Exploring the Effectiveness of Interventions Aimed at Promoting Collaboration Through Interactive Whiteboards and Google Apps for Education

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Abstract

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Over the course of the past decade, the use of interactive whiteboards (IWB) in North American and European elementary classrooms has surged in popularity. Nevertheless, their procurement has been scrutinized due to their questionable 'interactivity', lack of usage by students, and steep price tags. This design-based study aimed at determining the effectiveness of a performance improvement campaign's interventions designed at encouraging dialogic interactivity by utilizing both the IWB and Google Apps for Education (GAFE). The project was structured using the ADDIE model. Participatory action research techniques informed the performance needs analysis, which subsequently led to the design and development of the interventions as outlined in the high level design. Interventions were implemented over the course of one school year. Both qualitative and quantitative data collection instruments were used to evaluate the efficacy of the interventions, as well as to explain the numerous factors that had an impact on their effectiveness. Results found that the *tiered professional development sessions*, the *eNewsletters*, the *online tutorials*, and the *collaborative IWB and GAFE activities workshop* were the most useful interventions. Various themes, notably that of time as a constraint, the potential for pedagogical use, and teachers as creatures of habit, emerged as factors that influenced the efficacy of the performance improvement campaign's interventions.

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INTRODUCTION

This design-based study explores the effectiveness of the interventions set forth in a performance improvement campaign on the use of Google Apps for Education (GAFE) to encourage dialogue when using the interactive whiteboard (IWB).

An IWB is a system that projects an image, linked from a computer, onto a touch-sensitive surface, such as a whiteboard. Its elements can be manipulated directly on the whiteboard using a stylus (electronic pen) or a finger. Its tactile and visual nature, make it an appealing technology, especially in elementary classrooms, where these two senses are commonly explored.

Although, IWBs have been researched extensively, especially in countries with high adoption rates such as Great Britain, its usage is debated primarily due to its high cost, its insignificant effect on student performance, and its use as a pseudo-whiteboard. Educators are too often self-trained or only receive basic technical training without much or any insight as to how to merge IWBs in their pedagogy. The implication that IWBs have the potential to promote active student learning is challenged by underlying teacher-centric philosophies. Although student-centered learning is preached in many jurisdictions, teachers often return to didactic methods. This impasse begs the question: if teachers' fundamental perceptions of student learning remain passive, do the interactional affordances of IWBs actually make any difference in increasing collaborative learning in classrooms equipped with this technology? Unfortunately, far too much research confirms that although IWBs may lend themselves well to collaborative student learning, this potential is rarely tapped into due to underlying teaching philosophies and poor training exemplars utilizing constructivist models.

This study's objectives are to find innovative ways of capitalizing on the IWBs affordances to promote active student learning through collaborative and cooperative learning environments. By investigating elementary teachers' reactions, learning, and behaviour following the implementation of collaborative cloud-computing technologies such as GAFE linked to IWBs, researchers and educators will gain insight into whether such collaborative tools can promote dialogic interactivity in the classroom.

The first chapter will delve into the present-day context of IWB in Quebec schools. From this perspective, I will investigate IWBs' potential affordances for collaboration. I will then illustrate the current problem with regards to technology implementation faced by a French private elementary school in Montreal. The study's central questions will also be reported.

The second chapter will showcase the existing literature pertaining to the research problem. I will present a theoretical framework for the study stemming from a primarily social constructivist viewpoint. Subsequently, I will explain IWBs and its functions, as well as its affordances. Interactivity will also be defined, as well as two frameworks, and will present a pretext for which active student learning can occur. Finally, I will investigate the use of GAFE in order to promote collaborative and cooperative learning.

The third chapter will explain the study's methodology, including the setting, participants, research design, procedure, interventions, data collection instruments, data analysis, as well as validity and reliability.

The fourth chapter will provide the results gathered from the various data collection instruments. A synthesis of each intervention's effectiveness will also be presented.

The fifth chapter will interpret the emerging themes as factors influencing the efficacy of the interventions and compare them to the existing literature in educational technology. Finally,

the study's limitations will be detailed, alongside a summary of the findings and recommendations for similar projects.

CHAPTER I: Context and Research Problem

This chapter will investigate the current context of interactive whiteboard (IWB) integration in Quebec elementary and high schools. The initial section describes the political influences on IWB integration in Quebec elementary and high schools over the past decade. The final section explains the underlying technology implementation problems faced by a French private elementary school, from which this dissertation will further explore.

IWBs in Quebec Education

Technology integration in elementary schools has been a topic of interest for educators and school administrators for the better part of 30 years. Since the advent of the computer lab, to the installation of IWB, to laptop and tablet programs, there is a vast amount of resources that are allocated to 'digitalizing' the 21st century school. Like many educational systems around the world, in 2011, the Quebec Ministry of Education (MELS) pledged to provide funding to equip IWBs for all its schools citing benefits such as convenience in presenting digital content and increased student motivation (Côté, 2012; Chouinard, 2012). Nevertheless, the IWB program seemed doomed from the start. The initial request for proposals was cancelled following intense scrutiny over the majority supplier of IWBs, Smart Technologies, whose lobbyist was a former cabinet minister (Côté, 2012; Chouinard, 2012; Gervais, 2013). Less than a year following the IWB pledge, the opposition came into power and the Quebec Education minister did away with the 240 million dollar funding program (Chouinard, 2012; Gervais, 2013). Various reasons for this halt were cited, notably that the technology was not necessarily appropriate for many schools' needs, as well as its inconclusiveness with regards to academic performance (Chouinard, 2012). The principal report reviewed by the MELS was a study conducted by *La Chaire de recherche du Canada sur les technologies de l'information et de la communication en*

education that surveyed 800 Quebec teachers, of which 86% cited inconveniences in using IWBs, such as problems with calibration and blown fuses (Gervais, 2013). Indeed, a vast amount of researchers and educators have scrutinized IWBs, as many studies cannot confirm the effectiveness of IWBs as a dialogic tool with substantial effects on student learning and performance. While many agree that IWBs have affordances for interaction, one question seems to resonate in numerous studies: Do IWBs really promote student interactivity?

Research Problem

The elementary school in question underwent a major technology overhaul as a result of pressure from parents, as well as competition from other Montreal-area private schools. There were three major ICTs being invested in. First, IWBs were installed in various phases. Four were installed at the beginning of the school year, three were installed in January, and the remainder were installed over the course of the 2014 school year. Funding for these IWBs was provided by the school's parent foundation. Second, laptops were purchased in order to supply all elementary classes with better access to ICTs in order to compensate for the overbooked computer lab, which was not available to all teachers. Third, a school-wide Google for Education account was created in order to gradually transfer files onto cloud storage rather than to the sluggish file server.

With the implementation of the above-mentioned technologies, most elementary teachers were excited to finally embrace a new era in education. Nonetheless, there were others who were more reluctant to face these changes. It was clear that training would be required throughout the year in order to provide teachers with the rudimentary skills of various IWB and Google Apps for Education (GAFE) functions. Nevertheless, in many cases, training is not enough to alter the desired performance (Stolovitch & Keeps, 2004). This premise, led to the creation of a

performance improvement campaign, in which non-learning interventions, such as job aids, work environment redesign, incentives, and support were deemed necessary in order for participants to achieve the desired performance (Stolovitch & Keeps, 2004).

The purpose of this study is to determine the effectiveness of a performance improvement campaign's interventions to improve teacher use of IWBs and GAFE, and to utilize these technologies in order to promote dialogic interactivity. Dialogic interactivity is defined as a collective discourse, that utilizes higher-order thinking skills to co-construct knowledge (Mercer, Hennessy, & Warwick, 2010). This form of interactivity differs from didactic teaching, as students make meaning of knowledge through an egalitarian interaction with peers and their teacher. Given that much of the IWB's interactive nature relies on the tools in which it projects, GAFE offers collaborative, synchronous features that lend themselves well to whole-class dialogue. Using the parameters of IWBs and GAFE, the objective of this project is to plan, design, develop, implement, and evaluate various interventions and deliverables. With research recommendations in mind, I hope to provide elementary teachers with insight as to how they can use laptops to connect to online collaborative tools such as GAFE and facilitate student and teacher interactivity through the IWB. Using participatory action research techniques informed the performance needs analysis, which subsequently helped in designing and developing performance interventions. Assessment of the performance improvement campaign followed the Kirkpatrick model, as well as various other data collection methods such as interviews, focus groups, and self-assessment activities.

Central Questions

- Will the performance improvement campaign's interventions focused on IWB and GAFE promote the use of these technologies amongst elementary teachers?

- Will interventions showcasing the combined use of IWB and GAFE promote the use of dialogic interactivity by elementary teachers in their teaching?

CHAPTER II: Literature Review

This chapter will initially clarify the theoretical foundation by explaining the socio-constructivist nature of this study. Interactive whiteboards (IWB) will then be elaborated on, focusing in on their functions and associated affordances, as well as exploring an existing framework on teachers' use of IWBs. Interactivity will also be generally defined, as well as a model of ICT interaction between teacher and student. Teacher-centric epistemologies, as well as mediocre training will present a basis for why dialogic interactivity is rarely exploited with IWBs. Finally, information will be provided on Google Apps for Education (GAFE) and its emergent use in K-12 classrooms.

Constructivism, Collaborative and Cooperative Learning

Over the past decades, a wave of sociocultural ideology has reformed North American educational systems. The concepts of constructivism, collaborative learning, and cooperative learning are synonymous with this reform. Constructivism is an educational theory in which the learner actively creates, discovers, and transforms meaningful knowledge through interactions with the surrounding environment (Driscoll, 2005; Panitz, 1999). Constructivists argue that the learner does the learning and that "students do not passively accept knowledge from the teacher or curriculum. Students activate their existing cognitive structures or construct new ones to subsume the new input" (Panitz, 1999 p. 3). Social constructivism adds to this definition the importance of learning through a sociocultural context (Driscoll, 2005). Both collaborative and cooperative learning stem from this constructivist epistemology (Panitz, 1999). Collaborative learning is a personal philosophy with regards to learning within a group setting (Panitz, 1999) According to Panitz (1999) this "suggests a way of dealing with people which respects and highlights individual group members' abilities and contributions. There is a sharing of authority

and acceptance of responsibility among group members for the groups actions" (p. 3-4). Cooperative learning is an instructional strategy whereby the structuring of interaction focuses on 'social interdependence' helping learners work towards a common purpose (Denton, 2012; Panitz, 1999). Cooperative learning differs from collaborative learning in that the teacher closely monitors the interactional processes he or she has set forth in order for students to realize a goal (Panitz, 1999). In addition to these definitions, Panitz (1999) explains that cooperative learning concentrate more on the end product, whereas collaborative learning focuses on the process in which the students were able to complete the end product. Although collaborative and cooperative learning differ, Denton (2012) explains that the skills acquired from both of these learning environments include: "teamwork, flexibility, and collaborative problem solving", all of which are considered indispensable and sought after by future employers (p. 36).

The Sociocultural Importance of ICTs. While educational researchers are constantly debating the impact of technologies on student performance, one fact remains: whether or not educators, policymakers, or researchers agree on the benefits or drawbacks of digital education, much of the technologies are already widely implemented in schools around the western world (Desjardins, 2014; Karsenti & Collin, 2013). According to Desjardins (2014), education serves as a preparation for society and educators must ensure students can function well after finishing their education. Schools and educators that chose not to provide access to and instruction on ICTs are in fact, excluding students from the sociocultural presence of digital technologies all around them (Desjardins, 2014; Karsenti & Collin, 2013).

Interactive Whiteboards

IWBs usually consist of a computer or laptop connected to a projector that produces an enlarged image of the screen onto a board. These boards can be regular white- or dry-erase

boards or they can be tactile-responsive electronic boards. Usually a finger or a stylus (electronic pen) allows for the manipulation of digital objects.

IWB Affordances. The term 'affordance' was first coined by Gibson (1979) and later developed by Norman (1988), suggesting we determine how to use objects according to their actual and perceived properties (as cited in Armstrong et al., 2005; Deaney, Chapman, & Hennessy, 2009; Soegaard, 2003). Norman (1988) noted that socio-cultural factors such as experience, knowledge, and culture have the potential of skewing our perception of an object's affordances (as cited in Soegaard, 2003). In terms of the IWB, it can afford interaction given that the teacher sees its potential use (Armstrong et al., 2005). Therefore, the affordances of a non-digital whiteboard and an IWB may be similar, especially if the teacher perceives the latter as a simple presentation device (Armstrong et al., 2005). Armstrong et al. (2005) explain this, "what students learn relates to how a technology is used in the classroom, and how a technology is used relates to the teacher's (and students') perceptions of how it can be used, which also relates to their previous experience of similar technologies" (p. 459).

IWBs have an array of "added value" functions that are useful for retrieving digital content, presenting various media, editing, operating of digital manipulatives, and receiving feedback (Deaney et al., 2009). While IWBs are most commonly used as a presentation tool to display text, web content, documents, presentations, images, and videos, there are many functions that differentiate it from a non-digital surface (Northcote, Mildenhall, Marshall, & Swan, 2010; Parent, 2011). Objects can be moved, rotated, enlarged, or deleted, areas can be spotlighted, and handwriting can be converted to digitalized text (Mercer et al., 2010). IWBs also allow for annotation by noting, highlighting text, and framing various elements (Parent, 2011). Moreover, a myriad of reusable learning objects, some belonging to proprietary IWB software

and others as freeware resources, offer specialized tools such as rulers, compasses, and grids (Parent, 2011). IWBs also provide screen-capturing capabilities allowing for the teacher and the students to review processes in a step-by-step manner (Parent, 2011). It is these functions that have caught the interest of many educational researchers. In a study by Deaney et al. (2009), the use of the IWB's technical affordances such as multimodal support, annotations, spotlighting, magnification, hide and reveal, as well as drag and drop, allowed the educator to scaffold his students for higher-order thinking in a high school history class. The researchers also found that IWBs allowed students to recall past sequences such as annotations, which proved useful when revisiting student-generated contributions in future classes (Deaney et al., 2009). According to the researchers, "in this way, the technology became a resource that both shaped and enabled activity, deliberately exploited by the teacher to facilitate collaborative learning" (Deaney et al., 2009, p. 385).

Transition Framework of Teachers Use of the IWB. According to Beauchamp (2004), teachers advance along a 5-stage continuum in their use of the IWB. Starting off as novice users, teachers progress from using the IWB as (1) a *black/whiteboard substitute*; (2) an *apprentice user*; (3) an *initiate user*; (4) an *advanced user*; and finally as a (5) *synergistic user* (Beauchamp, 2004).

The initial stepping stone for employing the IWB is to utilize it as a *black/whiteboard substitute.* This denotes teachers who annotate on the IWB similarly to any other board (Beauchamp, 2004). Usually the teacher will be the sole or dominant user of the IWB rather than the students (Beauchamp, 2004). An *apprentice user* is a teacher who uses his or her basic ICT skills to plan out lessons, with limited software and applications (Beauchamp, 2004). Students are called upon to access the IWB in order to complete a predetermined task (Beauchamp, 2004).

Initiate users are more confident in their IWB skills, and therefore realize that there is "the potential of the IWB to change and enhance practice" (Beauchamp, 2004, p. 338). Here, users plan lessons with a variety of resources, which are organized prior to teaching (Beauchamp, 2004). Furthermore, students are encouraged to start selecting IWB tools to complete tasks (Beauchamp, 2004). *Advanced users* use resources not only found online or on the computer, but also create or upload their own documents, demonstrating a sense of appropriation by the teacher (Beauchamp, 2004). Moreover, student-use of the IWB is more impromptu, recognizing a shift from teacher- to student-centric (Beauchamp, 2004). The most transformative echelon in Beauchamp's model is that of the *synergistic user* (Beauchamp, 2004). Both teachers and students at this level are quite competent at using the IWB and therefore are able to escape the technicalities of the medium to define a new sense of collaborative pedagogy (Beauchamp, 2004). According to Beauchamp (2004),

> […] a synergistic user focused on the opportunities offered by the IWB to create new learning scenarios (rather than reinterpreting existing strategies), where teacher and pupils work together to achieve learning objectives. The technology thus becomes a liberating force and allows children to interact confidently with, and respond to, the IWB at both a physical and cognitive level. A synergistic user demonstrates an intuitive interaction with technology which facilitates a fluid lesson structure the direction, momentum and scale of the next step in the lesson, although the teacher retains control of the central theme which is dictated by the learning objective of the lesson. (p. 343-344)

Interactivity

According to the literature, interactivity takes many forms, mainly that of technical, physical, or conceptual. *Technical interactivity* is defined as the "rapid and dynamic feedback

and response" functions of the IWBs (Beauchamp & Kennewell, 2010; Tanner, Jones, Kennewell, & Beauchamp, 2005, p. 725). Such functions include drag and drop, pull and abandon, hide and reveal (Liang, Huang, & Tsai, 2012). *Physical interactivity* is described as the actual physical manipulation on the IWB (Beauchamp & Kennewell, 2010). *Conceptual interactivity* also called *dialogic* or *pedagogical interactivity* "actively builds on learners' contributions, engages both teachers and students in generating and critically evaluating ideas, and encourages explicit reasoning and the joint construction of knowledge construction […] through the use of talk and other means of communication" (Beauchamp & Kennewell, 2010; Deaney et al., 2009; Mercer et al., 2010, p.195-197). Collaborative environments encourage dialogic interactivity through open-ended tasks and promote higher order thinking skills (Deaney et al., 2009; Mercer et al., 2010).

