

Utilizing Chromebook in Ontario Elementary Schools: Teachers' Perspectives

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Abstract

In-service teachers' voices must be heard in order to understand the status of technology integration in Canadian elementary schools. In this qualitative case study, two Ontario private school teachers were invited to share their experiences and perspectives about their daily instruction with Chromebook through the lens of the TPACK theoretical framework. The study's objectives were twofold: (a) to identify participating teachers' attitudes, perceptions, and experiences teaching with Chromebook in a convincing narrative manner; and (b) to provide recommendations concerning the use of this type of digital technology device to other teachers and educators in practice. This research study once again affirmed the advantages of using Chromebook in the elementary classrooms in across three categories: saving funds, granting stable and durable hardware, and offering seamless and continuous learning. Additionally, the study attempted to add two new benefits: using Chromebook in teaching enables educators to keep their students on task and helps educators differentiate their teaching by providing more options and accommodating students' different learning styles and abilities. Participants in the study also found it difficult to make sure students stayed on task and were not lured by the out-of-class digital world. The study also found that a better filtering system of apps working on Chromebook can benefit students' and teachers' experience alike. The study concludes with a discussion and implications for future research.

Acknowledgments

“I want to thank me for believing in me, I want to thank me for doing all this hard work, I want to thank me for having no days off, I want to thank me for never quitting, I want to thank me for always being a giver and trying to give more than I receive.”

~ Snoop Dogg, 2018

Doing this whole thing—writing a Major Research Paper—was kind of like competing in 24 hours of Le Mans. When I started writing, I wrote so fast. It felt like driving over 300 km/h on the Mulsanne Straight. Then, when I was waiting for my ethics approval, it was like racing in the long night. The school board rejected my research; it was like contact and an accident—2 months passed waiting for the ethics, yet I have to get back to the pits for some major technical failure. Fortunately, I did not withdraw from the game; I quickly found solutions and successfully got myself back on the track. This was like Le Mans. I did not win the race; I finished it, and finishing the 24 hours of Le Mans is considered a huge success.

My supervisor, Dr. Mira Bajovic, was my team director. It was she who talked to me in my helmet, telling me when to stop at the box and get refueled. She guided me throughout the whole process; she instructed me what to do, and how to do it. This research study would NOT even exist without her. My forever appreciation also goes to my second reader Dr. Sally Hooper and Mr. Clinton Kewley for their generous help in my research. Lynne Lin and Matthew Gerrior were two major sponsors of my team. The supports I received from them to get through those tough times was simply priceless.

The chequered flag is just up ahead: push, push, push.

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CHAPTER ONE: INTRODUCTION TO THE STUDY

We are now living in the second machine age in which our society relies heavily on technology (Mocanu & Nichimiş, 2018). Prensky (2001) described and popularized the idea of a generation of digital natives, “often defined as those born after the year 1980” (Marchetta, Masiello, & Roseblatt, 2018, p. 193) who are growing up utilizing technology and interactive media in their daily lives (Davidson, 2010; Livingstone, Haddon, & Görzig, 2012; Zabatiero, Straker, Mantilla, Edwards, & Danby, 2018).

Integrating technology into classrooms is currently an inevitable trend since it has become a vital tool required in practically every career field. Scholars Haji, Moluayonge, and Park (2017) stated that information and communication technology (ICT) plays a crucial role in the knowledge and information society achieving broad socio-economic goals in education, health care, employment, and social development. They stated that ICT “offers innovative tools for restructuring teaching and learning processes in preparing students for the 21st Century skills” (p. 147). Another reason for bringing technological devices into schools is based on the “societal demands for technology competencies” (Kimmons, Darragh, Haruch, & Clark, 2017, p. 13), as digital native students today are required to “learn basic keyboarding and word processing skills at a young age” (Kimmons et al., 2017, p. 13). Based on the new societal demands, ICT tools such as laptops, tablets, and other mobile devices have become widely adopted in schools (Sahin, Top, & Deleon, 2016; Soykan, 2015). The adoption of ICT in the educational field has resulted in the shift of teachers’ role in practice. The 21st-century teaching and learning approach sets students at the centre of the class, which is very different from the more traditional, teacher-directed classroom (Soykan, 2015); thus, the “traditional model

of education with lectures and students sitting in straight rows is no longer sufficient” (Harrell & Bynum, 2018, p. 13). Hwang, Lai, and Wang (2015) suggested that teachers in a classroom with technology are assuming roles as facilitators who guide students to actively think and discuss, rather than as instructors who provide students solely with knowledge and evaluate students’ knowledge based solely on students’ overall performances. Without proper technological guidance from the teachers, technology integration is incomplete (Saylan, Onal, & Onal, 2018).

Today, technology tools have become a crucial and reliable component within the classroom context in North American schools. The current official elementary curriculum documents issued by the Ontario Ministry of Education (OME) emphasize the role of ICT in every single subject. For example, the latest version of the Grades 1 to 8 Ontario Language curriculum published by the OME in 2006 stated that

Information and communications technologies (ICT) provide a range of tools that can significantly extend and enrich teachers’ instructional strategies and support students’ learning in language. Computer programs can help students collect, organize, and sort the data they gather and to write, edit, and present reports on their findings. Information and communications technologies can also be used to connect students to other schools, at home and abroad, and to bring the global community into the local classroom. (OME, 2006, p. 30)

Even though numerous educators and researchers have studied teachers’ attitudes and experiences regarding integrating technology into classrooms (e.g., Sahin et al., 2016), there is a need to continuously change the oil in such an educational engine due to the

accelerating developments of educational technology, as well as the fast-paced, changing society.

Purpose of the Study

This research study explores Ontario teachers' experiences using Google Chromebook in their teaching instruction, and identifies the benefits and the possible challenges of using Chromebook in the classroom. The study was guided by three research questions:

1. What are the attitudes of elementary school teachers toward the use of Google Chromebook as a supportive tool in school?
2. What are some benefits and challenges that Ontario elementary teachers currently experience using Google Chromebook in the classroom context throughout teaching and learning processes?
3. What future features/improvements do Ontario elementary teachers recommend for Google Chromebook?

Rationale of the Study

Requirements of contemporary teaching and learning have resulted in the introduction of technological devices equipped with multimedia applications into schools. Based on the evidence of current research and literature, teachers and students alike can benefit from technology integration during daily schooling in numerous ways (Conole, De Laat, Dillon, & Darby, 2008; Kumar & Kumar, 2003; Thompson, Schmidt, & Davis, 2003). Sahin et al. (2016) illustrated that students are more engaged in the learning process and have more active roles in their learning with technology.

Another study found that in language class, students write, revise, and enjoy writing more and even perform better by completing writing assignments on electronic devices rather than using traditional paper-pencil mode (Kimmons et al., 2017). Similarly, Soykan (2015) noted that “students have also stated that ICT in classrooms, particularly tablets, have increased their motivation in class” (p. 241). Soykan (2015) further proposed that with the assistance of modern technology, learners learn faster and better because teachers and students are able to use those rich visual materials, such as coursework materials that have been transferred into diverse digital formats and can be displayed on various electronic devices. Furthermore, when the entire class has access to the Internet, students are capable of reaching to every corner of the world immediately by directly typing and clicking on their devices without leaving their seats (Soykan, 2015). By doing so, students are exposed to limitless resources and information that further extend their knowledge and broaden their horizons.

Contrary to the research evidence about the potential benefits of integrating technology in schools, some studies have indicated a few potential problems of using technology in the classroom (Ahlfeld, 2017; Sahin et al., 2016; Soykan, 2015). They identified that technical and infrastructure problems occur often during the learning process that consequently interrupts or even ultimately ends a lesson (Soykan, 2015). One of the problems identified by teachers and students is that they experienced difficulties transferring digital files from one device to another (Soykan, 2015). Infrastructure problems could surface simultaneously, as many reported problems with the repeated charging notification, along with uncensored commercials and advertisements (Demsiki, 2012; Sahin et al., 2016; Soykan, 2015). Sahin et al. (2016) suggested that teachers may

develop negative attitudes toward technology due to unfamiliarity and the lack of systematic training and technical support, and as a result they may limit the use of technological devices. Gorder (2008) argued that “technology integration is not much about the availability of technology, but more about the teachers’ effective use of technology that makes a difference in reforming the classroom” (as cited in Saylan et al., 2018, p. 28).

For all of the aforementioned perspectives, continued research on current technology integration in education is required to accomplish the mission of improving the experience of learners and teachers through teaching and learning processes. Soykan (2015) emphasized that by conducting such research “the problems and needs of users experienced while using devices will be identified, [and] strategies for effective use of technology could be developed in the future” (p. 230). The existing literature regarding the implementation of ICT in elementary schools is heavily constructed in an American context; however, fewer studies had revealed the attitudes and experiences of elementary teachers teaching with the aid of technological tools in Canadian elementary schools. This study endeavours to fill this gap in the current literature to bring awareness of how Ontario teachers are utilizing ICT to support their instruction and to enhance students’ learning. In this research, Google Chromebook has been selected as the dominant classroom technology tool.

Why Chromebook?

McKinnon Secondary College Media teacher Peter Quinn (2016) defined Chromebook as a lightweight laptop that runs neither any windows system nor any Linux system but is specially designed for an operating system called Chrome OS by Google.

While Chromebook is a subbranch under the category of laptops, it differs from the mainstream laptops for two reasons. First, instead of saving most files to the hard disk drive, data are stored remotely on Google virtual servers when interacting with a Chromebook (Rouse, 2011). Another unique feature of a Chromebook is that due to its mandatory use of Google accounts, users are able to access their files on any Internet-connected computing devices (Rouse, 2011). Besides these two features, a Chromebook is like any other ordinary laptop that can be seen almost everywhere today—a twofold, thin rectangular box equipped with a screen, a keyboard, a touchpad, two cameras, along with several input ports (Figure 1).

Statistics show that Chromebook already occupies a substantial portion of the whole education market of the North American classroom (Ahlfeld, 2017). The school district such as Waterloo Region District School Board (n.d.) in Ontario, Canada announced that by September 2016, all Grade 9 students in this board had received their own Google Chromebook. Nearby Durham District School Board also proposed in their 2017 to 2018 annual operating goals that 10,000 Chromebooks were to be assigned to all Grade 7 students and half of the Grade 10 students (Follert, 2017). In addition, public meeting notes from the largest school board (the Toronto District School Board) show that Chromebook is well equipped among schools in the area (Guildwood JPS, Elizabeth Simcoe JPS, Poplar Rd. JPS, Jack Miner JPS) to have access to G Suite applications created by Google for educational use (Toronto District School Board, 2017).

Chromebook has many benefits that have consequently made it become the most popular option for North American schools. As Quinn (2016) stated, Chromebook has a



Figure 1. Middle school gifted students' Chromebooks. Source: Jeff Billings, IT Director, Paradise Valley Unified School District Chromebook Pilot Project (Billings, 2011). Permission granted by students' parents for publication.

stable and straightforward email system, cloud storage, word processing, and presentation software. Kimmons et al. (2017) argued that Chromebook requires less management overhead compared with other mobile devices due to their flash memory and Chrome OS use. Likewise, Demski (2012) mentioned that one the participating schools in her research chose to use Chromebooks without much hesitation because Chromebook only needs 8 seconds to boot and can instantly wake up by reopening the lids that consequently allows teachers in that school to maximize their instructional time. Several existing studies also pointed out that Chromebooks are affordable in pricing (Ahlfeld, 2017; Demski, 2012; Kimmons et al., 2017; Quinn, 2016; Sahin et al., 2016). All of these strong points have eventually made Chromebooks preferred among North-American elementary schools.

Theoretical Framework

This research is constructed based on the Punya Mishra and Matthew J. Koehler's (2006) proposed educational technology framework: Technological Pedagogical Content Knowledge (TPACK). This conceptual framework has filled the gap of missing theoretical ground regarding conducting research in educational technology fields by connecting Shulman's (1987) formulation of pedagogical content knowledge and further reinforced it with the phenomenon of teachers embedding technology into their instructions (Mishra & Koehler, 2006).

The three fundamental components of TPACK are outlined as: content knowledge (CK), referring to teachers' subject matter knowledge; pedagogical knowledge (PK), stating teachers' knowledge of the teaching and learning processes based on the effective teaching methods; and technological knowledge (TK), a type of knowledge that describes how teachers think and work with technological resources (Al-Harthi, Campbell, &

Karimi, 2018; Elliott, 2018; Mishra & Koehler, 2006). By combining these three types of knowledge, Mishra and Koehler (2006) defined four more new types of knowledge: technological pedagogical knowledge (TPK) comes from TK and PK; technological content knowledge (TCK) originates from overlying TK with CK; and pedagogical content knowledge (PCK) arises from PK and CK overlapping (Figure 2).

The TPACK framework “emphasizes the connections, interactions, affordances, and constraints between and among content, pedagogy, and technology” (Mishra & Koehler, 2006, p. 1025; see also Al-Harhi et al., 2018). This study employs the TPACK conceptual framework to interpret and present what the participants have experienced using Chromebook to integrate technology into their teaching practice.

Summary of the Chapter

This chapter first discussed the background of technology integration in educational fields, and then presented the purpose as well as the rationale of this study. The third section of this chapter briefly explained why this research is based on utilizing Google Chromebook in elementary schools, followed by the conceptual framework employed by the whole study.

The following chapter presents a literature review examining what is known in the current literature regarding educational technology implementations. The design and methods utilized throughout this research are explained in Chapter 3. Chapter 4 will present the data derived from the research, along with generalized analyses based on the data. Finally, Chapter 5 will draw conclusions for the study, as well as its limitations and implications for educators, apps designers, and researchers sharing similar interests.

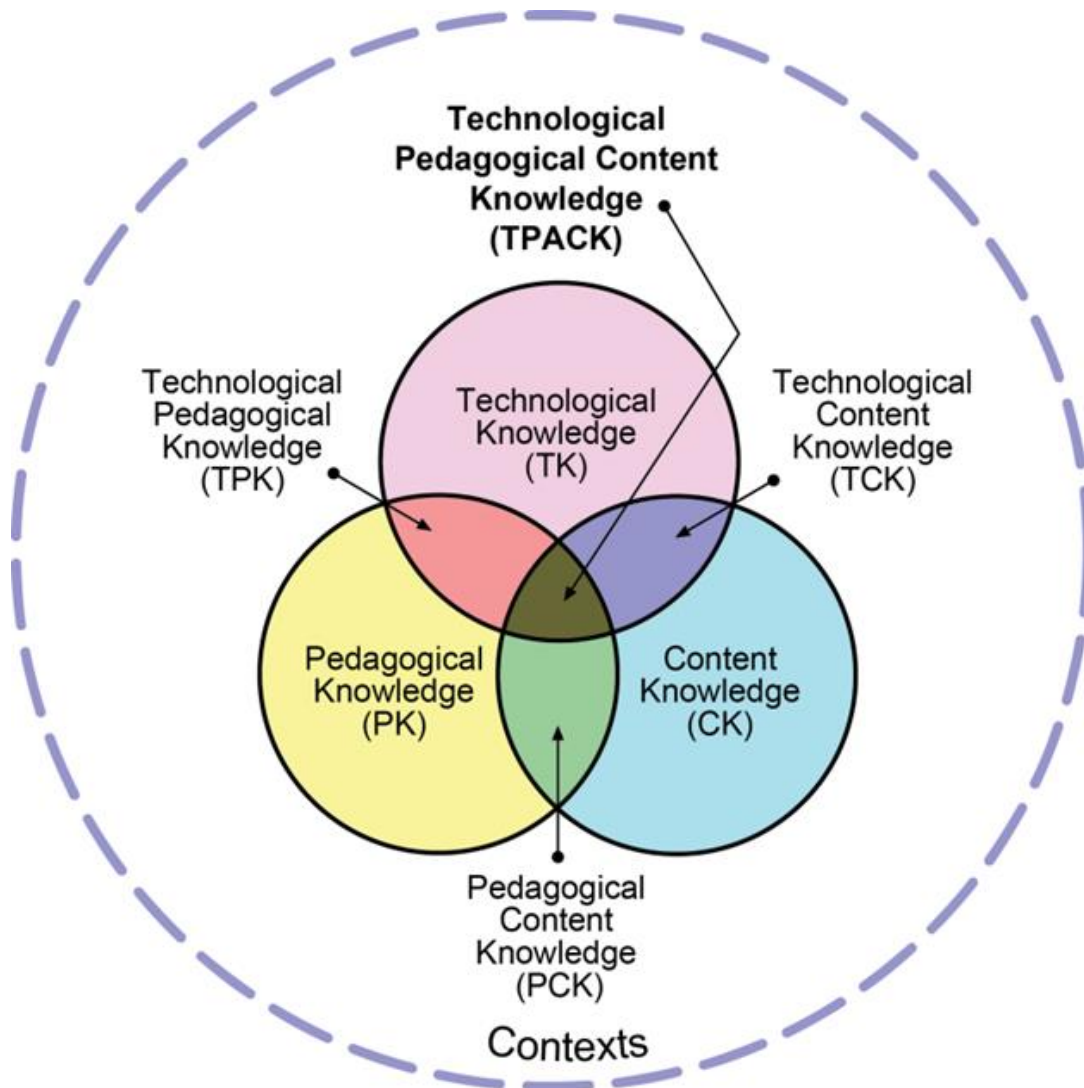


Figure 2. The technological pedagogical content knowledge (TPACK) framework

(Koehler, 2011). Reproduced by permission of the publisher, © 2012 by tpack.org.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents a review of the relevant literature. First, it provides a brief history of educational technology integration. Next, it outlines past and present research examining technology in classrooms and discusses advantages and disadvantages of technology in education. Finally, the chapter provides a detailed explanation of the selected theoretical framework: TPACK. These four sections all work to demonstrate how technology shaped contemporary teaching and learning practice.

