher, lead teacher, School A, 12/7/2016

Here, it appears that School A's leadership was hands-off and allowed the teachers to make their own decisions in conducting digital lessons.

Frank, the subject teacher from School A, also mentioned that teachers had the autonomy to decide which of the school's digital learning resources or materials to use:

> *Regarding the decision on using the contents related to teaching materials, it will be up to individual subject teachers' decision.*
>
> Frank, subject teacher, School A, 12/7/2016

Faye, another subject teacher from School A, revealed:

> *Our teachers enjoy the freedom to decide what content is used and how to conduct the digital lessons. Our principal gives us room to develop.*
>
> Faye, subject teacher, School A, 12/7/2016

For School A, it appeared that the leadership provided empowerment and established mutual trust among the teachers to develop new approaches and ideas using digital technologies.

The principal of School B, Samuel, stated that the school created a digital technology learning environment with the target of a 100% student population to have the opportunity to utilise digital technology for self-learning in the school environment (School B Document, 2016). This was also confirmed in the interview with the principal, Samuel:

> *In our school, for instance, before the morning assembly time, our students have the opportunity to learn extracurricular knowledge provided by the EDB (Education Bureau) website. Students can use tablets provided by the school connecting to the website and learn various topics like Earth Science, Astronomy, Palaeontology, and Hong Kong Economic Environment. Students just pick a topic of their interest and learn more about it. Digital technologies provide such a learning environment for our students.*
>
> Samuel, principal, School B, 10/6/2016

The above might indicate that the school principal intended to establish a digital learning environment as a showcase to attract students from the neighbourhood to enrol in the school. Samuel noted in the interview that he established a digital technology learning environment for the students that modernised the school's equipment. From Samuel's decision-making perspective, he focused on tangible items. Thus, Samuel aligned with the school's aim (see section 5.3.2.1 for School B's aim).

Samuel, the principal of School B, claimed that his school had a clear view of the role of teachers regarding the use of digital technologies. According to Samuel, the teachers' primary focus should be on student learning. Samuel clarified his viewpoint:

> *Our teachers should take advantage of the existing digital teaching materials instead of creating their own since their expertise is not in the area of digital technologies.*

Samuel said that teachers should spend time understanding digital teaching materials and how to use them:

> *I do not expect teachers to design their digital teaching materials since they are not experts in digital technologies. But on the other hand, our teachers are experts in teaching and pedagogical practices. Therefore, our teachers should play the teaching role appropriately.*
>
> Samuel, principal, School B, 10/6/2016

Samuel did not seem to realise that teachers need to play a new role in the digital technology era as facilitators of learning and creators of digital courseware (Chan, Lee, and Cheung, 2015). Also, Samuel's viewpoint suggested that teachers' regular and digital lesson teaching roles are incompatible. Samuel separated the teachers' duties into two, i.e., preparing digital materials and teaching, which meant that the teachers' agency and control of the curriculum were being eroded when they were deprived of acquiring digital skills for their teaching.

Mutual trust was also an issue with School B's leadership. In response to principal Samuel's policy, Sandra, the e-learning team leader, wanted to protect herself by ensuring her digital lessons adhered to the school curriculum review and approval policy (see section 5.3). Sandra illustrated her point:

> *I will employ the pilot strategy for the digital lessons and the collective decision-making process. First, the curriculum director will propose different pilot points to the development and administrative committees based on topics. Then, the curriculum director will present the pilot points in the regular teacher meeting. Once all committees and teachers approve*

the proposed pilot points, trial classes will be set up. Such a process puts the overall school curriculum into consideration. Digital lessons are tied to school development and the administrative decision process.

Sandra, lead teacher, School B, 10/6/2016

From the above, Sandra employed a tight approval procedure to share her responsibility with the school's various administrative members. As a result, when a problem occurs related to digital lessons, Sandra will not be the only one responsible; other administrative members are also accountable.

The subject teachers from School B also formed an informal working group among the teachers to seek mutual support and share the responsibility and workload to minimize the risk of failing related to their digital lessons. For example, Sarah, the subject teacher from School B, commented:

Even though the principal asked us to work individually to prepare and conduct the digital lessons, we didn't feel comfortable working alone. So instead, we formed an informal group and shared our work preparing and conducting digital lessons.

Sarah, subject teacher, School B, 10/6/2016

As a result, Sandra, Sarah, and the other digital lesson teachers chose to evade the order from the principal by introducing work-around strategies. When considering the leadership style, the teachers appeared to have less empowerment and trust. Samuel's viewpoint suggested a contradiction to one of the CHAT principles of multi-voicedness where actors have different perspectives, roles, interests, and positions (Engeström, 2001). In the above situation, teachers' voices were suppressed. The type of contradiction was a "conflict" in which the teachers disagreed with Samuel and took a compromising position (Engeström and Sannino, 2011, p. 373). In Figure 7.1, the red bi-directional line indicates the conflicted relationship between the teachers and the leadership.

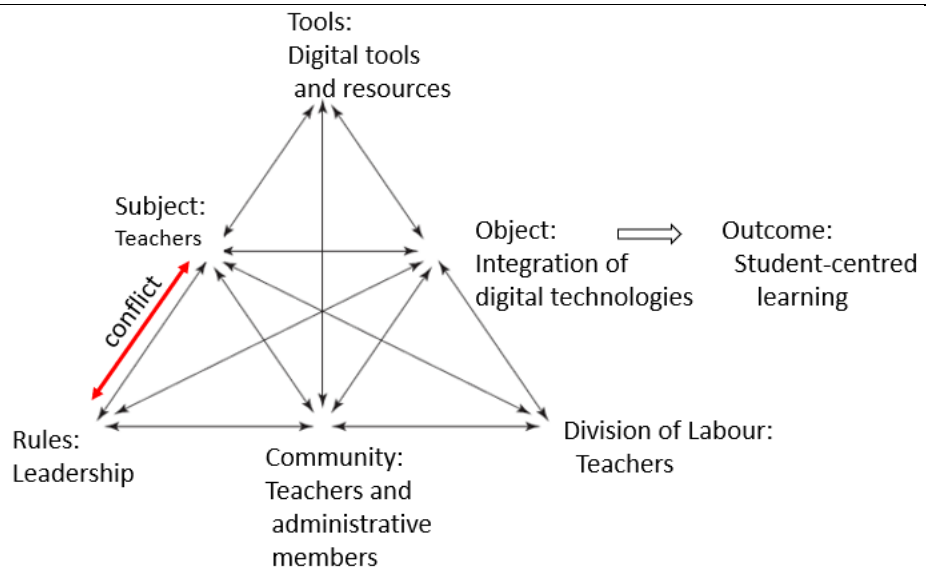

Figure 7.1 Conflict relationship between teachers and leadership for School B

In the case of School C, principal Theresa confronted a group of teachers with a long history of teaching experience. Theresa commented:

> *Because most of our teachers have been teaching for over twenty years, they see no problem with the current pedagogical practice. Therefore, there is no particular reason for the teachers to make changes.*
>
> Theresa, principal, School C, 14/7/2016

Theresa understood the problem and addressed the issue by providing a communication channel with her teaching staff. It took the first year of the WiFi 100 project in which digital lessons were conducted to convince her teaching staff. Nevertheless, she took the time to demonstrate to her staff that there was a need for the school to integrate digital technologies into the school curriculum. Ertmer and Ottenbreit-Leftwich (2010), in the process of teacher professional development, noted that the teachers' mindset regarding the use of digital technologies needs to change from being supplemental tools to essential ones for student success (p. 256). Theresa attempted to change the mindset of her experienced teaching staff. Theresa recalled that she needed to answer questions from her teaching staff, such as:

> *Do you want to use the electronic school bag to replace the paper-based textbook learning mode? Do you want the e-textbooks to replace all paper-and-pen learning and practices?*
>
> Theresa, principal, School C, 14/7/2016

Theresa was trying to establish mutual trust with her teaching staff. However, Tad had a different opinion about Theresa's policy:

> *The school tried to avoid putting teachers under pressure. The current policy only requires one subject teacher to conduct one digital technology-mediated lesson in one school year.*

As a result of the above policy, according to Tad, teachers might not have the confidence to conduct digital lessons and were not given enough first-hand practice. Such a contradiction of policy might be attributed to the school's conservative culture:

> *We need to allow teachers to practice and have hands-on involvement. There should be no penalty if some digital learning lessons are unsuccessful as long as the school explicitly states that. It strongly depends on how the leadership handles the situation. If it allows teachers to make mistakes and have no bad feelings, they will be more willing to take ownership and give the digital lesson a try.*
>
> Tad, subject teacher, School C, 14/7/2016

In Tad's opinion, mutual trust between the principal and the teachers was critical. When leadership allows teachers to make mistakes, teachers will accept risks. Unfortunately, this also revealed a contradiction between the object of Theresa's attempt to align her school's pedagogy with the historical and cultural influences of her school.

As Kuutti (1995) stated, cultural artefacts could be physical or mental, which can empower or prohibit the transformation of the activity. In this case, School C's historical and cultural traditions impeded the school's transformation. The contradiction that occurred could be characterised as a "critical conflict" (Engeström and Sannino, 2011) since the experienced teachers had 'inner doubts' which they could not resolve by themselves (p. 374). The red bi-directional line (Figure 7.2) indicates the critical conflict relationship between teachers and leadership.

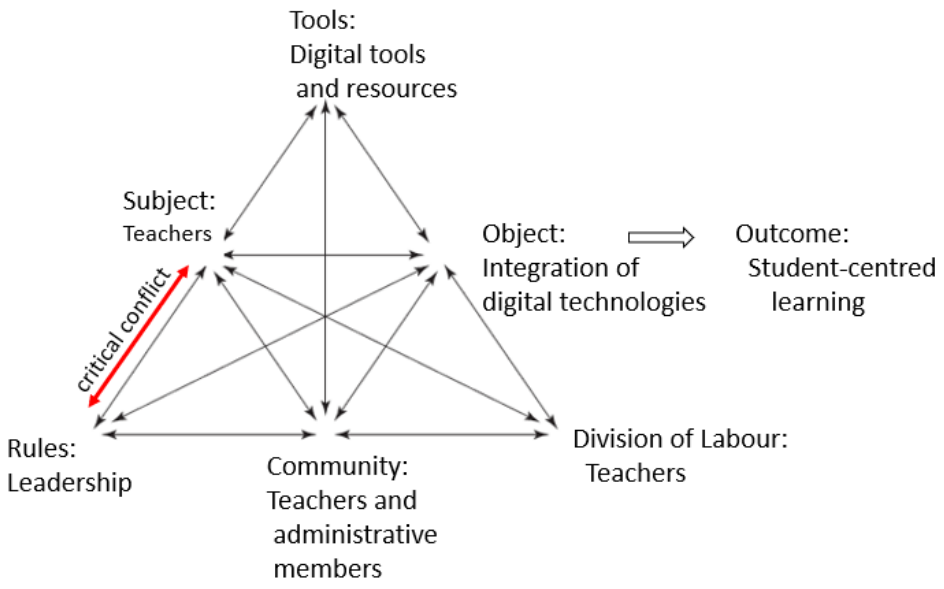

Figure 7.2 Critical conflict relationship between teachers and leadership for School C

7.2.2 Lesson co-planning policy

This section describes the current practices influencing the schools' digital lesson co-planning policy for teachers.

When examining the different implementation approaches of the WiFi 100 initiative among the three schools, a tightly structured and closely monitored management approach in School B appeared to have been implemented. According to Sandra, the lead teacher from School B, there were five stages involved in the digital lesson approval process, namely, school-wide approval involving various stakeholders, lesson co-planning meetings for the preparation of digital lessons, class visitations, observations among teachers, and year-end lesson reviews. Sandra commented:

> *Digital classes will not be isolated from the school development direction and administrative policy.*
>
> Sandra, lead teacher, School B, 10/6/2016

However, regarding actual duty allocation in lesson co-planning meetings, digital teacher team members were required to meet after school hours. Sarah, the subject teacher, noted:

The co-planning meetings are for non-digital lessons only. The responsible teachers will organise themselves to meet after school for the digital co-planning lesson preparation. We will divide the contents into different parts and distribute the contents among us.