Classroom ICT Interactivity Framework. Building upon Beauchamp's (2004) Transition Framework of Teachers Use of the IWB model, Beauchamp and Kennewell (2010) developed a framework to analyze the level of ICT interactivity between teacher and student. Their linear model suggests five categories of ICT interactivity: (1) *no interactivity*; (2) *authoritative interactivity*; (3) *dialectic interactivity*; (4) *dialogic interactivity*; and (5) *synergistic interactivity*. Beauchamp and Kennewell (2010) claim that educators should aim to promote dialogic and if possible, synergistic interactivity, in order to achieve higher-order thinking, richer discussions, as well as more metacognitive reflection on the part of the student.

No interactivity refers to an absence of ICT interactivity, whereby IWB is used to present content that students are to absorb passively while the teacher controls the lesson by delivering all the content (Beauchamp & Kennewell, 2010). In *authoritative interactivity*, the teacher designs tasks such as predetermined questions and responses that chosen students can manipulate

on the IWB (Beauchamp & Kennewell, 2010). Beauchamp and Kennewell (2010) state that with authoritative interactivity "the ICT resource switches between being a participant in interactions with the group and being the object of interaction between group members" (p. 763). Students are considered to be 'reactive' learners, doing what their teacher asks of them (Beauchamp & Kennewell, 2010). *Dialectic interactivity* denotes a more 'proactive' role by the students, albeit in a teacher-structured environment with less content provision (Beauchamp & Kennewell, 2010). In this case, the teacher tailors the lesson according to students' responses through an array of ICT resources (Beauchamp & Kennewell, 2010). The IWB provides students with the opportunity to defend their responses (Beauchamp & Kennewell, 2010). *Dialogic interactivity* occurs when the student plays a more metacognitively active role in their learning with the help of the teacher's less rigid structure (Beauchamp & Kennewell, 2010). The IWB allows a whole class of students to share differing ideas through the use of this technology in order to create and explore, changing the ICT paradigm from "a participant in the interaction to being to tool through which to interact" (Beauchamp & Kennewell, 2010, p. 764). The last category in this framework is that of *synergistic interactivity,* which can be explained as a collective effort by both teachers and students to reflect on their thinking and share the IWB space to explore various resources (Beauchamp & Kennewell, 2010). Beauchamp and Kennewell (2010) state the following,

> This does not represent a more advanced way of using an IWB, rather a shift in ownership of the resource. This new relationship can be supported by the use of devices which students can operate from their own desks, such as a tablet PC or 'slate' device which is wirelessly linked to an IWB. In group work there may be a role for collaborative software, such as a wiki, to generate collective reflection even in classroom environment.

> At an individual level, the synergistic type of interactivity may be seen when ICT capable students engage in challenging tasks for which they use ICT tools and resources in an almost seamless integration of mind and technology, which we characterise as 'exploiting' in order to achieve a sophisticated solution. (p. 764)

Lack of Dialogic Interactivity. Interactivity is a concept studied in the fields of both pedagogy and educational technology, and this nexus, Beauchamp and Kennewell (2010) assert, is "one of the key roles claimed for ICT in promoting learning is *interactivity* – the ability to respond contingently to the learner's actions" (p. 759). The premise of interactivity is what has encouraged much of the western world to adopt IWBs in education, as it is believed that the technical interactivity of these could potentially promote dialogic interactivity. Nonetheless, there is a staggering amount of research that concludes that IWBs are most often used in whole-class teaching whereby most of the interaction with the technology is made by the teacher or by the person controlling the IWB, leaving students with infrequent occasions to use it (Armstrong et al., 2005; Beauchamp & Kennewell, 2010; Deaney et al., 2009; Gervais, 2013; Higgins, Beauchamp, & Miller, 2007; Mercer et al., 2010; Northcote et al., 2010; Şad & Özhan, 2012; Sundberg, Spante, & Stenlund, 2012; Warwick & Kershner, 2008). Northcote et al. expressed this dichotomy (2010), "despite the narrow range of use indicated by these definitions and descriptions, there appears to be widespread agreement amongst researchers and educators that, ironically, it is the affordances for interactivity, communication and collaboration that make these boards attractive for use in teaching and learning contexts" (p. 495). Furthermore, while the use of the IWB increases the extent of teacher-student interaction, it also tends to foster more superficial communication between the two parties (Beauchamp & Kennewell, 2010).

The literature indicates a two-tiered problem with IWBs and its unrealized potential for active student learning. The first, suggests that teaching philosophies largely predict educators' use of technologies. The second suggests that IWBs training is mediocre at best.

Teacher-Centric Philosophies. With considerable educational research focused on social constructivist learning in many parts of the world, most pre-service elementary teachers are taught to strive to foster active student learning. Hands-on tasks and collaborative learning is especially important with younger children in order to encourage the co-construction of knowledge (Şad & Özhan, 2012; Warwick & Kershner, 2008). Nonetheless, students are not given enough opportunities to interact with IWB thus leaving them to learn in a passive state. According to Parent (2011), IWBs do not present actual advantages for students unless they are given the occasion to interact with the system.

The existing IWB dilemma suggests that teachers' epistemological beliefs concerning pedagogy play an important role in how they decide to use a technology (Davidson & Desjardins, 2010; Parent, 2011; Tanner et al., 2005; Warwick & Kershner, 2008). Larose et al. (2008), put it well,

> As long as there is adoption of a pedagogical paradigm more centred on the pupil and on the implementation of active pedagogy, the conjugation of a set of technological tools, of which the computer is used in a network by pupils and recourse to IWB is in a more traditional teaching context, there is an increase in volume of the frequencies of interactions described earlier, as well as in the volume and quality of learning realized by pupils. In short, what the scientific literature tells us once again concerning a technological tool adopted as school material, is that the type of pedagogy taken up by the teacher determines the use of technology, and not the opposite. (p. 24)

In a study conducted by Davidson and Desjardins (2010), the researchers used pedagogy scales and competency categories to analyze teacher educators' use of ICTs and their pedagogical philosophies. The researchers found that teacher educators who were student-centered and focused on the process tended to privilege a social usage of ICTs more so than those who were teacher-centered (Davidson & Desjardins, 2010). Moreover, those who were student-centered but focused on the product also tended to privilege a social usage of ICTs (Davidson & Desjardins, 2010). This can be paralleled to the definitions of collaborative and cooperative learning, whereby the former focuses on the process, and the latter focuses on the end product (Panitz, 1999). In this case, we see that both collaborative and cooperative learning strategies can privilege a social usage of ICTs. Moreover, the same researchers found that many studies concluded that ICTs were better integrated in constructivist settings and that ICT use more often led to constructivist practices (Davidson & Desjardins, 2010).

Warwick and Kershner (2008) clarify that student-centered does not signify less teacher presence, but rather a teacher who designs lessons for "dynamic, interactive, and appropriate learning experience" (p. 270). Many teachers however, feel that creating lessons for dialogic interaction takes more time and inhibits spontaneity (Gervais, 2013). Nevertheless, it is believed that as with other strategies, if used more often, the feat of designing for student interactivity becomes less difficult and more 'natural' (Mercer et al., 2010).

IWB and Professional Development. Many of the conditions that have perpetuated this didactic use of IWBs stem from its integration as a "top-down process that is also 'technology-led' rather than 'education-led'" (Sundberg et al., 2012, p. 256). IWBs are often thrown into hands of educators without providing them with adequate training, time, and support. In the UK, where millions of dollars were spent on IWBs, Mercer et al. (2010), found that "research, policy

and training initiatives have often tended to ignore the vital need to relate the use of new forms of technology to what is known about effective pedagogy" (p. 196).

Training for both dialogic and technical interactivity are crucial elements to any school wishing to implement IWBs. The importance of high-quality IWB professional development echoes in the literature yet, adequate IWB training is scarce. According to Desantis (2012), the implementation of this technology has 'outpaced' its own training. There seems to be a disconnect from which the training sequence occurs. Gervais (2013) stated that some teachers underwent training prior to receiving their own IWB, only fiddling around with the technology months later, when their cognitive recall had significantly dwindled down. According to Armstrong et al. (2005), "teachers are critical agents in mediating the software; the integration of the software into the subject aims of the lesson and the appropriate use of the IWB to promote quality interactions and interactivity. Training and ongoing support is required for teachers to appropriately use IWBs and to support their selection of appropriate software" (p. 468). One cannot deny the significance of technical know-how when dealing with IWBs. As Sundberg et al. (2012) noted, teachers were often side-swept away from interactivity due to technical issues, such as using common functions like drag and drop. Without technical support, educators lose countless hours trying to remedy problems (Gervais, 2013). Nevertheless, Warwick and Kershner's (2008) findings describe how IWB training cannot be based on technical skills alone but must be discussed in conjunction with dialogic interactivity. It is presumed from the literature that if teachers are not shown the potential for interactivity with their students through IWBs, they most likely will not feel comfortable enough to use it. According to Higgins et al. (2007), "as teachers become more fluent in their use of IWB and as they recognise the link to pedagogical change, the IWB becomes a potential catalyst for further change" (p. 217). In order

to accomplish this, Parent (2011) states that teachers must be given time and learning opportunities in order to refine their awareness of IWB and dialogic interactivity. Mercer and al. (2010) noted that the process in which teachers familiarized themselves enough with IWBs to produce more interactive lessons for students, took about two years.

Mobile and cloud computing technologies are also making progress in the realm of K-12 ICT integration. While physical interactivity with the IWB is usually through the means of a stylus or finger on contact with the surface, tablets and slates are becoming the tools of choice in many classrooms (Deaney et al., 2009). According to a report on IWB usage in Quebec, Parent (2011) foresees interactive activities that are multi-user and multi-contact, such as using shared individual student tablet or laptop screens to an IWB. While these are still not readily available in Quebec, Parent (2011) claims that 'collective creation' is already being explored through IWB. Collaborative web 2.0 tools such as Google Documents provide an interface for student exchange, without complex screen sharing (Parent, 2011). As Denton (2012) puts it,

> While the integration of cloud computing as a method for improving academic achievement may seem distant, the way that these tools align with learning theories and modes of instruction suggests otherwise. The ability to share and publish student constructed content, or to simultaneously craft written narratives, or to collaborate on a wide variety of activities, will surely accelerate the use of these modes of learning in classrooms across the K-16 spectrum. (p. 40)

Utilizing collaborative cloud-computing technologies such as GAFE in conjunction with IWBs will provide the technical framework for this study and will explore its capacity to promote a more student-centered approach to teaching and learning.

Google Apps for Education

Google Apps for Education (GAFE) is a free, self-hosted cloud-based application suite that allows users to communicate and collaborate using tools such as email, calendar, file sharing, and online publishing all through the same email address (Denton, 2012; Google, n.d.). Within the package are applications such as Gmail, Calendar, Drive, Docs, Slides, Sheets, Forms, Draw, Video, Sites, and Vault (Google, n.d.). These applications are similar to the interfaces of many popular office suites such as Microsoft Office and Apple iWorks (see Table 1). A large number of these applications are standard on regular Google accounts, which are for users aged 13 and over. With GAFE however, user-accounts can be created for any user younger than 13 years old with parental consent (Google, n.d.).

Table 1

App Comparison Between Google Apps for Education, Microsoft Office, and Apple iWorks.

Google Apps for Education	Microsoft Office Equivalent	Apple iWorks Equivalent
Docs	Word	Pages
Sheets	Excel	Numbers
Slides	PowerPoint	Keynote

Thanks to its resources and change management support, GAFE has gained much headway in schools since its inception. It currently provides its services to more than 15 million users (Google, 2012) in many educational jurisdictions around the United States such as Oregon and New York (Denton, 2012). This success can be attributed to Google's provision of appropriate training and support. The GAFE website offer information for educators on how to setup and deploy its products, as well as case studies, learning guides, instructional videos, lesson plans, and webinars (Google, n.d.). Moreover, Google provides free online training and certification for educators (Google, n.d.). Google also offers community outreach to connect with other GAFE educators (Google, n.d.).

Cloud-computing applications "support activities for accessing prior knowledge such as retrieving and sharing information" (Denton, 2012, p. 35). Among its many features, users can view any document's history, allowing them to understand the sequence of revisions, as well as who made the changes and what date and time (Denton, 2012). Socially, these tools encourage collaboration through both synchronous and asynchronous writing, editing, group-brainstorming, as well as peer-evaluations. Through cloud-computing technologies like GAFE, files can be displayed on IWBs showcasing dynamically co-constructed knowledge (Denton, 2012). It also tackles issues regarding traditional means of communicating, as presented in the following quote,

> One typical approach to classroom discussion is for students to share their responses one at a time. Although this method promotes order, primarily because the instructor acts as a conversation gatekeeper, it also tends to create a bottleneck in the flow of information. Alternatively, simultaneous responding through a shared file in the cloud promotes information flow, albeit in nonverbal forms. Another advantage is that students can see the thoughts of their peers as they type, which promotes open communication, which is a characteristic of constructivist teaching. (Denton, 2012, p. 35)

At its core, this form of cloud-computing technology uses socio-constructivist elements to seamlessly deliver cooperative learning strategies. Denton's (2012) article highlights various collaborative endeavors such as: group projects, peer assessments, student presentations, simultaneous class discussions, collaborative reflection, assisted writing, collaborative rubric construction, and website publishing.

CHAPTER III: Methodology

This chapter illustrates the study's methodology using existing literature and theoretical framework to guide its approach. First, the site selection will be justified and the school's setting will be explored. Second, sampling strategies will be explained, participants will be described, and my role as the researcher will be clarified. Third, the research design will situate the study within the context of a design-based research combining instructional design approaches and action research perspectives. Fourth, the procedure will outline the study's overall steps and timeframe, alongside a detailed overview of the interventions. Fifth, the section on data collection will explain which instruments were used and how data was analyzed. Finally, concerns about validity and reliability will be addressed.

Setting

This study took place in Montreal, Quebec, Canada. Quebec has a French-English bilingual education system. A large majority of the schools are francophone, which is the official language of the province. The educational system consists of public, private, and independent schools. Public schools, which are governed by non-denominational, linguistic school boards, are completely funded by the government. Private schools, which represent approximately 25% of elementary students, are self-governed and the government subsidizes approximately 60% of the tuition (Gouvernement du Québec, 2016). Independent schools are not subsidized; rather the parents pay for the totality of the tuition. Elementary education spans seven years, starting from kindergarten until the final year of Cycle 3 (grade 6).

Site selection. A French private elementary school in Montreal was the setting for this project. This site was selected according to the following criteria. For the study to be generalizable to a greater population, the chosen school must teach a government-mandated

elementary curriculum. In Quebec, private schools must teach the public curriculum, and teachers must have same qualifications as the public sector in order for a portion of the tuition to be subsidized by the government. As the researcher worked in a French private elementary school with access to a sponsor, as well as stakeholders, this research location met the above-mentioned criteria.

The selected school's building contains both an elementary and a secondary school. There are approximately 500 students in the elementary school, with class sizes ranging from 28 to 31. There are two classes for Cycle 1 (grades 1 and 2) and Cycle 2 (grades 3 and 4), and three classes for Cycle 3 (grades 5 and 6). Girls are more numerous than boys, with boys representing only a quarter of each class.

There are interactive whiteboards (IWB) installed in every homeroom teacher's classroom. The components of the IWBs were purchased separately, unlike the all-in-one kits such as SMART Technologies' SMARTBoard or Promethean's ActivBoard. These kits usually comprise of the hardware (i.e.: whiteboard, projector, and speakers) as well as the software (i.e.: SMART Notebook and ActivInspire). Due to budgetary constraints, the school purchased components separately in order to reduce costs. These components include: a regular dry-erase whiteboard, a ceiling-mounted projector, two wall-mounted speakers, and a portable electronic receiver called the *eBeam Edge* that is magnetically attached to any whiteboard. The software installed on these computers are eBeam Scrapbook, eBeam Interact, and a freeware software called Open Sankoré.