History of Digital Technology Integration in Education

Practices of integrating various forms of technology in classrooms is not a new trend in education. According to an online resource from Purdue University (2019), many years ago in the colonial times a type of teaching material in the form of printed lessons were installed on wooden paddles and used to assist students in learning poems. It further illustrated that the primitive version of a slide projector—the Magic Lantern—was invented around the year 1870 and thus enabled students at that time to learn from the images painted on glass slides and projected through the retro camera-like Magic Lantern. Statistics show that nowadays these delicate Magic Lanterns are rare to find unless searching in museums; however, by the time World War I ended, around 8,000 lanterns were serving their job in Chicago public schools (Purdue University, 2019).

It was the development of radios in the 1920s that enabled the possibility of distance learning and for the very first time people living in the listening ranges had begun to take on-air classes (Purdue University, 2019). Another vital invention in the educational technology field was the Teaching Machine created by Harvard University psychologist B. F. Skinner in the 1950s. Data from the National Museum of American

History (n.d.) showed that Skinner's machine was once popular among many classrooms in the 1960s:

The [teaching] machine is a rectangular wooden box with a hinged metal lid with windows. Various paper discs fit inside, with questions and answers written along radii of the discs. One question at a time appears in the window nearer the center. The student writes an answer on a paper tape to the right and advances the mechanism. This reveals the correct answer but covers his answer so that it may not be changed. (para. 2)

While students were enjoying their learning with tangible forms of teaching technology in class, another superstar—digital technology—was being developed as fast as the speed of light. Unlike traditional forms of technology, digital technology employs computer- and electronic-based equipment to transfer information, by breaking it down into numerical code (Sheposh, 2019).

Running on the University of Illinois's ILLIAC I computer since 1960, the Programmed Logic for Automatic Teaching Operations (PLATO) system was a computer-based teaching system aiming to explore the possibilities of automatic individualized instruction for mass numbers of students (Bitzer, Hicks, Johnson, & Lyman, 1967; see Figure 3). Additionally, research by Boss (2011) illustrated that the Massachusetts Institute of Technology professor Seymour Papert was another pioneer who began to recognize that digital technology had the potential to reconstruct the learning enterprise fundamentally. Papert, together with Wallace Feurzeig and computer scientist Cynthia Solomon, introduced the unique Logo Programming system to the world.



Figure 3. Elementary school students using PLATO terminals, 1969. Image courtesy of the University of Illinois Archives. Reproduced by permission of the publisher.

The Logo Programming Language system empowered students to take control of the movements of its symbolic turtle graphics feature in order to assist learners in developing mathematical problem-solving skill (Pardamean, Suparyanto, & Evelyn, 2015). When interviewed by *Computer Decisions* in 1970, Papert further stated:

With computers, there is a substantially bigger chance that you can lead the child with less effort into something he really likes doing...The intersection with the set of fun things with the set of educational things is sufficiently big so that you should be able to keep every student internally motivated. (As cited in Boss, 2011, para. 4)

Following Papert's innovative application of digital technology in the educational area, several well-known digital technology manufacturers had realized the potential market of introducing technology into classrooms. Apple Inc., a computer company which had successfully survived and escalated to the top of the harsh competing market environment, released the Apple II desktop computer to permit students having entirely new geography and mathematics learning practices through computer games back to the year 1977 (Ayala, 2018).

At the end of the 20th century, interactive whiteboards were gradually introduced to schools before massive installations of modern computers and teaching platforms. Once prevalent, interactive whiteboards served as a powerful tool to assist students learning mathematical problems, particularly in dealing with shapes, as students were able to draw, drag, and physically interact with objects on the large-scale screen (Beauchamp, 2004; Davison, 2004; Miller, 2004).

Since Papert's groundbreaking work, digital technology tools have become increasingly powerful and widespread in educational fields throughout the past 60 years (Boss, 2011). On the other hand, technology itself is always changing and upgrading at a fast and frequent pace. The COMPAQ SLT/286, the first battery-powered laptop with VGA graphics, which was launched by Compaq computer company in 1988, weighed 6 kilograms and cost more than US\$5,000 (Lewis, 1988). Dramatically, as the wheel of time spins unstoppably, laptops today have already become both more affordable and remarkably portable (Donovan, Green, & Hansen, 2012) that such an amount of money can purchase almost two top-performance laptops.

According to California State University Emeritus Professor Dr. Everett E. Murdock (n.d.), by the year 1994 most American classrooms had at least one computer available for teachers to delivery instructions, while 2 years later some schools established web servers and provided faculty platforms to create instructional websites. Since the rapid development of both desktop and laptop computers, accompanied by significant price drops year by year, these technology tools have found their new place in schools. Baylor and Ritchie (2002) noted that "some schools opt to place computers in labs, whereas others use group techniques in the classroom" (p. 398). More recent research found that "mobile technologies, such as laptops or tablets, are now being used in schools and have become the most popular and useful device used for instruction in K-12 schools" (Sahin et al., 2016, p. 362).

As for Canada, a piece of official information derived from Statistics Canada (2008) revealed to the public that by the year 2006, in Canada almost six students in a school had to share one computer. The latest version of such governmental investigation

of ICT in educational areas revealed that 3 years later in 2009, the number of computers per Grade 10 student in Canadian schools was 0.73, meaning only 73 computers were ready to serve every 100 Grade 10 students (Statistics Canada, 2015b). The mean index of the computer as the digital technology use at school in the same year, however, was only, 0.22 which means 22 students out of 100 students frequently used computers in schools for nine computer-based activities as follows:

Chat on-line; use e-mail; browse the Internet for schoolwork; download, upload or browse material from the school Web site; post work on the school's Web site; play simulations; practice and do drills (e.g., for mathematics or learning a foreign language); do individual homework; and do group work and communicate with other students. (Statistics Canada, 2015b, para. 1)

The mean index of students using computers at school in 2009 among provinces of Canada, on the other hand, showed that the ratio of Ontario was 0.30 and ranked at three out of the entire 10 provinces, following Alberta and Saskatchewan (Statistics Canada, 2015b). This number can be further illustrated that 30 out of 100 students in 2009 were utilizing computers as their digital technology at school for the educational purposes.

Nowadays classroom digital technology such as interactive whiteboards, tablets, projectors, and laptops are playing an increasingly important role in educational fields in Canada and around the world (Glowacki, 2015). CTVNews reported that students in Grades 6 to 8 at St. James-Assiniboia School Division, as well as their teachers, received an iPad in September 2013 with educators suggesting iPads are a great digital technology to help stoke interest in students' learning ("iPads for Winnipeg Students," 2013). As an

alternative option, the Waterloo Region District School Board (n.d.) in Ontario announced that by September 2016, all Grade 9 students in this board had received their own Chromebook. Also, Durham District School Board proposed in the 2017 to 2018 annual operating goals that 10,000 Chromebooks were to be assigned to all Grade 7 students and half of the Grade 10 students (Follert, 2017). In addition, public meeting notes from the largest school board in Canada—the Toronto District School Board—showed that Chromebook is well equipped among schools in such area (Guildwood JPS, Elizabeth Simcoe JPS, Poplar Rd. JPS, Jack Miner JPS; Toronto District School Board, 2017).

This brief history of integrating technology in educational areas stops here; however, its wheels will not stop rotating thanks to the continuous and rapid technology development. The researcher of this study firmly believes that in the near future, students will be able to experience increasingly advanced technology-based learning.

Advantages of Integrating Digital Technology in Classrooms

For years researchers (e.g., Ahlferd, 2017; Barak, Lipson, Lerman, 2006; Demb, Erickson, & Hawkins-Wilding, 2004; Eteokleous, 2008; Goktas, Yildirim, & Yildirim, 2009; Kimmons et al., 2017; Quinn, 2016; Sahin et al., 2016; Soykan, 2015) continuously pointed out the advantages teachers and students gained from implementing ICT in classrooms. The foremost benefit educators and learners acquired from classroom ICT is that digital technology helps educators to create an unprecedented mobile learning environment with the accessibility of comprehensive learning materials (Rusu & Tudose, 2018; Sahin et al., 2016). Soykan (2015) concluded that tablets, as an essential component of classroom ICT, enable using transferred teaching materials as visualized

coursework materials. Also, the dramatically increased mobility brought by ICT offers numerous advantages (Sahin et al., 2016). For example, a modern ICT device is capable of breaking the space limitation of learners' learning. Windschitl and Sahl (2002) reported an example that "a student can easily use the same laptop in a science lab while writing an experiment report and in a classroom to complete classwork" (as cited in Sahin et al., 2016, p. 362). Quinn (2016) suggested from his own experience that

As an educator, the idea of giving computer access to every student in the school at any time was revelatory: no longer would we need to shift classrooms and book computer rooms hoping that it would not clash with another class. (p. 92)

With the ICT assistance, learners are able to learn seamlessly without being limited by a location, as ICT devices provide learners and instructors with a flexible environment for both teaching and learning (Demb et al., 2004). Hwang et al. (2015) suggested another example in their study:

...with the help of mobile devices, students can bring the annotations and notes they made as well as the data they collected at home or in the field to their classes at school. They can even review the learning content or do practice on the way to and from their home and school. (p. 456)

Moreover, the use of ICT has gone beyond the bond of time, as both learners and educators are able to go through the lens of history by simply left-clicking their mice on any ICT devices with access to the Internet (Colesniuc, 2018). Danielson and Meyer (2016) stated that "the increasing availability of devices (e.g. laptops, Chromebooks, smartphones, and tablets) and networks allow students to access the Internet quickly and reliably" (p. 259). Similarly, several studies (e.g., Kalolo, 2019; Rusu & Tudose, 2018;

Sahin et al., 2016; Sokyan, 2015) pointed out that instructors and learners are able to utilize ICT to access databases and acquire demanding information thanks to the wide construct and spread of the Internet. While in the past, the learners had to find enormous amounts of materials from libraries, students and teachers today can use the Internet to browser data immediately. Rusu and Tudose (2018) concluded that by creating computer-generated learning environments, instructors and learners successfully overcame issues of distance and time and can further customize their learning experiences upon personal preferences.

Another essential merit of integrating ICT in the classroom is that digital devices such as laptops, tablets, and smartphones are positive stimuli that promote learners' motivation and engagement during their learning processes (Beeland, 2002; Currie, 2016; Sahin et al., 2016; Soykan, 2015; Woloshyn, Bajovic, & Worden, 2017). Currie (2016) noted that ICT can help to promote engagement and empowerment of students (p. 17). Trimmel and Bachmann (2004) from the University of Vienna compared a laptop classroom and a traditional classroom, and they finally confirmed from their study that laptops in class helped increase the motivation and participation of students. Correspondingly, Woloshyn et al. (2017) suggested that using iPads in a Grade 1 classroom positively impacted students' engagement, as well as increasing their motivation (Clark & Luckin, 2013, as cited in Woloshyn et al., 2017). Park and Choi (2014) found that students express a more positive view of learning in a high-technology active learning class environment than in traditional teacher-based classrooms (as cited in Nicol, Owens, Le Coze, MacIntyre, & Eastwood, 2018). Beeland (2002) noted that an interactive whiteboard, as one component of classroom ICT, engaged students with

visual, auditory, and tactile learning, and thus became a great motivator to student learning and further increased student engagement through the learning process. As for tablets, Soykan (2015) found that tablets, as another ICT device and currently a popular option among schools, helped students increase their desire to learn by making the lessons more fun. Researchers from Brock University, Ontario, stated in their study regarding using iPads in a Grade 1 classroom that students have been offered opportunities to engage in multifaceted learning and therefore extended their learning experiences (Woloshyn et al., 2017). Such improvements on learners' engagement can be further illustrated as Currie (2016) stated that technology-infused student activities, along with pedagogically effective teaching, would promote learners' engagement.

Another advantage of integrating digital technology in classrooms based on current literature is that learners and instructors can enhance their learning experiences from pre-installed or downloaded educational software programs with little or even no cost when utilizing digital devices during their learning processes. This advantage of using digital technology in education also helps educators differentiate their teaching. Current literature finds that differentiation means "tailoring instruction to meet individual needs" (Beasley & Beck, 2017, p. 551). Differentiation can take place at many stages in the context of education, "whether teachers differentiate content, process, products, or the learning environment, the use of ongoing assessment and flexible grouping makes this a successful approach to instruction" (Beasley & Beck, 2017, p. 551). On the other hand, due to the nature of ICT devices as portable multi-context learning platforms, ICT devices such as the Chromebook are particularly suited for differentiating teaching (Haelermans, Ghysels, & Prince, 2015). Morgan (2017) suggested that "with the digital

tools commonly available in many schools, teachers can teach through various intelligences to make content more meaningful for students” (p. 182).

For example, Kelly Ahlfeld (2017), a teacher from Mettawee Community School in the United States, confirmed that access had been offered to her students for “seemingly unlimited storage for a variety of media they might create” (p. 286) for very little money when buying Chromebooks. Peter Quinn (2016), a teacher who works at McKinnon Secondary College in Melbourne, Australia, stated that Chromebooks offered a variety of apps that can be installed on laptops, smartphones, and tablets, and these apps are more than adequate for elementary level learners. Quinn (2016) further illustrated with examples such as Pixlr (a free Chromebook-based picture editing software for students to learn basic picture editing and compositing) and WeVideo, another free online video-editing software for learners to produce basic video content collaboratively. Demski (2012) also noted that schools are being supported by integrating Chromebook-based Google Apps for Education (GAPE) in classrooms.

Disadvantages of Integrating Digital Technology in Classrooms

Previous discussion confirms that technology integration in educational fields is highlighting the modern education system with its multifaceted benefits; however, several studies (e.g., Rusu & Tudose, 2018; Sahin et al., 2016; Sokyan, 2015) showed that using digital devices in classrooms to assist teaching and learning also may restrict developments of instructors and learners in multiple ways.