Sarah, subject teacher, School B, 10/6/2016

Here, there appeared to be inconsistent and unfair treatment. The lesson co-planning meeting was the formal requirement for all lessons regardless of whether they were non-digital or digital lesson preparations. However, the lesson co-planning for digital lesson preparation was not part of the school's policy. As a result, digital lessons were isolated from the school's overall development planning.

Similarly, subject teacher Tad from School C stated:

The lesson co-planning meeting covered all subjects and lessons. However, the digital lessons were excluded from the regular co-planning arrangement. Teachers will meet outside the regular co-planning schedule. The time the digital lesson teachers spend will not count as the teacher's duty hours.

Tad, subject teacher, School C, 14/7/2016

Thus, School C also mistreated the digital lesson co-planning effort.

Frank, from School A, also had a similar experience:

The school only schedules co-planning time for the regular classes. There is no official arrangement for e-learning teachers. Therefore, we will discuss and share our ideas after school hours.

Frank, subject teacher, School A, 12/7/2016

Therefore, the digital preparation co-planning meetings among teachers in all the schools were excluded from regular school operations. The school administration simply maintained the status quo based on historical operations and did not adjust the school policy. As a result, the digital lesson teachers from all three schools could not influence the school's historical practice. Such a separation between digital and mainstream teaching planning underscored the marked nature of digital lessons, which failed to become part of the mainstream school policy, revealing a "conflict" contradiction (Engeström and Sannino, 2011, p. 373). The red bi-directional line highlights the dialectic relationship between school policy and teachers. Teachers responded to this conflict by submitting to school policy and working out a solution by meeting outside regular school hours. This conflict also shows the importance of taking

CHAT's historicity principle into account since the co-planning policy was established long before the WiFi 100 project and will continue with or without it in the future. Such a conflict is also associated with the systemic inflexibility of the school policy. Figure 7.3 shows the conflict between the digital lesson team members and the school co-planning policy.

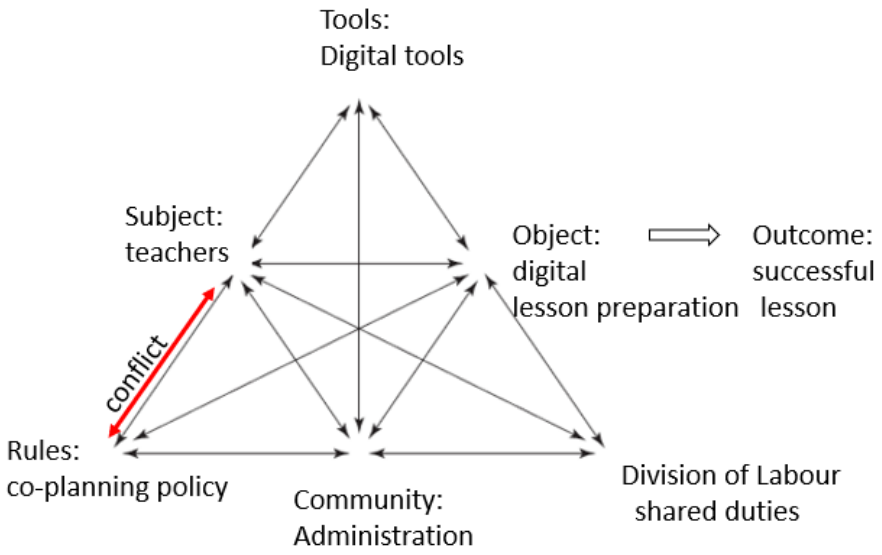

Figure 7.3 The conflict contradiction between teachers and co-planning policy among the three schools.

7.3 Macro-level government policy influences

This section describes the themes and CHAT contradiction analysis related to government educational reform policies and their influence on the three schools.

7.3.1 The contradiction between government policies and the socio-cultural context of schools

This section examines the contradiction between the Hong Kong Government's educational reform policies and the expected outcome of using digital technologies among the three schools. The first part of the findings in this section is based on an analysis of two main Hong Kong education reform documents, namely, "Learning for life – Learning through life" (Education Commission, 2000) and "Learning to learn – The Way Forward in Curriculum Development" (Curriculum Development Council, 2001). The second part of the findings is based on interview data from the three schools. Finally, contradictions are identified based on the influence of the government reform policy in integrating digital technology in schools.

Hong Kong's education reform was initiated in 1997 leading toward a knowledge-based economy. It can be summarised by the two titles of the Education Bureau policy documents mentioned above. These two documents emphasise the need for lifelong learning including the associated skills, i.e., using digital technologies in a knowledge-based society. Accordingly, curriculum and assessment reforms were introduced in the above two policy documents. The curriculum reform encouraged schools to move away from inflexible practices to a more flexible and diversified pedagogical approach to fit various learners' needs. The Education Commission (2000) policy document stated the characteristics of the curriculum reform:

> Through more flexible timetabling, the use of more diverse teaching materials, the integration of all-round learning activities both inside and outside the classroom, inspiring teaching methods as well as diversified assessment mechanisms, students will become more proactive in their learning, and they will "learn how to learn" (p. 9).

Here, the "more diverse teaching materials" suggests the government aimed to extend teaching materials from the pre-defined curriculum and textbooks to learning activities outside the formal curriculum and the classroom setting. Also, the "diversified assessment mechanisms" were not limited to "quantitative assessment" as stated in the following text:

> We recommend the use of various modes of assessment, including flexible formative assessment. Quantitative assessment should be minimized to make way for more analytical assessment that produces a more comprehensive picture of the performances and needs of students in different areas. Excessive dictation exercises, mechanical drilling, tests, and examinations should be eliminated to allow students more time to participate in useful learning activities. (Education Commission, 2000, p. 10)

Therefore, the assessment reform moved toward more flexible formative and analytical assessments to better understand students' learning achievements. More importantly, from the above text, rote learning, such as "excessive dictation exercises, mechanical drilling, tests, and examinations" should eventually be dropped to allow students to learn based on their needs. In addition, the curriculum and assessment reforms attempted to eliminate the one-size-fits-all approach the schools were practicing in Hong Kong (Curriculum Development Council, 2001, p. 3). The one-size-fits-all situation in the policy document refers to one summative assessment standard and one set of curricula for all schools. Furthermore, the Curriculum Development Council (2000) policy document promoted a decentralised school-based curriculum reform:

> Under the new curriculum framework, the concept of school-based curriculum development does not mean transferring all curriculum development work back to

> schools. Rather, it is an attempt to encourage schools to adapt the open curriculum framework based on the curriculum development direction, curriculum aim and curriculum guides set by the CDC. Schools can flexibly exercise their professional autonomy to select teaching contents, teaching and learning activities, homework arrangements, assessment strategies, etc. that cater for their students' needs (Curriculum Development Council, 2001, p. 20).

From the text above, the policy document suggested that the school-based curriculum reform delegate the control of the curriculum to schools and allow schools "to select teaching contents, teaching and learning activities, homework arrangements, assessment strategies." Such selection of teaching contents, learning activities, homework assignments, and assessment methods also considered digital learning and the use of e-textbooks within the scope of curriculum reform. However, when closely examining the above text, the "new curriculum framework" serves as the centralised control of the curriculum reform. In other words, the selection available to schools was limited by the government's approved textbook list, including the e-textbook booklist (e-RTL) (Fok et al., 2017).

The following findings based on interview data illustrate the contradictions between teachers' use of and perspectives on digital technology with the education reform discussed above.

Frank, the subject teacher from School A, recalled his conversation in a parents' meeting:

> *I usually tell the parents that my digital learning classes may not provide the skills the students require to do well in public examinations. Instead, their results may be lower. On the other hand, their level of competency in information, digital, and media literacy is better. It is because my class has moved away from spoon-feeding and rote learning mode. Unfortunately, public examination results still determine a student's achievement level. It is still Hong Kong's mainstream culture.*
>
> Frank, subject teacher, School A, 12/7/2016

Here, Frank's approach aligns with the government's education reform. However, Frank also says that even though his students may learn well during digital lessons, their achievement in the public examination may not be outstanding because the exams require students to reproduce specific materials from the designated curriculum.

Faye, the subject teacher from School A, pointed out the difference between traditional textbook-based pedagogy and digital technology multimedia pedagogy:

> *The difference is in the pedagogical approach. The traditional textbook approach is a single dimension, while the e-learning lesson will be multi-dimensional. As a result, e-learning*

will change students' learning habits. However, such changes in learning habits have little influence on how students are assessed academically. This is because Hong Kong's education system still considers how well they can reproduce learning material from the syllabus in the examination.

Faye, subject teacher, School A, 12/7/2016

Here, Faye says that the Hong Kong education system in assessment is still lagging behind the new learning methods that have changed students' learning practices using digital technologies.

The subject teacher from School B, Sarah, commented:

If our Hong Kong education system continues to assess students' performance based on reproducing facts and memorising text, the kind of tool, such as digital technologies, to deliver the teaching material will do very little to influence the result of education.

Sarah, subject teacher, School B, 10/6/2016

Similarly, Tad, subject teacher from School C, also agreed that:

Digital technology makes learning more diversified, more interactive, and more attractive. It helps students to understand the subject matter. However, eventually, we still use paper and pen to assess students' achievements. We cannot deny that Hong Kong assessment still requires rote learning more than understanding. Therefore, the impact of e-learning is very limited in the current assessment culture if the assessment policy does not change in Hong Kong society.

Tad, subject teacher, School C, 14/7/2016

Frank, Faye, Sarah, and Tad all agreed (even though they came from different schools) that Hong Kong's assessment policy and learning culture contradict the outcome of using digital technologies in education. Finally, the Education Commission (2000) policy document also acknowledged the public examination contradiction:

> "Teaching" and "cultivation" have always been placed at the centre of traditional Chinese education. The dissemination of knowledge has gradually become one-way transmission, and the attention is put on schools and teachers. In Hong Kong, the workload of teachers has become increasingly heavy, while the students' learning has become more passive. This situation is in conflict with the principle of developing students' self-learning ability, exploratory skills and creativity (p. 20).

From the above, it is apparent that the Education Commission is also aware of the contradiction between traditional local education culture and employing digital technologies in education.

In sum, both the government agency and the teachers recognised the centralised nature of the public examination and curriculum policies contradicted the use of digital technologies in teaching and learning. Such a contradiction could be characterised as the "double bind" contradiction (Engeström and Sannino, 2011, p. 374) that neither the government education agency nor the teachers could change. This "double bind" revealed that all parties repeatedly encountered the conundrum but could not make a change. This contradiction also falls into the principle of the historicity of CHAT because the examination culture in Hong Kong is long-standing and has a strong local cultural influence (Thanh Pham and Renshaw, 2015). The contradiction applied to all three primary schools in this study is a structural contradiction and socially bounded in a way that teachers cannot change the system by themselves. Instead, it requires multiple parties, such as government agencies, parents, teachers, and school administrators, to make the change. In Figure 7.4, the red bi-directional line indicates the "double bind" contradiction between the local learning assessment culture, education policies, and digital technologies as educational tools.

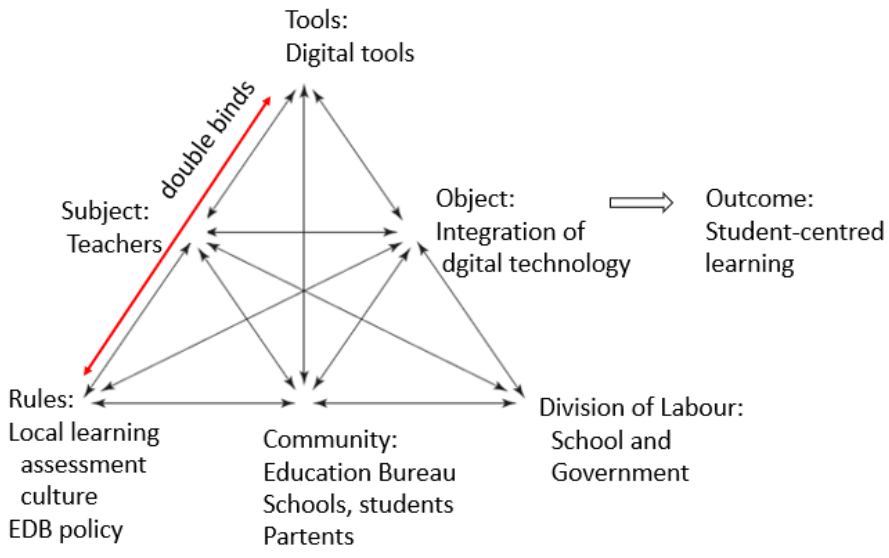

Figure 7.4 The contradiction between local learning assessment culture, government policy, and digital technologies

7.3.2 Principals' dilemmas

This section illustrates the contradiction between the school principals and the government's WiFi 100 initiative.