All teachers and students at the school had Google Apps for Education (GAFE) accounts configured at the beginning of the school year by the IT technician. Upon initial activation of account with a default password, teachers were asked to choose their own password.

Participants

The school's teacher demographics are diverse, ranging in ethnicity and age. Among the elementary teachers, 8 are aged between 25 to 30 years old; 9 are aged between 31 to 40 years old; and 9 are aged between 41 to 50+ years old. Two of the 26 elementary teachers are males. The elementary school consists of 14 homeroom teachers that teach French, Mathematics, and Social Studies. There are 12 specialists that teach English as a Second Language, Science, Art, Music, Drama, Physical Education, ICT, Enrichment, Ethics and Religious Culture, and Catechism.

It is important to note that homeroom teachers have the most access to IWBs, with one IWB installed in every classroom. Most specialists do not have a classroom, with the exception of the physical education, drama, art, and music teachers of which, none have IWBs installed in their locales. Moreover, homeroom teachers are with students for longer periods of time than specialists, who only teach students for a maximum of three 45-minute periods per week.

Participant recruitment. Following the approval for the study by the Concordia University Ethics board in June 2014, an email was sent to all elementary teachers, as well as the principal and IT technician providing them with information about this research project. The same information, as well as the consent form was printed and placed in staff mailboxes. The school principal granted access to both the school staff's emails and mailboxes for the purpose of this project. On the consent form, interested participants checked-off the data collection activities they wished to partake in: pre- and post interviews (n = 2); focus groups (n = 12); survey and assessment document (n = 12); and observations (n = 12).

Participants' identities were held confidential throughout this project. All participants' documents were identified with codes in lieu of names. Pseudonyms were also used to identify participants' remarks during focus group discussions.

Participant selection. Purposeful sampling was used for the survey, assessment document and observations. For the focus groups, maximum variation sampling was used in order to enlist teachers from different grades, as well as different subjects (see Table 2). This type of sampling offered a comprehensive overview of the IWB and GAFE skills desired by different participants.

Table 2

Participant Overview and Attendance Record

Participants[a]	Teacher status	Grade	Sex	Focus groups & Socratic wheel activity	Efficacy of interventions questionnaire	Reaction survey – Kirkpatrick 1b	Lesson plan – Kirkpatrick 2b	Observations – Kirkpatrick 3
Therese	Homeroom	1	F	1 & 3	✓			
Danielle	Homeroom	1	F	1				
Rachel	Homeroom	2	F	1, 2, & 3	✓			
Tania	Homeroom	2	F	1, 2, & 3	✓			
Brigitte	Homeroom	3	F	1, 2, & 3	✓			
Beatrice	Homeroom	4	F	1 & 2		✓		
Fabienne	Homeroom	5	F	1, 2, & 3	✓			
Robyn	Homeroom	5	F	1, 2, & 3	✓	✓	✓	
Rosanne	Homeroom	6	F	1, 2, & 3	✓			✓
Genevieve	Specialist	all	F	1, 2, & 3	✓			✓
Patricia	Specialist	all	F	1 & 2				

Note. $n = 11$.
[a]Pseudonyms were used to protect the identity of the participants.
[b]These were administered following the IWB and GAFE collaborative activities workshop.

The Role of the Researcher. My role in this project was that of a collaborative researcher. As a member of the teaching staff at the elementary school, I have taught English as a Second Language for three years. Since the beginning of the 2014-2015 school year, I am also the ICT pedagogical consultant for the elementary school. This position has provided me with

numerous insights as to how the school envisions its technology use within the next couple of years. Furthermore, as the ICT pedagogical consultant, many of my colleagues have approached me with their various issues, as well as ideas and suggestions. My prolonged engagement in this research setting has strengthened my credibility amongst the participants. This rapport, I believe, helped me to provide my colleagues with relevant interventions and deliverables that were of service to them in their pedagogy.

Research Design

The study was defined as a design-based research, with an action research perspective using traditional instructional design methods. According to Reeves, Herrington, and Oliver (2005), design-based research is characterized by:

- "A focus on broad-based, complex problems […]
- The integration of known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems,
- Rigorous and reflective inquiry to test and refine innovative learning environments as well as to reveal new design principles,
- Long-term engagement involving continual refinement of protocols and questions,
- Intensive collaboration among researchers and practitioners, and
- A commitment to theory construction and explanation while solving real-world problems." (p. 103)

True to design-based research, this project evolved through repeated reflection and revision. The genesis for this research emphasized the IWB, however throughout the course of the study the focus shifted towards GAFE. Initially, the business need addressed by the principal was to make the most of the newly-acquired IWBs. With the implementation of GAFE at the

school, the researcher sought to combine both technologies in order to promote student dialogue, given the existing literature's recommendations about the IWB's lack of interactivity. Through discussions with teachers, it become apparent that they were more interested in GAFE's potential to foster this interaction. Therefore, interventions were designed to accommodate the specific needs, voiced by participants, of both technologies. The complex interdependence of many factors within a school, such as existing ICT skillsets and technology infrastructure, confirmed that both learning and non-learning interventions were required in order to have an impact on teachers' behaviour.

Procedure

This performance improvement campaign sought to first, improve elementary teachers' use of IWBs and GAFE, and second, promote student dialogic interactivity by coupling IWBs with GAFE. In order to do this, the ADDIE model was used to structure the project. The ADDIE model is widely used in instructional design and is an acronym that stands for *Analysis, Design, Development, Implementation,* and *Evaluation* (Carliner, 2003). All of the steps were accomplished throughout the course of this project (see Table 3). Within the ADDIE structure, the researcher followed the EEP model (*Engineering Effective Performance*) as a means of outlining the performance needs analysis (Stolovitch & Keeps, 2004). Qualitative data collection such as a focus group paired with participatory action research techniques was employed to get the most out of this analysis. Finally, the Kirkpatrick model (levels 1 to 3) served to evaluate the overall performance improvement campaign, using both qualitative and quantitative data collection instruments. Using mixed methods allowed for a more thorough insight into participants' reaction to the project, as well as their use of IWBs and GAFE immediately following interventions and throughout the school year.

The project was devised into two phases (see Table 3). In the initial phase, a performance needs analysis (PNA) was conducted. Following the PNA, a high-level design mapped out various instructional and non-instructional interventions, as well as project deliverables. This phase was completed in September 2014. The second phase of the project consisted of the implementation and evaluation of the learning program and other performance interventions. This phase was completed in June 2015.

Table 3

Project Phases, Descriptions, Tasks, and Timeline

Phase	Deadline	ADDIE	Objective	Possible Tasks
Phase 1	June to September 2014	Analysis	Conduct a performance needs analysis (PNA) using the EEP model (Engineering Effective Performance) * As cited in Stolovitch & Keeps (2004)	* Identify the business requirements
				* Specify desired performance
				* Specify current performance
				* Define performance gap
				* Identify performance gap factors
				* Identify potential interventions
				* Select performance interventions
	July to September 2014	Design	Create a High-Level Design (HLD)	Design the IWB and GAFE training programs
		Develop	Develop the IWB and GAFE training programs	Create course materials
				Create assessment instruments
				Create job aids
Phase 2	September 2014	Implement	Launch training programs and performance interventions	Implement interventions
	December to June 2015	Evaluate	Evaluate the effectiveness of the performance improvement campaign	Evaluate data collected

Prior to data collection, consent forms were provided to all elementary teachers at the school. Interested participants signed the consent form and checked off which activity they were to take part in (focus groups, reaction survey and assessment, and/or observation).

Phase 1 – Analysis, Design, and Development. Phase 1 aimed to inform the performance needs analysis, the high level design, as well as the detailed design. This phase started in June 2014 and was completed in September 2014.

The interventions for this research project were primarily directed by the needs of the teachers voiced during the initial hour-long focus group, which met in June 2014. Here, participatory action research methods were used to determine the participants' desired skills, as well as their current proficiencies regarding these skills. This information was used to establish a baseline for future comparisons. Additional feedback from the principal and the IT technician was also useful for listing the constraints and other administrative requirements within the PNA document. These three sources of data were crucial in outlining the PNA, as well as, constructing the interventions in the High Level Design (HLD) document. The HLD mapped the outline of the performance improvement campaign by addressing objectives and describing the various instructional and non-instructional interventions (see Figure 1).

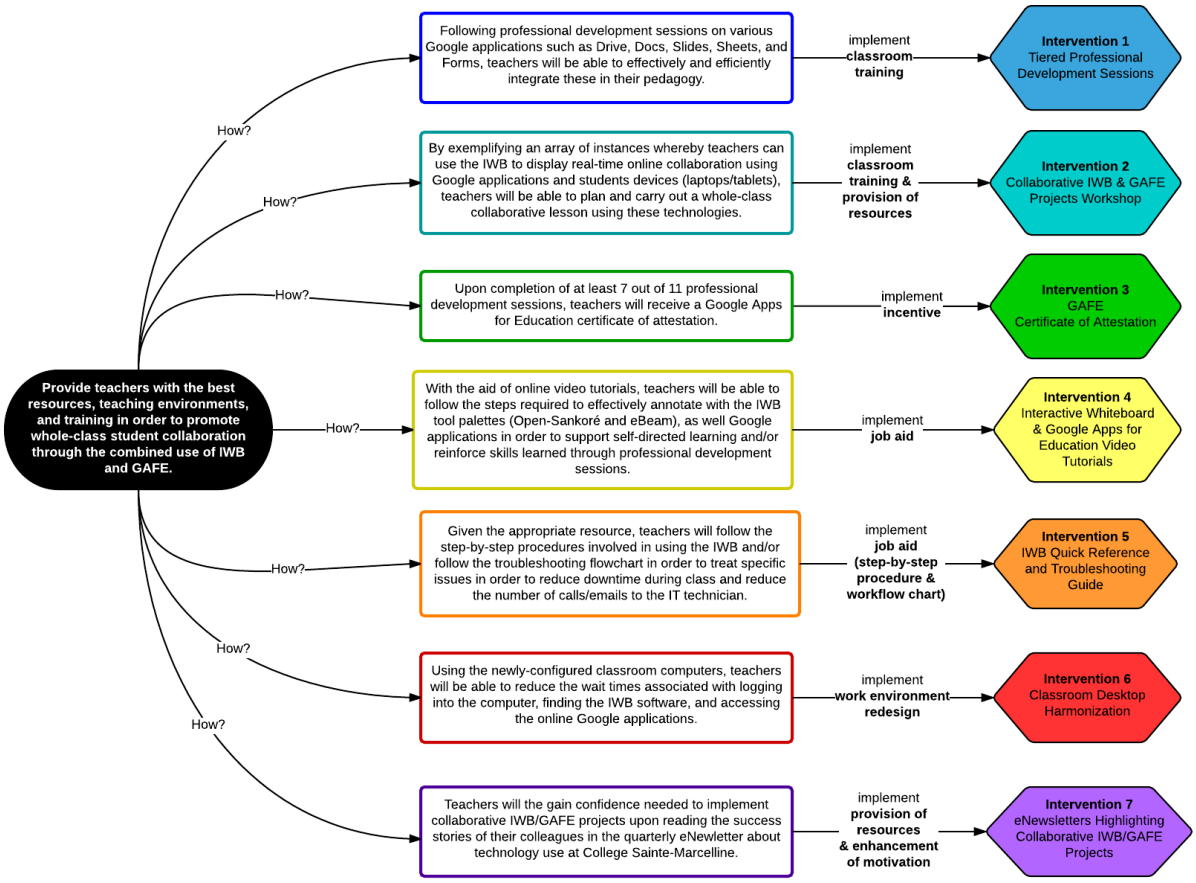

Figure 1. High-Level Design: Job One, Objectives, and Interventions.

Phase 2 – Implementation and Evaluation. Phase 2 aimed at determining the efficacy of the interventions implemented in promoting IWB and GAFE collaborative activities. In addition to the focus groups and the Socratic wheel activities, Kirkpatrick evaluation methods were utilized to better determine participants' reaction, learning, and transfer of the interventions on the job. This phase started in October 2014 and was completed in June 2015.

Following the completion of the HLD, interventions were implemented and deliverables were provided to participants. These included: (1) tiered professional development sessions; (2) GAFE certificate of attestation; (3) IWB and GAFE collaborative activities workshop; (4) IWB and GAFE video tutorials; (5) IWB quick reference and troubleshooting guide; (6) classroom

desktop harmonization; (7) eNewsletters highlighting collaborative IWB and GAFE activities. The second and third focus groups discussed these interventions and their efficacy in promoting collaboration through IWB and GAFE.

Finally, the overall project was evaluated using Kirkpatrick model. The Kirkpatrick model is extensively used in instructional design and uses four levels of assessment to check to evaluate learners' reaction, immediate learning, and long-term transfer on the job (Carliner, 2003). Levels 1, 2, and 3 were employed to evaluate this performance improvement campaign.

Synthesis of Interventions

Tiered Professional Development Sessions. Following recommendations from the first focus group discussion, these professional development sessions were focused on Google applications, and were tiered for beginners, intermediate, and advanced learners, as suggested in the initial focus group. A schedule was sent to all teachers and staff members. Each session was held twice, once at lunch and once after school in order to accommodate the most personnel as possible.

Collaborative IWB and GAFE Activities Workshop. In addition to the tiered professional development sessions, which were very technical in nature, participants also wanted concrete examples of collaborative IWB and GAFE activities they could create for their students.

GAFE Certificate of Attestation. In order to motivate teachers to participate in the tiered professional development sessions and the collaborative IWB and GAFE activities workshop, the certificate of attestation was created. The researcher took attendance during every tiered professional development session, as well as during the collaborative IWB and GAFE activities workshop. Participants who completed a minimum of 7 out 13 sessions received a certificate of attestation. Seven sessions were chosen due to the fact that participants would have

completed more than 60% of the sessions, which is inline with the passing grade in our elementary school system.

IWB Quick Reference and Troubleshooting Guide. The creation of the *IWB Quick Reference and Troubleshooting Guide* was a direct result of the discussion concerning mastering (1) the technical functions of the IWB and (2) using the various functionalities of the IWB software. For example, many participants voiced that they wanted to know how to calibrate their IWB, instead of always having to ask the IT technician.

This guide explained the basics of an IWB, as well as the two IWB software installed on the school computers, that of Open-Sankoré and eBeam Interact. The guides were printed and placed in every classroom near the IWB (see Figure 2).

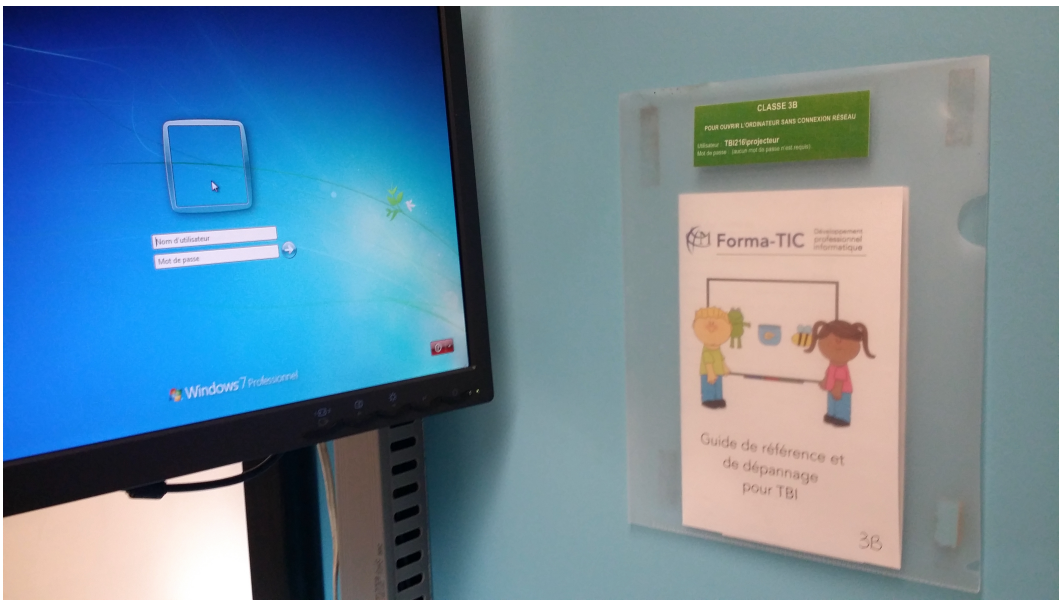

Figure 2. The IWB Quick Reference and Troubleshooting Guide was placed in every class, near the computer connected to the IWB.

eNewsletters. eNewsletters were sent twice throughout the school year. Each eNewsletter focused on providing key technology information to the staff, as well as sharing interesting finds and collaborative online projects.