Among its drawbacks, the top problem of integrating digital technology in education is that ICT devices in classrooms sometimes can become great distractors (Rusu & Tudose, 2018; Sahin et al., 2016; Soykan, 2015). Talebian, Mohammadi, and

Rezvanfar (2014) noted that students constantly get access to unsupportive and unrelated information; similarly, Soykan (2015) recruited 319 students, 64 teachers, and 134 parents in his study for a total of 18 weeks using tablet computers in classroom. In his section of disadvantages of the use of tablets, Soykan mentioned that teachers in his research pointed out that students continuously use iPads for personal purposes such as listening to music, watching videos, and accessing social networks, rather than for educational purposes. Ahlfeld (2017) suggested that this distraction even start from the homepage of any search engine, as she noted:

The distraction factor begins with a Google search page that usually includes the Google Doodle, an interesting, sometimes animated, picture connected with that date in history. Before students have typed in a keyword, they are drawn to explore an unrelated, albeit fascinating, topic. (p. 287)

Another general disadvantage of using ICT in classrooms is the technical and infrastructure problems which students and teachers have experienced during their learning and instructing (Sahin et al., 2016; Sokyan, 2015). Harrell and Bynum (2018) noted that learners can be limited getting access to the Internet when the infrastructure fails to build a working Wi-Fi connected learning environment, especially “in rural schools and older building without proper power voltage to support multiple tech devices” (p. 13). Similarly, students have to cope with technical difficulties from time to time when utilizing laptops in their learning while lacking efficient and sufficient technical support (Trimmel & Bachmann, 2004). Soykan (2015) also suggested from his data that students and teachers in classes that used tablets to enhance learning were disappointed by the frequent charging notification shown on their devices. Walsh and

Farren (2018) cited a study by Engin and Donanci (2015) that teachers and students wasted much time dealing with technical issues when using iPads in class. Sahin et al. (2016) also suggested that technological problems aroused in utilizing Chromebooks in teaching and learning occurred throughout the semester, where “teachers highlighted that Chromebooks had some tech problems that generally thwarted the works they were doing” (p. 370).

Other studies (e.g., Nicol et al., 2018; Rusu & Tudose, 2018; Soykan, 2015; Zsoldos-Marchis, 2017) also showed that using digital technology in teaching and learning may cause learners to have inadequate socialization. Parent participants from Soykan’s (2015) research claimed their concern that students were spending too much time on digital technology and were “not interacting with others during this time” (p. 40). Similarly, Rusu and Tudose (2018) suggested that educational technology integration reduces both student–student and student–teacher interactions, and also slows down learners’ development of oral communication skills. In their research, Nicol et al. (2018) noted from their observation in both a high-technology active learning college classroom and a low-technology active classroom that some students “appeared stymied in their ability to discuss ideas” with other students (p. 260).

The above-mentioned advantages and disadvantages of utilizing modern digital technology in educational fields have together shaped the way how teachers incorporate teaching with these digital tools. In addition, these characteristics of educational technology also influence educators’ attitudes toward using ICT in teaching and learning processes, which consequently brings associated effects to the learning process. The next section examines three general factors impacting teachers’ attitudes toward implementing ICT in classrooms.

Chromebook as the Digital Technology in Classrooms

Chromebooks, in a nutshell, refer to laptops running Google Chrome OS (John, 2016). To make a clear distinction between Chromebooks and traditional laptops, two facts need to be examined. The first one is that Chromebooks use a unique operating system—Chrome OS. Chrome OS is a Google product derived from modifying Chromium OS, an open source project which is available for anyone to access, modify, and build (The Chromium Projects, n.d.). These two operating systems share the same code base; however, Chrome OS has more additional features and is supported seamlessly by Google in auto-updates programs and only “run on specially optimized hardware in order to get enhanced performance and security” (The Chromium Projects, n.d., para. 2). It can be understood that since Chromium OS is an open operating system and is welcoming anyone to improve and extend it, Google is one of the developers of Chromium OS and therefore has created Chrome OS for general consumer use. The official website of Chromium OS (The Chromium Projects, n.d.) also indicated that the most significant difference between Chromium OS and Chrome OS is that the logo of the former is blue while the latter has three colours (green, yellow, and red) and is visible on every Chromebook lid (see Figure 4).

Moreover, Chrome OS is not available for purchase on a disc to install or download from the Internet even though developers working in the technology fields have created alternative ways to do so (The Chromium Projects, n.d.). The only way for the general public to use such an operating system is to purchase Chromebooks that have Chrome OS installed by the original equipment manufacturer (OEM). Saran (2018) defined the uniqueness of Chromebooks in another way in his paper that the operating system, the Chrome OS, “is a Linux-based operating system that relies on cloud-based applications with the Chrome browser as its primary user interface” (p. 20).



Figure 4. The logo of the Chrome OS, as shown on the lid of every Chromebook.

The second fact is that Chromebooks normally do not have many local applications or software, as well as local storage because everything is designed to be accessed through the Internet (Saran, 2018). Initially not designed for recreational purposes, Google then developed Google Apps for Education (GAFE), a set of web-based software for Chromebook users.

Using such an operating system has many benefits. The first advantage is that Chromebooks require minimal hardware specifications thanks to their lightweight operating system use, which also means Chromebooks have a high system boosting speed. Chromebooks do not need the latest processors to work (Bonheur, 2018; Demski, 2012). In addition, Chrome OS lacks local storage, and is therefore free from large size programs which consequently has helped enhance Chromebooks' overall performance (Bonheur, 2018). A student only needs to flip the lid and log in his or her Google account while another student from other grades can log in on the same Chromebook without losing anything since everything is cloud-based and can be downloaded when connected. Finally, due to the design of minimal hardware requirements, Chromebooks can be built thin and lightweight that ultimately are easy for elementary students to carry around the classroom (Bonheur, 2018). Another benefit brought by design such a type of laptops is that the battery life of Chromebook is significantly longer than its competitors. According to Bonheur (2018), "this energy efficiency comes from the fact that Chrome OS consumes minimal hardware resources and running apps requires minimal computing power" (para. 15).

The disadvantages of the Chrome OS and Chromebook had also made Chromebooks a great choice for educational fields. Low-cost spending on hardware has limited Chromebooks in performing resource-intensive software programs. That is to say

that professional users such as artists or designers may find difficult using a Chromebook for their works because Chromebooks are not powerful enough for heavy duty workloads, such as 3D modelling and high-definition film producing (Bonheur, 2018). However, Chromebooks are suitable for educational lightweight tasks, particularly in elementary schools (e.g., word processing, slide presentations, and basic video producing). One participating elementary school from Demski's (2012) study mentioned that Chromebooks had become their educational technology choice because their needs of seamless integrating with Google Apps for Education is accomplished by employing Chromebooks into classrooms. Students are automatically authenticated to all GAFE, such as Google Docs for word processing; Google Slides for giving presentations; Google Forms for students to create quizzes for each other. Moreover, all these apps are web-based, which is entirely different from a traditional software program. First, users' data are being saved all the time; thus, there is no more need to worry about losing progress. For instance, a student is able to click on the icon of the Google Docs if his or her task is to write a short essay and in the next second a new browser window will show up on his or her screen because Google Docs is not a program stored locally; rather, it is more similar to a website where students are able to do word processing.

In his paper, Currie (2016) created a fictitious learning environment to demonstrate teaching and learning with Chromebooks:

After checking in, students make their way to their Chromebooks or other personal computing devices, and log into Google Classroom to access posted assignments, participate in virtual conversations among students and the teacher, and reference shared resources in a safe and controlled environment. A Do Now

assignment, created in Google Forms and listed on the class feed in the Google Classroom platform, prompts the students to reflect on their homework topic. As students answer questions about the homework, the teacher reviews the responses in real time via the class feed to look for trends or themes. (p. 17)

To conclude, Chromebooks are powerful student-centred technology tools in classrooms and are able to help both students and teachers in their learning and instructing processes.

Factors Affecting Teachers' Attitudes toward Technology Integration

Teachers' attitudes toward integrating technology devices in classrooms vary due to multifaceted factors (Levin & Wadmany, 2008; Sahin et al., 2016). In their paper, Sahin et al. (2016) noted that teachers might generate negative attitudes toward educational technology use in classrooms when they are not confident enough to teach with laptops, tablets, or other modern educational digital technology. Moreover, teachers' confidence of utilizing technology in delivering knowledge comes from their familiarities with ICT. Yildirim (2000) found that "teachers who used computers more would tend to develop positive attitudes that promote further use of the computer in their daily teaching tasks and conduct activities that require computers to play a major role" (as cited in Teo, Wong, & Sing, 2008, p. 268). Similarly, according to Baylor and Ritchie (2002) integrating technology will remain at an unproductive level if the instructors do not have the necessary skills and knowledge to support themselves to infuse technology properly into instructing. Teachers who have little knowledge utilizing technology will become less likely to deliver course contents using an innovative and technological way. In other words, use of ICT in classroom will be limited if teachers do not have sufficient knowledge and experience regarding technology use (Lim & Khine, 2006, as cited in Sahin et al., 2016).

The lack of familiarity with various digital devices also results in another factor which Sahin et al. (2016) defined as teachers' technology training that also influences teachers' attitudes toward integrating digital technology in their classrooms. Unlike most of the children today who are born as the new generation of digital natives, many senior teachers may not have sufficient technology use experience, thus requiring appropriate training before implementing technology in their teaching (Sahin et al., 2016). Teachers who were born after the year 1980 are considered as digital natives as well (Marchetta et al., 2018); however, they still need to both understand and implement current technology in order to pursue the possibilities of new technology-integrated instructing methods (Sahin et al., 2016). Teachers, young or senior, can be provided with formal or informal technology training courses (Pena-López, 2010, as cited in Sahin et al., 2016). Finally, teachers' personal attitudes toward technology also influence their frequencies and performances of integrating technology in teaching and learning processes. Teachers are more likely to integrate ICT into their instructing if they have favourable attitudes toward digital technology (Sang, Valcke, van Braak, Tondeur, & Zhu, 2011, as cited in Shin, Han, & Kim, 2014). Banas (2010) analyzed reflections regarding attitudes toward technology from 225 student participants, and she quoted one participant from her research who said:

I did not understand why it was necessary to incorporate technology into the classroom. I grew up with limited use of technology tools during my elementary and secondary education; therefore, I never saw it as a means necessary to increase student achievement and instructional practices. (p. 121)

Conversely, another participant in Banas's (2010) research expressed an almost entirely

different attitude towards using technology in class:

I am not a digital native but was a migrant to it long before this course. It started off more than a decade ago with me, the excitement with real time communication using simple emails and surfing the information superhighway. I can effectively develop a student-centered inquiry based, self-directed learning environment with equitable assessment. (p. 120)

To sum up, teachers' self-confidence regarding using technology, their familiarity and training level of utilizing technology, as well as their personal attitudes towards educational technology integration are the three general independent variables impacting the dependent variable: the efficacy and quality of technology integration in classrooms.

Technological Pedagogical Content Knowledge as the Conceptual Framework

Mishra and Koehler's (2006) proposed educational technology framework TPACK has been selected as the theoretical framework in this research. This conceptual framework is proposed to assist educators in developing new ways of integrating technology in teaching and learning process (Koehler, Mishra, & Cain, 2013). Also, TPACK was proposed to reinforce educators with the rapidly appearing challenges of teaching with digital technology, as ICT "is qualitatively different in that its functioning is opaquer to teachers and offers fundamentally less stability than more traditional technologies such as pencils, chalkboards, or microscope that are not even considered to be technologies" (Koehler et al., 2013, p. 14). Technological Pedagogical Content Knowledge (TPACK) "is the fundamental of teaching with technology" (Sensoy & Yildirim, 2018, p. 29). Moreover, to understand how TPACK is able to benefit educators, its elements must first be understood. According to Mishra and Koehler (2006), TPACK

consists of seven core elements: CK, PK, TK, PCK, TPK, and TPACK. All elements will be explained in detail in the following sections.

Content Knowledge (CK)

The first type of knowledge as one of the three fundamental components of TPACK is content knowledge (CK). Koehler et al. (2013) defined content knowledge as “teachers’ knowledge about the subject matter to be learned or taught” (p. 14). Roig-Vila, Mengual-Andrés, and Quinto-Medrano (2015) suggested that CK covers the knowledge linked to a subject matter (p. 152). CK is a very broad definition as it is dependent on the specific subject matter while being independent from teaching strategies (Chai, Koh, & Tsai, 2013; Vickrey, Golick, & Stains, 2018). For example, the content to be covered in a master course in educational fields is very different from the content to be covered in elementary school Grade 8 language course. Koehler et al. (2013) noted that teachers’ CK is critically important, as students may otherwise receive incorrect or incomplete knowledge which ultimately leads to the generation of misconceptions in the content area (National Research Council, 2000; Pfundt & Duit, 2000, as cited in Koehler et al., 2013).

Pedagogical Knowledge (PK)

A teacher’s pedagogical knowledge (PK) is his or her in-depth knowledge that corresponds to the “processes and practices or methods of teaching and learning” (Koehler et al., 2013, p.15). Such knowledge also includes how to manage and organize classrooms, how to analyze and plan curricula, as well as students’ learning and assessment (Chai et al., 2013; De Rossi & Trevisan, 2018; Koehler et al., 2013; Roig-Vila et al., 2015). For instance, a teacher’s knowledge about how to integrate the Brain-Targeted Teaching Model proposed by Dr. Mariale Hardiman (2010) from Johns Hopkins University in his or her teaching is considered to be his or her PK. Koehler et al. (2013)

further indicated that his or her students would not benefit from instruction by their teacher if the teacher fails to understand how they form their knowledge system and acquire skills, and “how they develop habits of mind and positive dispositions toward learning” (p. 15). Therefore, teachers today are not only required to master the CK in their fields but also are expected to understand various cognitive, social, and development learning theories, and how to apply them in practice (Koehler et al., 2013).

Technology Knowledge (TK)

Technology knowledge (TK), on the other hand, is easily understood as this type of knowledge is the general knowledge of a teacher towards various forms of digital technologies, as well as the skills of how to operate with them (Bingimlas, 2018; Chai et al., 2013; De Rossi & Trevisan, 2018; Koehler et al., 2013; Vickrey et al., 2018).

Examples of such knowledge include the “knowledge of the existence of a technology or the knowledge of the kinds of technologies used in an instructors’ discipline” (Vickrey et al., 2018, p. 67), such as the use of a Google Chromebook in daily office hours as well as implementing it with teaching students how to write an online reflection. Furthermore, according to Koehler et al. (2013), this type of knowledge demands its learners to evolve throughout their lifetime to generate new knowledge regarding how to interact with the latest forms of technologies, particularly the fast-paced self-updating digital technology. Successful technology integration in educational fields thus requires contemporary teachers to have sufficient TK to support their instructing performances regarding teaching with different forms of modern digital technologies.

Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge (PCK) is derived from overlapping PK with CK (Figure 5). According to Shulman (1987), PCK is the amalgam of content and pedagogy

from the view of teachers based on their professional understanding of specific contents. Built upon this concept, PCK in the TPACK framework refers to the knowledge that comes from the transformation from contents of specific subject matters into pedagogical forms that could be adapted by learners in their favour (Bingimlas, 2018; Chai et al., 2013; De Rossi & Trevisan, 2018). In order to do so, teachers are required to have sufficient PCK to recognize teaching and learning strategies that are suitable for their learners, and design teaching practices to present particular CK through such pedagogical strategies to the learners in a more understandable manner (Bingimlas, 2018; Chai et al., 2013; Vickrey et al., 2018).

Technological Content Knowledge (TCK)

Similarly, technological content knowledge (TCK) is derived from overlapping TK with CK (Figure 5). As Chai et al. (2013) noted, TCK is a type of knowledge about “how to use technology to represent/research and create the content in different ways without consideration about teaching” (p. 1044). For example, a university professor needs to have sufficient TCK in regard to the educational platform his or her university is using (e.g., Sakai, an educational computer-based online platform) to post teaching materials or start online discussions; an Ontario elementary teacher needs to find the most-appropriate online dictionary to assist his or her newly immigrated students in their English learning. Therefore, contemporary teachers not only have to master the content knowledge in their areas but also must deeply understand what forms of modern technology can be used to improve or constraint their teaching performances and students’ learning (Koehler et al., 2013).