The aim of the WiFi 100 initiative published by EDB in 2014 was to support 100 primary and secondary schools' use of e-textbooks and related digital technologies resources in the classroom:

> *The Support Scheme for E-learning in Schools aims to provide 100 public sector schools with funding to enhance their WiFi infrastructure to cater to the need to use e-textbooks and e-learning resources in class. The funding will also allow schools to acquire mobile computing devices sufficient for use in class by students. (Education Bureau, 2014, p.1)*

While the three schools were receiving funding from EDB, they were obliged to accomplish the aim set forth by the initiative. Therefore, the three schools shared a common object. Below, I discuss the contradiction between the principals of Schools B and C as the subjects and the object of meeting the aim of the WiFi 100 initiative.

Theresa, principal of School C, commented on the funding allocation from the government:

> *The funding was enough to cover WIFI infrastructure expenses, tablet rental, and hiring one full-time TSS (teaching support staff). However, the software and digital teaching materials would be extra and must be covered by the school budget.*
>
> Theresa, principal, School C, 14/7/2016

Here, Theresa highlights the issue of not having enough funding to sustain integrating digital technologies into her school.

Similarly, Samuel, principal of School B, also confronted the problem of insufficient funding in acquiring the required digital resources to move his WiFi 100 project forward. Samuel comments:

> *EDB did not provide a standardised learning platform for all schools. Instead, individual schools struggle their way to source different teaching software. EDB wants to replace paper-based textbooks with e-textbooks. However, using e-textbooks in Hong Kong was unsuccessful because there is no standard to follow. For the current situation with the WiFi 100 funding allocation policy, EDB intended to create competition among schools.*
>
> *EDB wanted to see what strategy a particular school employed would be more successful than other schools since EDB did not have a concrete plan for implementing digital technologies. As a result, EDB was seeking best practices among the schools. In addition, EDB did not provide a long-term road map for us.*

Samuel, principal, School B, 10/6/2016

Here, Samuel notes an important strategy employed by the government in implementing the WiFi 100 initiative where EDB intended to seek and consolidate best practices among schools. However, based on Samuel's argument, EDB did not have a long-term plan to implement digital technologies in schools.

Theresa reinforced Samuel's viewpoint about insufficient government funding:

> *We can only plan according to this 3-year cycle and cannot plan long-term beyond the 3-year cycle.*

Therefore, for short-term planning, Theresa could only select several teachers in the initial phase in 2014:

> *It was unrealistic for all teaching staff to participate in the initial stage. It was my authority to organise the division of labour among teachers. Unfortunately, since the initiative has limited funding, I cannot hire additional staff for the project.*
>
> Theresa, principal, School C, 14/7/2016

As a result, Theresa noted that the WIFI 100 meant extra work to select teaching staff on top of their current responsibilities. Implementing digital technologies is an added workload and burden for these teachers, especially with the limited funding. From the above discussion, the competition (mentioned by Samuel and confirmed by Theresa) created by the government was a contradiction in the activity system. Such budgetary control by the government had historical roots that could be traced back to 1997. According to Theresa:

> *In 1997, EDB provided the first batch of computers to schools based on the education reform policy. However, most schools did not know how to put this computer equipment into use. So instead, the schools put the computers in storage and wrote them off when they became obsolete. Therefore, the WiFi 100 initiative does not provide school tablets this time. Instead, the government's strategy allowed individual schools to make decisions.*
>
> Theresa, principal, School C, 14/7/2016

From the above discussion, the principals have to cope with the unrealistic funding available and the government's mission to achieve the WiFi 100 aim. Such a contradiction is identified as a "dilemma" contradiction according to Engeström and Sannino (2011) which occurs within 'a single person' and is "reproduced rather than resolved" (p. 373). In other words, the funding

problem was unsolvable since Samuel and Theresa could not ask the government for additional funding. Figure 7.5 depicts the dilemma between the subject, the principals, and the object, WiFi 100.

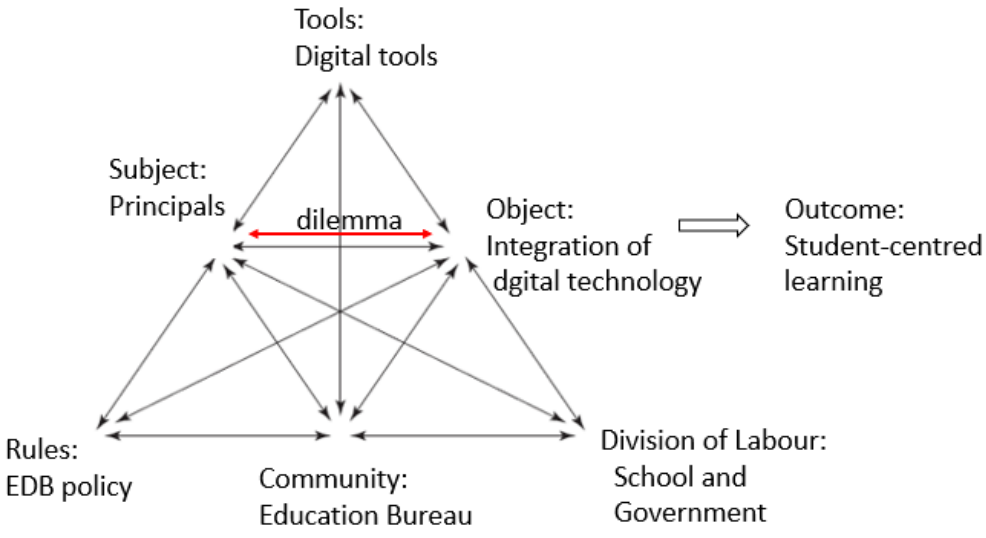

Figure 7.5 Dilemma situation occurred between the subject and the object.

The following two sections are the strategies implemented by the three schools as the outcome of the dilemma contradiction. Refer to Appendix F for the table of strategies summary.

7.3.2.1 School strategies in acquiring hardware resources

Fisher from School A, the lead teacher and e-learning team leader, claimed that funding from EDB could only be designated for the network infrastructure and the related hardware equipment. Therefore, additional equipment and resources, such as tablets and software for digital technology-mediated lessons would need to be allocated from the school's budget. As a result, School A could buy only a small number of tablets in one school year from their own school budget, and the number of tablets was not even enough for one class. Therefore, according to Fisher, School A asked parents to buy tablets for their children, and parents supported the BYOD policy. On the other hand, Schools B and C were non-BYOD schools. Therefore, they devised different strategies for obtaining the hardware.

Samuel, principal of School B, mentioned his school was small with a minimal budget for the WiFi 100 project. Therefore, School B collaborated with hardware vendors. The school

participated in the education scheme from a hardware vendor, Samsung, in order to acquire tablet donations.

> *We did not have the budget to buy enough tablets. Therefore, we contacted Samsung to see if we could borrow tablets from the company for educational purposes. Samsung appreciated our effort and contribution to education. Eventually, the company donated 70 tablets to us, enough for two classes to run digital lessons simultaneously.*
>
> Samuel, principal, School B, 10/6/2016

Theresa, the principal of School C, noted that EDB said the WiFi 100 funding could only be used for the school's network infrastructure. Therefore, the school could not use the funding to buy tablets or learning software. EDB recommended her to lease tablets so that funding would be available and approved by EDB.

Tad, the subject teacher from School C, concluded:

> *The critical element was consistency: Regardless of what type of tablet, iOS or Android, iPad or Samsung, BYOD or non-BYOD is unimportant. We need to select a reliable tablet and a clear policy, which should last for years and be implemented consistently.*

Tad highlighted the importance of a stable school policy in integrating digital technologies in school. Tad continued:

> *Teachers do not want to learn Android this year and learn iOS the following year. Therefore, for the BYOD or non-BYOD policy, the school must decide with care so that teachers can follow.*
>
> Tad, subject teacher, School C, 14/7/2016

7.3.2.2 School strategies in acquiring software resources

Besides the issue related to tablet acquisition, teachers' selection of software applications and platforms was another concern. Different teachers from these three schools adopted various strategies to obtain software resources for their digital lessons. Since there were no clear guidelines from EDB on what software platform or applications to use, teachers had to find ways to handle the situation.

According to Fisher, the lead teacher from School A, EDB assumed the teachers would use e-textbooks from the recommended curriculum booklist (e-RTL), and parents would pay the publishers for them. As a result, the WiFi 100 initiative did not allow schools to acquire software-related resources from the funding.

Frank, the subject teacher from School A, stated that he collaborated with publishers and designed his courseware. He relied on applications downloaded from the Internet to design his own courseware.

> *First, two years ago, we worked with publishers. The publishers offered us a series of courseware. We gave the publishers feedback on what topics were essential for the school. Second, we designed our own courseware, a combination of different applications downloaded from the Internet.*
>
> Frank, subject teacher, School A, 12/7/2016

Frank took the downloaded software one step further. He combined different applications with multimedia videos to custom-make his own courseware suitable for his students' backgrounds.

Sandra, the lead teacher and e-learning team leader from School B, received free software and support from the publisher despite the limited budget:

> *We will take every opportunity to get to know external resources such as local universities and publishers. If we encounter courseware suitable for us, we will request a copy of the courseware for our teachers to try. The result of the trial was bringing feedback to the original author, such as the local publisher. Our teachers work with the publisher to convey their viewpoints and required features suitable for the teaching needs.*
>
> Sandra, lead teacher, School B, 10/6/2016

School B collaborated with external partners to obtain digital teaching materials. This approach was consistent with School B's policy that teachers should offload the digital material preparation task to the experts, and teachers can integrate it into their lessons.

Instead of collaborating with local universities and publishers, Tom, Terry, and Tad, teachers from School C, took advantage of the Internet resources. As the e-learning team leader and an English teacher, Tom used the online web-based learning platform, Socrative (free edition), to teach English in his lessons. The other English subject teachers used Nearpod (free edition) for English lessons in School C. Tom mentioned that teaching English is fine when using these online learning platforms. However, he and his colleagues could not use these platforms for Chinese Language lessons since these platforms have problems handling Chinese input and displaying Chinese characters.

As a music teacher, Terry searched for free Android applications for his music lessons. His primary complaint was the pop-up advertisements from the free Android applications. Terry wished EDB could provide the authoring tools for teachers. According to Terry, searching for specialised software for his online music lessons was challenging.

Tad, the Mathematics teacher from School C, claimed that interactive classroom activities provided by either the publisher or online websites were helpful for his classes:

> *An online website that provides 3D rotation is helpful. I can animate the rotation on the screen for the whole class, and students can experience the 3D rotation on their own tablets through the same website. Most of the online exercises are excellent and free of charge.*

Tad continued to state that it was essential to select an appropriate publisher to suit teachers' needs:

> *Publishers play a vital role in teaching and learning activities. We have the choice of downloading the demo software from the Internet. However, it will be time-consuming since I need to assemble different demo software for various topics. On the other hand, when the publisher has already prepared the groundwork, we can directly use the digital learning materials.*
>
> Tad, subject teacher, School C, 14/7/2016

From the above, School C's default strategy was to obtain courseware from the Internet. However, the material provided by publishers was still essential for teachers.

7.4 Chapter summary

This chapter consists of two main sections: a contradiction analysis of integrating digital technologies at the school level in the first section and a contradiction analysis of government policies' influence in the second section. The first section covers the leadership styles in Schools B and C, which found all three schools were unique. In addition, the school co-planning policy regarding digital lesson planning was found to be treated unfairly across all three schools. The second section showed the influence of the government's educational reform policies revealing that they played an important role in the local education culture. Finally, a contradiction occurred when the government allocated insufficient funding to conduct the WiFi 100 project. As a result, all three schools employed different strategies to obtain various resources in order to sustain the WiFi 100 project.