Online Tutorials. Using the school's YouTube account, the researcher created tutorials or added ready-made tutorials in order to guide teachers through the various aspects of the IWB and GAFE. The private link to these tutorials was included in both eNewsletters, as well as various email communications with the personnel.

Personalized Classroom Desktops. Since classroom computers cannot be personalized by teachers due to a constraint in the school's network, a universal profile was created for elementary teachers to use in their classrooms. At the beginning of the school year, an email was sent to all teachers, asking them to share which files, software, and websites they used often. Upon receiving responses, the researcher compiled a list of these resources and categorized them by subject matter. This list was sent to the IT technician who then created a new profile for all elementary classroom computers. The login information regarding the universal profile was labeled near every classroom computer.

Data Collection Instruments

An array of qualitative and quantitative instruments was used for data collection, such as, interviews, focus groups, a self-assessment document, a reaction survey, an assessment document, observational fieldnotes, and a questionnaire. Each of these allowed for a more in-depth look at the data and presented richer findings about this study.

Interviews. Pre and post semi-structured interviews were held with the school principal and IT technician (see Appendix A). The initial interviews provided data necessary to complete the PNA (determine the objective and desired performance of the participants with regards to their collaborative use of IWB and GAFE) and subsequent high-level design. The latter interviews focused on determining whether the objectives of the project, as well as if the desired performance of participants were met.

Focus Groups. The use of focus groups was an integral part of this study. The dynamic interaction of this data collection method allowed for collective decision-making (Creswell, 2012; Stolovitch & Keeps, 2004), which helped determine the skills desired by participants. Collecting large amount of varying data quickly proved faster than interviewing participants individually (Stolovitch & Keeps, 2004), keeping in line with the project's sponsor wish to introduce interventions as soon as possible.

In all, three time-series focus group discussions were held throughout the year. The first took place in June 2014, the second in January 2015, and the third in April 2015. During these audio-recorded focus groups, the researcher acted as the group moderator and guided the discussions using semi-structured questions, but also left room for participants to divert, which provided interesting and surprising data.

Socratic Wheel Self-Assessment Instrument. In addition to discussing and determining the skills required for effectively using IWB and GAFE, participants also employed the action research technique called the 'Socratic Wheel' (see Appendix B). This is defined by Chevalier and Buckles (2013) as a method used "to evaluate and rate one or several elements or alternatives (project goals, options to choose from, individual skills, leadership styles, products, activities, etc.) on multiple criteria" (p. 47) and "to measure current and expected progress in achieving project results" (p. 28). Furthermore, the Socratic Wheel instrument served as a form of self-regulation for the participants. Schunk and Zimmerman explained self-regulation as "the process whereby students activate and sustain cognitions, behaviors, and affects, which are systematically oriented toward the attainment of their goals" (as cited in Driscoll, 2005, p. 310). An important facet of self-regulation is the reflection of one's actual performance with that of their goal or desired performance (Driscoll, 2005). This proactive behaviour is necessary in fine-

tuning their performance (Driscoll, 2005). Within the context of this study, participants set goals for their desired performance and formally reviewed their progress twice (Focus group 2 and 3), allowing them to make adjustments in order to achieve their goals. Furthermore, participants were free to choose the interventions they deemed necessary in order to attain their level of desired performance. Choosing the direction of learning is another important component of self-regulation (Driscoll, 2005).

The first focus group took place on the last day of school in June 2014. Following a pedagogical day meeting, 11 participants attended an hour-long focus group in the school's library. Following information concerning this research project, participants were given notepapers whereby they had to write skills they wished to learn more about with regards to IWB and GAFE. Using all of their individualized responses, the group categorized these skills and through social negotiation, ranked them in order of importance. This decision-making allowed participants to eliminate redundant or unrelated skills, and prioritize those that would be useful for the majority of participants. Participants enumerated the following skills which served as the framework for the PNA and HLD: (1) mastering the technical functions of the IWB, (2) using the various functionalities of the IWB software (Open-Sankoré) to its full potential, (3) uploading and converting documents into Google Drive, (4) creating documents using Google applications, (5) sharing documents using Google Drive, (6) commenting on documents using Google applications, (7) managing and organizing these documents, and (8) creation of collaborative activities utilizing both the IWB and GAFE. Using these skills, participants used a Socratic Wheel to plot their current proficiency, as well as their desired proficiency in each skill. The latter served as comparative baseline in order to illustrate whether participants' proficiency in each skill progressed.

In order to accommodate the most participants as possible, both the second and third focus groups were separated on two different days. This was also done to ensure more effective moderating, as Creswell (2012), states that a focus group typically has four to six participants. During these focus group discussions, participants were asked a series of questions (moderated by the researcher) concerning the effectiveness of the interventions. They were also asked on plot their current skill proficiency on a Socratic Wheel. In order not to biased the results, participants were given a new Socratic Wheel sheet every time.

Reaction Survey. Following an IWB and GAFE collaborative activities workshop, a reaction survey (Kirkpatrick level 1) containing Likert-type and open-ended questions, was administered to participants (see Appendix D). According to Carliner (2003), Kirkpatrick level 1 evaluations help to explore the following points:

- if the participants learned something,
- the probability that these learners will use what they have learned on the job,
- the usefulness of the instructional strategies used in the training, and
- the worth of the overall training program (p. 74)

Lesson Plan Assessment Document. In addition to the reaction survey, participants who took part in the collaborative IWB and GAFE activities workshop also were asked to complete an assessment document (Kirkpatrick level 2). In order to assess whether or not teacher learned ideas from the workshop and previous training sessions (Carliner, 2003), participants brainstormed ideas to create their own IWB and GAFE lesson plan to promote collaboration with students (see Appendix E).

Observation Fieldnotes. The last data collection method was unstructured observation fieldnotes. These observations took place after the implementation of the interventions. As per

Kirkpatrick level 3, the researcher wished to evaluate behavior with regards to transfer of learning on the job (Carliner, 2003). Using fieldnotes, the researcher jotted information about one participant's use of the IWB and GAFE to create a collaborative project and/or activity. More specifically, the degree of interactivity was examined. For this activity, the researcher was a nonparticipant observer, which is defined as someone who makes observations without being implicated in the participants' endeavor (Creswell, 2012).

Efficacy of Interventions Questionnaire. During the last focus group, participants were asked to complete a questionnaire on the efficiency of the interventions implemented during the performance improvement campaign (see Appendix C). Using Likert-type questions about the usefulness of the interventions, participants used this information as a springboard for the focus group discussion.

Data Analysis

Qualitative Data Analysis. Verbatim data from the pre- and post- interviews with the school principal, as well as the three focus group discussions were audio-recorded for confirmability and were transcribed using Microsoft Word. Textual documentation from the IT technician's email pre- and post- interviews, the reaction survey, the assessment document, and the observational fieldnotes were also transcribed using Microsoft Word. Both verbatim and written transcriptions were analyzed using methods from Strauss and Corbin's (1990) Grounded Theory. Data analysis employed open coding for the first cycle of data coding from each above-mentioned instrument (Saldana, 2009). Initial coding included descriptive, emotion, and in-vivo codes (Saldana, 2009). During the second cycle, focused coding was used to refine patterns of initial coding into categories (Saldana, 2009). Finally, axial coding was used in order to try to achieve category saturation, and ultimately determine the emerging themes (Saldana, 2009).

Quantitative Data Analysis.

Quantitative data was collected for the Socratic Wheel Self-Assessment, the Efficacy of Interventions Questionnaire, and the reaction survey. These datasets were analyzed using descriptive statistics produced in Microsoft Excel. Frequency distributions were used for the ordinal type questions in the questionnaire, as well as for the reaction survey. For the Socratic Wheel instrument, each participant's scores for all three self-assessments were entered into individual sheets, alongside the mean, the standard deviation, the minimum and the maximum score. Once individual data were entered, actual performance means for all participants were averaged for each focus group and compared with the agglomerated desired performance mean. The agglomerated data also reported the standard deviation, minimum, and maximum for both actual and desired performance mean. The difference between the actual performance mean and the desired performance means was also reported. In addition to tabular data, radial charts aided in visualizing the changes between each self-assessment activity (see Figure 3, as well as Appendix F for individual results).

Credibility, Transferability, Dependability and Confirmability

Being a member of the teaching staff at the elementary school, there was potential for researcher bias when it came to my creditability as a researcher. My prolonged engagement at the school however, helped to counteract this. My role as the school's ICT pedagogical consultant also allowed me to use persistent observation in order to get a better idea of the studied phenomenon throughout the entire project, which lasted a year. In addition to this, I peer debriefed with my thesis supervisor to review the methodology, interpretation of data, and proposed findings of the study. Moreover, interviews and focus group sessions were audio-recorded for confirmability. I also made use of member-checking in order to confirm

participants' thoughts during focus group discussions, as well as Socratic Wheel Self-Assessment exercises. Finally, I employed three types of triangulation. Firstly, I triangulated the methods of data collection by using interviews, a questionnaire, focus groups, a reaction survey, an assessment document, and observations. Secondly, I triangulated the sources of data for the Socratic Wheel Self-Assessment Instrument, which were collected at three different times over the course of the project. Lastly, I triangulated my sources of data collection, which were teachers, the principal, and the IT technician.

Transferability was dealt with by providing a thick description of the study's context and conditions. Moreover, using maximum variation sampling for the action research focus group "[allows] for a greater range of application of the findings by consumers of the research" (Merriam, 2009, p. 229). This information provided enough details to aid other researchers in deciding whether or not this project's findings can be transferable to their specific situation.

To ensure dependability, an external audit was utilized. The external auditors were two Concordia Masters students in the Child Studies program. Both were well-informed in qualitative research and investigated this study through an educational perspective.

Lastly, confirmability was warranted through the use of an audit trail and reflexivity. The audit trailed allowed me to log the research procedures, as well as to keep a record of the raw data collected and analyzed. Reflexivity permitted me to explore my "assumptions, experiences, worldview, and theoretical orientation" (Merriam, 2009, p. 219).

CHAPTER IV: Results

The purpose of this mixed methods study was to determine whether this performance improvement campaign's interventions on interactive whiteboards (IWB) and Google Apps for Education (GAFE) promoted relevant use of these technologies by elementary teachers. This study's secondary research question investigated whether showcasing the combined use of IWB and GAFE promoted the use of dialogic interactivity between teachers and students.

The use of both mixed methods and action research tools and techniques supported the design of this study. Researchers increasingly acknowledge the parallels drawn from these two methods and note how the interconnectedness of their features makes them useful approaches for action-researchers (Ivankova, 2015). Ivankova (2015) states, "These features relate to the overarching goals of mixed methods and action research; their philosophical foundations, social justice perspective, and certain methodological and procedural characteristics" (p.52). Although the project was primarily focused with the human experience of teachers, the use of descriptive statistics offered a more comprehensive insight into the changes brought forth by this performance improvement campaign. This project aimed to find issues, develop interventions, and evaluate their effectiveness, all by using qualitative and quantitative methods to enrich the findings, complementing each form of data. Ivankova (2015) reiterates this, "applying mixed methods in action research may help provide a comprehensive initial assessment of the problem, develop a more solid plan of action, and conduct a more rigorous evaluation of the action/intervention implementation through informed integration of multiple quantitative and qualitative data sources" (p. 58). It is also important to note that this study employed primary and secondary data collection instruments (see Table 4). The findings of this study were predominantly focused on the data collected from primary instruments, which specifically aimed

at answering the research questions. While the secondary instruments were necessary in developing the performance needs assessment, the high-level design, and detailed design, the data was also used within these findings to supplement those of the primary instruments.

Table 4

List of Primary and Secondary Data Collection Instruments

Primary Data Collection Instruments	Secondary Data Collection Instruments
Socratic Wheel Self-Assessment Instrument (QUAN)	First focus group discussion (QUAL)
Efficacy of Interventions Questionnaire (QUAN)	Pre- and post-interventions interview with school principal (QUAL)
Second focus group discussions (QUAL)	Pre- and post-interventions interview with school IT technician (QUAL)
Third focus group discussions (QUAL)	
Reaction survey (Kirkpatrick Level 1) (QUAN + qual)	
Lesson plans (Kirkpatrick Level 2) (QUAL)	
Observation fieldnotes (Kirkpatrick Level 3) (QUAL)	

Using secondary data collection instruments allowed for the development of the following learning interventions: (a) tiered professional development sessions; (b) IWB and GAFE collaborative activities workshop; (c) online IWB and GAFE tutorials; (d) IWB quick reference and troubleshooting guide; as well as the following non-learning interventions (e) GAFE certificate of attestation; (f) eNewsletters highlighting collaborative IWB and GAFE activities; and (g) classroom desktop harmonization. Upon the execution of these interventions, primary data collection instruments were applied in order to determine their effectiveness in promoting teacher IWB and GAFE use, as well as IWB and GAFE collaboration with students.

The following section will detail the primary instruments' findings. A synthesis of the individual interventions will also be highlighted using supporting data from focus group discussions.

Socratic Wheel Self-Assessment Instrument

The Socratic Wheel self-assessment instrument, completed during each of the three focus groups, provided the researcher with important statistical data that reinforced the qualitative findings. This instrument assessed whether participants' proficiency in various IWB and GAFE skills increased. It is important to note that this instrument only assessed the following interventions: the tiered professional development sessions, the collaborative IWB and GAFE activities workshop, online tutorials, and the IWB quick reference and troubleshooting guide.

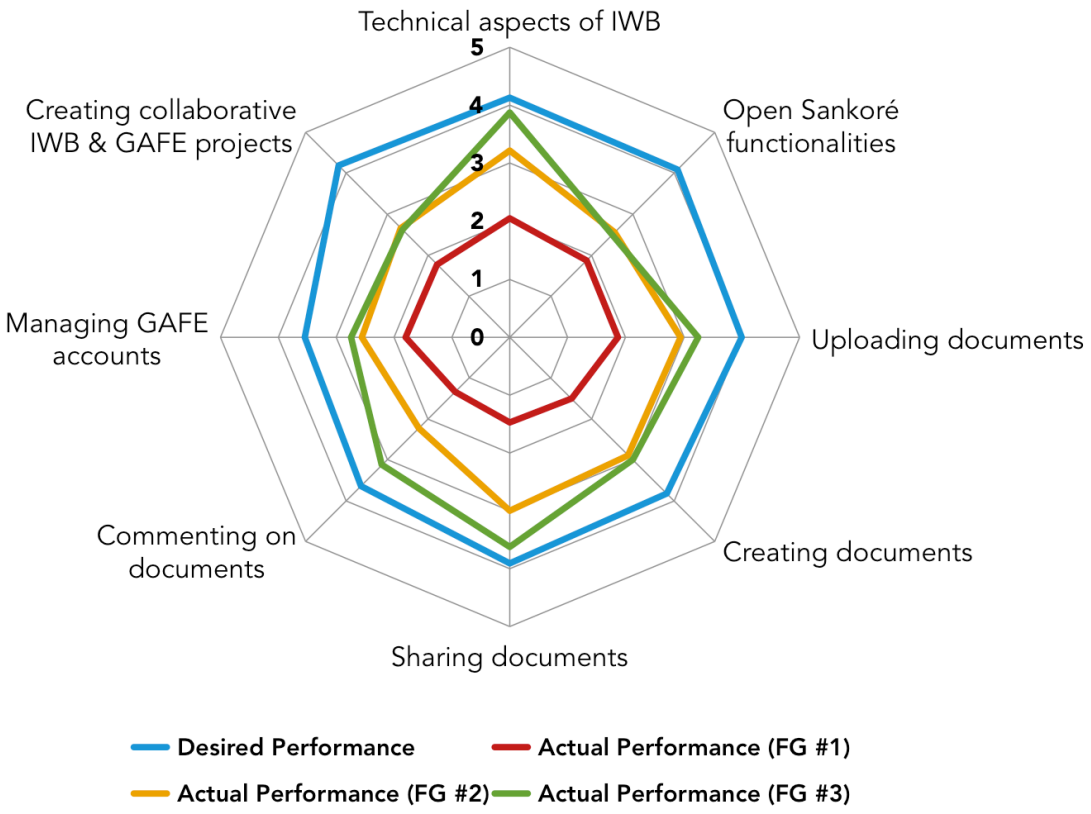

Figure 3. Actual performance means for all three Socratic Wheel Self-Assessments compared to the desired performance means established at the beginning of the study.