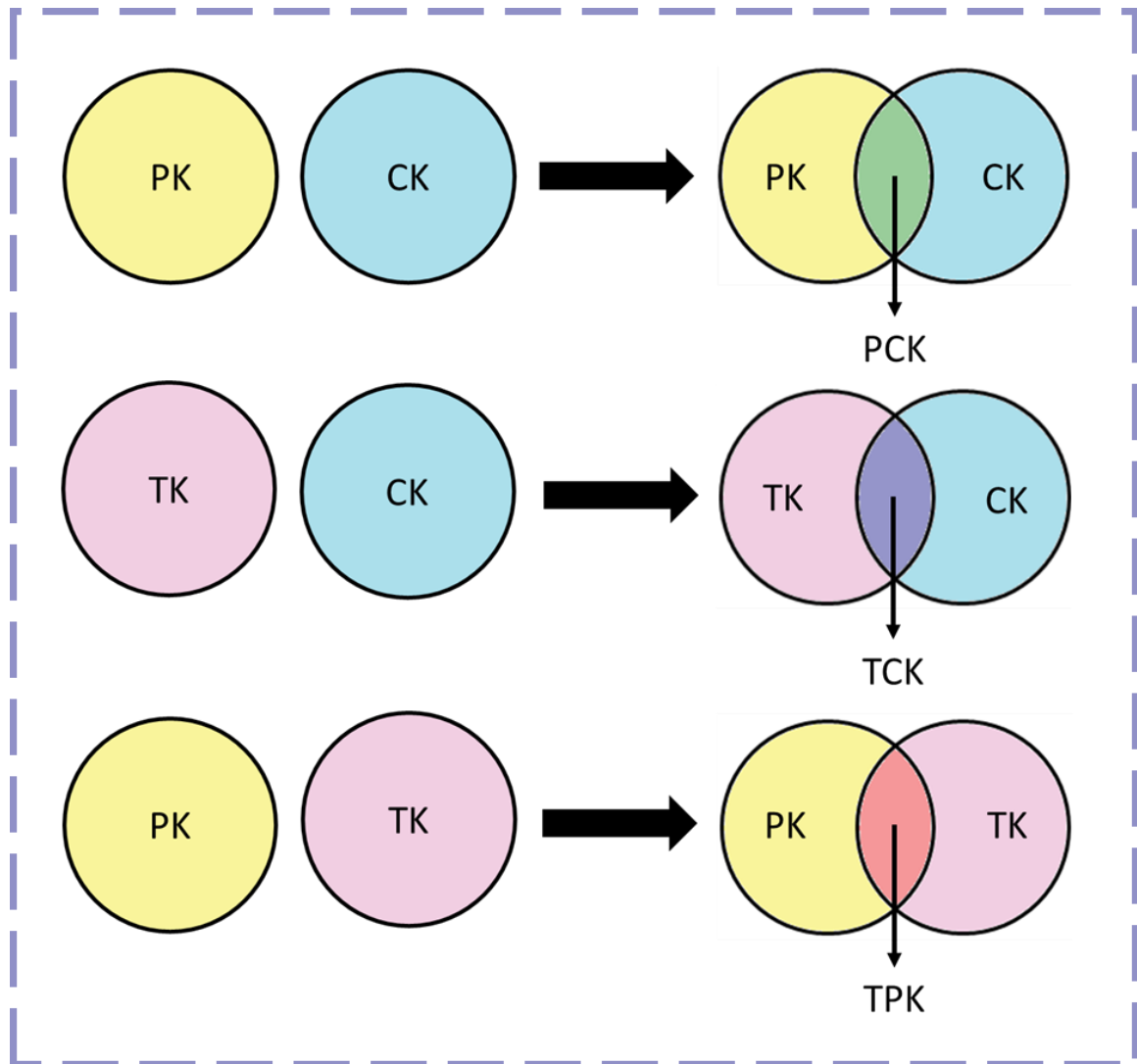


Figure 5. The formation of pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK).

Technological Pedagogical Knowledge (TPK)

Technological pedagogical knowledge (TPK) comes from overlapping TK with PK (Figure 5) and represents as the “knowledge of employing technologies to support teaching strategies and instructional practices” (Bingimlas, 2018, p. 2). Educators need to understand how particular technologies can change teaching and learning when being used in specific ways, which further indicated that teachers need to understand potential promotions and restrictions of educational digital technologies in fields regarding their user developments (Koehler et al., 2013). TPK is different from TCK because it is a type of knowledge that associate with teaching strategies whereas TCK is a type of knowledge that emphasizes subject matter knowledge but not teaching practices (Chai et al., 2013). The seamless flipped learning theory proposed by aforementioned scholars Hwang et al. (2015) is an example of TPK in which this theory is knowledge that educators need to understand before fulfilling their flipped classroom teaching with a variety of teaching strategies (e.g. problem-based learning, knowledge construction tools), as well as teaching with digital technology (e.g. laptops, tablets). In their paper, Koehler et al. (2013) called on teachers to broaden their eyesight and be creative when integrating technology in classrooms, particularly to seek for advancing student understanding and learning when using computer-based software in teaching.

Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2006) named the ultimate product technological pedagogical content knowledge (TPACK or TPCK) from re-overlapping three overlapped areas (PCK, TCK, TPK). An easy-to-understand explanation of the TPACK model is that it is knowledge for educators to understand in order to filter suitable technologies out of a

pool of modern digital technologies to present particular subject matter knowledge via effective teaching strategies, as well as learning approaches (Bingimlas, 2018; Chai et al., 2013). Koehler et al. (2013) further indicated that TPACK is a unique and individual knowledge system compared to all three types of core knowledge (CK, PK, TK) because

TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face, knowledge of students' prior knowledge and theories of epistemology, and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones. (p. 16)

Hence, TPACK is a dynamic and systemic knowledge construct which reveals digital technology's potential in facilitating learning by involving all three base types of knowledge, as well as another three types of knowledge gained from overlapping them with each other (De Rossi & Trevisan, 2018; Setiawan, Hamra, Habu, & Susilo, 2018) rather than TPK, a type of knowledge that is independent from content knowledge or TCK, a type of knowledge which does not take teaching into consideration (Chai et al., 2013). Despite still being a rather young research field, TPACK brought significant effect to the current educational system because it describes "the knowledge teachers rely on when designing and implementing curriculum and instruction while guiding their students' thinking and learning with digital technologies in their specific content areas" (Niess, 2015, as cited in Setiawan et al., 2018, p. 1043). The pioneers proposing the

concept of TPACK, Mishra and Koehler (2013), concluded that the performance of teaching with technology could be enhanced by consistently “creating, maintaining, and re-establishing a dynamic equilibrium” among all the components of TPACK knowledge system (p. 17).

TPACK Framework in Practice

TPACK has been widely adopted by researchers and practitioners since its invention (Elliott, 2018; Evans, Nino, Deater-Deckard, & Chang, 2015; Koh, Chai, Hong, & Tsai, 2015; Lefebvre, Samson, Gareau, & Brouillette, 2016; Paneru, 2018; Patahuddin, Lowrie, & Dalgarno, 2016; Szeto & Cheng, 2017). In their paper, Szeto and Cheng (2017) adopted TPACK as a framework to deepen their understanding of how preservice teachers integrate technology in teaching. Elliott (2018) applied TPACK in his research not only to individuals but also to educational organizations to seek connections between educators’ professional developments and academic performances within an effective technology-assisted learning environment. In his paper, he called on colleges and universities to “align professional development and academic programs using the TPACK framework” (p. 21). Evans et al. (2015) cited from the literature that “TPACK framework could be used to evaluate the affordances and constraints of a technology in the classroom, as well as the possible changes in practice that these implementations could bring” (Sobel & Grotti, 2013; Tokmak, 2013; p. 496). In addition, TPACK is well received by researchers because this conceptual framework allows setting particular targets to teachers, as well as their instructing actions (Lefebvre et al., 2016). Muir, Callingham, and Beswick (2016) showed evidence of using the TPACK framework to evaluate a Grade 1 teacher’s use of

interactive whiteboard (as cited in Patahuddin et al., 2016). Finally, Patahuddin et al. (2016) summarized that using the TPACK framework has enabled describing teaching practices with technology integration.

This research intends to interview in-service Ontario elementary teachers regarding their instructing with one latest form of digital technologies—the Google Chromebook in the frame of TPACK. Besides, by design interview questions based on the TPACK model, the researchers intend to gather information about how well contemporary Ontario teachers integrate technology with their PCK in assisting their teaching as well as students learning through exploring their experiences with Chromebooks. Finally, TPACK is particularly suitable for this research because the definition of technology has been constrained in this research to refer to “emerging technologies, which are new, typically digital” (Cox, 2008, as cited in Vickrey et al., 2018, p. 67).

Summary of the Chapter

Five elements have been examined in this literature review chapter. The first section reviewed the history to briefly introduce the revolution from traditional teaching techniques to the latest educational digital technology. The significance of utilizing digital technology in educational fields has been investigated in this chapter as the second, and the third sections examined current literature for advantages and disadvantages of implementing a various type of digital technology (e.g. Chromebooks, tablets, and interactive whiteboards). Following these sections, the next section explored teachers’ attitudes toward contemporary ICT integration in educational fields. The final section of the literature review chapter introduced TPACK as the theoretical framework

of this study in detail. The next chapter—Methodology and Methods—explains the study's selected research design, how data were collected and further analyzed, as well as the limitations of this research.

CHAPTER THREE: METHODOLOGY AND METHODS

This chapter outlines the methodology of the study. The purpose of this study is to explore Ontario teachers' experiences using Google Chromebook in their teaching instruction, as well as to address the benefits and the possible challenges of using Chromebook in the classroom. In summary, this chapter describes the methodology and design, the participant selection, the data collection and analysis, and concludes with data limitations.

Methodology of the Study

This study implements a qualitative case study. The case study allows the study to explore an in-depth understanding regarding how people interpret their life experiences and how they build their worlds, as well as “what meaning they attribute to their experiences” within a bounded system (Merriam & Tisdell, 2016, p. 6). Qualitative research (sometimes referred to as the qualitative inquiry) employs words as the most basic data to be collected and further analyzed in various ways (Merriam & Tisdell, 2016). Van Maanen (1979) defines qualitative research as “an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world” (p. 520).

Similarly, Denzin and Lincoln (2013) suggested that qualitative research attempts to “make sense of, or interpret, phenomena in terms of the meanings people bring to them” (p. 3). Finally, Merriam and Tisdell (2016) concluded that qualitative research is an inductive process where researchers are the primary instrument to collect and analyze

richly descriptive data, such as words and pictures, to achieve in-depth understandings of certain phenomena and meanings behind in social contexts.

Qualitative studies usually have six types of designs: the basic qualitative research, phenomenology, ethnography, grounded theory, narrative inquiry, and the last one that is used by this research—the qualitative study (Creswell, 2007; Merriam & Tisdell, 2016). According to Creswell (2007),

Case study research is a qualitative approach in which the investigator explores a bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observation, interviews, audiovisual material, and documents and reports), and reports a case description and case-based themes. (p. 73)

Consequently, in order to forge a case study, the unit of analysis must be “a noun, a thing, an entity” (Stake, 2006, as cited in Merriam & Tisdell, 2016, p. 39). In this study, the participants—two teachers from private elementary schools in Ontario—were considered as the units of analysis. The use of case study is appropriate when there is a lack of understandings of phenomena and is used to analyze new details in order to inform practice (Yin, 2009). This research will be conducted following a qualitative case study design to explore Ontario elementary school teachers’ experiences in terms of teaching with Chromebooks as the classroom digital technology.

Research Participant Recruitment

A type of purposeful sampling, namely the Criterion-i, is used in this research to “identify and select participants that meet some predetermined criterion of importance” (Palinkas et al., 2013, p. 535). Two Ontario teachers from elementary schools who

declared teaching with Google Chromebooks participated in this study. The number of participants is small because the researcher sought to investigate an in-depth understanding of the selected topic, as Plano Clark and Creswell (2015) noted that

it is typical in qualitative research for the researchers to study a small number of sites and individuals or a few cases. This is because the overall ability of a researcher to provide an in-depth exploration diminishes with the addition of each new site and individual. (p. 335)

Moreover, details of participating teachers are to be ignored when selecting participants on purpose in this research (e.g., teaching length, teaching grades, and areas) due to the nature of this study which is to explore general perspectives of how these participants integrate Chromebooks in their teaching through the lens of TPACK framework. In other words, there were no required demographics for participants other than being an Ontario elementary teacher who uses Google Chromebook in her/his instruction. Participants were recruited from elementary schools in southern Ontario.

Once ethical clearance was obtained from both the university and the district school board, the initial contact with the schools was established through an arrangement of an in-person meeting with the principals to discuss potential interest in the research. If the interest in the research was expressed, following the meeting, a letter of invitation was sent via email or in person. Once the teachers confirmed their interest in participating in the research, a follow-up meeting was established with the teachers who expressed interested in participating in the research to ask them to sign the consent letters and arrange the time for the interviews. There was no prior relationship between the researchers and the principals or teachers at participating schools.

Data Collection of the Study

According to Merriam and Tisdell (2016), the three common types of interviews categorized by structures are highly structured interviews, semi-structured interviews, and unstructured interviews. Merriam and Tisdell (2016) noted that among these three types of interviews, the most popular option for conducting interviews for qualitative studies should be more open-ended and use less-structured interviews (e.g., semi-structured interviews). Semi-structured interviews “include a mix of more and less structured interview questions” (Merriam & Tisdell, 2016, p. 110) without predetermining wording or question orders and all these interview questions can be used flexibly (i.e., the order of the questions can be rearranged by the interviewer upon the answers from the participants). In addition, because this study sought to explore participants’ experience and meaning behind their technology-assisted teaching, in-depth interviews—which Lapan, Quartaroli, and Riemer (2011) define as a type of interview that is conducted with unique individuals or a small number of people—were also employed in this study.

Interviews

In this study, one-time in-depth semi-structured one-on-one interviews were conducted with participants. An interview guide with open-ended questions (what their attitudes toward Chromebook use are, how much their instruction changed since using Chromebooks, etc.) was used to explore participating teachers’ perceptions, attitudes, and experiences about using Google Chromebook in their instruction (see Appendix A). These interviews were audio recorded and transcribed for subsequent analysis. Each interview lasted about 30-45 minutes and was audio recorded and transcribed by the

student principal investigator. Interviews were scheduled at the time of the teachers' convenience either during or after the regular school day. Additionally, this study has been reviewed and received ethics clearance through Brock University's Research Ethics Board [file # 18-262 - BAJOVIC].

Member Checking

Participants were also invited to do member checking after interview audio files had been transcribed into digital documents format to ensure the reliability of the data. By doing that, the participants had the opportunities to clarify, add, or correct what they said in the interview. Emails attached with their transcripts were sent to each participant in order to proceed with member checking. Participants were given 2 weeks to review and make necessary modifications, and the due date was outlined in the email correspondence. The researchers assumed the transcript was accurate and proceeded with the study if any participant failed to communicate his or her feedback on the transcript within 2 weeks.

Data Triangulation

Triangulation is a method used by qualitative researchers to guarantee data consistency and reliability by "using multiple investigators, sources of data, or data collection methods to confirm emerging findings" (Merriam & Tisdell, 2016, p. 259). In this research, two types of digital recording equipment were employed to record audio files documenting entire interviews with participants. Member checking is the second insurance applied in this research to enable the researcher to confirm data's validity and reliability.

Field Notes

As “an essential component of rigorous qualitative study” (Phillippi & Lauderdale, 2018, p. 381), the researcher recorded field notes before, during, and after each interview. Field notes are used by qualitative researchers to add details when constructing a thick, rich description of their study context, such as “sights, smells, sounds of the physical environment, and researcher impressions shortly after they occur” (Phillippi & Lauderdale, 2018, p. 382). In this research, the researcher wrote a short reflective journal immediately after every interview for future data analysis use, as Phillippi and Lauderdale (2018) suggested in their paper that critical reflection can be a convenient supporting resource when analyzing data.

Reporting Results

A summary research report will be provided to the district school board as well as to participating teachers upon completion of this MRP. Participating teachers will also receive a copy of the final report either in hard-copy or electronically upon their own preference.

Data Management of the Study

Audio files recorded during interviews with participating teachers were transcribed into digital documents, as the result of the activity of transcribing performed by the researcher (Flick, 2017). These transcripts were transcribed as soon as possible in order to document the fresh impressions of those interviews; that is, participants’ tones, expressions, emotions, movements, and so on were documented. Besides, teachers’ names and years of experience were collected at the onset of the process. All personal identifiers were coded with a pseudonym, and this pseudonym was referred to throughout

the data analysis and dissemination of results processes. All information was presented in aggregated formats in any reporting of the data so that no individual participant can be identified on the basis of the demographic information collected. Furthermore, these audio files and their according transcripts were both numbered and categorized by date (Swaminathan & Mulvihill, 2018).