Chapter 8: Discussion

8.1 Introduction

This thesis investigates the integration of digital technologies into three Hong Kong primary schools at the classroom and school levels based on the government's education reform initiative. It explores the activities of primary school teachers and principals in translating the government's digital technology initiative. CHAT was the guiding theoretical framework to identify the contradictions and constraints in integrating digital technologies.

Chapter 6 and chapter 7 organised findings into three levels: micro, meso, and macro. Chapter 6 covers micro-level and meso-level findings related to classroom and teachers' activities. Chapter 7 covers macro-level findings related to school leadership and the influence of the government's digital technology initiative. The main research question was:

How are digital technologies integrated at school and classroom levels in three Hong Kong primary schools?

Four sub-questions underpin the main research question as follows:

RQ1: What were the activities teachers and students engaged in, in the process of using digital technologies in the classrooms of three Hong Kong primary schools?

RQ2: How was the division of labour organised among teachers to facilitate the use of digital technologies for teaching and learning?

RQ3: How did school leadership and school culture influence the integration of digital technologies into the three schools?

RQ4: What contradictions between government policies on digital technologies and classroom practice can be identified? How did these contradictions influence the implementation of digital technologies in teaching and learning and school leadership in the three Hong Kong primary schools?

This chapter consolidates and interprets the findings from Chapters 6 and 7 and is organised at three levels: micro-, meso-, and macro-levels. The interpretation of findings is based on the CHAT theoretical framework, including objects, historicity, and rules influencing the integration of digital technology in school. In addition, it draws on key literature to discuss the significance of the findings.

8.2 The object of integrating digital technologies into schools

According to Delgado et al. (2015) and Higgins (2003), governments worldwide have significantly invested in integrating digital technology tools into their education systems. However, the objects of digital technology in primary education have varied from country to country and school (UNESCO/IITE3, 2014). For example, according to one report, "ICT in Primary Education Vol. 3" from UNESCO/IITE3 (2014), the object of the digital technology policy was to prepare students for the future (p. 27); other objects of schools include establishing an internationally connected school (p. 44), providing modern education to students (p. 50), and providing student-centred learning outcomes (p. 38). Similarly, the three participating schools in this research also had unique objects for integrating digital technology into their schools.

Hong Kong EDB introduced the WiFi 100 initiative in 2014. EDB stated the initiative aimed to fund schools to construct or update the WiFi network infrastructure to support electronic textbooks (e-textbook) in teaching and learning (HK Education Bureau, 2014c). The participating schools understood that the initiative intended to replace printed paper-based textbooks with electronic digital-based ones. However, the three participating schools also understood that comprehensively using e-textbooks in the classroom was unrealistic. School A had been using e-textbooks for the past 10 years, and the result was unsatisfactory. (see section 5.2.2.1 for details). This suggests that the interpretation of the object of using digital technology varied depending on the principals and teachers, together with school culture and priorities. Replacing paper-based textbooks with e-textbooks was not on every school's plan. The different interpretations of the object of the initiative are discussed in detail in this chapter.

The different interpretations of the government's digital technology initiative align with Engeström's (2000b) argument that individual actors in the activity system might understand the object differently based on the individual's unique situation and social context because of the varied nature of object interpretations. Consequently, according to researchers (Song and Kim, 2016; Yamagata-Lynch and Haudenschild, 2006), contradictions and tensions may occur among the actors through the interaction of elements and the social context in the activity system to achieve various competing objects. More importantly, Kaptelinin (2005) stated that the object of an activity is the reason for the activity giving meaning to the activity. Furthermore, activities are socially connected, although individuals may carry out the activities. Therefore, it is essential to understand the objects of the participants. The following sections present

different objects at the micro (classroom), meso (teacher), and macro (school and government) levels.

8.3 Micro-level: classroom activities

To understand the use of digital technologies, such as tablets, computers, the Internet, and software applications, it is essential to understand how classroom activities are conducted.

From observations of participating teachers, it was found that the level of class interaction was improved by using digital technologies despite the classroom constraints (see sections 6.2.1 and 6.2.2 for details). It seems the use of digital technologies increased teacher-to-students and student-to-student communication and helped teachers know the student's learning needs while assisting them in learning from one another. The benefits of classroom interaction are also supported by Beatty and Feldman (2012), who found that students were able to communicate and learn from each other:

> What a real learning technology-mediated classroom looks like: change of classroom from a teacher standing in front of the class and students sitting behind the desk listening to the teacher to students grouping into small groups and making a lot of noise discussing with each other. (p. 298)

This suggests that student interaction may be nurtured to create a creative environment.

Other benefits mentioned by the teachers in my study were a higher level of class participants, broader scope in learning with digital technologies' immediate feedback feature, and Internet use. Students were motivated and engaged in learning. The multimedia features of digital technologies make learning more vivid and meaningful, while the immediate feedback feature reinforces learners' understanding of the teaching material. Therefore, Herman et al. (2008) noted that student-centred learning appeared to be happening by integrating digital technologies into classrooms. However, Lawless and Pellegrino (2007) cautioned that pedagogical design using digital technologies needs to also map onto student learning outcomes, which was less evident in teacher interviews.

Despite the above benefits, upon further investigation, findings also showed that the schools, parents, and teachers had their own expectations and objects. Ertmer and Ottenbreit-Leftwich (2013) pinpointed that teachers expected the use of digital technologies would lighten their workload and reduce the amount of work inside and outside the classroom. Teachers reported that it took more time to prepare a digital lesson and learned to expect the unexpected in

conducting digital lessons (see section 6.3.1 for details). On the contrary, Carless and Harfitt (2013) noted that principals' and parents' objects were more focused on the expectations of students performing better in public examinations when exposed to digital technologies.

8.4 Meso-level: Teachers' activities

This section covers the division of labour, collaboration, attitudes, and strategies for adopting digital technologies among teachers. The influence of school leadership and school vision in integrating technologies is discussed in this section. The strategies for implementing the integration of digital technologies are also explored.

8.4.1 Teachers' division of labour and collaborations

Findings indicated that preparing digital pedagogies and lesson planning can be a complex task for teachers. It involves searching, filtering, and selecting appropriate digital teaching materials. In addition, teachers felt the preparation time was two to three times greater than for non-digital lessons. Furthermore, Moss (2006) argued that digital technologies are evolving continuously. From the issues mentioned above, division of labour was necessary to share the workload among teachers. As a result, the three schools handled the division of labour differently.

School A took a hands-off approach allowing teachers to form their working teams based on friendship. Teachers from School A worked together to create, invent, and design digital teaching materials with animated clips and online exercises. School B leadership took a top-down authoritarian management approach in which teachers were requested to work individually and were limited to a user role instead of a creator role. This approach contradicts the viewpoint of Chan et al. (2015) that teachers should become designers and creators in the digital era. Some teachers were uncomfortable with the management style without their voices being heard. This contradiction echoes Engeström's (2001) principle of multi-voicedness, where people have different perspectives, roles, interests, and positions that need to be acknowledged.

Consequently, teachers from School B took an informal route to form their own working teams without leadership intervention. The division of labour was based on the collaborative, personal relationships among School B teachers. School C also took a top-down approach in arranging six seed teachers (digital resource subject teachers) to cover specific subject areas (see section 5.4.2.3). As a result, the seed teachers were overloaded with the task of consolidating the school's digital teaching resources. In contrast, the remaining teachers were not involved in the

seed teachers' preparation workload. Therefore, the level of division of labour was not well distributed. In addition, the seed teachers' arrangement appeared to be more inflexible, preventing non-seed teachers from participating.

The findings suggest the division of labour from the bottom up is preferable since teachers have the room to negotiate and organise themselves. On the other hand, the top-down division of labour approach was undesirable since teachers could not adjust the division of labour and the workload among themselves. In sum, the findings agreed with Barnes and Sutherland (2010) that the division of labour is always influenced by school leadership.

8.4.2 Teachers' attitudes concerning the use of digital technologies

The findings in this study have shown that teachers from Schools A, B, and C consistently expressed the view that digital technology is a supporting tool in the classroom (see section 6.2.2 for teachers' attitudes). For example, a teacher from School A considered digital technologies are the only tools to supplement his teaching, and he felt he could still teach without digital technologies. Equally valid for the e-learning team leader from School B, who believed that digital technologies are only supportive tools that facilitate her teaching tasks. Similarly, a teacher from School C agreed that using digital technologies could make learning more interesting and enjoyable, and digital technologies might move towards a student-centred learning direction. However, he would only use them when the technologies helped him illustrate his teaching topics and lighten his workload.

The above findings do not appear to align with Selwyn's (2011) and Ertmer and Ottenbreit-Leftwich's (2010) assertions of a general move towards digital technologies in mainstream education because many teachers from all three schools showed internal doubts about using digital technologies. Lai (2008) and Law (2008) acknowledged the transformative potential of digital technologies in empowering students to construct knowledge in learning that teachers were not recognised. Furthermore, Fu (2013) suggested a detailed list of teachers' internal and external factors that may hamper technology integration in teaching and learning. From the above findings, teachers from all three schools appeared to have internal doubts about the significance of using digital technologies in their teaching. Such internal attitudes influence how teachers use digital technologies and under what circumstances they use them for their teaching. Furthermore, Durff and Carter (2019) argued that the source of the internal doubt

appeared to stem mainly from insufficient technical and administrative support from the school and the imposition of government policies.

Nevertheless, despite the internal doubts teachers demonstrated, the findings show that they were still actively involved in using digital technologies. According to Durff and Carter (2019) and Ertmer and Ottenbreit-Leftwich (2010), the school's vision influenced its actions, culture, policies, and historical practices. For instance, School A's strong vision was to nurture students' creativity (see section 5.2.1). School B's vision was related to the principal's vision to modernise and uplift the school image with digital technologies (see section 7.2.1). School C has a more conservative tradition, and the use of technology was not the school's primary focus. However, School C's vision is related principal's vision to meet the need of the knowledge-based economic society (see section 5.4.2.1). There may be different visions related to other school contexts. Nevertheless, in all these three schools, teachers' attitudes adjusted according to the leader's vision and culture, agreed with the observation from researchers Durff and Carter (2019) and Yuen et al. (2003).

8.4.3 Teachers' strategies for adopting digital technologies

Underwood (2014) illustrated three strategies for adopting digital technology in teaching and learning, namely, "(1) Minimise the use of technology which just maintains the status quo; (2) Use technology to support the current practice that removes the role of catalyst for change; and (3) Merge and evolve digital technology that necessarily requires us to reassess how learners learn and teachers teach" (p. 8). Findings show that teachers from all three schools adopted one of the above strategies. However, it seemed that teachers did not maintain the status quo in their teaching. Instead, most teachers who adopted the second strategy in the study demonstrated their commitment to utilising digital technologies in their teaching tasks. On the other hand, only two teachers seemed to embrace the third strategy in merging and evolving digital technology in teaching tasks. These two teachers explored different approaches to mixing digital technology elements in their teaching. According to Ertmer and Ottenbreit-Leftwich (2010), the third strategy is the most challenging because it requires the most effect involving the most changes in pedagogical practices.

The findings also show that all three schools employed different strategies in acquiring hardware and software resources for the WiFi 100 initiative despite the limited funding. The three schools were also able to use different software acquisition strategies to save money on

the school budget. Teachers from School C noted that searching, selecting, and learning the different kinds of free software available on the Internet was time-consuming. The other problem is that some free software and education platforms only provide English interfaces and cannot support Chinese input. As a result, the software strategy for School C was limited to English subjects.

On the other hand, other teachers from School A were using the iPad (IOS) platform, and they combined software from publishers and resources from the Internet to produce their own courseware. Also, in the case of School B, the digital teaching materials came from external collaborative partners. The advantage of this strategy was that teachers did not need to spend time searching for suitable kinds of software for their digital classes. However, at the same time, teachers would not have the opportunity to exploit the available digital technology skills to explore the possibilities of using digital technologies. To summarise the above various situation, stability was the primary concern among the teachers in this study, regardless of hardware or software resources being used.

8.5 Macro-level: leadership, history of the school, and government policies

This section covers the macro-level school and government policy influences and considers the leadership and historical influences on the teachers and the integration of digital technologies. Three areas are covered in this section: school leadership, school policy, and government education reform policy related to CHAT's principle of historicity.