Observing the data from figure 3, we can note that all actual performance means experienced an increase from focus group #1 to focus group #3. Nevertheless, it is important to note that *IWB software functionalities* and the *creation of collaborative IWB and GAFE activities* experienced a slight decrease from focus group #2 to focus group #3 (-0.06 and -0.04 respectively). Moreover, we can also see that three focus group #3 actual performance means came close to attaining their desired performance means: *technical aspects of the IWB, sharing documents*, and *commenting on documents*. Reviewing the data in Table 5 allows for a more accurate representation of these gains following the implementation of the interventions (from focus group #1 to focus group #3).

Table 5

Socratic Wheel Self-Assessment Instrument Results: Teacher's Self-Assessed Actual Performances With Regards to IWB and GAFE Skills

Skill	Actual performance mean (*M*)	Standard deviation (*SD*)	Minimum	Maximum	Difference between 1st and 3rd focus group
Technical aspects of IWB					
- 1st focus group [a]	2.05	1.27	0.50	4.00	
- 2nd focus group [b]	3.22	1.48	1.00	5.00	+1.83
- 3rd focus group [c]	3.88	1.46	1.00	5.00	
IWB software functionalities					
- 1st focus group	1.86	1.00	0.50	3.00	
- 2nd focus group	2.56	1.51	1.00	5.00	+0.64
- 3rd focus group	2.50	1.41	1.00	5.00	
Uploading documents					
- 1st focus group	1.86	1.10	0.50	4.00	
- 2nd focus group	2.94	1.38	1.00	5.00	+1.39
- 3rd focus group	3.25	1.58	1.00	5.00	
Creating documents					
- 1st focus group	1.50	0.74	0.50	3.00	
- 2nd focus group	2.89	1.36	1.00	5.00	+1.50
- 3rd focus group	3.00	0.93	2.00	4.00	

Table 5 (Cont.)

Skill	Actual performance mean (*M*)	Standard deviation (*SD*)	Minimum	Maximum	Difference between 1st and 3rd focus group
Sharing documents					
- 1st focus group	1.48	0.78	0.25	3.00	
- 2nd focus group	3.00	1.32	1.00	5.00	+2.15
- 3rd focus group	3.63	1.51	1.00	5.00	
Commenting on documents					
- 1st focus group	1.34	1.29	0.25	5.00	
- 2nd focus group	2.22	0.97	1.00	4.00	+1.79
- 3rd focus group	3.13	1.55	1.00	5.00	
Managing GAFE account					
- 1st focus group	1.80	1.54	0.25	5.00	
- 2nd focus group	2.56	1.42	1.00	4.00	+0.95
- 3rd focus group	2.75	0.89	1.00	4.00	
Creation of collaborative IWB and GAFE activities					
- 1st focus group	1.77	1.03	0.50	4.00	
- 2nd focus group	2.67	1.12	1.00	4.00	+0.86
- 3rd focus group	2.63	1.19	1.00	4.00	

Note.
[a]$n = 11$
[b]$n = 9$
[c]$n = 8$

By the end of the research project, the skills that experienced the most gain were *sharing online documents through Google Drive* (+2.15), *technical aspects of the IWB* (+1.83), and *commenting on GAFE documents* (+1.79). The skills that experienced the least gain following the implementation of interventions were *IWB software functionalities* (+0.64), *creating collaborative GAFE activities* (+0.86), and *managing GAFE account* (+0.95).

When asked to discuss the differences between their initial and last actual performance mean, most participants saw an increase in their skills and felt more confident using these skills. Some teachers admitted that they did not fully understand some of the skills at first, which led to some lower and some higher results, especially during the focus group #1. Nevertheless, after the

implementation of the interventions, many stated that they felt more comfortable with the self-evaluating their skills, as they were more aware of what these actually entailed.

None of the skills attained or exceeded the mean desired performance outlined by teachers during focus group #1 (see Table 6). Nevertheless, the actual performance means for mastering the *technical aspects of the IWB* (-0.26) and *sharing online documents* (-0.28) were the closest to that of the desired performance means (4.14 and 3.91 respectively).

Table 6

Socratic Wheel Self-Assessment Instrument Results: Teacher's Self-Assessed Desired Performances With Regards to IWB and GAFE Skills

Skill	Desired performance mean[a] (*M*)	Standard deviation (*SD*)	Minimum	Maximum	Last actual versus desired performance mean
Technical aspects of IWB	4.14	1.00	1.50	5.00	-0.26
IWB software functionalities	4.09	0.70	3.00	5.00	-1.59
Uploading documents	4.00	1.18	1.00	5.00	-0.75
Creating documents	3.82	0.87	2.00	5.00	-0.82
Sharing documents	3.91	1.22	1.00	5.00	-0.28
Commenting on documents	3.64	1.36	1.00	5.00	-0.51
Managing GAFE account	3.55	1.29	1.00	5.00	-0.80
Creation of collaborative IWB and GAFE activities	4.18	0.75	3.00	5.00	-1.55

Note. $n = 11$.
[a]The desired performance was determined during the first focus group meeting. Individual desired performance scores were aggregated and averaged.

Efficacy of Interventions Questionnaire

The Efficacy of Interventions Questionnaire served to examine the usefulness of all interventions. Its findings are reported as a frequency table (see Table 7). According to the findings, three interventions deemed the most useful were the *tiered professional development sessions* (100%), the *eNewsletters* (88%), and the *online tutorials* (63%). The *IWB troubleshooting and reference guide* was also considered useful and very useful amongst teachers (50% and 25% respectively). On the other hand, the *GAFE certificate of attestation* was the least effective intervention with the majority of the votes being not applicable, not at all useful, and not very useful (38%, 13%, and 13% respectively).

Table 7

Questionnaire on the Efficacy of the Performance Improvement Campaign's Interventions

Interventions	N/A[a]	1 (not at all useful)	2 (not very useful)	3 (somewhat useful)	4 (useful)	5 (very useful)
Tiered professional development sessions on GAFE						8
Collaborative IWB and GAFE activities workshop	3				2	3
Online IWB and GAFE tutorials	2				1	5
IWB quick reference and troubleshooting guide	1		1		4	2
GAFE certificate of attestation	3	1	1	2	1	
eNewsletters					1	7
Personalized classroom desktops	3			1	2	2

Note. $n = 8$.
[a]N/A refers to teachers who did not use these interventions.

Synthesis of Individual Intervention Efficacy.

Tiered Professional Development Sessions. According to results from the Efficacy of Interventions Questionnaire, the tiered professional development sessions were deemed to be the very useful according to all respondents (see Table 7). The majority of the skills taught in these sessions were listed on the Socratic Wheel Self-Assessment Instrument: uploading, creating, sharing, and commenting on documents, as well as managing their Google Drive account (see Table 5). Most teachers reported a moderate gain in all of these skills, with the exception of *managing GAFE account* with only a 0.95 increase. Moreover, when comparing teachers' actual performance means with that of the desired performance means, *sharing documents* came out on top of the list with a slight difference (-0.28), followed by *commenting on documents* (-0.51), *uploading documents* (-0.75), and finally *managing the GAFE account* and *creating documents* had the greatest actual versus desired performance mean (-0.80 and -0.82 respectively).

With the help of an attendance record, the most popular and least popular sessions were identified (see Figure 4). Both sessions 5 (*sharing documents through Google Drive*) and 6 (*real-time collaboration with Google Docs*) were the most popular (n = 12). Sessions 11 (*online evaluations with Flubaroo and Google Forms)* and 9 (*creation of spreadsheets with Google Sheets*) were the least popular with only 1 and 2 participants attending respectively.

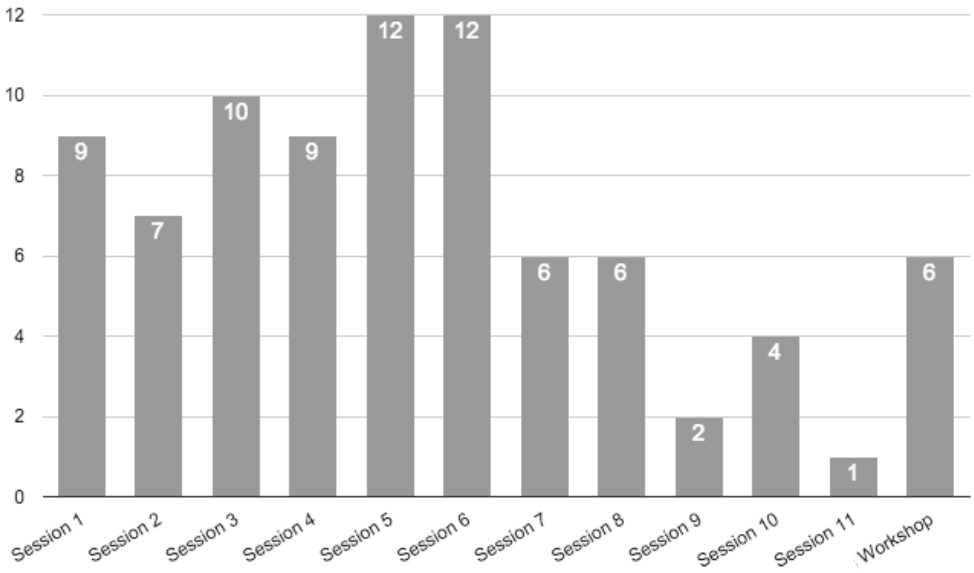

Figure 4. Attendance record for the GAFE tiered professional development sessions and the collaborative GAFE and IWB activities workshop.

Collaborative IWB and GAFE Activities Workshop. Of all the interventions put into place, the researcher deemed this workshop to be the most pertinent as it related directly to the study's research questions. It is for this reason that the researcher used a variety of data collection instruments such as the focus group discussions, the Socratic Wheel Self-Assessment Instrument, the Efficacy of Interventions Questionnaire, as well as the Kirkpatrick evaluation model (levels 1, 2, and 3) to determine the effectiveness of this specific intervention.

While participants in focus group #1 unanimously voiced the need to implement a workshop showcasing ideas utilizing both IWB and GAFE, not many attended the workshop (n = 6). When reviewing actual performance means from the Socratic Wheel Self-Assessment Instrument (see Table 5) for the *creation of collaborative IWB and GAFE activities*, we can see that gain between the first and last focus group was small (+0.86). Moreover, teachers were quite far from reaching the desired performance mean of 4.18 (-1.55) (see Table 6). Nevertheless, the Efficacy of Interventions Questionnaire (see Table 7) showed that those who attended the

workshop selected it as being *useful* (2) and *very useful* (3). Three participants did not attend and therefore chose *not applicable*.

Reaction Survey. The reaction survey was administered to teachers immediately following this workshop in order to receive feedback on this intervention. Out of the six teachers who completed this workshop, half completed the reaction survey.

The survey featured close- and open-ended questions regarding participants' reaction to the workshop (see Appendix D). The first five questions used smiley faces to determine participant satisfaction. Results show that all participants (n = 3) chose the smiley face for questions 1 to 5 (see Table 8). Participants also left notes in the margin explaining their choices. Beatrice jotted a plus sign next to question 2 about the slides; for question 1, Rachel wrote that she liked discovering new applications, and for question 5, she found that the instructor found solutions to the problems encountered during the workshop and answered questions; Robyn stated that the format of the workshop was satisfactory except for the coldness of the room.

Table 8

Reaction Survey – Results for questions 1 to 5

Question	☺	😐	☹
1. Comment évaluez-vous cet atelier?	100%		
2. Comment évaluez-vous le matériel d'apprentissage (diapositives) ?	100%		
3. Comment évaluez-vous les exemples de projets ?	100%		
4. Comment évaluez-vous le format de cet atelier (à midi au labo)?	100%		
5. Comment évaluez-vous la rigueur de l'instructeur?	100%		

Note. n = 3.

Questions 6 and 7 pertained to participants' prior knowledge about the Google applications shown and their likelihood in using these applications in the future. Results from question 6 confirm that the majority of participants did not have any prior knowledge about the Google Apps showcased during the workshop (see Table 9).

Table 9

Reaction Survey – Results for question 6: Avant cet atelier, quel était votre niveau de connaissances par rapport à l'utilisation des applications suivantes pour promouvoir la collaboration?

Application	1 Aucune	2	3 Assez	4	5 Excellent
Google Docs		1	1	1	
Google Feuilles de calcul	1		2		
Google Présentations		1	1	1	
Google Formulaires	1	2			
Google Maps			2		1
Google Hangouts	3				
YouTube et EdPuzzle	2	1			
LucidPress	3				
LucidChart	3				

Note. $n = 3$.

Results from question 7 show that teachers' opinions on their potential future usage of Google applications were almost evenly divided (see Table 10). All teachers believed they would use Google Docs, as well as Google Maps. Estimated frequency of use for these two applications ranged from everyday to every term. Two of the three teachers considered using Google Sheets, Google Slides, as well as Youtube and EdPuzzle. Teachers who answered that would use these applications in the future, predicted a use every month and every term. This shows that these applications were not as popular, nor were their potential frequency of use as regular as Google Docs and Google Maps. The Google applications that did not seem to be practical for future use were Google Forms, Google Hangouts, LucidPress, and LucidChart.

Table 10

Reaction Survey – Results for question 7: Après cet atelier, croyez-vous utiliser ces applications afin de promouvoir la collaboration dans votre classe?

Application	Non	Oui	Jours	Semaines	Mois	Étapes
Google Docs		3	1			2
Google Feuilles de calcul	1	2			1	1
Google Présentations	1	2			1	1
Google Formulaires	2	1				1
Google Maps		3		1	2	
Google Hangouts	2	1				1
YouTube et EdPuzzle	1	2			2	
LucidPress	2	1				1
LucidChart	2	1			1	

Note. $n = 3$.

Lesson Plan Assessment Document. Similarly to the reaction survey, this assessment document in the form of a lesson plan was also given to teachers immediately following the workshop. Out of the six teachers who participated in the workshop, only one completed this lesson plan. When participants ($n = 6$) were asked why they did not complete the lesson plan, they unanimously stated that they did not have enough time following the workshop to complete it and eventually forgot altogether.

The only completed lesson plan for an online collaborative project was for students to provide a quality for each classmate on Google Form created by their teacher. Using these responses, the teacher entered the thirty qualities into a word cloud website (www.tagxedo.com) in order to create a personalized Valentine's Day offering to her students.

Observation Fieldnotes. One participant invited the researcher into her classroom to observe them during a collaborative lesson that involved both GAFE and the IWB. Rosanne's

sixth grade class worked in triads in order to create a group presentation using Google Slides. Students were asked to bring in a laptop or tablet, or use one provided from the school. They were given three periods to work on a social studies project. At first, many students were unsure how to share a common presentation, but they were all able to figure this out by themselves. Some had difficulties working on the same presentation synchronously, citing discontentment with wording corrections, image placement, as well as other facets of group work. Nevertheless, many were amazed at how much more efficiently they were working and enjoyed having the embedded Google search function within the Slides application. Upon finishing their presentations, Rosanne used groups, which volunteered their presentation to be reviewed by the class. Together with her students, Rosanne modeled how to review an assignment, such as reviewing grammatical mistakes. By having access to a mobile technology, whether a laptop or tablet, students were able to co-review each other's presentations at the same time while Rosanne projected them on the IWB.

Online IWB and GAFE Tutorials. Results from the Efficacy of Interventions Questionnaire showed that these online tutorials were very useful according to 5 out of 8 participants (see Table 7). During discussions, participants stated that the online tutorials provided immediate support, which could be paused and re-listened to if necessary. Moreover, many teachers were self-proclaimed visual learners and appreciated seeing procedural tasks rather than solely reading or hearing them.

IWB Quick Reference and Troubleshooting Guide. During focus group discussions, the majority of teachers voiced that they had mastered the technical functions of the IWB such as turning the projector on and off, calibrating the board, activating the interactivity, and using the

stylus. Nevertheless, most agreed that they did not use the actual IWB software, be it Open-Sankoré or eBeam Interact.

When reviewing this information with that of the Socratic Wheel Self-Assessment Instrument, we clearly see the dichotomy between mastering the IWB technical functions versus mastering the IWB software functionalities. There was a substantial gain between the initial and last focus group for *IWB technical functions* (+1.83), as well as a very small difference between the actual and desired performance means (-0.26). The *IWB software functionality* had opposite results. It experienced the smallest gain out of all the skills (+0.64), and had the largest difference between actual and desired performance mean (-1.59). This information is in-line with the discussion held by teachers during focus groups.