To protect the identity of all participants, pseudonyms were used in all data records, analyses, and dissemination activities. Data was stored on a password protected laptop and online Google Drive. Data from this study (hard copies) was stored securely in a locked filing cabinet in the principal investigator's office to ensure that the confidentiality of participants is upheld. All data (hard copy and electronic) will be fully destroyed within 2 years of data analysis. Written records and paper transcripts were secured in a locked filing cabinet in a locked office with access by the principal investigator. Access to computer files was protected with a secure password. All written records were shredded following data analysis, and digital audio files were erased. Any computer files storing data was purged following data analysis.

Data Analysis of the Study

Data analysis, the “process of making sense out of the data” (Merriam & Tisdell, 2016, p. 202), was processed after the researcher finishes transcribing interview audio files into digital word documents. In the context of this research, the analyses of participating teachers' words provided the information regarding their experiences with Chromebooks—the digital technology that they are using in their daily instruction, as well as the potential challenges and benefits of incorporating such a technological device in teaching and learning processes.

Coding

In this section, the researcher first started with coding the data, to break down the transcript into pieces to relabel into segments that are responsive to the research questions (Merriam & Tisdell, 2016). The researcher re-arranged information in data and categorize similar segments together to form themes by highlighting in different colours and commenting on the commonalities that answer a particular research question in the transcripts. Themes of each paragraph of transcripts were coded first; then, the researcher went through the transcripts again for additional meanings in order to eliminate any possible unit of data that has been left during the first-round coding. The researcher re-read the transcripts and coded themes for an extra round to ensure the categories are complete.

During the coding process, Computer Assisted Qualitative Data Analysis Software (CAQDAS) was employed to help develop categories and themes (Bogdan & Biklen, 2011; Merriam & Tisdell, 2016). The researcher chose the popular software NVivo 12 to do so. NVivo 12 is a qualitative data analysis assisting software that had been pre-installed on desktop computers and ready to use in the researcher's university. It is important to note that using this software to handle data did not do anything more than organizing and categorizing data to enhance user's accessibility to the data; instead, only the researcher had the ability to analyze the transcripts (Bogdan & Biklen, 2011).

Ethical Considerations of the Study

The nature of this research study indicated that no possible physical risks will ever arise toward the participating teachers, as well as any psychological risks. Yet, two other types of possible risks brought alerts to the researcher.

The first one is possible social risks that loss of privacy may occur to the teachers when their participation becomes known in the school. Although all data were treated as confidential, and the participating teachers were provided with pseudonyms, it is still possible that their identities would be suggested in the reporting of the data. The second issue regarding ethics is that the power-dynamics exist within the body of this research study. Participating teachers might feel obligated to participate given that the invitation would come from the school principals.

Hence, prior every interview each teacher who has expressed interest in participating in this research study were provided with a consent letter outlining the purpose of the research study and their rights as participants. The teachers were under no obligation to sign the consent to participate, and participation was entirely voluntary. Statements regarding voluntary participation were included in the consent form. Also, within the consent forms, participating teachers were provided with a description of reasonably foreseeable harms and benefits that may arise from participating in the research study, and all the research procedures were outlined in the consent forms. Teacher participants were assured that their participation is voluntary, and they had the right not to participate or withdraw from the study at any time without any forms of penalty or consequence, and they were informed of their right to refuse to answer any question(s) during the interviews.

Limitations of the Study

By examining the use of technology in the classroom, teachers' practices, and experiences with Google Chromebook, differences as well as commonalities in educational practice related to these practices were illuminated, adding a considerable

qualitative depth of understanding to the present literature. Despite the multiple benefits produced by this research, it still has its shortcomings due to two reasons.

First, the sample size of this research is too small; thus, it cannot be taken as an adequate representation of the broader society. For example, participants of this research are only two Ontario elementary school teachers. Therefore, their experiences of using Chromebook scaffolding their instruction cannot convincingly represent other elementary teachers in Canada. Moreover, participating teachers' experiences regarding teaching with technology are based on self-reported data, which also has had limitations on reflecting on the whole elementary school teachers' population.

A second limitation is that this study is conducted only on Google Chromebook as the dominant classroom technology, disregarding the existences and use of other digital technology, such as tablets or iPads, and neglecting the fact that these digital devices are also employed and utilized in classrooms in Ontario. Rieti (2014), for example, reported that in 2014, Ontario's Education Minister Liz Sandals announced the government's plan of spending \$150 million on iPads to scaffold classroom teaching and learning. More research studies regarding using various forms of digital technology, consequently, need to be conducted in the future.

Summary of the Chapter

This chapter examined and demonstrated in detail the procedures of this study. The researcher first illustrated the qualitative design of this study; he then followed on explaining the participants of the research. Data collection, management, and analysis were described after. Finally, this chapter ends by informing its readers about the ethical

considerations and the limitations of conducting such a study. The next chapter will present findings from analyzing collected and transcribed data.

CHAPTER FOUR: PRESENTATION OF THE RESULTS

The purpose of this research study was to explore Ontario teachers' experiences using Chromebook in their teaching instruction, as well as to address the benefits and the challenges of using Chromebook in the classroom. Three primary research questions were addressed:

1. What are the attitudes of elementary school teachers toward the use of Google Chromebook as a supportive tool in school?
2. What are some benefits and challenges that Ontario elementary teachers currently experience using Chromebook in the classroom context throughout teaching and learning processes?
3. What future features/improvements do Ontario elementary teachers recommend for Google Chromebook?

In this chapter, responses to these questions are presented in detail, supported by the data collected.

Responses to Research Question 1

The study's first research question—What are the attitudes of elementary school teachers toward the use of Google Chromebook as a supportive tool in school? —sought to inquire about elementary school teachers' attitudes toward utilizing Chromebooks as a supportive tool in school. The results from the two interviews have confirmed that both Mr. Plant and Mr. Page held highly positive attitudes toward utilizing Chromebooks in the daily instructions.

When asked their overall opinion of using Chromebooks in teaching, Mr. Plant mentioned that "I really enjoy having them. I found them helpful" (Transcript 1, p. 1).

Similarly, Mr. Page said that “it’s a tool that is very seamless. The actual hardware I really like” (Transcript 2, p. 1). Thus, both participants expressed that they enjoyed having Chromebooks as a supportive and helpful tool in their teaching and student learning.

“It Didn’t Exist”

Despite the fact that both participants have already taught more than 20 years, they both stated that they did not receive any formal training regarding how to use and incorporate technology in their instruction in their preservice training when computers were not as available as today. The evidence of lacking technology knowledge (TK) can be found in the interview as Mr. Plant stated when asking how well he was prepared to deliver his instruction utilizing Chromebooks. Mr. Plant stated:

...mentally I was prepared, but as far as training, I had no official training going into it. So, what I meant by mentally prepared, and that ... this is for all the staff members upstairs, is that the idea that they were willing to adapt and learn how to use Google Chromebooks, and it was not a big stretch for them. So ... none of the staff upstairs had gone through any official training of how to use a Chromebook.
(Transcript 1, p. 2)

Mr. Page also possessed no official training on how to utilize Chromebooks in delivering instruction, as he suggested during the interview:

...I mean I started teaching 22 years ago so when I first started teaching the first classroom, I had no need for the Internet. So, we had two or three computers.
My... my professional practice has not ... evolved with the use of technology.
(Transcript 2, p. 3)

The two participants did not have any formal training; however, they both had quite a lot of authentic self-training outside school throughout the years. Mr. Page explained:

I have ... Cohort 21 is one that's amongst independent schools where we do things and share how IT can be leveraged. You'll find that online when you look. And the other one is, I've just taken the Google certification for Google certified teacher and I've also done, like if I did part two this summer, I'd be learning online about. Right; there's an online self-driven learning for me. (Transcript 2, pp. 6-7)

Mr. Page also chose to go to several educational technology conferences and workshops. He achieved the Google certificate on teaching with Chromebooks, and he has been trained specifically how to use the Chromebook and its web-based apps in his teaching. All these forms of training helped him build his technological knowledge and technological content knowledge, which in the end benefited him in his teaching with Chromebooks more effectively. Mr. Plant also wanted to actively engage in more workshops and programs. He shared an example of his desire to attend workshops or programs introducing coding:

Here's a quick example. I'm really uncomfortable with coding, I do not know how to code, I do not know how to evaluate coding, so, for example, if I give a coding assignment to my students, I don't know how to tell them that you are doing is all right. So, one of the things that I have been doing and I haven't done well this year is that I would need training on that, so, there is a program in Toronto called Hatch, that I'll be like okay, Hatch, I want you to come in, train

me how to ... how to use your software program to teach my students coding so I can make sure they are learning coding. (Transcript 1, p. 4)

Additionally, Mr. Plant chose an alternative way to extend his technology knowledge (TK) and technological content knowledge (TCK) by subscribing to a few educational online sites through social media that promote new ideas and new ways of using Chromebooks in classrooms. He shared his experience about online learning:

Some of the best training comes from other people. So, you need to ... if you have Google in your classroom, you need to subscribe to ... so, I get three emails a week ... you need to subscribe to people who know. And Eric Curtis, you should write that name down. ... He's phenomenal. So, I get email from him saying this is what I am doing, what I am seeing this week, this is what I am producing this week using Google [Chromebook]. (Transcript 1, p. 14)

Mr. Plant also explained his motive behind subscribing other educators:

Make sure you subscribe, follow them on Twitter, do something to make sure that's where your training come through, that's where your new ideas that are gonna come from, right? If I am in here with my classroom, and I don't go to conferences, and I don't talk to other people, I'm not gonna ... I'm gonna do the same thing I'm doing with Chromebook all the time. So, in order for me to improve, how I use Chromebooks, you have to be trained, you have to at least listen to people who are doing good things. (Transcript 1, p. 14)

The lack of formal training in technology use did not stop these two teachers from learning the fast-changing educational digital technology. Instead, they engaged in many alternative ways to become experts in using Chromebooks in their classrooms.

“It is Almost Like Osmosis”

Mr. Page used the vivid word “osmosis” to describe his pathway of learning how to use Chromebooks in his teaching. Osmosis is a biological term describing the scenario of how a particular type of liquid passing through a thin piece of a solid substance such as the roots of a plant (“Osmosis,” 2019). When using this term in an educational context, osmosis can be referred to as gradually or unconsciously exploring, adopting ideas (“Osmosis,” 2019). Mr. Page further explained during the interview that

We basically learn as a staff together using this and use it in our own ways. It almost like osmosis. It's there when we have this tool in our hand. We explore in our...as part of our own professional learning and because the internet's right there, and the software comes to us so quickly. We share ideas amongst each other...these are things where you know I get learn about the resource through a colleague or through a conference or workshop that I've been to and we'll go down and sit down and play around with it, and see how it will fit in within our classroom. (Transcript 2, p. 3)

Mr. Plant described receiving support from a third-party staff member regarding effectively using Chrome Management System. He stated that

the closest (that) I got personally was because I'm the head of technology at school, I had someone come in and show me how to use the Chrome management system, because I wasn't sure about how to use that most efficiently. But everything else, predominantly was just ... use through experience, learn through experience. So, we tried something, in the end it didn't work, or we tried something, it did work, and ... we tell others about it, etc. (Transcript 1, p. 2)

Both participants acknowledged the lack of sufficient technological knowledge due to lack of formal training, and at the same time they both gradually explored, learned, and adopted new technology in their daily instruction.

Responses to Research Question 2

Research question 2 asked: What are some benefits and challenges that Ontario elementary teachers currently experience using Chromebook in the classroom context throughout teaching and learning processes?

Throughout the interview, the two participants have given rich information regarding the pros and cons of using Chromebook in teaching based on their personal experiences with the device. Furthermore, as previously suggested in responding to research question one, both participants were highly satisfied with Chromebook's performance in assisting their teaching and student learning.

Advantages

According to the two participants, the advantages of using Chromebooks in the classroom can be categorized in five sections: saving funds, permitting full control, granting stable and durable hardware, offering seamless and continuous learning, and reinforcing differentiate learning.

Saving fortunes. Prior to introducing the Chromebooks in their teaching, both participants tried several other ICT, such as Mac-based devices and Windows-based desktop computers or laptops. When asked about the reason to switch to Chromebooks, both participants stated the affordability of Chromebooks. For example, as the head of his school's technology department, Mr. Plant was the one who was responsible in finding

the suitable technological devices to enhance students' learning. When recalling his decision to switch to Chromebooks, Mr. Plant stated:

I didn't actually spend a lot of time looking, so, I am the head of the tech department here as well, so, I didn't spend a lot of time looking. ... For us the real selling point was the price point; it was just cheaper than other options, like Microsoft surface, or any type of laptop, it was just much easier, much cheaper.
(Transcript 1, p. 2)

Mr. Page extended on this particular advantage of Chromebooks by stating:

It was pure cost. I think when we were looking at laptops and replacing the laptops that we had that were kind of falling apart. You're looking at about twelve hundred dollars per [laptop]. These ones that we had with the Chromebook ... we test drove with one class being a pilot class for an entire year. Three hundred dollars per student per laptop. We had a one-to-one ratio. It was affordable.
(Transcript 2, p. 1)

The low cost of Chromebooks enabled the mass adoption in schools, and this affordability of the devices were found to be one of the advantages of implementing it in the classroom.

Simple, stable, and durable. One of the main differences between Chromebooks and traditional laptops or tablets is that Chromebooks do not have much on-disk storage, which means it is unavailable to run software on Chromebooks. This also ultimately contributes to the dominant adoption of browser-based apps instead of traditional software that needs to be installed on the disk. Mr. Page found this particular attribute beneficial, as he pointed out that the Chromebook is the “actual hardware I really like

because it takes a charge and maintains a charge for the duration of a school day for the students” (Transcript 2, p. 1). He also pointed out that “the durability of the computer [Chromebooks] ... they’re now in their third year and they work just as well as they did last year” (Transcript 2, p. 2). Mr. Page further elaborated that

They’re robust. They are a little bit slower. ... I also bought Chromebooks for my own children who are in the public-school system and they’ve never had a problem with the speed and it’s the Chromebook that I bought them I bought them over 6 years ago and ... my daughter still uses at Grade 11. I’ve saved myself a thousand ... a couple of thousand dollars just going that route and it’s 6 or 7 years old. It’s ... the hardware is not as important as the ability to just connect to the cloud. That’s just a vehicle to connect to the cloud to use Google Suite as far as I’m concerned. (Transcript 2, p. 8)

Mr. Plant, the head of technology of his school, made a comparison between Chromebooks, MacBooks, and iPads when asked about the device performances. He said that

In an elementary school, I think Chromebooks are fine. I wonder about getting to upper ends, like for ... for example, one of these ... we would never use a Chromebook for that we used our iPads for a lot is ... movies. ... But I would never use a Chromebook for any, any sort of videoing, we still use Chromebooks, but then the editing, you will need ... you can do it a little bit on the iPads, but a MacBook could be better for that. (Transcript 1, p. 7)

Mr. Plant also approved as he added that “for elementary school, Chromebooks are great. I do not think they (elementary school students) need anything really more than that,

because that is what we do” (Transcript 1, p. 7). It is simplicity, stability, and durability that have ultimately made Chromebook a great fit in their teaching practices at the elementary level.

Seamless and continuous learning. When asked about his overall opinion about utilizing Chromebooks in teaching, Mr. Page stated that “it’s a tool that is very seamless” (Transcript 2, p. 1). Chromebooks inherited the legacy of traditional portable devices that one can use anywhere and anytime, as Mr. Plant described: “students can work on stuff at school, and then at home” (Transcript 1, p. 6). On the other hand, it was the adoption of Google accounts that completely went beyond the limitation of both software and hardware. For instance, Mr. Plant suggested that “I found them [Chromebooks] helpful and with more and more things available online, you are not so dependent on any software anymore” (Transcript 1, p. 1). Traditional laptops require one to log in to be able to use and are heavily dependent on the software that has been installed on them. However, Chromebooks enable one student to log off entirely without worrying about losing any progress on the assignment and allows another student to log in immediately after and continue working on his own assignment. The idea of having Chromebooks in the classroom is more like having workstations available to all students at different times. Therefore, it is fair to say that Chromebooks are somewhat heavy-duty because their nature allows multiple classes to use them seamlessly and without losing existing students’ work if the one-to-one ratio cannot be achieved financially.