8.5.1 School leadership influence

During my class observations, a teacher from B combined the traditional paper and chalkboard pedagogy with digital tools to enhance learning despite the constraints imposed in the school context (see Figure 5.5 in section 5.3.2.2). In contrast, the leadership focused on providing WiFi infrastructure. Still, it did not encourage teachers to explore different pedagogical approaches to uncover the potential use of digital technologies in teaching and learning. The leadership assumed that students would automatically learn when the digital technologies infrastructure was provided in the school. The leadership believed that increasing access to digital tools would automatically result in higher-level learning.

On the contrary, the above-mentioned leadership belief contradicts Zhao et al.'s (2002) argument that educators must understand the affordances and limitations of technology to

integrate technology successfully in teaching and learning. Similarly, Higgins (2003), Lim and Oakley (2013), and Rubagiza et al. (2011) also observed that merely making digital technologies and their infrastructure available in the classroom will not enhance learning. Instead, according to the authors, it requires teachers to innovatively integrate digital technologies into the current curriculum and scaffold students to use digital technologies in acquiring knowledge. Durff and Carter (2019) argued that the influence of school leadership critically facilitates or hampers the success of integrating technology in school. Furthermore, findings demonstrated that teachers actively exploited the hardware and software capabilities to incorporate them into their digital lessons. In other words, teachers in this study realised their role as change agents and contributors to the pedagogical change in the integration of digital technology. The findings also showed that all participating teachers from the three schools understood the need for the active involvement of teachers in integrating digital technologies into learning. In this study, teachers' own actions, as well as leadership, contributed to successful integration. As Pohio (2016) and Fu (2013) argued, school culture and leadership bring long-lasting effects on school improvement.

8.5.2 School historical and cultural artefacts

School C was consistent in its more conservative school tradition, and the development of teaching and learning using digital technology was, therefore, not the school's priority. Especially mature teachers with a long history with the school appeared to be reluctant to change. The principal from School C attempted to change the conservative school culture and reported that she tried to convince the more mature teachers to embrace innovations. The attempt was unsuccessful, and mutual trust was not established, although this improved over time. The situation suggested that the influence of conservative school culture and the influence of school leadership can sometimes be in competing positions. (see Figure 7.2 section 7.2.1). The conservative school tradition acted as a cultural artefact prohibiting the school from changing and adopting digital technologies. According to Kuutti (1997), cultural artefacts can be physical or mental, empowering or prohibiting an activity's transformation. The finding suggests that school culture may substantially influence a school more than leadership. It is because school culture may develop and be rooted in the school for a long time, while school leadership may come and go and have a shorter life span than the school culture.

School B had a four-stage lesson approval process for all lessons, including digital ones. Lesson co-planning was one of the steps in the approval process; digital lessons should not be isolated

from the school policy. However, the lesson co-planning duty only counted for regular lessons. Teachers in the e-learning team met outside the regular school hours, and their time did not count as a regular duty. Therefore, School B was inconsistent and unfairly not considering the digital lesson co-planning activities. The treatment from Schools A and C on the digital lesson co-planning was similar to School B in that it did not count as the mainstream school duty. The findings suggest that all schools maintained the status quo of the current school operation. As the co-planning policy was established long before digital lessons appeared, the policy would continue with or without them. Yet clearly, co-planning was crucial for teachers in implementing digital technologies. As Somekh (2008) argues, teachers' use of digital technologies depends on not working alone and is contingent on many interconnected social, cultural, and organisational factors. CHAT's emphasis on historicity helps to identify this contradiction and the systemic inflexibility of the school policy.

8.5.3 Government education reform policy

At the macro-government policy level, the findings showed how the two Hong Kong Government education reform documents (see section 7.3.1) indicate that the reforms related to digital technologies are intended to make Hong Kong education more diversified, assessment more formative and analytical and to lead to a shrinking influence of pre-defined curricula and textbooks. On the other hand, the "new curriculum framework" proposed in the reform document, Council Curriculum Development (2001), exhibited the centralised control of the curriculum reform. In order words, the selections of textbooks available to schools were limited by the government's approved textbook list, including the e-textbook booklist (e-RTL). According to the teachers' feedback on integrating digital technologies, this study is contradictory because assessment is central to all teaching and learning activities. For example, preparing for public examinations is the mainstream activity in student learning. Moreover, such assessments are still based on rote and memorisation learning. This makes it more challenging to focus on digital technology-based pedagogic designs that embrace the open curriculum and student centred-learning.

This finding suggests that the Hong Kong government appears unable to change despite the contradiction in its decentralised policy. Marsh et al. (2014) argued that the government is promoting decentralised educational reform but maintaining centralised curriculum control. According to Carless and Harfitt (2013), parents and students expect a centralised curriculum due to the local examination culture, which makes preparing and studying for the public

examination more straightforward. However, the reform document from Education Commission (2000) also acknowledged the local examination culture and realised that it could not change the cultural context in the foreseeable future. These contradictions were evident in the three schools trying to implement digital technologies in teaching and learning.

8.6 Chapter summary

In this chapter, findings from Chapters 6 and 7 were discussed, and the discussion was informed by the literature review chapter (Chapter 2) and CHAT theoretical chapter (Chapter 3). The findings weaved micro-, meso- and macro-levels into the areas of different objects, classroom activities, division of labour, school leadership, and the historicity nature of the school and government policies to form a network of an interconnected body of knowledge offering insights about integrating digital technology into schools.

At the micro-classroom activities level, the findings suggest that teachers, principals, and parents have a misconception regarding the outcome of the integration of digital technologies. Finally, at the meso-teacher activities level, regarding the division of labour and collaboration, the findings indicate that school leadership and culture critically and strongly influence teachers' activities.

At the macro-school policy level, the findings show that the school co-planning policy is linked to the school practice from the past and is challenging to adjust. For example, School C's traditions were a cultural artefact that prohibited the school from transforming in the digital era. Lastly, at the macro-government policy level, it appeared that the government could not change its centralised curriculum control policy even though it contradicted the decentralised proposed educational reforms. However, the history of the local examination culture, which the government acknowledged, made it impossible to change the cultural context in the foreseeable future.

All three schools, including principals and teachers, were very resourceful. The hardware and software resources were secured at the school level with a low budget. At the teacher level, they were committed to finding ways to resolve problems they encountered. Finally, the findings also suggest a misconception at the macro-school cultural level where the principal assumed that by making digital learning resources available, students would learn by themselves without teacher guidance.

Chapter 9: Conclusion

9.1 Introduction

This study investigates the integration of digital technology into three Hong Kong primary schools at the classroom and school levels based on the implementation of a government education reform policy. The three schools appeared to successfully integrate digital technology into their schools with a limited budget from the government. Data analysis was organised at three levels, micro-, meso-, and macro-levels, and mapped onto the four research questions (see Table 4.4 in section 4.6.1 for the mapping details).

In this concluding chapter, I present the key findings grounded in the four research questions. Then, I discuss the limitations and contributions of this research. Finally, insights derived from the key findings are presented.

9.2 Summary of key findings by research questions

In this study, I argued that using digital technology for educational advancement requires school leadership, good government policies, teachers' pedagogical expertise and experience, and a school culture that seeks to learn continuously. To successfully integrate digital technology into practice, it must also consider a school's historical, social, and cultural factors.

As mentioned in Chapter 2, there is a gap in the literature related to teachers' perspectives and activities regarding the integration of digital technology as it relates to the socio-cultural leadership influences and also in examining multiple levels of implementation on successful outcomes.

I answer the research questions in the following sections by summarising the key findings.

9.2.1 Research question 1

RQ1: What were the activities teachers and students engaged in, in the process of using digital technologies in the classrooms of three Hong Kong primary schools?

Regarding the micro-classroom level findings, the participant teachers demonstrated their commitment to achieving the expected outcomes from integrating digital technologies despite classroom constraints, such as local classroom culture, classroom configuration, class time, and size. Certain aspects of observable student-centred learning were displayed in the classroom, such as a higher level of student participation, motivation to learn, and more engagement in

learning. Immediate feedback on the classroom activities was found beneficial to learning. However, principals, teachers, and parents expected more from integrating digital technologies. For example, teachers expected digital technologies would lighten and reduce their workload in teaching. In addition, the principals and parents expected that the digital lessons would improve students' public examinations results.

9.2.2 Research question 2

RQ2: How was the division of labour organised among teachers to facilitate the use of digital technologies for teaching and learning?

Regarding the meso-teacher level findings, one of the three schools exercised a high level of division of labour based on a bottom-up management approach, and the teachers had the autonomy to form teams based on friendship. As a result, there was trust between school management and the teaching staff, who were free to exploit their ideas when using digital technologies. For other schools, the management style was top-down. Teachers were asked to work independently, discouraging forming work teams among teachers. As a result, the workload among teachers was unbalanced. Therefore, teachers found ways to work together and avoided the invention of leadership.

Similarly, leadership also drove the way the teachers collaborated among themselves or collaborated with outside school partners. For instance, School A collaborated with internal teachers and external publishers. The leadership encouraged the e-learning team to explore various available options. On the other hand, School B collaborated only with external publishers. Again, it was because the leadership emphasised external publisher support. Finally, School C collaborated only with internal staff. Again, it was because the leadership focused on the internal support of the school.

9.2.3 Research question 3

RQ3: How did school leadership and school culture influence the integration of digital technologies into the three schools?

Regarding the macro-school level findings, as mentioned under the key findings for research question 2, teachers' activities were influenced by school leadership's decisions. In research question 3, more specific leadership management styles are discussed.

School A's leadership style was based on empowerment and established mutual trust between the school leadership and teachers. The school leadership allowed digital lessons with new

ideas to be employed. In contrast, the principal of School B had the misconception that by providing a digital learning environment, students would learn by themselves without the guidance of teachers. With such a misunderstanding, the principal discouraged teachers from developing their digital skills and instead relied on external partners to provide the digital learning materials. As a result, teachers were deprived of the opportunity of acquiring up-to-date digital technology skills. Thus, the level of mutual trust between School B's leadership and the teachers was low. The teachers appeared to have less empowerment and trust. The principal's viewpoint contradicted one of the CHAT principles of multi-voicedness, where participants may have different perspectives, roles, interests, and positions. "Conflict" contradiction resulted from the above situation (Figure 7.1 in section 7.2.1).

School C's principal attempted to resolve the doubt from her mature and experienced teaching staff with 20 years of teaching experience. However, because these staff inherited the school's conservative tradition, using technology did not fit the school's aim (see section 5.4.2.1). Furthermore, the principal failed to establish a mutually trustworthy communication channel with the teaching staff because the conservative school tradition acted as a cultural artefact prohibiting the school from successfully integrating digital technology (see Figure 7.2 section 7.2.1). Thus, such contradiction is related to one of the CHAT principles of historicity.

Regarding cultural influences, the lesson co-planning policy showed that the three schools maintained the status quo of school administrative practices without incorporating the new digital lesson co-planning into the schools' mainstream operations. Teachers conducting digital lessons met outside school hours to plan and prepare, and the hours spent did not count as their regular teaching duties. This is another example of the principle of historicity in CHAT manifested in executing a school policy. The contradiction identified is the "conflict" contradiction (see Figure 7.3 in section 7.2.2).

9.2.4 Research question 4

RQ4: What contradictions between government policies on digital technologies and classroom practice can be identified? How did these contradictions influence the implementation of digital technologies in teaching and learning and school leadership in the three Hong Kong primary schools?

The findings suggest that the Hong Kong education reform policies conflicted with the prevailing local examination culture. The education reform policy intended to take advantage of the power of digital technologies stating that diversified assessment would replace the

traditional excessive dictation exercises, mechanical drilling, tests, and examinations. The new open curriculum framework would replace the pre-defined curriculum and textbooks in alignment with the nature of digital technologies used in education. However, the current local examination culture dominates how students are assessed. According to the teacher's opinion, the dominant local examination culture still focused on drilling the students to prepare for the public examinations. Eventually, as the teachers pointed out, how students are assessed needs to change to take advantage of the power of digital technologies. Somewhat paradoxically, the reform documents acknowledged the problem with the dominant summative assessment culture. On the contrary, the government continued supporting its centralised curriculum—noting that it contradicts the decentralised intentions of the education reform. This contradiction is identified as a "double binds" contradiction (see Figure 7.4 section 7.3.1), also attributed to the historicity principle of CHAT.