GAFE Certificate of Attestation. Referring to the Efficacy of Interventions Questionnaire, the GAFE certificate of attestation had responses across the board (see Table 7): *not useful at all* (1), *not really useful* (1), *somewhat useful* (2), *useful* (1). Although noted on the tiered professional development sessions schedule, as well as the collaborative IWB and GAFE activities workshop email, three participants were not aware of this certificate and therefore answered *not applicable*. Out of the 20 teachers who participated in the tiered professional development sessions and the collaborative activities workshop, only 5 attended at least 7 courses and therefore received a certificate of attestation. The results show that this intervention was not an effective motivator for participants, nor did it have an impact on their attendance.

eNewsletters. These eNewsletters were well liked by teachers, with 7 out 8 teachers stating that they were very useful (see Table 5). Teachers found that this intervention engaged their curiosity and provided motivation for them to try various tools listed in the newsletters.

Teachers stated that it was a good way of informing them of new trends, which they were free to read and try at their pace and on their own time.

Personalized Classroom Desktops. This intervention was designed following the recommendation of many teachers to decide what to place on their classroom desktop, especially with regards to Google applications and the two IWB software. At the start of the study, teachers were confined to using the same network profile as the high school teachers. This meant that the desktop did not provide a user-friendly interface, as it was not tailored for elementary educators. Although complete personalization was not an option due the school's network infrastructure (as per the IT technician), teachers were asked to send a list of files and websites they most commonly used to the ICT pedagogical consultant. These were then organized into subject-matter folders on the desktop, which were then cloned onto every elementary computer. Although this was a step up from before, it was still unpopular amongst teachers. Robyn stated that she did not appreciate having to look through the subject-matter folders and find files or websites, as they were grouped with other grade-level resources. This is inline with research, which suggests that learners need to be able to organize their information according to their own schemata (Driscoll, 2005).

Upon reviewing the data collected from the various instruments, one can determine that the *tiered professional development sessions*, the *eNewsletters*, and the *online tutorials* were the most useful interventions. Since the goal of this performance improvement campaign was to promote collaborative use of both the IWB and GAFE, the hands-on interventions (tiered sessions and online tutorials) seemed fitting as they provided the prerequisite skills needed to create such projects. The eNewsletters offered tid-bits of information concerning many different Google apps, generating ideas for numerous collaborative projects. Furthermore, the

collaborative activities workshop, which was directly aimed at accomplishing the performance improvement campaign's goal, was also well-appreciated by the participants who attended. Nevertheless, this intervention did not receive the turnout desired by the researcher. Throughout focus group discussions, teachers voiced reoccurring themes that helped give reason to the successes and failures of these interventions. The subsequent chapter will highlight participants' reflections on the various factors that influenced this performance improvement campaign.

CHAPTER V: Discussion

This study's objective was to examine whether or not the interventions implemented promoted collaborative use of both the interactive whiteboards (IWB) and Google Apps for Education (GAFE) at a specific school. More specifically, it aimed at determining whether showcasing the combined use of both technologies promoted dialogic interactivity by elementary teachers in their teaching.

Many interesting themes emerged through the analysis of the qualitative data. These themes highlight the factors that impacted the efficacy of the interventions realized within this performance improvement campaign. This section aims at describing these factors, reviewing them amidst the existing literature in educational technology, and providing pragmatic suggestions for similar projects.

Time as a Constraint. Time or the lack thereof was a popular topic amongst teachers who believe that is nearly never enough of it to get all of their work done. Evidently, in the focus group discussions, teachers voiced the need for extra time to assimilate IWB and GAFE skills. According to multiple participants, teachers are often overwhelmed with many non-teaching bureaucracy, which in turn eat into their time and energy. This, they state does not permit teachers to attend every professional development sessions to perfect their skills, much less give them the opportunity to try their hand at enhancing pedagogy through technology. Nevertheless, most participants found that the tiered professional development sessions at school, motivated them to discover the novel technologies in a context whereby they were not forced to discover it on their own at home. Nevertheless, numerous participants voiced that they felt rushed at lunchtime, that it saturated an already hectic work schedule. Moreover, teachers stated that after

school training sessions were difficult to attend, given many of their non-work obligations, such as picking up their children from daycare, and bus schedules.

Retaining and recalling information were other important factors that were explored within the discussions. Participants stated that exploiting the computer lab was helpful, as each teacher was able to experiment with the GAFE interface alongside the instructor. This 'learning through doing' method proved successful for one participant who said this helped her retain information more easily. Yet, the majority of the participants who attended the professional development sessions admitted that they had difficulty recalling the skills they learnt. Multiple reasons were cited for this, notably cognitive load, automaticity, authentic learning, selecting priorities, and the fast-paced nature of technology.

Undoubtedly, having extra time to put these skills into practice was a popular echo amongst teachers. With each session lasting 45 minutes to an hour, participants' recall suffered due to excessive cognitive load. With a lack of time to assimilate so much information, automaticity was also brought forth as an important factor affecting recall and retention. Therese confessed that she did not use the applications enough for them to become automatic. Other participants noted that they were too invested in the process of using GAFE or IWB to actually focus on the actual goal, that of creating a collaborative online project for their students. Since these procedural tasks require more attention, the learning process often becomes long and tedious for the learner, who tries to navigate through what was learnt during the tiered professional development sessions, the online video tutorials, or the collaborative online projects workshop. Step-by-step processes, which have yet to become automatic tend monopolize the learners' working memory thus negatively affecting their cognitive load (Driscoll, 2005). It is these above-mentioned factors, which are explored in Cognitive Information Processing Theory

(Driscoll, 2005) that can help explain why many participants had difficulty accomplishing collaborative projects using GAFE and IWB.

Fabienne also mentioned that seeing or doing something once will often be forgotten unless it is integrated in meaningful way immediately. This 'use it or lose it' interpretation brings about the concept of meaningful learning, whereby retaining information is more easily accomplished as the learner creates personal connections through real-life experiences (Driscoll, 2005). Upon comparing results from the Socratic Wheel Self-Assessment Instrument, participants who noticed a gain in competence, all continued using Google applications in their pedagogy, whether through online collaboration with colleagues or through collaborative projects with students. The mastery of such skills was acquired through authentic activities that provided the purpose for which practicing these various skills were necessary and useful. Nonetheless, Fabienne stated that she forgot much of what was shown or practiced collaboratively during the sessions because she would only use the applications on her own, if she were confronted with a necessity to use them. Driscoll (2005) also raises the point that a sole authentic activity is often not enough to enforce recall: "not all skills or knowledge readily lend themselves to immediate application. Sometimes, component skills or bits of knowledge must accumulate over a long period before they become useful" (p. 337).

How teachers prioritize their time is another element that impacted the efficacy of the interventions. The contractual nature of the teaching job plays a considerable part in how they decide to use their time. Beatrice had been on multiple replacement contracts without ever having a tenured position. Given the fact that she was almost always assigned to different grade levels, she admitted that her time was often used to create her curriculum, and not so much how to enhance it with technology. This is reiterated in her written response on the reaction survey

from the collaborative IWB and GAFE activities workshop: “Changer de niveau chaque année me démotive à investir du temps pour développer des projets avec des nouveaux logiciels” (Beatrice, question #9, reaction survey). This highlights how the amount of time invested in the creation of technology-enhanced lessons can be limited, especially if it cannot be used in subsequent years.

Finally, while teachers agreed that the ever-evolving facet of technology allows for endless societal and scholarly opportunities, reinventing their pedagogical practices requires time. Most participants voiced having trouble keeping up with the fast pace of technology, gruntingly acknowledging that they often have to relearn a new technology, after finally mastering a previous one. This disgruntlement was not only directed at the novelty of IWB- or GAFE-use, but also at the variety of proprietary publishers’ software and online pedagogical material.

Potential Pedagogical Applications. Throughout the tiered professional development sessions, teachers’ learned about various Google applications and how to work with them. In this sense, the sessions were very methodological, with technical step-by-step instructions, accompanied by a visual job-aid (the online video tutorials) for further exploration. While these sessions provided necessary training on how to use the tools, they did not focus on the potential pedagogical applications. It is for this reason that providing participants with meaningful project-based ideas was crucial in motivating them to use IWB and GAFE. According to Driscoll (2005), “to be motivated, learners must first recognize that given instruction has personal utility” (p. 335). Teachers who attended this workshop especially liked the examples as they helped them make links about feasible projects they could design for their classes. Robyn explained this,

> Justement, j'ai vraiment aimé la dernière formation, une présentation avec des exemples, des exemples concrets. Comment puis-je utiliser cette application-là concrètement dans ma classe? J'ai besoin d'un exemple pour voir. Si tu fais juste m'expliquer comment ça fonctionne, bien ça me semble trop gros d'aller, moi, jouer dedans, puis je [peux] le faire, mais ça va me prendre six mois [plutôt] que si tu me montres exactement [ton projet]. La prochaine fois, je vais faire le lien […] Tu m'as vraiment donné des exemples concrets. (Robyn, focus group #2)

This is inline with Driscoll's (2005) explanation of Keller's Model of Motivational Design, "[…] instructors should relate instruction to their learners' experiences by providing concrete examples and analogies. The more familiar something is, the more likely it is to be perceived as relevant to the learner" (p.336). Beatrice also stated that although they might not remember the steps necessary in creating a specific project, (i.e. creating a collaborative Google Slides presentation about clothing throughout the 20th century), they could remember the overall idea, and transform it according to their needs.

> En même temps, c'est intéressant aussi quand il y a plusieurs exemples, chacune va capter ou retenir un truc qu'elle trouve plus intéressant pour son niveau ou sa matière. Ce qui fait que finalement ce n'est pas grave si on n'a pas retenu [par exemple] les 15 activités, mais si j'en ai retenu juste deux puis je l'ai fait cette année en 4e année, et Robyn en a retenu deux autres et elle les fait en 5e, bien ce n'est pas la même chose au fond, alors c'est correct qu'on n'ait pas retenu la même chose nécessairement. (Beatrice, focus group #2)

This remark illustrates that transfer of knowledge is possible even if examples are subject- or grade-specific. Driscoll (2005) describes this retention in her description of Ausubel's

Meaningful Reception Learning Theory: “over time, because it is more economical to remember a single inclusive concept than a large number of specific details, subsumed ideas become less and less distinguishable, or dissociable, from the inclusive anchor” (p. 123).

Furthermore, participants appreciated that the instructor shared the workshop presentation with them so that they could refer to it in the future. Nevertheless, having more time to practice was also suggested for this workshop, with multiple teachers stating that it was nice to be shown examples, but they would have wanted additional workshops whereby they could work on a potential project that was more pertinent to their grade level and subject matter alongside the instructor. Rachel voiced that while practicing certain skills with the instructor at the computer lab was helpful, she believed that having homework or a project related to that skill would help teacher retain more information (focus group #3). The majority of participants agreed stating that it would give them a chance to take a particular skill and apply it to a lesson that was meaningful to them in their teaching. Rosanne stated the following “le faire sur place, le refaire la semaine prochaine, le faire à la maison à partir des choses qu’on veut travailler dans la classe. Ça, c’est vraiment multiplier les occasions. Pour moi, ça serait été encore plus utile.” (Rosanne, focus group #3). Another idea was to have time during a pedagogical day to work on a specific project or lesson utilizing the skills learnt with the ICT pedagogical consultant,

> Tu nous donnes un devoir dans de petits ateliers et un autre devoir qu’on crée, parce que là tu sais que sur l’heure du midi, on n’a pas beaucoup de temps. Si c’est un devoir qu’on doit faire à la maison, bon, on sait comment c’est à la maison, des fois, c’est dur d’en mettre plus que l’on fait. [Alors] si ça pouvait être introduit [pendant une journée pédagogique], tout le monde pourra travailler sur un petit projet, propre à leur vécu de classe. (Rachel, focus group #3)

Once again, the importance of meaningful learning was reiterated in order to increase confidence and automaticity with GAFE and IWB, as well as provide a tangible pedagogical application specific to each teacher.

Teachers as Creatures of Habit. Most teachers acknowledged having difficulty adopting Google applications such as Google Docs and Google Slides, even though they believed in its potential benefits. Many stated they were more familiar with the functionalities found in Microsoft Word, of which, some had not yet been integrated in Google Docs (columns, merging cells, etc.). Rachel reiterates this:

> Je suis restée dans mes vieilles habitudes […] À un moment donné, j'ai commencé [un Google Doc] et je cherchais juste le bouton, bon je ne me souviendrais pas lequel, un bouton super simple et je me disais, ah bien voyons donc! Alors je me suis dit, oh non je n'ai pas de temps encore [alors] pouf! Je suis allée chercher un doc [Word]. (Rachel, focus group #2)

Another participant, Rosanne, stated that she usually started her documents in Word because she found that Google Docs was still missing too much functionality. Upon uploading these Word documents to Google Drive, she then converted them into Google Doc format in order to work on them directly. Since Rosanne had prepared collaborative projects with her Grade 6 class, all of her students had Google school accounts, allowing Rosanne to share her documents with her students through Google Drive. While Rosanne was able to find a way around this functionality setback through format conversion, others made their lives somewhat more complicated when they viewed Google Drive solely as a form of storage rather than a multidisciplinary suite of collaborative applications. Beatrice illustrates this, explaining that her reflex is to work in Word at home and then upload to Drive. At school, she would access her

document through Drive, download a local copy onto the computer to make modifications, upload the new Word document onto Drive, and then delete the old one. These tedious extra steps were common complaints amongst many teachers and suggest that old habits can be detrimental in the acquisition of technologies with hidden affordances (Gaver, 1991).

Choice was another factor that played into changing teachers' habits. Fabienne admitted that she would only use Google Docs if she had no other option, simply because she still had the opportunity to use Microsoft Word. Nevertheless, she recognized that once the school would eliminate its costly licenses for software, she would eventually force herself to use Google applications, only because she would have no alternative.

While routine was a common issue across the board, Genevieve was able to push her boundaries and break out of her habit. This particular teacher has always been quite apprehensive about her abilities in using technology, often referring to herself as a "dinosaur" or "technologically-challenged." Nevertheless, of all the participants in the research project, she is the one person who seemed to have really embraced her newfound confidence using technology. After admitting to having never used an IWB, Genevieve said that it was the collaborative nature of GAFE that encouraged her to take the plunge and learn how to use an IWB. An online newspaper project proved to be what she needed to use GAFE in conjunction with the IWB in order to showcase articles and allow students to work on them collaboratively. She even found herself using IWB software functionalities, highlighting text and annotating directly on the IWB.

> […] J'utilise de plus en plus le TBI pour enseigner et faire des corrections, ce que je ne faisais pas avant. [Alors] là, je fais mon montage, mes plans de cours, mes corrigés à l'ordinateur puis après ça on travaille là-dessus, puis des fois je vais chercher mon doigt puis là je le surligne en jaune avec mon doigt, puis regarder ça c'est important, surlignez-

> le aussi. C'est toutes des affaires que les enfants puissent voir, puis là ils ne disent pas – 'On est rendu où? On fait quoi là?' Regard tu sais on est rendu où. Juste ça là, qu'est-ce que moi j'étais capable de faire [auparavant], je me sens déjà bien avancé! (Genevieve, focus group #2).

Driscoll (2005) explains this paradox using Bandura's Theory of Self-Efficacy,

> Performance clearly determines whether outcome expectations are satisfied, and self-efficacy beliefs control performance. People can harbor beliefs about their capabilities (or lack thereof) that bear no relation to their actual ability to perform some task. But making good use of the capabilities they possess depends upon the self-assurance with which they approach and manage difficult tasks. (p. 317-318)

The Convenience of Ready-Made Products. During the focus groups, the theme of ready-made convenience became apparent. Robyn stated that she did not have the skills nor the time to create IWB and GAFE documents, especially since she was able to utilize ready-made tools online on Gynzy.com, such as timers, fractions, handwriting sheets, and spelling games which took her far less time to find. Therese concurred, stating that it took too much time to prepare lessons utilizing IWB software functionalities such as drag and drop for a simple Grade 1 word order activity. She found a website whereby simply typing the sentence would automatically render a mixed-up drag and drop sentence. Moreover, Beatrice brought up the fact that many publishers now offer USB keys and online access codes for answer keys, as well as supplemental activities. Interestingly, she also mentioned that usually these publishers had created their own proprietary IWB interface complete with highlighting, zooming capabilities, note-taking, and other functionalities found in IWB software. Within this interface, teachers could use Cartesian planes, protractors, and solids for example, without ever having to leave the

publisher's application. For this reason, she did not feel it necessary to use the IWB software such as Open-Sankoré during her math class, since the publisher's version was more complete and directly related to the activity book students used. These remarks hinted at the notion that the IWB's functionalities were superfluous, given the myriad of tools available online or through existing software.