In addition, due to the overwhelming popularity of Google products (e.g., Gmail, Google Drive), Chromebook is fully capable of using such web-based products on various devices with one single Google account. Mr. Plant further added during the

interview that “my students can do their work, can access their work from everywhere, right? So, when they go home, they can do an assignment as easily at home as they came at [to] school” (Transcript 1, p. 5). The log-in and set-up processes are two groundbreaking sections favoured by the two participants, particularly by Mr. Page, who is a teacher working at a G-Suite school where he noted that they have been “using the Google products in the classroom for a long period of time” (Transcript 2, p. 1); thus, log-in process on Chromebook mandatorily using a Google account worked perfectly for his class, as he stated that “the log in part is really closely connected with the Google Suite [Google apps] that we’ve always had in our school for a long, long time” (Transcript 2, p. 1). Mr. Page further explained that

the log in part is really, really easy. Because when the message goes to the students, you share a link and they log in using their Gmail account. And when they log in using that email account, it’s ... it’s pretty seamless how they can begin to use that resource online. (Transcript 2, p. 3)

He then shared his experience using a web-based video creating and sharing app FlipGrid on Chromebooks:

I’ll give you another example. So, I’ll show you this one here called FlipGrid. This is again so closely connected with Google. When the students want to log in, when I log in with an educator log in, you know I can log in with Google. And when I log in with Google, I use this email and bang—I’m right to the place. When I share, you know something? Student work that I want them to do so I can share that FlipGrid code, and I can put that on as an email. I tell my students, or I can put it on to my class pages which isn’t Google Classroom; it’s something

different. But the students go there and then they ... when they log in as student, they just use their email log in. And then I can collect videos, video evidence of student thinking through these and it basically shows up in to, you know. Here's an example of students that have done. I use this now as an assessment tool, and I can click on each person's work, and I can either do this at home or in the classroom. (Transcript 2, p. 3)

Mr. Page repeatedly emphasized the word “seamless” throughout the interview. He later stated that “the seamless part with Google is so easy because even the log-in part, there's no set up from my point in terms of adding email addresses ... or it [is] just you send them [students] the links” (Transcript 2, p.3-4). Moreover, the seamlessness and continuity of using Chromebooks and Google accounts allowed students to work and study across different platform, as Mr. Page suggested that “[the students] can use their Apple at home because they can use all these things. That ... everything's seamless with any computer because all the information stored in the cloud” (Transcript 2, p. 5).

The use of Chromebooks also helped build closer teacher–student relationships and provided opportunities for immediate feedback. For example, Mr. Plant found that he is more comfortable giving student feedback online. He said that “students can submit assignments online, and I can evaluate them online, I can turn them back online” (Transcript 1, p. 9). It is possible for any teacher to give feedback at any time, and even make direct contact with students. Based on the participants' experiences, it can be concluded that the seamless and continuous nature of Chromebooks and its Google web-based products, and the opportunities for immediate feedback provide ample opportunities to raise students' learning quality.

Keeping students on task. As previously discussed in Chapter 2, modern technology devices with access to the Internet can become great distractors (Rusu & Tudose, 2018; Sahin et al., 2016; Soykan, 2015; Talebian, Mohammadi, & Rezvanfar, 2014). Throughout the two interviews, the two teachers gave several examples to illustrate the strong capability of Chromebooks in empowering teachers to keep students on task.

During the very beginning of his interview, Mr. Page stated that “I like that when the students log in, they’re limited to the spaces where they can go using Google Chrome only” (Transcript 2, p. 1). Later he also added: “I really like the control, that not just the Chromebook has but this Google software that comes with it, how it works for us” (Transcript 2, p. 3). According to Mr. Page, he is using a web-based classroom management app called Hapara— “a tool to monitor students’ progress in the middle of class” (Transcript 2, p. 2). He then offered the following example:

... these are all the files and organized into the four subjects that I worked on. So, these are all their language files ... but also, I can use highlights so what happens here is I’m not sure if teachers use this [Hapara] to their benefit that you’ve worked with; but, there’s all 20 of my students and they’re not logged in right now. But, what will happen is I can see all the tabs that they have opened, and I can physically close the tabs—if they’re working on an independent period. I can also go to, you know, here; I can guide student browsing. So, at the start of the session I can set up a focus session, and when I go into this focus session, I can put in up to 10 links and I can set the duration whether they stick to these whole sites or only the pages that I’ve shared. And it keeps them in those space and they

cannot go anywhere else other than the web pages. So, I can make sure they're only on the web pages that I've asked them to be on. (Transcript 2, p. 2)

Mr. Plant, as the head of the technology department in his school, has richer experience regarding controlling the ICT use on both the students and even the whole school. On the general level, Mr. Plant and his school are using the Chrome Management Console to manage all the Chromebooks and their Google products and services on site. Chrome Management Console—the Chrome-based (browser) managing system mentioned earlier in his words that required him to be trained by an off-school staff—is a powerful tool (the educational version) for school administrators to manage Google devices and services in school contexts. Mr. Plant highly endorsed the Chrome Management Console; as he described:

You can't disregard the Chrome Management System. It is fantastic ... I have the ability from here to control what apps are on all the Chromebooks, what websites are loaded, what they can access, what they can't access, and that all through this program. And that for me is a huge advantage. So, I can push things out to my students ... I can do enrollment. [The Chrome Management System] can also allow or ban guest mode. So, it's for their protection and school protection. Protection is well ... what can I keyboard ... what apps that are allowed ... what is shut down right away and then if I go back one again ... here, now because all these are for my users, so, they sign in, even at home, some of these stuffs still applies to them, ... and then safe browsing, all kinds of things, what their home button is, what ... they are allowed Java Script to run, what things are on their

bookmarks, all kind of things. So, this is being really, really helpful. (Transcript 1, p. 8)

Additionally, Mr. Plant indicated that only three people including himself in his school have access to this console. He explained that he does not “want people to have access to change things that don’t need to be changed” (Transcript 1, p. 8).

While inside their classrooms, Mr. Plant and other upper elementary teachers on the second floor were using another web-based Chrome management system named GoGuardian. According to their official website, GoGuardian is a web-based classroom filtering and managing solution that designed specifically for education without installation and maintenance across Chromebooks and many other platforms. Similar to the Chrome Management Console, GoGuardian enables teachers to build up a safe environment for students to use Chromebooks or any other ICT devices. Mr. Plant bought GoGuardian for every teacher upstairs who was using Chromebooks in their teaching. He further explained that

as a school, we bought a program called GoGuardian. ... And with GoGuardian, if I go to my computer, and I log in, I can see what’s on each of their screens from my computer. I can actually see their screen. It’s a great program, I keep ... telling people they have to get this, if you get Chromebooks in your classroom, you have to get GoGuardian, because otherwise it’s impossible, right? It’s impossible to register. So, what’s nice about GoGuardian is also ... sort of like a firewall as well, so, it will not allow certain sites, it will ... so, I can tell that not to allow students to go onto this site as well. So, it can block programs, it can block websites as well. (Transcript 1, pp. 10-11)

Mr. Plant further shared his story using GoGuardian when teaching with Chromebook:

One day about 3 weeks ago, my son was sick. So, I had to stay home with him.

And it was a substitute teacher that day. From home I logged in GoGuardian, and I can close, so, I can close their tabs. So, I am at home and I look on my student in this math class, this student is play Survive, Survive.io, right? They are playing a game. So, click, close; click, close; click, close. He's shopping online, right? He's buying shoes. Click, close; click, close. (Transcript 1, pp. 10-11)

The combination of utilizing Chrome Management System and GoGuardian has offered satisfactory services to Mr. Plant and his colleagues in teaching with Chromebooks without bothering them spending extra time in installing the software.

A vast selection of web-based apps shows up when searching keywords "Chromebook classroom management system" or similar. Hapara, the other web-based management system employed by Mr. Page, is a famous and successful app among its many rivals. It is notable to mention that Hapara works better for Mr. Page since he is focusing more on teaching with Chromebooks; while the Google officially supported and updated Chrome Management System makes more sense to Mr. Plant as he not only needs to teach his students using Chromebooks but also is obligated to manage his school's technology infrastructures. Overall, these two additional management software applications have contributed to both participants' effective classroom management strategies.

Promoting differentiation and creation. With Chromebook and its endless online tools and apps, Mr. Plant and Mr. Page found it easier to personalize the students' learning and stimulate students' engagements in various learning activities. Mr. Plant

found it easier in differentiating his teaching, as he described:

For some students, [Chromebook is] very helpful. Differentiation is really good with Google Chrome, with Chromebooks. You can differentiate ... I feel you can differentiate easier. For example, on those book reports, right? You can differentiate because ... students can find what they are better at easier. So, for example, for the Comic Strip, right? For some students, drawing it would be a nightmare, they couldn't do it. but having a technology available that they can imagine that out, that's way better for them. So, differentiation is really good with Chromebooks. ... With this app, they create a book report. So, they read a book, and they create a [book report] ... this is where differentiation comes in, all right? ... They had options. (Transcript 1, p. 9)

The use of Chromebooks and its accompanying apps enables students to choose their favoured ways to learn and get involved in different learning activities rather than working on endless work sheets. Mr. Plant further explained that

[showing another student project] This student did a ... oh ... they had to find songs that go with these different points. So, YouTube links, right? Find me the song that goes with this and goes with that. This student typed out a diary, okay? This student did a Comic Strip. So, variety of different things. Now, this student was comfortable in writing, so they said [using speech-to-text app] and wrote it all, because this is what they wanted to do. (Transcript 1, p. 9)

Therefore, in Mr. Plant's class, his students were able to customize their own pathways toward the learning goals. Later during his interview, he concluded that "I feel one of my jobs as a teacher is to help the students to understand their gifts, right? Their

abilities. Chromebooks allow me to do that differently, possibly even better”

(Transcript 1, p. 11).

Mr. Page also provided several examples regarding using web-based apps or Chrome extensions to promote differentiated instruction and creative learning. For example, he described his experience using FlipGrid, an educational web-based app that allows students and teachers to communicate through posting videos:

I use this FlipGrid at the end of a language arts lesson instead of students recording things with pen and paper. Use this as my assessment tool for students to record it as a video response to a question. ... The question was ... select a section of your novel where you felt the greatest amount of suspense likely in the fourth or fifth section that you read. That was how we divided up our novels. Share the page number, read this part out loud and explain how the suspense problem conflict at this part of the novel was resolved. So that was the actual question that came up on the screen and then they recorded themselves doing that. ... After they went through the whole actual language arts activity, which was 25 minutes, they had 10 minutes at the end of the activity to create or do this video and share their thinking at the end. For me it's just being brilliant to have the video access it from a special education standpoint to allow every student the opportunity to present their thinking and so those students that have difficulty putting their brain and ideas on the paper, videos being helpful.

(Transcript 2, p. 16)

Moreover, Mr. Page shared more stories about using apps on Chromebooks, as he described:

I use Google slides. I think (Google Slides) is an amazing way for students to

create social studies or science projects on there. There's also the video we use an extension called Screencastify where the students can create videos using the slides. ... But every day where we use such a very wide way even as a source of them doing research. It's just not ... it's not the same everyday if that makes sense to you but it's just one of those things that I would say is out on their desks about for 40 minutes a day or so it used as a tool to create. (Transcript 2, p. 9)

Chromebooks also helped Mr. Page and his students to maximize their learning experiences when otherwise they would be restrained by factors such as time and place. He gave an example of him using Gizmo, a comprehensive online learning platform:

Gizmo - it's very hands on. We can create construction situations and creation situations about learning science that can't happen. As efficiently as if we're to have a class discussion or whatever nothing will replace that actual hands on learning and science, but they can definitely create a virtual experience using microscopes for example on Gizmo when we did our human body thing and try to examine cells. There were a lot of interactive microscope tasks which dovetail really nicely with the actual microscope use that we did do but that only happened during one period. (Transcript 2, p. 16)

Moreover, Mr. Page believed in the opportunity for Chromebooks to continue to grow, as he mentioned that "every year these additional extensions get better and better and better" (Transcript 2, p. 6). With such room to improve, using Chromebooks in the classroom will bring more benefits to students and teachers. Based on their shared experiences, both teachers found beneficial using different apps on Chromebook in differentiating their instruction and providing students with multiple options for learning.

Challenges

“It’s cat and mouse.” Although the two participants were overwhelmingly satisfied with Chromebooks as their in-class ICT device; they also shared their opinion about challenges and difficulties teaching with utilizing Chromebooks in their teaching practice. In the present study, one great challenge when utilizing Chromebooks in the classroom has been heavily emphasized by both teachers: the demanding effort from teachers to monitor students minimizing unproductive screen time. Mr. Page told the researcher that

I think one big problem is how kids are wired today. I think we’re using technology a lot and the kids have too much screen time. So, when I’m running my classroom, I have to justify the screen time that I have to make sure it’s productive screen time because I ... they are can be easily distracted by technology too. (Transcript 2, p. 12)

He then elaborated the real challenges and classroom management issues he has experienced. Mr. Page stated that:

We’ve had some pretty significant incidents at the start of our year with students watching a YouTube video or all having YouTube video and possibly having too much control themselves and us not having enough and students writing inappropriate comments on ... YouTube about the video and it goes public. It goes live. ... Challenges I’ve had in the past is they can use email inappropriately. They can put out massive emails to the whole school with something that is ... was putting out just to play around is bad enough but can become disruptive in terms of being inappropriate content. (Transcript 2, p. 12-13)

Ultimately, these incidents have contributed to the design of the contract that Mr. Page and colleagues created with their students and posted in every classroom (Figure 6). According to Mr. Page the students in his school are required to sign and to respect the contract when using Chromebooks at school. However, when misbehaviours occur, Mr. Page and his colleagues have to take a series of actions, as he described:

Step number one is to go through and notify parents, explain that the learning is going to be impacted, or it's going to look different than their classmates who are all using Chromebooks. I could use it responsibly but I do think that yeah there is ... those moments where students in all cases misuse digital technology whether it's a Chromebook or a phone or an iPad to, to do harm rather than good ... irresponsible bullying ... all those things. (Transcript 2, p. 12)

The second step to take when misuse of technology happened was to suspend the use of Chromebooks to prevent further misbehaviours. Mr. Page further pointed out that during his instruction, distraction occurs very frequently, as he expressed “during my instruction, it's just to correct and redirect, and it happens fairly frequently, it's cat and mouse [game]” (Transcript 2, p. 14). He again emphasized that the cat and mouse game in which generates misuses of Chromebooks was the biggest challenge in his teaching, as he stated that “the temptation to go to other places absolutely is challenging” (Transcript 2, p. 15). He described what usually happens under such a contract when misbehaviours occur:

[Students] are knowing that it's a tool that can be used and it is possible for them to stray away but it's also easy for them to be held accountable. So, when they do stray, we have our discipline moments. Some kids that are tempted to go on a website which they haven't been given permission to go to, will have their laptops taken away from them for a certain period of time. (Transcript 2, pp. 10-11)