Another drawback of the government initiative was the insufficient funding allocated to schools. The grant covered only the WiFi infrastructure and the related hardware for the schools to operate the digital lessons. The government funding did not cover the budget for tablet computers and software. As a result, the three schools had to devise strategies to acquire the tablets and software for their digital lessons (see Appendix F). The government created a "dilemma" contradiction among the school principals (see Figure 7.5 in section 7.3.2). Such dilemma contradiction can be attributed to the government's lack of long-term planning.

9.3 Contributions to knowledge

This study has offered a cultural and historical perspective using CHAT to analyse the implementation of digital technologies in three Hong Kong primary schools. It has shown what happened in the three schools at multiple levels: micro-, meso-, and macro-levels, including the details of teachers' and principals' perspectives and activities. In addition, this study highlighted several areas, such as classroom activities, teaching strategies, teacher collaborations, the leadership impacts on teachers' division of labour, and school policies and culture which were particularly significant in terms of implementation. Finally, this section shows how the study has contributed to research into the understanding of integrating digital technologies in the contexts of three Hong Kong primary schools.

Firstly, the findings show the complexity of integrating digital technologies in three primary schools in Hong Kong. Fewer studies have explored the integration of digital technologies in

primary schools than at other school levels, both in Hong Kong and more widely. Therefore, this study adds to the literature on primary school digital technology studies and to a better understanding of the complexity of integrating digital technologies in primary school contexts, especially in Hong Kong. In particular, my study highlights the cultural and historical factors at the macro-government policy level, the issues relating to school leadership, school culture, teachers, collaboration, and classroom practice. On the one hand, the move toward the government policy, including WiFi 100 and the "open curriculum framework" discussed in Chapter 7 (which includes the use of digital technologies in schools), decentralizes the control of curriculum to schools. However, on the other hand, my study highlighted how the local examination culture reinforces the government's pre-defined curriculum which remains centrally controlled. Such a contradiction exhibits the challenges of implementing digital technologies in schools such as the three schools in my study. Therefore, this study contributes to an understanding of how education reform intended to change Hong Kong education, reinforces the status quo of the current rigid and inflexible public examination policy, and how centralised curriculum control makes educational change much more difficult to implement.

Secondly, my study emphasises the importance of paying attention to how school leadership impacts the implementation of digital technologies in schools and highlights the contradictions in the division of labour and the effects on collaboration amongst teachers. The three schools devised different strategies to organise their teachers and classroom practices, but their cultural settings always influenced the schools' practices. As discussed in Chapter 2, school culture has lasting effects on school improvement and is one of the CHAT research community's under-research areas. Thus, my study has contributed to the cultural inquiry of integrating digital technologies in three Hong Kong primary schools.

Finally, this study has been motivated and guided in employing CHAT to analyse educational activity systems and their contradictions. Many research studies explore systemic contradictions based on CHAT and other studies employing multi-level analysis. However, the literature that discusses and clearly shows the analysis of CHAT is, in general, quite limited. My study enriches CHAT by building upon the use of multi-level analysis in the context of three primary schools in Hong Kong and gives a concrete example of the identification of dilemmas, conflicts, critical conflicts, and double bind contradictions as elaborated by Engeström & Sannino (2011). Consequently, this study may contribute to the literature on using CHAT's dialectic analysis in education.

The following sections highlight the implications for policy and practice.

9.4 Implications for policy and practice

Whilst the following sections highlight some of the possible implications for policy and practice in Hong Kong, it is essential to state that these have been generated based on the findings in a particular context, namely, three primary schools in Hong Kong. Moreover, data collected was in a particular timescale and may not be directly applicable to other contexts but offers some indicators of essential areas to consider.

9.4.1 Implications for Hong Kong government policy

This study shows how local school historical and cultural factors conflicted with the government WiFi 100 policy and constrained government efforts to reform education. The findings suggest that the integration of digital technologies in schools, although supported by the WiFi 100 policy, may lack government support for implementation and training. Whilst there was support for infrastructure and hardware, the study showed insufficient support for implementing digital technologies in particular school contexts and for teachers to innovate and experiment. This suggests that policymakers in Hong Kong need to work more closely with schools, including principals and teachers when developing future policy initiatives and funding opportunities and setting out the requirements for successful digital technology innovations.

9.4.2 Implications for classroom practice

At the micro-classroom level, findings demonstrated that despite classroom constraints, such as local classroom culture, classroom configuration, class time, and size, the participant teachers were very committed to successfully integrating digital technologies in the classroom. However, such short-term commitment relied mainly on individual teachers and their capabilities which varied and also relied on their own initiatives in developing teamwork, for example. Therefore, it may be necessary to offer long-term solutions, such as increased teacher training and support and additional time allocated to innovate and experiment with digital technologies and associated pedagogies.

Findings also showed a high level of student participation in classroom activities using digital technologies that provided immediate feedback for students' responses. In addition, teachers felt that the immediate feedback afforded by digital technologies in the classes benefited

student learning. This suggests that other schools implementing digital technologies could emphasise the importance of digital technologies' interactive affordances for improving student participation and classroom interaction.

9.4.3 Implications for division of labour and school leadership practice

At the meso-teacher level, the findings show that division of labour and teacher collaboration are strongly connected to the leadership management style. This study found that one of the three schools exercised a bottom-up management style regarding the division of labour among teachers. This school allows teachers to form work groups, exploit new ideas, and make decisions by applying digital technologies in teaching. As a result, the level of trust between the principal and the teachers was high. On the other hand, the other two schools exercised a more top-down management approach.

Consequently, for the top-down management style, teachers found that they had little room to make decisions, and the workload among the teachers was unbalanced. The top-down approach can lead to dissatisfaction among teachers and low trust between the principals and the teachers. The findings suggest that a bottom-up, teacher-led approach to digital technology innovation should be encouraged by principals. This study also highlights the importance of establishing mutual trust and fostering collaboration among teachers.

This study also suggests that school principals must thoroughly understand the potential of digital technologies in teaching and learning as part of their leadership and aim to restructure the school to facilitate the implementation of digital technologies. For example, the findings show how misconceptions about digital technologies may prohibit the undertaking successfully. Furthermore, from the findings regarding the co-planning policy among three schools, there was no adjustment to school policy to accommodate the preparation of digital lessons. The cultural influence of maintaining the status quo may be related to the leadership putting digital technology integration as a lower priority. Hence, it is critical for leaders to give guidance and direction and to understand their role in the success or failure of integrating digital technologies.

In conclusion, the findings suggest that the school leadership is responsible for forming and sharing school culture and driving the school vision of integrating digital technologies in teaching and learning.

9.5 Limitations of the research

While all the participants were doing their best to answer my questions during the interview, teachers and principals were actively involved in the WiFi 100 initiative and were knowledgeable digital technology users. Unfortunately, this study did not interview teachers who were not as knowledgeable. As a result, these outsiders' viewpoints were not reflected in my research. In other words, the insights provided in this study are limited to competent digital technology users.

Since this research used the snowball purposive sampling approach, teachers were selected by the principals, and the participant principals recommended other principals. I, as the researcher, was considered an outsider and a stranger to the interviewees. As some interview topics touched upon sensitive issues related to the school's reputation, the interviewees would likely avoid negative feelings or sensitive information about the school policies or their colleagues.

Since I have over 30 years of software development work experience and teaching digital technologies at a local tertiary institution, there may be some bias related to my technical background as I have a strong technological view on using digital technology tools. Thus, I may have ignored other socio-cultural factors essential in implementing digital technology in primary schools.

This study took place in the summer of 2016. A snapshot of three primary school practices and their changes in integrating digital technologies. However, these schools continuously evolved, and my study did not capture a more comprehensive view of the changes over a period of time.

9.6 Further research

This research involved a one-time interview with teachers from three primary schools. Pedagogical practices may change over time since teachers gain experience using digital technologies, and new software programs may become learning platforms for teachers. For example, teachers from School C used Nearpod and Socrative web-based learning platforms when the interviews were conducted. In addition, the school was actively searching for other learning platforms, such as eClass and iClass. In this case, future research can be launched related to the use of new digital technology learning platforms.

Longitudinal studies of digital technology use in primary schools can also be considered. Since technology changes rapidly, new technology, such as virtual or augmented reality, may be used

in primary education. Therefore, a longitudinal study on the effects of the latest technology would enrich the understanding of using cutting-edge digital technologies. More specifically, how digital technologies are used in a specific subject, such as English, Chinese, General Studies, and Mathematics, could be insightful.

Future research can investigate digital tools' impact on primary students inside and outside the classroom. For example, it would be worthwhile to explore students' experience in handling their time between learning and socialising when they have digital tools at their fingertips.

9.7 Final remarks

It was quite a learning experience for me. Since I do not work in a primary school, my experience with Hong Kong primary education is based on teachers' feedback and my EdD classmates working with primary schools. Therefore, it was difficult for me to deeply understand the Hong Kong primary school culture and the problems primary teachers confront. Therefore, primary school culture, historical background, and working norms were challenging as I have worked in technology companies for over 30 years. Consequently, it was difficult for me to switch from technological to cultural and historical perspectives in educational activities. In sum, it was a rewarding experience for me to conduct this study under the lens of CHAT.

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Appendix A GSoE research ethics form

GSoE RESEARCH ETHICS FORM

It is important for members of the Graduate School of Education, as a community of researchers, to consider the ethical issues that arise, or may arise, in any research they propose to conduct. Increasingly, we are also accountable to external bodies to demonstrate that research proposals have had a degree of scrutiny. *This form must therefore be completed for each piece of research carried out by members of the School, both staff and students*

The GSoE's process is designed to be supportive and educative. If you are preparing to submit a research proposal, you need to do the following:

1. **Arrange a meeting with a fellow researcher**
   The purpose of the meeting is to discuss ethical aspects of your proposed research, so you need to meet with someone with relevant research experience. A list of prompts for your discussion is given below. Not all these headings will be relevant for any particular proposal.
2. **Complete the form on the back of this sheet**
   The form is designed to act as a record of your discussion and any decisions you make.
3. **Upload a copy of this form and any other documents (e.g. information sheets, consent forms) to the online ethics tool at:**
   https://dbms.ilrt.bris.ac.uk/red/ethics-online-tool/applications.

   Please note: Following the upload you will need to answer ALL the questions on the ethics online survey and submit for approval by your supervisor (see the flowchart and user guides on the GSoE Ethics Homepage).

If you have any questions or queries, please contact the ethics co-ordinators at: gsoe-ethics@bristol.ac.uk

Please ensure that you allow time before any submission deadlines to complete this process.

Prompts for discussion
You are invited to consider the issues highlighted below and note any decisions made. You may wish to refer to relevant published ethical guidelines to prepare for your meeting. See http://www.bris.ac.uk/education/research/networks/ethicscommittee/links/ for links to several such sets of guidelines.

1. Researcher access/exit
2. Information given to participants
3. Participants right of withdrawal
4. Informed consent
5. Complaints procedure
6. Safety and well-being of participants/ researchers
7. Anonymity/ confidentiality
8. Data collection
9. Data analysis
10. Data storage
11. Data Protection Act
12. Feedback
13. Responsibilities to colleagues/ academic community
14. Reporting of research

Be aware that ethical responsibility continues throughout the research process. If further issues arise as your research progresses, it may be appropriate to cycle again through the above process.

Name(s): Brian LAI
Proposed research project: The study of the use of ICT among Primary School Teachers in Hong Kong
Proposed funder(s): n/a
Discussant for the ethics meeting: Miss Mandy Tsang (Cohort 14 classmate)
Name of supervisor: Dr. Susan Timmis
Has your supervisor seen this submitted draft of your ethics application? Yes

Summary of this research project:

This research takes the perspective of cultural influence on the use of technology in education. It will investigate how technology integrated with cultural environment in the Hong Kong education context. This is an exploratory and qualitative research in understanding what are the cultural factors involved in the dimension of using ICT in education in Hong Kong primary schools.

The main research question is:

> How do the practices and the culture in HK primary schools influence the implementation of ICT in education?

This research will look into the prominent cultural factors guiding the activities of primary school teachers in Hong Kong in the usage of ICT artifacts for the process of preparing teaching materials and conducting classes.