The Usefulness of Job Aids. The online video tutorials provided step-by-step instructions for using both GAFE and IWB. Driscoll (2005) states "imagery can be a very effective means of encoding information" (p.90). This visual aid was employed to help participants remember what they learned during the tiered professional development sessions and to accommodate those who did not attend. Some participants had difficulty following procedural information and so, visual aids helped to provide representations of these technicalities. According to the dual-code model of long-term memory, recall can be easier when learners use both verbal and nonverbal memories (Driscoll, 2005).

Fear of the Unknown. With the imminent removal of the school's file server, teachers were well informed of the administration's unanimous decision to rely solely on Google Drive for file storage. Throughout the years, many teachers lost important files and folders located on the school's local file server, which were never retrieved. This experience seemed to have scarred many, as teachers commonly expressed their apprehension of losing uploaded files 'in the cloud'. The fact that cloud storage is not a tangible object like a USB key or an external hard drive made teachers even more fearful, wondering where in the world their files would end up. A handful of teachers confessed to backing up copies on multiple USB keys, in case Google servers would ever go faulty. Although the IT technician, as well as the elementary and secondary ICT pedagogical consultants tried to reassure teachers, scepticism was still evident in

their voices. It became apparent that prior issues with technology at the school, ingrained trust issues with many of the participants.

Fear of Missing Out. When asked about the effectiveness of the certificate of attestation intervention, a recipient, Tania stated that her goal was not necessarily to acquire the certificate, but to get informed. On the other hand, Rosanne voiced her concern when she did not receive a certificate, not so much because she wanted it, but because she realized she had not attended all sessions and would have liked to know which ones she was still missing. The primary concern for these two individuals was to be well informed by not missing out on information, which they deemed to be important. In this case, the use of an external incentive, such as the certificate, was not particularly effective in inciting motivation since the participants who intrinsically valued learning the skillsets in question attended the sessions regardless. Nevertheless, Rosanne suggested that she would have liked to know which sessions she had missed so that she could retake those with the ICT pedagogical consultant (focus group #3).

Lack of Resources. The lack of resources was another hindrance in the implementation of collaborative online projects with students. Robyn noted that for now, she used Google applications as more of a presentation tool on the IWB, rather than a collaborative one. She stated the fact that the elementary school only has access to 16 laptops for approximately five hundred students. She believed that in order to promote this online collaboration, each class should have enough mobile devices for 30 students, available for them at all moments. At the time of the study, she believed that it was much simpler to have her students go to the computer lab on a weekly basis rather than booking the poorly equipped laptop cart.

The Importance of Having an ICT Pedagogical Consultant On-Hand. Although the researcher never specifically investigated the usefulness of an ICT pedagogical consultant, this factor emerged from multiple focus group discussions.

Teachers found it very useful to have an ICT pedagogical consultant on-hand. This contrasts many Quebec public schools whereby the ICT pedagogical consultant is shared amongst a school board. In addition to drop-in availability one day a week, the ICT pedagogical consultant ensured that if participants had specific questions regarding IWB or GAFE, they could ask her in person, by email, or by telephone. Therese admitted that she could not attend all tiered professional development sessions because there was too much going on at the time, however the fact that the ICT pedagogical consultant was on-demand support, allowed her to continue honing in on her skills.

Furthermore, many voiced the need for the ICT pedagogical consultant to have more availability in order to support teachers in their collaborative class projects. Some explained that having the ICT pedagogical consultant support them during an initial collaborative IWB-GAFE activity would give them the extra confidence required to tackle future projects on their own.

Enhancing Motivation Through Recognition of Professional Development. An interesting proposition by Rosanne was for the school to recognize and validate teachers' dedication to ICT professional development (focus group #3). She suggested that the ICT pedagogical consultant train a small group of teachers, noting their presence for every session and after a certain number of sessions, for the school to compensate the hours spent at lunch or after-school to let this small group of invested teachers have an afternoon or a couple of hours off to work on an ICT project together. She believed that this incentive would allow more

teachers to partake in non-mandatory professional development and ultimately aid the school in reaching higher technology initiatives.

Parent Collaboration. Another interesting facet brought up was that of parent collaboration. Teachers unanimously stated that parents had to model how to work appropriately with a computer, as well as other mobile devices. Many recognized that technology had a bad rap, as parents often associated them solely as a form of entertainment, either through games or mobile applications. Others perceived them as potentially unsafe, especially with regards to communicating online. Unfortunately, due to this, many teachers experienced a refusal on the parents' part to allow for online homework and projects. Rachel said that she would love to vary the homework she gives her Grade 2 students, by using more innovative approaches to learning all while utilizing technological devices such as computers and tablets. Nevertheless, she believes that there is still a long way to go from the parents' perspective. Following this statement, there seemed to be a consensus amongst teachers that parents had to let their kids learn how to work appropriately with a computer. Many voiced that parental refusal to allow for structured technology-use at home (either for homework or projects), was detrimental to student acquisition of so-called '21st century skills'. Rosanne gave the following analogy, bringing forth the triviality of the computer-use in the home:

> C'est tellement important de pouvoir utiliser l'ordinateur. Nous, quand on était jeune, j'écoutais l'histoire des 'Grands-parents' et on n'avait pas le droit d'allumer les boutons de la télévision. Cela était réservé aux pères de famille. Là on a changé de médium, on est rendu avec les ordinateurs et maintenant ils n'ont pas le droit de toucher à l'ordinateur, mais un jour ça va être aussi niaiseux que dans ce temps-là; ne pas être capable de toucher aux boutons de la télé. (Rosanne, focus group #2)

Limitations

This research project had a number of limitations. First, due to the small sample size and research design of this project, the findings of this study cannot be generalizable to the population. However, the sample is representative of teachers who are trying to improve student interaction and collaboration with IWBs, which ensures the transferability of the results of this study to teachers facing similar challenges. Second, participants knew the researcher, therefore some of the results could have been skewed more positively or negatively depending on the relationship held between both parties. Third, the fact that the professional development sessions and the collaborative IWB and GAFE activities workshop were restricted to lunch time and after school, made time management difficult for many participants. If this constraint had not been placed on the project, for example having time allocated for training during pedagogical days, perhaps more teachers would have participated in the training. Fourth, a similar study may have more interesting results if the ICT pedagogical consultant is full-time. Since I split my teaching task with that of an ICT pedagogical consultant, I was unable to dedicate myself fully to interventions at all times, which led the project to last longer than expected. The fact that the interventions were spread throughout the school year also explains the following limitation, that of participant mortality. Initially, the focus groups included 11 participants, which slowly dwindled down to 8. Various factors influenced this mortality notably time constraints, motivation, and disinterest. It is also important to note that if none of the disinterested participants would have dropped out of the project, the mean Socratic Wheel results for the last focus group, would have likely regressed.

Conclusion

Throughout the course of this design-based study, it became clear that teachers were less interested with the IWB and more so with GAFE. While the IWB has many potential affordances, the fact is that it is still a medium in which to display information. The real interactivity lies in the way in which the tools projected onto the IWB provide the interaction. This is especially clear when comparing the findings with that of the Beauchamp and Kennewell's (2010) Classroom ICT Interactivity Framework model. It is important to note that this was the first year teachers had access to Google accounts, and the second year they had IWB in their classrooms. While there is no doubt that during this 'transitory' year, teachers augmented their professional use of these two novel technologies, only a few actually designed learning to promote some sort of interactivity with students. The majority of teachers who integrated collaborative IWB and GAFE activities did so using authoritative and dialectic interaction, but never really attained dialogic or synergistic interaction (Beauchamp & Kennewell, 2010). This can be explained with the fact that most teachers had become initiate users, with a certain level of technological competence, but not enough to redirect their energy towards pedagogical change (Beauchamp, 2004). In order to help them deal with time constraints, many participants used these technologies to improve the management of their workload, instead of creating new lessons and activities for their students. Ultimately, teachers need to have more training, time, and pragmatic opportunities to work with these technologies in order to promote higher-level interactivity with their students. They require both strong technical and pedagogical competences, which would allow them to delve into teacher-facilitated pedagogy and permit students to utilize both the IWB and GAFE to co-construct their knowledge and showcase their metacognitive skills.

References

Armstrong,V., Barnes, S., Sutherland, R., Curran, S., Mills, S., & Thompson, I. (2005). Collaborative research methodology for investigating teaching and learning: the use of interactive whiteboard technology. *Educational Review, 57*(4), 457-469. DOI: 10.1080/00131910500279551

Beauchamp, G. (2004). Teacher use of the interactive whiteboard in primary schools: towards an effective transition framework. *Technology, Pedagogy and Education, 13*(3), 327-348.

Beauchamp, G. & Kennewell, S. (2010). Interactivity in the classroom and its impact on learning. *Computers and Education, 54*, 759–766. DOI:10.1016/j.compedu.2009.09.033

Carliner, S. (2003.) *Training Design Basics.* Alexandria, VA: American Society for Training & Development Press.

Chevalier, J. M. & Buckles, D. J. (2013). *Handbook for Participatory Action Research, Planning and Evaluation*. Retrieved from http://www.sas2.net/sites/default/files/sites/all/files/manager/Toolkit_En_March7_2013-S.pdf

Chouinard, T. (2012, November 19). Tableaux blanc interactifs: Québec suspend le programme. *La Presse*. Retrieved from http://www.lapresse.ca/actualites/politique/politique-quebecoise/201211/18/01-4595166-tableaux-blancs-interactifs-quebec-suspend-le-programme.php

Côté, N. (2012, May 8) Tableau blanc interactif: l'impact sur la réussite n'est pas démontré, selon des chercheurs. *Le Huffington Post Quebec*. Retrieved from http://quebec.huffingtonpost.ca/2012/05/08/tableau-blanc-interactif-impact-reussite_n_1499064.html

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed). Columbus, OH: Merrill Prentice-Hall.

Davidson, A.L., & Desjardins, F. (2010). Vers l'identification d'une relation entre les représentations de la pédagogie et de l'usage des TIC chez des formateurs d'enseignants. *Revue Canadienne de l'Éducation 34*(3), 47-67.

Desjardins, F. (2014, February 27). High Level Deductive Reasoning. In A.-L. Davidson, *Human Performance Technology*. Lecture conducted from Concordia University, Montreal, QC.

Deaney, R. Chapman, A., & Hennessy, S. (2009). A case-study of one teacher's use of an interactive whiteboard system to support knowledge co-construction in the history classroom. *The Curriculum Journal, 20*(4), 365-387. DOI: 10.1080/09585170903424898

Denton, D. W. (2012, July/August). Enhancing instruction through constructivism, cooperative learning, and cloud computing. *TechTrends, 56*(4), 34-41.

DeSantis, J. (2012). Getting the Most From Your Interactive Whiteboard Investment: Three Guiding Principles for Designing Effective Professional Development. *The Clearing House, 85*, 51-55. DOI: 10.1080/00098655.2011.607867

Driscoll, M. P. (2005). *Psychology of learning for instruction* (3rd ed.). Needham Heights, MA: Allyn & Bacon.

Gaver, W. W. (1991). Proceedings from CHI '91 conference: *Technology affordances*. New Orleans, LA, 9-84. DOI:10.1145/108844.108856

Gervais, L.-M. (2013, August 22) Bilan noir pour le tableau blanc dans les écoles. *Le Devoir*. Retrieved from http://www.ledevoir.com/societe/education/385701/bilan-noir-pour-le-tableau-blanc-dans-les-ecoles

Google. (n.d.). *Google for Education.* Retrieved March 8, 2014 from http://www.google.com/edu/index.html

Google. (2012). *Google in Education: A New and Open World for Learning.* Retrieved March 15, 2014 from http://docs.google.com/viewer?url=http%3A%2F%2Fwww.google.com%2Fedu%2Fpdf%2FGoogle_EDU_Report_PRIM-SEC.pdf

Gouvernement du Québec. (2016). Écoles privées. *Éducation et Enseignement supérieur du Québec*. Retrieved April 14, 2016 from http://www.education.gouv.qc.ca/parents-et-tuteurs/ecoles-privees/

Higgins, S., Beauchamp, G., & Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media and Technology, 32*(3), 213-225.

Karsenti, T. & Collin, S. (2013). TIC et éducation: avantages, défis et perspectives futures. *Éducation et francophonie, 41*(1), 1-6.

Larose, F., Grenon, V., Bédard, J., Dezutter, O., Hasni, A., Lebrun, J., Morin, M.-P., Samson, G., Theis, L., Thomas, L., & Savoie, A. (2008). *Study of utilization motives and profiles for adoption of computerized didactic material (CDM) by Quebec Elementary School Teachers*. Retrieved from www.crie.ca/enligne/mdi/CDM-report.pdf

Liang, T.-H., Huang, Y.-M., & Tsai, C.-C. (2012). An Investigation of Teaching and Learning Interaction Factors for the Use of the Interactive Whiteboard Technology. *Educational Technology & Society, 15*(4), 356–367.

Mercer, N., Hennessy, S., & Warwick, P. (2010). Using interactive whiteboards to orchestrate classroom dialogue. *Technology, Pedagogy and Education, 19*(2), 195-209.

Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation*. San Francisco, CA: Jossey-Bass.

Northcote, M., Mildenhall, P., Marshall, L., & Swan, P. (2010). Interactive whiteboards: Interactive or just whiteboards. *Australasian Journal of Educational Technology, 26*(4), 494-510.

Panitz, T. (1999). *Collaborative Versus Cooperative Learning – A Comparison of the Two Concepts Which Will Help Us Understand the Underlying Nature of Interactive Learning.* Retrieved from http://eric.ed.gov/?id=ED448443

Parent, M. A. (2011). Les tableaux numériques interactifs: considérations d'interopérabilité. *Groupe de travail québécois sur les normes et standards en TI pour l'apprentissage, l'éducation et la formation - Québec*. Retrieved from http://www.gtn-quebec.org/publications/article/tableaux-numeriques-interactifs-interoperabilite/

Reeves, T. C., Herrington, J., & Oliver, R. (2005). Design Research: A Socially Responsible Approach to Instructional Technology Research in Higher Education. *Journal of Computing in Higher Education, 16*(2), 97-116.

Şad, S. N., & Özhan, U. (2012). Honeymoon with IWBs: A qualitative insight in primary students' views on instruction with interactive whiteboard. *Computers & Education, 59*(4), 1184-1191.

Saldana, J. (2009). *The coding manual for qualitative researchers*. London: Sage Publications.

Soegaard, Mads (2003). *Affordances*. Retrieved 18 March 2014 from http://www.interaction-design.org/encyclopedia/affordances.html

Strauss, A., & Corbin., J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* London: Sage Publications.

Stolovitch, H. D. & Keeps, E. J. (2004). *Training Ain't Performance*. Alexandria, VA: American Society for Training & Development Press.

Sundberg, B., Spante, M., & Stenlund, J. (2012). Disparity in practice: diverse strategies among teachers implementing interactive whiteboards into teaching practice in two Swedish primary schools. *Learning, Media and Technology, 37*(3), 253-270. DOI: 10.1080/17439884.2011.586352

Tanner, H., Jones, S., Kennewell, S. & Beauchamp, G. (2005) Interactive whole class teaching and interactive white boards. In M.E.R.G.A. (Ed.), *Proceedings of the conference of Mathematics Education Research Group of Australasia* (pp. 720-727). Melbourne (AU): University of Melbourne. Document available at http://www.merga.net.au/documents/RP832005.pdf

Warwick, P., & Kershner, R. (2008). Primary teachers' understanding of the interactive whiteboard as a tool for children's collaborative learning and knowledge-building. *Learning, Media and Technology, 33*(4), 269-287. DOI: 10.1080/17439880802496935

Appendix A

Entrevue avec la directrice (avant)

- Quel est votre objectif pour le projet « L'exploration de l'efficacité des interventions visant à promouvoir la collaboration en utilisant les tableaux blancs interactifs et Google Apps pour éducation »?
- Quelle est la performance désirée des enseignants en ce qui concerne les TBI et Google Apps pour éducation?
- Quelle est la performance actuelle des enseignants en ce qui concerne les TBI et Google Apps pour éducation?
- Y a-t-il des contraintes pour ce projet (budget, temps, etc.)?
- D'après vous, quel est le format le plus efficace pour ces sessions de développement professionnel, ainsi que d'autres interventions (en classe, en ligne, un mélange des deux, etc.)?
- D'après vous, est-ce que les sessions de développement professionnel résoudront tous les problèmes de performance ou est-ce qu'il y a d'autres mesures qui devraient être mises en place pour assurer la performance désirée des enseignants (guides de références, tutoriels vidéo, etc.)?
- Prévoyez-vous des problèmes en ce qui concerne:
    - Les enseignants?
    - Les technologies?
    - Le format des interventions?
    - La participation aux sessions de développement professionnel?