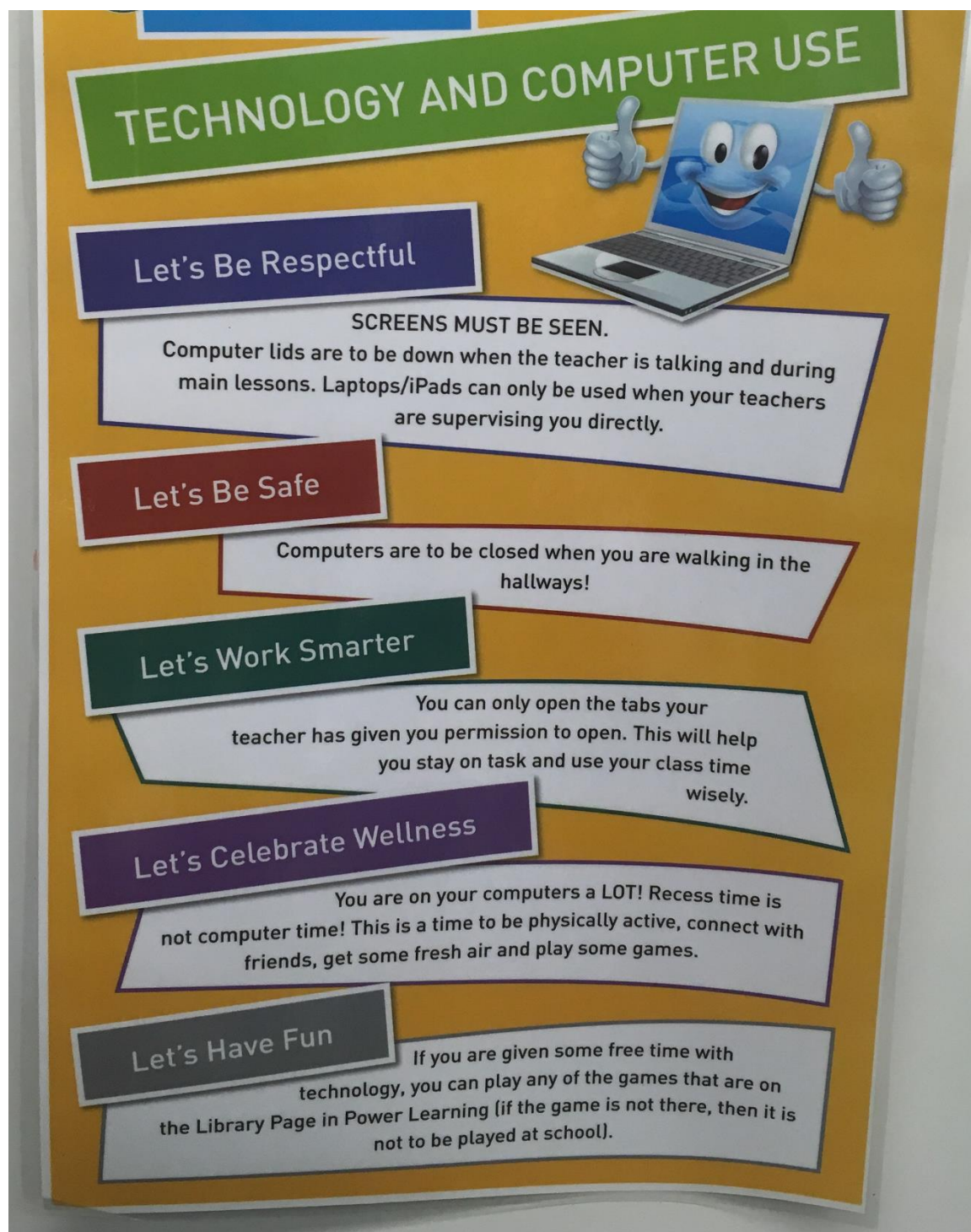


Figure 6. Contract created by Mr. Page and associates with their students, as posted in every classroom.

Mr. Plant experienced the same challenges in his classroom. His earlier-mentioned experience of using GoGuardian to keep his students on track is one convincing evidence that proved he played the role of cat in his class. He also mentioned:

The biggest difficulty is making sure your students are on task. Okay? So, in this classroom, they all ... you see how they are sitting. So, they sit with their Chromebook like this, I can't see what's on their screen. Okay? And when I walk around, Grade 8s, right? They are smart enough to go, oh, well, shift next tab, okay? So, you have to think ahead of them. ... So, that's ... the biggest difficulty I would say, for sure. The biggest challenge is just trying to keep them on task.

(Transcript 1, p. 10)

Mr. Plant giggled when talking about dealing with one specific student of his class in the cat and mouse game:

This is the student who has difficulty focusing with the screen in front him, he'll always try to do something else anyway, so, I will typically have that on almost right away. So, anytime I log in, I see the screens, if there's going to [be] something, click, close, click, close. (Transcript 1, p. 11)

It can be affirmed that students' temptation of browsing non-academic content rather than learning was the tremendous challenge to both participants, which resulted in applying different classroom management strategies to ensure that their students are on task.

Quality assurance on apps. Due to his role as the head of the Information Technology (IT) department in his school, one part of Mr. Plant's job is to determine what apps he and his team are using on Chromebooks. Mr. Plant talked about the

challenge that he and his class are constantly facing in searching for and finding the apps with quality educational content. As he explained,

before we bought Chromebooks at the school, we bought the iPads. So, we have 20 iPads in the school as well, I really like the apps on the iPads better. I found they are more well-organized, and they are ... just simply better. The apps on Chrome, for example, the Chrome Store, the web store, there's a whole lot of...just crap on there. Just not very good stuff. That you can buy, you can download, you can try to use it with the students, so, it takes ... this disadvantage is you have to do a lot more sorting out of what's good and what's not, as opposed to on an iPad. On an iPad if you look at the list of apps, chances are most of them are pretty good. On a Chromebook, if I'm looking for ... let's say ... voice recorder, right? On a Chromebook. I have to sort through 15 different voice recorders, and all those, five will have advertisements, five will not be good, and five will be good. And it takes a lot more to ... sorting out which ones are good and which ones aren't. (Transcript 1, p. 5)

Aiming to add further details to this point, Mr. Plant shared another example:

One of ones recently, for example, and my students help with this, right? Is trying to find ... so, talking about grammar again, they still, some of my students don't know how to make complete sentences, right? ... When they typed out, they don't think about what they are typing, all they need is for something to read that paragraph to them, and they go, oh, here's a mistake, right? And you've done that too, right? If you read aloud what you wrote, you are going oh, that's a mistake, that's a mistake, that's a mistake. ... So, as a class, we said, okay, let's try to find

an app that going to do text to speech, and it was not easy; [chuckling] it was not easy, right? We found one with advertisements, right? That we had to get rid of; one that didn't do it right, and one that worked, right? (Transcript 1, p. 13)

Oppositely, Mr. Page was using apps on Chromebook that have been examined by his IT department. He explained to the interviewer that when adding new apps or extensions to their Chromebooks, "it's gotta be something that's used and tried tested and true" (Transcript 2, p. 11). Overall, Mr. Page praised his IT department for assuring the quality of apps they were using on Chromebooks, as he noted that he felt "totally supported amongst our IT department" (Transcript 2, p. 5).

In this section, two side effects of using Chromebooks in class have been presented with convincing evidence from two in-service elementary school teachers. In the next section, the participants proposed several suggestions in order to improve Chromebook experience according to these disadvantages they faced in their daily teaching.

Responses to Research Question 3

The purpose of the third research question of the present study—What future features/improvements do Ontario elementary teachers recommend for Google Chromebook? —was to investigate what features or improvements that elementary school teachers would like to have on their Chromebook in the future. In response to his statement earlier when discussing the disadvantages of using Chromebook in his teaching, Mr. Plant called on the need for a better filter system on the Chromebook and its app store. As he explained,

They need someone in Google, right? Who, when someone puts an app up, right? Says that app's not good, get rid of it. That app's great, that's useful, let's keep

it. ... They need someone to do that more. Because there are so many apps out there, and a lot of them, like I said, five of them will have advertisements on them, five of them will be lousy, and five of them might be good. And this one's the best one, so you should use this one. (Transcript 1, p. 12)

Teachers and students will eventually produce more when they no longer need to take time and efforts to find appropriate apps that fit for their learning.

When asking the same question to Mr. Page, he did not give much information about the features and functions that he would have to be able to experience on Chromebook, as he was very satisfied with the Chromebook as the hardware and Hapara (the web-based management app) and other apps such as Gizmo and FlipGrid mentioned earlier that he was using all the time. He explained:

this software [Hapara] here is the most benefit and it is ... it's a matter of anything that we can create on our laptops to grade you know, Grade 3, 4, 5, 6 to really channel and focus student thinking and work as an on-task behaviour is the best thing possible. I don't know what that looks like, but I think a Hapara is the closest thing that we have. That is the most valuable tool. (Transcript 2, p. 15)

Mr. Page's case also could have been influenced by his identity as an upper-elementary teacher, while Mr. Plant works both as a Grade 6 teacher and the head of IT department in his school that consequently made him research and reflect more on the use of Chromebooks, as well as their daily use Chrome-based apps.

Field Notes

Two private school elementary teachers participated in this study. The first participant, Mr. Jimmy Plant (pseudonym), is a male Grade 6 teacher who has taught for 20 years and currently works at a private elementary school in the Niagara Region,

Southern Ontario. Mr. Plant also serves as the vice principal and the head of the technology department at his school, which made him the perfect person regarding the nature of the present study.

The researcher met Mr. Plant for an interview which lasted for 56 minutes at the private school in the classroom on the second floor where Chromebooks are being used. The school is located in the centre of the city; it serves its nearby community from kindergarten to Grade 8. According to Mr. Plant, the upper levels of elementary schools (Grade 6 to Grade 8) were using Chromebook while a computer lab equipped with a sufficient number of desktop computers was being used by students from Grade 1 to Grade 5. iPads also served in this school for multiple purposes, such as music and video editing. Mr. Plant explained to the interviewer:

We started with a class set that we shared, and with [Grades] 6, 7, 8, and we noticed pretty quickly that it was difficult to schedule time for your class to use it, cause every class wanted to use it all the time. So, over the next 4 years, we managed to purchase enough for one-to-one in Grade 6, 7, then 8. It took a while, but we just built up slowly. Last year, we actually retired the first set of Chromebooks that we bought. (Transcript 1, p. 1)

The second participant, Mr. Robert Page (pseudonym), is a male Grade 5 teacher who has 22 years of teaching experience and currently works at a large independent school with more than 600 students and several castle-looking stone-built buildings surrounded by tall and solemn pine trees. Mr. Page was waiting at the main entrance when the researcher arrived at the school. Then he led the researcher into the building, and the two had a 51-minute interview in Mr. Page's classroom.

Unlike in Mr. Plant's situation, all students in Mr. Page's school have their own Chromebook, which means they have achieved one-to-one ratio on their selected classroom technology regardless of grade. Nevertheless, Chromebooks were only available in the classrooms in both schools. Students were not allowed to bring Chromebooks home; thus, they were using different technology devices such as laptops, Chromebooks, and desktop computers when at home.

Summary of the Chapter

This chapter presented and analyzed different elements. The first section discussed the positive attitudes of the two participants toward using Chromebooks in their teaching; in the next section, the researcher described their satisfying experiences and a few unpleasant memories of utilizing Chromebooks in their classes. The advantages of utilizing Chromebooks included saving educational funds, permitting full control, granting stable and durable hardware, offering seamless and continuous learning, and reinforcing differentiated learning. The challenges these two participants had encountered were having too many commercials and the too-frequent need of leading students back to their study. The last section revealed demands from in-service private school teachers in order to improve their Chromebook experience, as the one participant demanded a better filter system on Chromebook apps.

The next chapter presents a discussion of the collected data in the context of the proposed research questions. The implications of this study's findings will be assessed, and the future research directions will be provided.

CHAPTER FIVE: SUMMARY, DISCUSSION, AND IMPLICATIONS

This chapter first presents a discussion of the collected data in the context of the study's research questions. The implications of this study's findings will be assessed, and the future research directions will be provided.

The major purpose of this study is to explore Ontario teachers' experiences using Chromebook in their instruction, as well as to address the benefits and the possible challenges of using Chromebook in the classroom. This research has been conducted following a qualitative case study design to explore Ontario elementary school teachers' experiences in terms of teaching with Chromebook as the classroom digital technology. Through the interview process, two elementary school teachers critically reflected on the use of Chromebook in their teaching practice and shared their experiences with the technology in the classroom.

Discussion and Implications

The following discussion and implications reflect upon three guiding research questions with the discussion informed by the analyses of obtained data. Throughout the two interviews, the participants offered the present study rich data concerning their Chromebook use. Two interviewed participants used the opportunities to share their critical perceptions of the benefits and challenges utilizing Chromebooks in teaching. Their insightful thoughts will remain an inspiration for future educators working with ICT.

Theoretical Framework: TPACK

The Technological Pedagogical and Content Knowledge (TPACK) is a theory that explains the set of knowledge educators need to have in order to teach effectively with

suitable technologies via effective teaching strategies, as well as learning approaches (Bingimlas, 2018; Chai et al., 2013). It was generated from combining technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological content knowledge (TCK). Moreover, TPK comes from overlapping technological knowledge (TK) with pedagogical knowledge (PK); PCK is derived from overlapping PK with content knowledge (CK); and technological content knowledge (TCK), which is derived from overlapping TK with CK.

Among these elements, TK refers to the general knowledge of a teacher towards various forms of digital technologies, as well as the skills of how to operate with them (Bingimlas, 2018; Chai et al., 2013; De Rossi & Trevisan, 2018; Koehler et al., 2013; Vickrey et al., 2018). This type of knowledge is the reflection of the familiarity of ICT devices of any teachers; more importantly, TK is the one crucial factor that directly influences teachers' attitudes toward using Chromebook and any other digital devices in class. According to Baylor and Ritchie (2002) technology integration in the classrooms will remain at an unproductive level if the instructors do not have the necessary skills and knowledge to support themselves to infuse technology properly into instructing. Sahin et al. (2016) suggested that teachers need appropriate and sufficient training before they can implement technology in their teaching. Otherwise, the use of ICT in the classrooms will be limited if teachers do not have adequate knowledge and experience regarding technology use (Lim & Khine, 2006, as cited in Sahin et al., 2016).

The participants in this study did not have any formal training due to the absence of modern technology when they were preservice students. Williams (2017) suggested that "in-service teachers have had varying degrees of technology experiences from their

teacher education preparation programs to professional development training ranging from no experience to applicable experiences to help foster transition into classroom teaching and learning” (p. 15). In other words, these teachers typically have little or insufficient technology knowledge (TK), the type of knowledge mentioned earlier in the literature review chapter.

The lack of TK may also contribute to the lack of technological content knowledge (TCK). TCK is a type of knowledge about “how to use technology to represent/research and create the content in different ways without consideration about teaching” (Chai et al., 2013, p. 1044). Teachers who do not have enough TK to support their daily in-class technology use will have difficulty using such technologies devices in their course content delivery. TCK is vital in the TPACK model because contemporary teachers need to be equipped with this knowledge to combine their content knowledge and deep understanding of what forms of modern technology can be used to improve or constrain their teaching performances and students’ learning (Koehler et al., 2013). Take an example of Chromebooks; teachers who do not have adequate TK will be less likely to know how to operate the Chrome system and the apps on Chromebooks such as Gizmo and FlipGrid. Both participants stated that the way how they learned using such apps were like “osmosis.” It would be not hard to imagine that these teachers will be more likely to encounter challenges and difficulties when teaching with Chromebooks due to insufficient TK. Therefore, teachers not only need training on their TK but also need training in TCK.

TK is the foundation that every teacher should have if teaching with Chromebooks; TCK, on the other hand, is the advance knowledge that requires teachers

to master and perform effectively using Chromebooks and the apps on Chromebooks in their particular teaching (Koehler et al., 2013). Moreover, according to Mishra and Koehler (2009), “teachers need to master more than the subject matter they teach; they must also have a deep understanding of the manner in which the subject matter can be changed by the application of particular technologies” (p. 65). Based on Mr. Plant’s experience, teachers today require both types of knowledge to maximize their use of any digital devices in the classrooms. Another example from Mr. Page’s case was his use of Gizmo. Mr. Page told the interviewer that through using Gizmo, he and his students “can create kind of construction situations and creation situations about learning science that can’t happen” (Transcript 2, p. 16). Meanwhile, through his learning of Gizmo’s use, Mr. Page has further developed his TCK in his teaching profession, which subsequently benefited himself in teaching and his students in learning.

More importantly, teachers’ attitudes toward using Chromebooks or educational technology in general are profoundly affected by their diverse levels of TK and TCK. For example, attending different training and being involved in self-learning, these two participants gained sufficient TK and TCK; more importantly, they have become more confident using Chromebooks in their teaching. Mr. Plant mentioned that “I would feel very uncomfortable teaching it without knowing exactly what I am doing” (Transcript 1, p. 4). Moreover, teachers are more likely to integrate ICT into their instructing if they have favourable attitudes toward digital technology (Sang et al., 2011, as cited in Shin et al., 2014). Both participants expressed those favourable attitudes toward using Chromebook in their instruction and were willing to learn new technology on their own.