In order to answer the above question, it is broken down into the following sub-questions:

1. What is the influence of rules and regulations from Education Bureau (EB) and school administration on the practices and decision making of the teachers?
2. How division of labour organized among teachers in the process of decision-making and preparation in order to facilitate the implementation of the use ICT in classroom?
3. What kinds of activities are necessary to enable teachers to use ICT in the classrooms confidently in Hong Kong?
4. What kinds of student centered learning are evident in classrooms where teachers are using ICT?

The research design involves case studies that explore the cultural influences in using ICT in primary schools, participating schools and teachers will be selected based on their involvement in the Hong Kong government e-learning Pilot Scheme Wifi-100 and Wifi-900 between 2014 and 2016.

The following are the schools arrangement for interview in May and June 2016 time frame:

Case one: Catholic co-ed primary school located in Fanling (northern rural area)
Case two: Catholic girls' primary school located in Kowloon City area (metropolitan area)
Case three: Non-religion co-ed primary school located in Yuen Long (western rural area)

In addition to interviews, class observations, teaching materials, ICT tools, and documents from government and respective schools are also the sources of data.

The table depicts the relationship between the research questions and the data collected:

Research Questions	Teacher interviews	ICT tools (software, hardware, teaching materials)	School documents such as meeting minutes	Principal interviews	Government policy documents	Class observations
RQ1	✓	✓	✓	✓	✓	
RQ2	✓	✓	✓	✓		
RQ3	✓	✓				✓
RQ4	✓	✓				✓

The following is the school visit schedule:

1. 6 Jun to 17 Jun, 2016: case one visit
2. 20 Jun to 30 Jun, 2016: case two visit
3. 4 July to 14 July, 2016: case three visit

Ethical issues discussed and decisions taken (see list of prompts overleaf)

1. Researcher access/exit

The participating schools and teachers will be selected based on their involvement in the Hong Kong government e-learning Pilot Scheme Wifi-100 and Wifi-900 between 2014 and 2016. The written form of the interview scripts will be given to participants to validate the accuracy of the scripts. Also, scripts will be kept for three years and for this research only. Scripts both paper and electric data will be destroyed after three years.

2. Information given to participants

There will be information sheet provided and consent form for the participants to sign. The consent form will be co-signed by the researcher and the participant. There will

be identical copies of the signed consent form: one copy for the participant and one copy for the researcher.

3. Participants right of withdrawal

Yes, the participant has the right to withdraw at any stage of the research.

4. Informed consent

Yes, a consent form is provided.

5. Complaints procedure

There are email addresses; both supervisor and the researcher, provided in case of the participants want to express their concerns.

6. Safety and well-being of participants/ researchers

Not applicable.

7. Anonymity/confidentiality

The identities of teachers will be protected by using only pseudonyms and ensure that their opinions will not be revealed to the school management for performance appraisal. In addition, the identity of the schools will also be protected by only revealing the essential information related to the research.

8. Data collection

Interviews will be conducted in Chinese and the key points of the interview will be translated to English. The original data collected will be destroyed after three years. However, the transcribed interview data will be put in the appendix of the dissertation.

9. Data analysis

Software tools will be considered for data analysis propose.

10. Data storage

Data will be stored both online and offline and will be protected against the use out the scope of this research.

11. Data Protection Act

Not applicable.

12. Feedback

The participants will be able to review the transcribed data.

13. Responsibilities to colleagues/academic community

Not applicable.

14. Reporting of research

This research will be written in the form of dissertation.

If you feel you need to discuss any issue further, or to highlight difficulties, please contact the GSoE's ethics co-ordinators who will suggest possible ways forward.

Signed: Brian Lai (Researcher)

Date: 4 May, 2016

Signed: Mandy Tsang (Discussant)

22 April, 2016

Appendix B Consent form

University of BRISTOL
Graduate School of Education
35 Berkeley Square
Bristol BS8 1JA

Informed Consent Form for the Research of the use of ICT among Primary School Teachers in Hong Kong

I am Brian Lai, currently working towards the Doctorate degree in Education from University of Bristol, UK. This research, as part of the requirement for the fulfilment of the degree, involves the study of using ICT under the influence of Hong Kong culture among primary school teachers. This is a qualitative research which will engage in in-depth interview. You are invited to participate in this research and, during your participation, you can opt out of the process at any stage.

The information you provided will be used solely for this research. Your identity will not be released to third parties in the course of and after the research. Also, your identity will be protected in my report by using pseudonym. I will be using an electronic device to record the interview. You can request to pause or stop the conversation during the interview if you feel necessary. By signing this form, you agree and aware of your right as a participant in this research. In addition, one class observation may be conducted with the consent of the school to observe how the ICT tools being used in the classroom.

You can refer to the information sheet for more details concerning this research. In case you have further questions regarding this research, I can be reached at the following eMail:

edkhbl@bristol.ac.uk

or my research supervisor, Dr. Susan Timmis

Sue.Timmis@bristol.ac.uk

Yours truly,

Brian LAI

Signature of participant _____

Name of participant _____

Date_____

Appendix C Information sheet

Research Information Sheet from Brian Lai (May 2016) University of Bristol
Title: The study of ICT as an education tool under the influence of Hong Kong cultural enviroment among primary school teachers

Introduction

It is commonly believed that technology (ICT) shapes and to certain extent, changes the culture of our society. Technology, such as the Internet, changes the way we shop, buy, do business, and communicate. Similarly, technology also changes and shapes teaching and learning in education. However, this research will take the perspective of the usage of ICT in education under the influence of Hong Kong practices and culture. The focus of this study will be the tool itself being influenced by the users.

What is the purpose of this research?

This is an exploratory research in understanding what are the cultural factors involved in the dimension of using ICT in education in Hong Kong primary schools. The usage of ICT, as a teaching and learning tool, through the lens of cultural influence will lead to more interesting and valuable findings. ICT as a tool is cultivated, shaped, and rooted in the Western society and is an artifact embedded heavily in Western cultural influence. Therefore, this research investigate the followings:

- Can ICT as an educational tool be directly adopted by the Hong Kong society where Chinese culture is the mainstream?
- What are the cultural factors that characterized the use of ICT in education in Hong Kong?

Your participation will provide valuable input in understanding of the cultural influence in using ICT in education. Such findings could provide insights in using and implementing ICT in our primary schools.

What will involve?

This research will involve interviews with primary school teachers and principals as well as class observations. There will be one time interview and the format of the interview will be one-on-one, face-to-face. The duration of the interview will be no more than an hour. In addition, sample ICT tools such as educational software packages and teaching contents will also be part of this study. School class materials relating to the use of ICT will be used as the supporting evidence. As far as your school is concerned, providing such materials will be at the discretion of the school administration.

What happy after the interview and class observation?

The participants will be able to review the transcribed interview contents and class observation data to confirm and give feedback.

Appendix D Interview sample questions

Principal's Questions
Question 1: How does government educational funding for e-learning programmes provide sufficient support for you to implement the use of ICT for your school?
Question 2: What is your personal experience in the past two years regarding the process of implementing the e-learning programme?
Question 3: From your personal point of view, do you think the e-learning programme is a success or otherwise?
Question 4: Do you think e-learning will improve the school image and help to recruit new students?
Question 5: From your point of view, is e-learning a must in education or just a trend people follow along?

Teacher's Questions
Question 1: What subjects do you oversee?
Question 2: What are the resource channels where you obtain the e-learning teaching materials? For example, downloading from the Internet is one of the channels. Courseware or software applications offered by publishers are another channel.
Question 3: How does the decision process work in deciding what topics should be considered for e-learning?
Question 4: What is the difference in preparing for the e-learning class compared to the traditional approach?
Question 5: Spoon-feeding education is a Hong Kong tradition; rote learning and routine drilling are regular activities in school. How do you see the use of ICT tools influencing such a tradition?
Question 6: What difficulties have you encountered at the personal and school levels in implementing e-learning in your school?

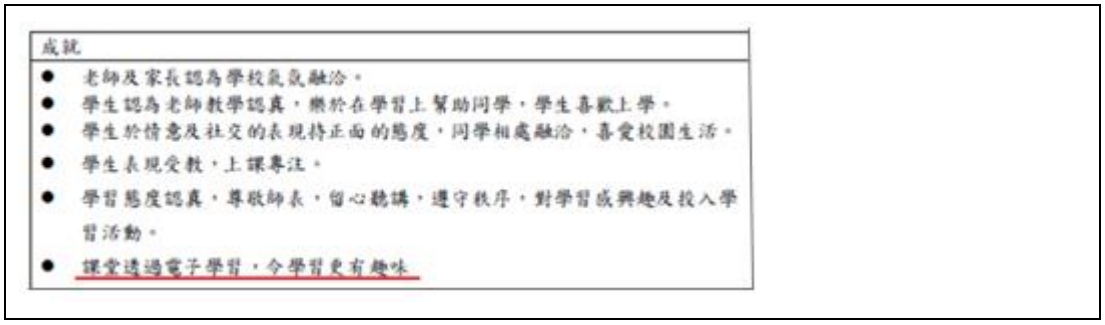
Appendix E Sample report extracts from Schools A, B, and C

This is the sample report extracts related to e-learning from School A:

本科 / 組目標	成就
配合「通過多元教學策略，培養學生成為自主學習者」，推動課堂設計，加強自主學習元素。	1.單元式備課，著重數學難點及提升學生高階思維出發，設計相關活動。科任透過討問技巧及教學難點，以提升學生學習效能。科任亦增加了預習案培養自學能力。加交流教學心得，從而提升教學質素。
	2.大部份課業已加入自學元素，例如預習案、影片學習及創意活動。而二至四年級某了學習策略。
	3.電子學習教學模式提高學生的學習興趣及自主學習能力，學生能善用電子課本學習

Texts highlighted with a red line are translated: Make learning fun and promote self-learning using digital technologies (School A Document, 2016, p. 60).

This is the sample report extracts related to e-learning from School B:

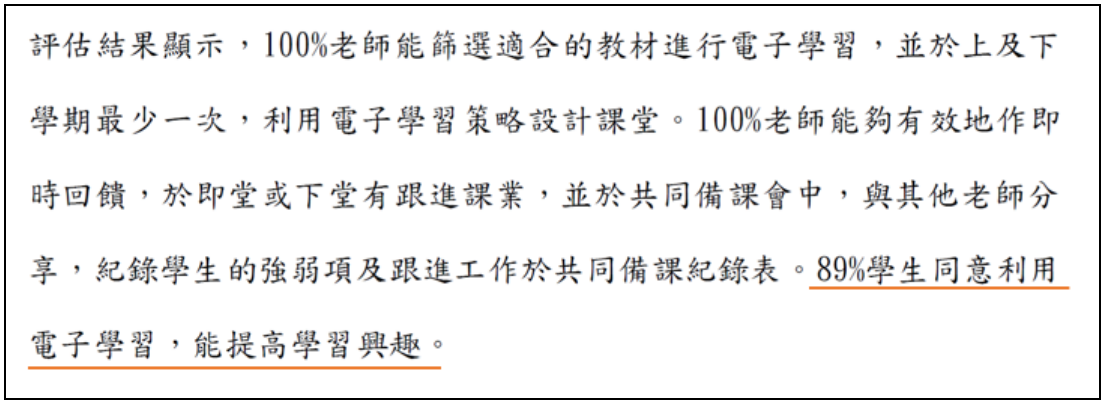


成就

- 老師及家長認為學校氣氛融洽。
- 學生認為老師教學認真，樂於在學習上幫助同學，學生喜歡上學。
- 學生於情意及社交的表現持正面的態度，同學相處融洽，喜愛校園生活。
- 學生表現受教，上課專注。
- 學習態度認真，尊敬師長，留心聽講，遵守秩序，對學習感興趣及投入學習活動。
- 課堂透過電子學習，令學習更有趣味

Texts highlighted with a red line are translated: Make learning more fun by using digital technologies in the classroom (School B Document, 2016, p. 32)

The sample report extracts related to e-learning from School C:



評估結果顯示，100%老師能篩選適合的教材進行電子學習，並於上及下學期最少一次，利用電子學習策略設計課堂。100%老師能夠有效地作即時回饋，於即堂或下堂有跟進課業，並於共同備課會中，與其他老師分享，紀錄學生的強弱項及跟進工作於共同備課紀錄表。89%學生同意利用電子學習，能提高學習興趣。

Texts highlighted with a red line are translated: School C survey results stated that 89% of students agreed that e-learning motivates learning and makes learning more fun (School C Document, 2016, p. 20).