Entrevue avec la directrice (après)

- Est-ce que le problème initial a été résolu?
- Est-ce que nous avons atteint notre objectif pour ce projet?
- Est-ce que la performance désirée des enseignants a été atteinte?
- Quelle est l'efficacité des interventions suivantes :
    - Formations - Google Apps (débutant, intermédiaire, avancé)
    - Atelier d'exemples de projets collaboratifs
    - Certificats d'attestation
    - Tutoriels sur le compte YouTube du Collège
    - Infolettre Forma-TIC
    - Guide de référence et de dépannage pour le TBI
    - Profil de bureau (desktop) personnalisé pour les ordinateurs du primaire avec raccourcis et liens utiles
- D'après vous y a t'il d'autres interventions qui devraient être remis en place ?
- Quels sont vos impressions sur :

- La réaction et la motivation des enseignants face à ce projet?
- Les lieux des sessions de développement professionnel?
- Les formats des sessions de développement professionnel?
- La participation aux des sessions de développement professionnel?

Entrevue avec le technicien (avant)

- Quel est le problème?
- Quel est votre objectif pour ce projet?
- Quelle est la performance désirée des enseignants en ce qui concerne TBI et Google Apps pour éducation?
- Quelle est la performance actuelle des enseignants en ce qui concerne TBI et Google Apps pour éducation?
- Quels sont les problèmes techniques les plus courants rencontrés par les enseignants du primaire?
- Parmi ces problèmes, y en a-t-il qui pourrait être facilement résolu par les enseignants eux-mêmes grâce à de la formation?
- Y a-t-il des problèmes d'infrastructure qui empêchent les enseignants d'utiliser correctement ces différentes technologies?
- Que peut-on faire pour résoudre ces problèmes d'infrastructure?
- Quelles autres compétences techniques «bonnes à savoir" devraient être démontré auprès des enseignants?
- Connaissez-vous des grilles ou des guides de référence qui pourraient aider les gens à utiliser cette information dans leur travail au jour le jour?

Entrevue avec le technicien (après)

- Est-ce que le problème initial a été résolu?
- Est-ce que nous avons atteint notre objectif pour ce projet?
- Est-ce que la performance désirée des enseignants a été atteinte?
- Recevez-vous moins d’appels de support technique depuis l’implémentation des diverses interventions (formation et autres)?
- Y a-t-il encore des problèmes d'infrastructure qui empêchent les enseignants d'utiliser correctement ces différentes technologies?
- Connaissez-vous si les enseignants utilisent les grilles ou des guides de référence dans leur travail au jour le jour?

Appendix B

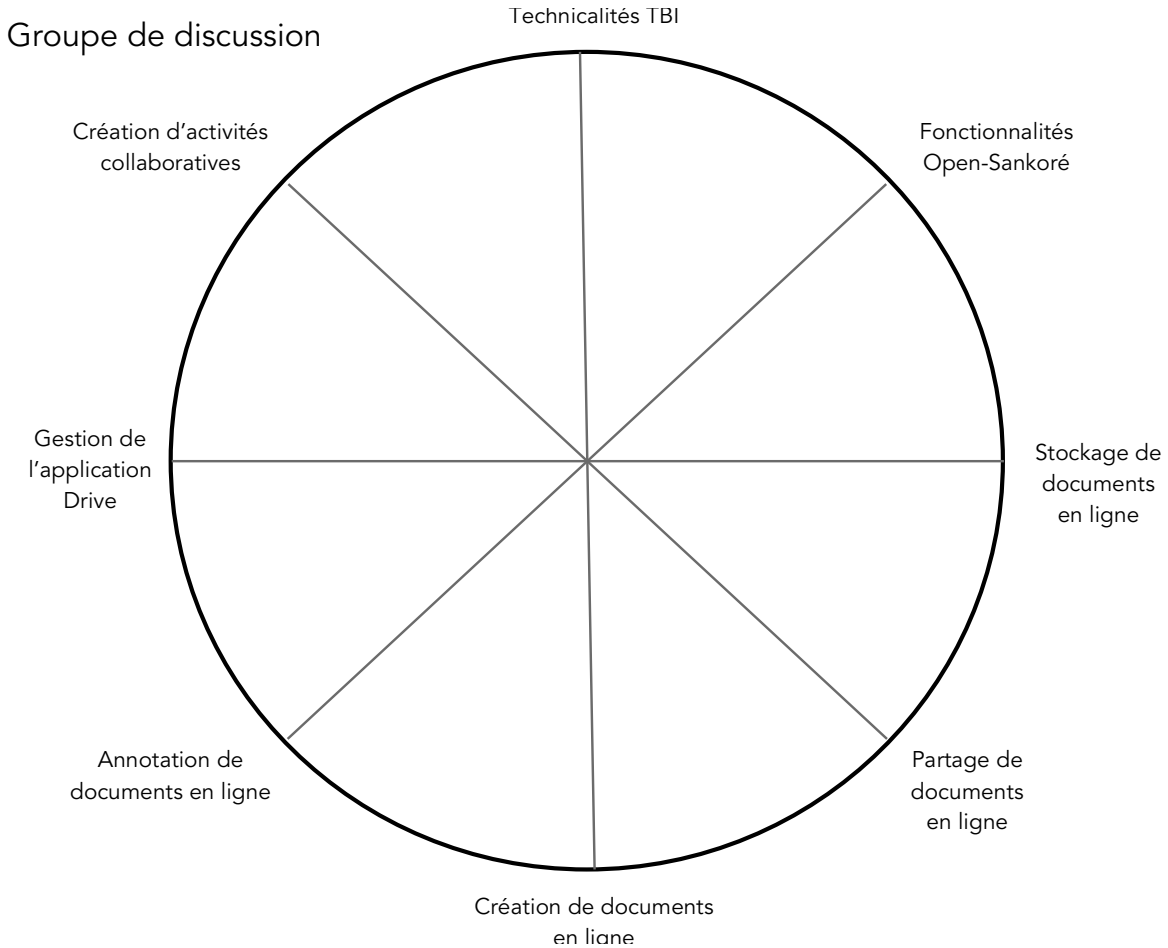

Figure B1. Socratic Wheel Self-Assessment instrument.

Appendix C

Questionnaire - L'efficacité des interventions

Objectif du projet

Ce projet de recherche vise à démontrer le potentiel d'encourager la collaboration entre les élèves et les enseignants en combinant les tableaux blancs interactifs (TBIs) et les applications collaboratives de Google Apps pour éducation.

Suite à l'analyse des besoins des enseignants par rapport aux TBIs et Google Apps pour éducation, diverses interventions telles que de la formation et des outils de travail ont été mis en place afin de démontrer ce potentiel.

Analyse de l'efficacité des interventions

Sur une échelle de 1 (pas du tout utile) à 5 (très utile), quelle est l'efficacité des interventions suivantes par rapport à votre utilisation combinée du TBI et des applications Google.

Interventions	**1**	**2**	**3**	**4**	**5**
Formations - Google Apps (débutant, intermédiaire, avancé)					
Atelier d'exemples de projets collaboratifs					
Certificats d'attestation					
Tutoriels sur le compte YouTube du Collège					
Infolettre Forma-TIC					
Guide de référence et de dépannage pour le TBI					
Profil de bureau (desktop) personnalisé pour les ordinateurs du primaire avec raccourcis et liens utiles					

Appendix D

Atelier - Projets collaboratifs avec les applications Google et le TBI

1. Comment évaluez-vous **cet atelier**? ☺ 😐 ☹
2. Comment évaluez-vous **le matériel d'apprentissage (diapositives)** ? ☺ 😐 ☹
3. Comment évaluez-vous **les exemples de projets** ? ☺ 😐 ☹
4. Comment évaluez-vous **le format de cet atelier (à midi au labo)**? ☺ 😐 ☹
5. Comment évaluez-vous **la rigueur de l'instructeur**? ☺ 😐 ☹

6. **Avant cet atelier**, quel était votre **niveau de connaissances** par rapport à l'utilisation des applications suivantes pour promouvoir la collaboration ?

	1 Aucune	2	3 Assez	4	5 Excellent
Google Docs					
Google Feuilles de calcul					
Google Présentations					
Google Formulaires					
Google Maps					
Google Hangouts					
YouTube et EdPuzzle					
LucidPress					
LucidChart					

7. **Après cet atelier**, croyez-vous **utiliser ces applications** afin de promouvoir la collaboration dans votre classe ?

			Si oui, tous les			
	Non	Oui	Jours	Semaines	Mois	Étapes
Google Docs						
Google Feuilles de calcul						
Google Présentations						
Google Formulaires						
Google Maps						
Google Hangouts						
YouTube et EdPuzzle						
LucidPress						
LucidChart						

8. Avez-vous assisté à des **sessions de développement professionnel** (le midi et/ou après les classes) ?

□ Non □ Oui

Si non, pourquoi?

- ☐ Manque de temps
- ☐ Conflit d'horaire
- ☐ Niveau trop avancé
- ☐ Niveau trop débutant
- ☐ Autre(s) : _____

9. Quels sont **vos projets à long terme** en ce qui concerne l'utilisation des TBI et les applications Google au primaire?

_____

_____

_____

10. Y a-t-il des **obstacles vous empêchant** d'atteindre ces objectifs? Si oui, lesquels ?

_____

_____

_____

11. Quelle partie de cet atelier avez-vous **préférée**?

_____

12. Souhaitez-vous apporter des **améliorations** à cet atelier?

_____

13. Questions et/ou commentaires?

_____

_____

Appendix E

Atelier - Projets collaboratifs avec les applications Google et le TBI

Veuillez SVP partager dans le tableau ci-dessous des idées de projets que vous aimeriez faire à l'aide du TBI et des applications collaboratives de Google.

Projet désiré

Titre : _____ **Niveau** : _____

Sujet : _____ **Compétence(s)** : _____

Brève description du projet	Exemple : En équipe, rédiger une histoire en utilisant un document Google.
Matériel nécessaire	Exemple : Chariot de portables ou labo d'informatique
Support nécessaire	Exemple : Formation sur Google Docs, aide supplémentaire de la conseillère TIC

Puis-je ajouter cette idée de projet dans une banque de ressources qui serait offerte aux enseignants du primaire du Collège?

□ Non □ Oui Signature: _____

Appendix F

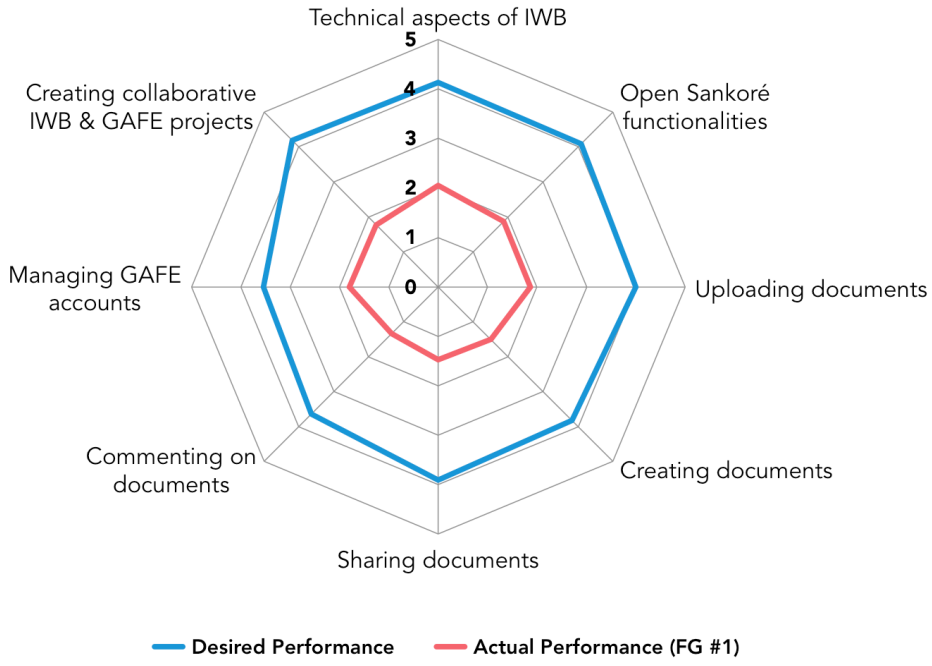

Figure F1. Actual performance means for the first Socratic Wheel Self-Assessment compared to the desired performance means established at the beginning of the study.

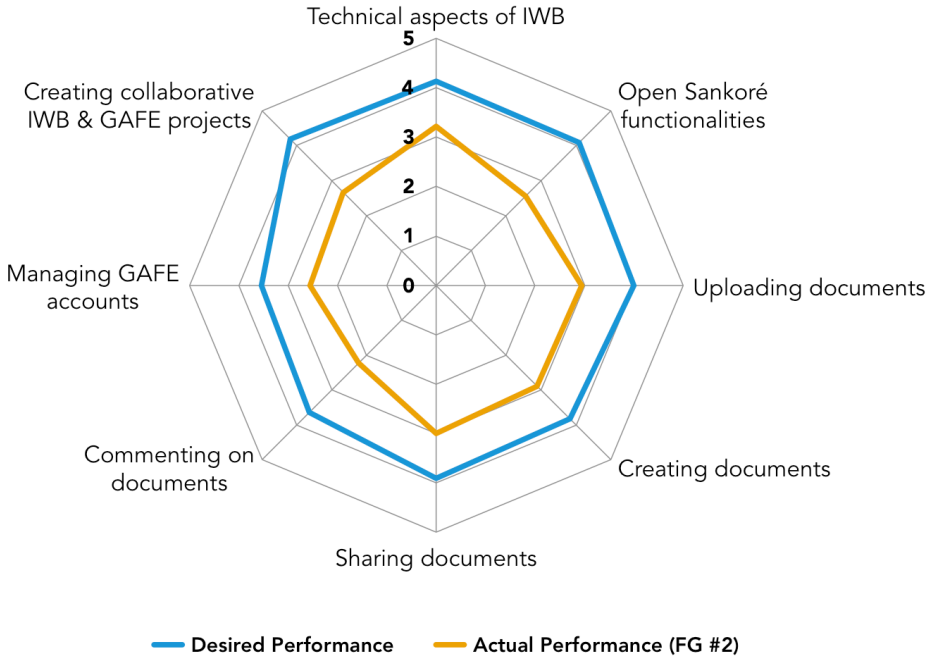

Figure F2. Actual performance means for the second Socratic Wheel Self-Assessment compared to the desired performance means established at the beginning of the study.

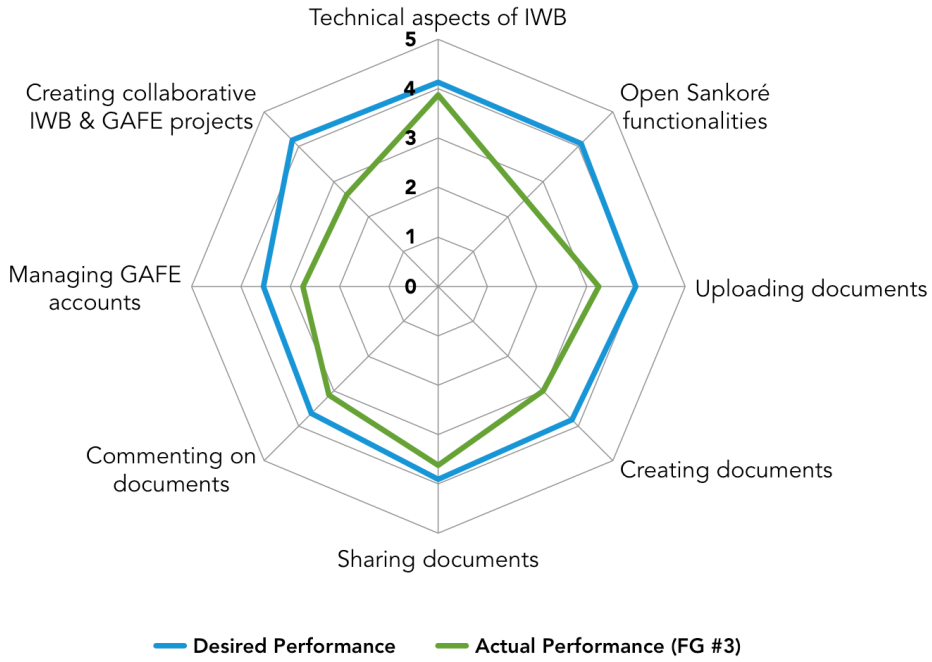

Figure F3. Actual performance means for the third Socratic Wheel Self-Assessment compared to the desired performance means established at the beginning of the study.