The present study also highlighted the importance of integrating TK and TCK development in preservice teacher training emphasizing the need for learning the new technologies in educational context (Sutton, 2011). Williams (2017) suggested that “An effective training system in teacher education programs should be implemented to ensure that, with the presence and introduction of new technology in the classroom, the teachers are equipped with newly developed skills” (p. 15). Teacher college programs should become the birthplace for teacher candidates to develop their authentic TK and TCK in an educational context. Therefore, universities and colleges should update their teacher programs in order to better serve teacher candidate with up-to-date technology training to foster their technology integration in future teaching.

Pedagogical content knowledge (PCK) in the TPACK framework refers to the knowledge that comes from the transformation from content of specific subject matter into pedagogical forms that could be adapted by learners in their favour (Bingimlas, 2018; Chai et al., 2013; De Rossi & Trevisan, 2018). Teachers need PCK to achieve better use of Chromebooks, because PCK also helps teachers recognize teaching and learning strategies that are suitable for their students, and design teaching practices to present particular content knowledge through such pedagogical strategies to the learners in a more understandable manner (Bingimlas, 2018; Chai et al., 2013; Vickrey et al., 2018). The present study showed that the two teacher participants had demonstrated their PCK through working with Chromebooks. For example, their differentiation in teaching with Chromebooks reflected their PCK growth. According to Beasley and Beck (2017), “whether teachers differentiate content, process, products, or the learning environment, the use of ongoing assessment and flexible grouping makes this a successful approach to instruction” (p. 551). In the present study, differentiation happens at the processing stage

when students are encouraged to use Chromebooks to produce various assignments and products. When discussing utilizing Chromebooks to differentiate his teaching, he introduced the researcher his “book report” project. He offered his students several options to produce such book reports on Chromebooks: they could create comic strips, story boards, video clips, and many other forms of outcomes rather than traditional paper-based working sheets. He explained that “we all know the assignment’s almost the exact same as when before we had Chromebooks, where I said, okay, here’s a book report, you need to either make a comic strip, or ... [Chromebook use] is just easier for them” (Transcript 1, p. 6).

Mr. Page’s case can also help explain his PCK growth:

I say to [the students] that takes a lot of time and a lot of preparation and after the planning is finished, out comes the [Chromebooks] where they can begin to draft and drafting is about just getting ideas down on paper, and I want them to go quickly not worry about spelling, not worry about grammar, not worry about punctuation. So, it’s changed my approach to the writing process. And after the draft is done then there’s a lot of time spent editing and the Chromebook allows the students when they’re using Google Docs to edit. (Transcript 2, p. 7)

In this case, Mr. Page’s focus has switched from more traditional way of learning when students are using pen and paper to work on Chromebooks and not to be conscious of grammar and punctuation; thus, his students can spare more energy emphasizing on their writing content.

Similarly, the earlier-mentioned use of classroom management software also contributed to the PCK develop of the two teacher participants. For example, Mr. Plant was using Google Chrome Management System to manage the Chromebook use and

Google Apps for Education (GAFE) use within his school. Within his classroom, he was using Google Classroom to assist his teaching. Mr. Page, on the other hand, was employing Hapara as his classroom assistant, which supported him to manage his class. All these types of Chrome-based software enabled the two teacher participants to switch their work weight from surveilling student to thinking of further differentiating their teaching caters to various student needs.

Utilizing Chromebooks in Everyday Teaching

Attitudes. Previous literature review suggests that teachers' attitudes toward integrating technology devices in classrooms vary due to multifaceted factors (Levin & Wadmany, 2008; Sahin et al., 2016). Through their interviews, the two participants held very favourable attitudes toward using Chromebooks in teaching. Sahin et al. (2016) noted that teachers might generate negative attitudes toward educational technology use in classrooms when they are not confident enough to teach with digital technology. However, the two teacher participants overcame this challenge through their continuous training and learning on Chromebook use. Combined with the advantages of the Chromebook use, the two participants not only produced effective Chromebook use but also consequently developed positive attitudes toward teaching with Chromebooks.

Advantages. Three significant benefits of utilizing digital technology in the educational context were recognized and discussed in the literature: (a) creating an unprecedented mobile learning environment with the accessibility of comprehensive learning materials (Rusu & Tudose, 2018; Sahin et al., 2016; Windschitl & Sahl, 2002); (b) promoting learners' motivation and engagement during their learning processes (Beeland, 2002; Currie, 2016; Sahin et al., 2016; Soykan, 2015; Woloshyn et al., 2017);

and (c) enhancing their learning experiences from pre-installed or downloaded educational software programs (Ahlfeld, 2017; Quinn, 2016). The two participants in the present study proposed in total five advantages from using Chromebooks in their teaching: saving funds, keeping students on task, granting stable and durable hardware, offering seamless and continuous learning, and reinforcing differentiated learning.

Among these merits, offering seamless and continuous learning can be matched with the first advantage from the literature in which students and teachers can work on both multiple platforms anywhere anytime including Chromebooks and their own digital devices (e.g., smartphones, laptops) due to Chrome Cloud use. Furthermore, because of the use of Chrome-based Chromebooks, students are able to access tremendous online database to seek for learning materials (Rusu & Tudose, 2018; Sahin et al., 2016; Windschitl & Sahl, 2002). For instance, Mr. Plant stated that “but now, with everything moving more and more online, it is easier to find programs that my students can use online as well, and even turning assignments in, stuff like that has been really helpful as well” (Transcript 1, p. 1). Therefore, his students have benefited from utilizing Chromebooks in their learning.

Moreover, these two participants were overall highly satisfied experiencing the apps on Chromebooks as suggested in the literature that teachers and students benefit from various educational apps (Ahlfeld, 2017; Quinn, 2016). For example, Mr. Page recommended Hapara while Mr. Plant gave credit to the Chrome Management System. These classroom management apps were found very useful in both participants’ teaching. Chung and Ackerman (2015) suggested that classroom management software helps “facilitate communication both between student and instructor as well as between

students themselves” (p. 221). However, in this study, this benefit has been extended as the two participants both used Hapara and Google Classroom to keep their students on task. For example, Mr. Plant and Mr. Page were able to physically shut down the unrelated websites their students were browsing; besides, they can also offer constructive suggestions and opinions to direct their students using Chromebooks to browse appropriate websites and learning materials as well. Also, the present study has demonstrated that Chromebooks are affordable in pricing (Ahlfeld, 2017; Demski, 2012; Kimmons et al., 2017; Quinn, 2016; Sahin et al., 2016).

Lastly, the participants have offered their convincing examples of differentiating their instructions by using Chromebooks in their teaching. For example, Mr. Plant pointed out that using Chromebooks in his teaching has contributed to the generation of various educational outcomes. In other words, by using Chromebooks in their class enables teachers to adjust instruction to meet individual desires (Beasley & Beck, 2017). His students were also able to experience multiple pathways on one assignment and produce different outcomes, such as when producing a book report using Chromebooks, they were offered alternative choices including writing up a traditional paper-based report, creating videos, and drawing electronic comic strips. In Mr. Page’s case, his students who were not good at putting their thoughts on paper had the opportunities to create videos to present their thinking.

Finally, although the present study did not suggest any explicit evidence regarding the use of Chromebooks in promoting students’ learning motivation and classroom engagement (Beeland, 2002; Currie, 2016; Sahin et al., 2016; Soykan, 2015; Woloshyn et al., 2017), several points from both interviews can be considered in supporting this idea.

For example, by using Chromebooks, these two teachers were capable of differentiating their teaching. Subsequently, the students could customize their pathways of getting educated and eventually become more active and more motivated in their learning.

Disadvantages. Three major disadvantages of using digital technology in the classroom are addressed in the literature. First, digital technology can cause some distractions to learning (Rusu & Tudose, 2018; Sahin et al., 2016; Soykan, 2015). The second challenge that frequently occurs according to the literature is that teachers are constantly disturbed by technical and infrastructure problems that appeared on their employed digital technology. The last difficulty addressed by several researchers indicated that using digital technology in teaching and learning may cause learners to have inadequate socialization (Nicol et al., 2018; Rusu & Tudose, 2018; Soykan, 2015; Zsoldos-Marchis, 2017).

Two participants' experiences with Chromebooks are in line with two major challenges outlined in the literature. They both agreed that the biggest challenge was leading students back to their tasks because Chromebooks provide options to get students to content other than course-related content. Both participants emphasized the use of Chromebook to students is a great distractor even though it offers students and teachers generous benefits. Mr. Page and his school developed a contract posted inside classrooms that warned students all the time that they could lose their privilege of using Chromebooks by disobeying the contract rules. Mr. Page believed this is inevitable when teaching students to learn the responsible use of technology. He stressed the importance of learning responsible use of technology and embracing technology for good rather than just for pure play—this conflict generated from having too much screen time and being a

fully-skilled digital citizen. Therefore, teachers have vital opportunities to guide students using digital devices and the Internet. When conflicts occur (e.g., Internet bullying, inappropriate comments), teachers need to help vulnerable students get back to the right track. In other words, teaching with Chromebooks is not a simple job that is focused merely on delivering course content electronically; instead, teachers must be the shepherds who observe, alert, remind, and intervene students' Chromebook use within the classrooms and campuses. During his interview, Mr. Plant offered the researcher his insights on this same topic:

What I tried to do is trying to make sure I don't use GoGuardian for only negative reasons, right? Don't do this, don't do this. If I'm looking at their screens, I can also say, hey, I notice you are on this website, this is really good, make sure you look at this information here, okay? Or, if they are typing something up, like a word document, like Google Docs, I can say, oh, you shouldn't use that word, you should this word instead. So, that's ... you try ... you try to make sure you don't use GoGuardian for just negative things, but also for positive things to help the students as well. (Transcript 1, p. 11)

Digging deeper in his words, the implication is that the role of teachers in a digitalized classroom is not to just stare at the monitor to try to catch the mouse; instead, they must use their privilege as supervisors in two ways: to guide and facilitate students' learning, and to teach them to be critical consumers of technology. In the present study, both teachers were using different classroom management apps to avoid the distraction and to keep students focused on the assigned task. For example, they set up firewalls on Chromebooks to prevent access to unnecessary websites.

The other disadvantage was evident in Mr. Plant's experience. He pointed out that he and his students had difficulty finding working apps with educational context on Chromebooks, and they have to waste time seeking appropriate apps. His case aligned with what Sahin et al. (2016) noted that teachers who work with Chromebooks were lacking proper technical support. By contrast, Mr. Page did not encounter this challenge due to his adoption of web-based apps that are recommended, filtered, and tested by the IT department of his school.

According to Soykan (2015), the most prominent challenge teachers and students encountered while using Chromebooks and other ICT devices was technical infrastructure problems. Nonetheless, these two teacher participants did not mention that they experienced any technical and infrastructure problems. It can be concluded from their interviews that first, both teacher participants have had authentic training regarding using Chromebooks; the other reason was that Chromebooks have a simple system and require minimum supports (e.g., Wi-Fi). Although Mr. Plant expressed his concern about students' overusing Chromebooks and ultimately developing a dependence on such devices, the teacher participants did not share in detail their perspectives in the context of students lacking adequate socialization.

Implications for Practice and Future Research

For teachers who are using Chromebooks in their classrooms, the present study indicated the advantage of using web-based apps, such as Gizmo and FlipGrid introduced by Mr. Page. These browser-based apps are better suited for Chromebooks in which they occupy fewer commercials and need no installment. Teachers and their IT department staffs should carefully investigate apps before school-wide adoption. Also, the present

study highlighted the importance of employing management apps in helping maximize classroom control. For example, Mr. Page used Hapara to achieve real-time monitoring and managing the class. As the head of his IT department, Mr. Plant used Google Classroom to interact with his students; in addition, he employed Chrome management system to assist him in managing the whole school by clicking the mouse. IT staff should choose appropriate management apps depending on their sizes and needs to maximize the Chromebook use on site.

Additionally, school principals and administrators can also learn from the present study that in-service teachers need support from board level. Teachers should be encouraged by the school board to attend educational technology workshops, conferences, and programs. Success experiences of utilizing Chromebooks should be shared among teachers and schools.

Finally, there is a need for researchers to continue studying the use of Chromebooks and other digital technology to benefit students and teachers. In addition, these digital technologies should be studied on how to challenge current teacher pedagogy to seek better ways to deliver course content to students, as well as to implement innovative teaching methods for 21st century students. Furthermore, in-depth and comprehensive research of developing training programs for in-service and preservice teachers in the context of utilizing digital technology in education is necessary. Taken together, they will maximize the use of Chromebooks and other ICT devices.

Conclusion

The two Ontario private school teacher participants invited in this research study have offered very rich and unique perspectives concerning their 5 or 6 years of

Chromebook use. In Chapter 1, the researcher introduced the reason to conduct the present study—to make a follow-up investigation to teachers who are using Chromebooks in their teaching. A brief historical review of utilizing technology in education started the second chapter, and then the researcher used much ink to find supporting evidence throughout the literature to predict the possible answers from the participants. Additionally, the conceptual framework—TPACK—has also been disassembled into pieces and explained in details in the second chapter. The third chapter described the research design and methodology of the present study. After critically analyzing the two interviews, the researcher presented the results and findings of the present study in Chapter 4. Finally, the researcher went a few steps forward to illustrate future implications based on the further analysis of the data.

This research study once again affirmed the advantages of using Chromebooks in the elementary classrooms in the following three sections: saving funds, granting stable and durable hardware, and offering seamless and continuous learning. In addition, the present study attempted to add two new benefits: using Chromebooks in teaching enables educators to keep their students on task and enables them to differentiate their teaching by providing more options and accommodating different learning styles and students' abilities. Due to all these benefits, the two teacher participants were overwhelmingly satisfied with utilizing Chromebooks in their teaching.

The two teacher participants shared similar challenges and difficulties as what has been described in the literature review. They found it challenging to battle with their students to make sure they were on the task and not lured by the out-of-class digital world. Besides, another innovative concern derived from this study was that a better

filtering system of apps working on Chromebooks can be benefit student and teacher experience.

This study also presented several implications for future educators. First, the findings of the present study revealed the fact that teachers did not receive sufficient formal training in TK and TPK to support them to be creative in utilizing technology in their teaching practice. They both were involved in self-learning and we able to further develop TK and TPK. The training such as attending educational technology conferences, completing training programs, and subscribing to online educators and educational technology websites should be promoted more often in elementary schools. Secondly, the two participants highlighted the concern of safety while using Chromebooks arguing that teachers must protect and guide students during their Chromebook use. The present study outlined the importance of the right balance of teachers' technological and pedagogical knowledge necessary for 21st century teaching and learning. Ultimately, it will be interesting to see in the future how Chromebooks and related modern technology could rock educators' teaching pedagogy to produce distinct outcomes in the classroom.

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Appendix A

Interview Protocol

1. What is your opinion/attitude towards utilizing Google Chromebook in your class?
 - a. What was the digital technology you used before Chromebook?
 - b. Why did you decide to use Chromebook? Why did your Board decide to switch to Chromebook?
 - c. How well were you prepared to use it in your instruction (TPACK related, Training)?
 - d. How many years of teaching experience you have?
 - e. How well you feel prepared to utilize new technological tool in your instruction?
 - f. What are some advantages/disadvantages of using Chromebooks compared to the last digital technology?
2. How much your instruction changed since using Chromebooks?
 - a. What do you like the most about Chromebooks?
3. How do you benefit from employing Chromebooks throughout your teaching? If possible, please provide an example.
4. How do your students benefit from employing Chromebooks throughout your teaching? If possible, please explain using examples.
5. Have you ever encountered any challenges or difficulties in teaching with Chromebooks?
 - a. If yes, could you please explain that in details?
 - b. What did you do to deal with the challenge?
6. In order to enhance students and teachers' experiences, what features/functions you would like to be installed on a Chromebook in the future? Please explain in detail.