Appendix F Digital resources strategies

This table illustrates different strategies employed by three schools in obtaining digital hardware and software resources:

	School A	School B	School C
Tablet policy	BYOD	Non-BYOD	Non-BYOD
Tablet budget	School budget and parents paid for BYOD tables	Donation from vendor	Leasing from vendor
Software acquisition	Collaborate with publishers; pay software by parents; download from the Internet; and teacher design courseware	Collaboration with publishers	Download from Internet and web-based learning platforms

Appendix G Sample subject teacher interview script

School B Interview: Sarah (Pseudonym) face-to-face interview
Date and Time: 10 June 2016 and class break (2:20 pm – 3:00 pm)
Location: Staffroom

Question 1: What subjects are you responsible for teaching?

Answer: I am responsible for teaching Chinese and General Studies. I am the General Studies subject leader. I have four years of teaching experience. When I started teaching here four years ago, we used the electronic whiteboard in the classroom. We started using tablets in the classroom only recently.

Question 2: What problems do you encounter with the courseware obtained from outside?

Answer: The courseware from publishers is mainly sufficient for our school in electronic textbooks accompanied by interactive exercises, games, and questions. However, not all contents are suitable for our students. We, as teachers, need to be selective. Decide what to drop and what to keep. The publishers also paid attention to school-based curriculum requirements. They make content adjustments according to individual school's needs. The school-based curriculum is the primary trend in Hong Kong. However, it is not only our school requirement.

Initially, these publishers offered electronic textbooks. However, EDB moved on to develop e-learning and tablets. Therefore, publishers presented us with interactive software applications instead of electronic textbooks. The introduction of such interactive software encourages the classroom participation of our students. Because of this, teachers are also more interested in using these software applications more often. These applications extend learning outside classrooms by supplying us with worksheets containing Internet links. Our students can search for more related learning material at home. When time allows, we will perform the Internet search in class. We prefer students to learn extra online material on their time. We will focus the course on discussion and sharing their viewpoints. We encourage our students to express their thoughts and share their experiences via the tablets. Their views will be displayed on the whiteboard. This way, our students can see different viewpoints on a particular topic.

Question 3: Does the use of tablets for learning affect students' motivation? What kind of problems do you encounter in class?

Answer: Our young students are very excited when they have tablets in hand. They would be thrilled to use the tablets in the exam to answer questions if we asked them to do so. The preparation work for us as teachers is tremendous. We want to ensure the class runs as smoothly as possible. Most problems are related the network stability and computer hardware. These are unrelated to preparation. We will ask students to share their tablets when a hardware problem arises since we have one tablet for each student. We only use tablets for learning activities.

Question 4: How does the school store tablet students' learning results?

Answer: The courseware provided by the publisher connects to the cloud server to store students' learning activity data. However, such a cloud service requires an extra payment. On the other hand, our school does not set up a local database server to collect learning data for future use. However, even the publisher is willing to pass the learning data to us, and we have the expertise to handle and store such data. Therefore, we will only use the learning results for instant feedback in the classroom.

Question 5: How do teachers share the preparation work for the e-learning class?

Answer: We have a regular schedule for the co-lesson planning meetings at the beginning of each school year. Usually, such meetings are scheduled during the morning activity session. While the students have free time before the class, we can meet for 20 to 30 minutes. Such an arrangement applies to Chinese and English subjects. For General Studies, we will have four meetings a week, and the subject leader will arrange the meeting time. For a particular unit or topic included in the e-learning practice, we will meet after school at 5 o'clock. The responsible teachers will meet for 20 to 30 minutes. Then, we will divide the contents into different parts and distribute the contents among us. Also, we will appoint a teacher to coordinate the work.

Question 6: Do you have support in preparing tablets for the students, such as setting up user accounts?

Answer: Yes, we have TSS (teaching support staff) set up the user accounts beforehand for the class. Students will log in to their respective accounts during class time. Usually, we do not need TSS in the classroom in a small class, such as 20 students. However, for a large class, around 30 students, we need TSS to assist the teachers.

Question 7: How are the tablets being utilised in the school?

Answer: We have an IT room that houses tablets regularly. The tablets will not move away from the room. This IT room is mainly for IT classes. We will use mobile charging carts for other subjects, such as General Studies and Mathematics classes, to bring tablets to the classroom. We need to request such mobile charging carts three days beforehand to allow the TSS enough time to prepare the tablets.

Question 8: Does the e-learning programme enhance the school image?

Answer: We do not have actual data to support the statement. However, based on my feelings, e-learning positively enhances the school image. Parents feel our school is more modern, forefront, and ahead of other schools' teaching-learning. It will also motivate our students to learn. In addition, parents are pleased that their children are encouraged to learn. Significantly, young parents are more receptive to our e-learning initiative.

Question 9: How is the support and training for you in running e-learning classes?

Answer: At the beginning of my teaching career, I knew nothing about using the whiteboard, and digital devices, such as tablets. For the whiteboard usage, I was trained by other teachers at the beginning of the school year. It took 10 minutes for my colleague to walk through the features with me. For tablet usage, our publisher partners offered some training classes related to the courseware. Some of us enrolled in those classes and shared the training with others. We also organized an e-learning team that team members conducted class observations with each other. As a result, we will observe how tablets are being operated in the classroom and how e-learning resources are being utilised.

Question 10: As far as class observation is concerned, is it only limited to teachers within the school?

Answer: For class observation, outside teachers are invited, and different subject teachers can observe other subject classes. For example, English teachers can observe the e-learning classes in General Studies and Mathematics. Our Physical Education teachers are also involved in observing other subject classes. This year, we are involved in the Samsung Smart School Buddy Programme, and we are required to invite other schoolteachers to observe how we run our e-learning classes. We even invited kindergarten teachers and external guests to come to our school to observe our e-learning classes. As a result, young children from kindergarten will come to our school hands-on and experience our tablet. In addition, we also got invited to different Education Bureau organized seminars and workshops. Therefore, there are many channels to share with and learn from external organisations.

Question 11: How do you summarise using ICT tools in your school?

The lead teacher answered: To summarize, the tablets and the software applications are only tools and not the core of the curriculum. We only take advantage of these tools to facilitate teaching and learning. Last week, we demonstrated using these tools to a group of young students from Macau. We can search the Internet, view videos, and combine students' discussions related to the topic. Instantly, we can display and share the discussion results on the whiteboard. Therefore, these digital tools are not the goal but the means to an end. We cannot follow the flow I need to do because other schools are doing it. Replacing physical textbooks with tablets carries little value in education. Therefore, it is up to us to take advantage of the tool in education.

Question 12: Spoon-feeding education in Hong Kong tradition. Rote learning and routine drilling are regular activities in school. How do the use of ICT tools influence such tradition?

Answer: I think ICT in e-learning is just a tool and not learning itself. Suppose our Hong Kong education system continues to assess students' performance based on reproducing facts and memorising the text. In that case, the tools to deliver the teaching material will do very little to influence the result of education. On the other hand, such ICT tools give young students the space to think, express, and learn in different modes. This is one step forward compared to reciting the printed textbook in our conventional spoon-feeding approach. The ICT tool motivates the students to actively learn and search for their own answers rather than relying on their teachers telling them the answer.

End of interview total time: 40 minutes

Appendix H Themes and sub-themes

Micro-level classroom activities

Top level themes	Sub-themes	Codes
Historicity of current classroom activities	Rules and classroom interactions	local school culture
		curriculum requirement
		skill transfer
	Rules and structure of the classroom	classroom configuration
		class size
		class time
Outcome of digital mediated classroom activities	Tool, object, and outcome of digitally mediated lessons	learning experience
		multimedia
		teacher expectation
		school expectation
	Subject and tool of digitally mediated lessons	space to learn
		more engaged
		immediate feedback

Meso-level teacher division of labour and collaboration

Top level themes	Codes
Rules and division of labour	lesson preparation no standard extra time extra effect workload select/filter material Internet search
Rules and internal and external collaborations	teacher object principal object initiative aim

Macro-level school leadership, school policy, and government policies

Top level themes	Codes
School leadership management style	seed teacher school policies group preparation
Learn co-planning policy	closely monitoring outside class time exclusion
Government policies and socio-cultural context of schools	parents' stands exam outcomes assessments HK education culture
Principals' dilemma	funding

Appendix I Codes from interview data

School A Fisher	School A Frank	School A Faye	School B Samuel	School B Sandra	School B Sarah	School C Teresa	School C Tom	School C Terry	School C Ta
EDB did not provide a standard Govt support WiFi TSS only infrastructure No software funding No long-term plan from EDB Unclear direction intended to create competition Two types of classes: BYOD and non- Subject teachers decide the topic Co-planning outside class time School implement Grades 3&4 then Grades 5 and 6 Grade 1&2 too young Teacher	Collaborate with publishers From Internet Problems with Internet materials Look for better platform eLearning team leader co-ordinate Subject teachers made their decision BYOD class Use both paper and tablet Parents stands School policy using Tablets for BYOD eLearning preparation No standard and more difficult	Resource based e-textbook Resource from Internet BYOD class Use both paper and tablet Share both material and experience Teachers make their decision Paper textbooks used at home Need more time to prepare eLearning class eTexbook play an important role need time to select/filter eMaterial surprises in	EDB does not provide hw and sw funding Teachers are not IT expert They should focus on teaching Resource from Edtech partners Partnership with publisher & university Set up a Learning team Activities including co-planning and class visit eLearning enough active participation many benefit take care individual learning capability immediate	Group preparation instead of independent Preparation Lock and control exercised Co-planning same topic and same grade Non-stop extra work eLearning is extra Pilot study needed Decision from curriculum director, form process	Main source from publisher e-textbook Material need to filter for students Students are motivated to learn Preparation Tremendous Co-planning meet before and after class time HW management IT room and tablet mobile charging cart Enhance school image Classroom observation Among teachers HK Learning culture contradict with power of ICT	Teacher are not trained IT expert Govt does not provide enough funding Experienced teacher with out dated IT skill Implement WiFi and access problems WiFi 100 has no pre-set goal. It require school clear vision EDB provide workshop to teachers PD is enough with curriculum development team in decision making Teachers' concern to be replaced	Resource from publisher Also create content using Nearpod Need to select/filter class exercise for students Teacher make decision in select a topic Curriculum no change Students are capable of learning new things Outside class room workshops preparation, it takes 2 to 3 times longer immediate feedback and 100% participation is beneficial	No sharing of material amount other schools Share experience Resource from publisher Download from internet digital technology provides a structured environment Assessments is still using paper and pen High level thinking Immediate feedback is a useful feature Assessment based on paper and pen a higher level of learning can be	e-textbook Apps from publisher Classroom interactive activities publishers c website. whiteboard PowerPoint and Tablet. search the Internet for teaching materials Q no develop our own mathematic calculations and formulas, PowerPoint with regula textbooks will be sufficient Abstract concepts us a tablet. seed teache for subjects eLearning is supportive role benefit: sav

loading is heavy	when compared to tradition class eLearning class need more preparation work eLearning needs more time Changes to students and teachers eLearning classroom more demanding extended outside the classroom Multimedia homework assignment ICT skill and exam outcomes are not related Gap between HK education culture and ICT learning culture	eLearning class classroom rule tablet is a learning tool no lock screen traditional assessment still valid single dimension vs multi-dimension eLearning changes how student learn problem in managing resource and parents expectation	feedback eLearning help recruit new students Will not cover the whole school because many unknows Parents consideration Conflict amount parents $			Pros and cons in eLearning Such as immediate feedback Cannot handle students' emotional problem Student-centred learning is possible Digital learning has little impact on student enrolment	the assessment method High level thinking Obstacles can be considered at 2 levels: lesson preparation, by its own nature is time consuming Classroom support TSS School expectation and personal expectation (similar to Frank)	carried out factual transfer and at the level of skill student centred learning to made possible based on digital technology home for playing games use of visualizer in classroom	time, learning difference, Student centred learning preparation time is longer select/filter materials Q 6workshop organised within school Tools: passive interactive co-teaching co-planning policy Role learning culture: Q7 Student-centred learning is outside the classroom Q8 obstacle are teachers' Q9 School policy to encourage active role Publisher Subject head teacher (DoL) Teacher networking