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The Effect of Reading Test Mode Interchangeability and Student Assessment Preferences on Achievement

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COLLEGE OF EDUCATION

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Abstract

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Computer-based testing (CBT) in education is on the rise; however, researchers question the interchangeability of CBT and pencil-based testing (PBT). Educators and leaders need to consider test mode interchangeability and student assessment preference prior to adopting CBT in K-8 schools. Following the new literacies theory, this mixed methods study examined test mode preference, the effect on achievement, and factors that influenced student preferences. Research questions investigated participants' computer attitudes and use to determine test mode preference, the impact of test mode and test mode preference on achievement, and factors that influence testing preferences. This sequential explanatory within-group design included 2 online surveys and 2 reading tests in CBT and PBT formats. Paired-sample *t* tests were used to analyze reading test data preferred and nonpreferred test modes and across CBT and PBT test modes. Qualitative themes were generated and coded using an inductive approach, and patterns among data were analyzed. Findings revealed that all participants used technology regularly at home and at school, and most students preferred CBT over PBT. Quantitatively, there were no significant differences in reading achievement between students' preferred and nonpreferred test modes or between CBT and PBT test formats. Qualitative analysis indicated that students who chose PBT as their preferred test mode did so due to their familiarity with the format. Overall, results supported the idea that CBT and PBT were interchangeable. Implications for positive social change include increasing teachers' effective use of testing modes to improve student confidence, which may translate into improved student achievement.

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Dedication

This dissertation is dedicated to my husband, Kevin Sterling and children, Kurtis, Jack, and Julia. Without their constant support, respect, and unwavering encouragement, I would never have been able to accomplish what I set out to do.

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Throughout this 5 year journey, I have often said that *it takes a village to raise a doctoral candidate*. I am so very grateful for the encouragement and support that have been offered to me by many family members, friends, and colleagues. My husband, Kevin, constantly reminded me of my ability and passion for education, and provided countless hours peering over my dissertation, offering insight and feedback when I needed clarity and a different perspective. To my amazing children, Kurtis, Jack, and Julia, my sincere thanks for your patience, insight, support, and understanding while I accomplished this huge goal that I set for myself. You can do anything if you set your mind to it! I am grateful to my parents for instilling integrity and passion in me for as long as I can remember. Special thanks to my little sister Dr. Katrina Laurent for her words of encouragement and assistance when it came to analyzing my data using statistical software. You were and continue to be a true inspiration to me!

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Section 1: Introduction to the Study

Background of the Study

Emerging technologies and the Internet have caused a shift in teaching and learning. Digital technologies are nopt only changing the way students receive and produce information; computers and the Internet are changing the way some teachers instruct and assess at school (Leu, Kinzer, Coiro & Cammack, 2004). Videogames, simulations, social networking, television, the Internet, magazines, books, radio, computer games, and instant messaging are all a fundamental part of students' lives (Ministry of Education, 2008). In light of the changing face of communication, in 2006, the Ontario Ministry of Education (2006) updated the language curriculum for grades 1 through 8 to include a new strand called media literacy. Media literacy helps students develop the skills required to decode and create new digital literacies both critically and responsibly (Ministry of Education, 2006a). The new media literacy strand promotes explicit teaching using electronic images, sounds, graphics, and words independently and in combination to create and convey meaning. Ontario's revised language curriculum demands a change in the way many educators teach and assess traditional literacy (Leu et al., 2004).

After several years of implementing media literacy into the language curriculum, teachers are beginning to realize the benefits of integrating new literacies into literacy teaching and learning. Examples of effective digitally literate educators are located in the classrooms of an innovative, *soft-walled* school in Ontario that are part of the current study district's technology learning center program. As part of Microsoft's Innovative

Schools Program, since 2007, teachers in this program have been provided with ongoing professional learning opportunities on how to plan, instruct, and assess using information and communications technologies (ICT). Technology learning center classrooms are equipped with digital literacy tools such as laptops, liquid crystal display (LCD) projectors, interactive white boards, digital cameras, handheld personal digital assistant devices (e.g., iPod™ or iPad™), document cameras, and streaming technology. In return, technology learning center teachers open up their classrooms to educators to watch lessons promoting collaborative learning, and sharing of ideas (Microsoft Corporation, 2007).

Among the innovative approaches used in technology learning center classrooms, teachers and students make regular use of an Internet-based *Modular Object-Oriented Dynamic Learning Environment* (Moodle) to access class assignments and respond online to texts they have critically viewed, heard, or read in class (S. Louca, personal communication, April 11, 2010). When introduced and monitored effectively in Moodle, learning is made more relevant for students when they have online access to threaded discussions, quizzes, or chats, and can receive feedback from peers or an expert regarding their work or progress (Olfos & Zultanay, 2007). Collaborative spaces, such as those afforded by Moodle, allow for peer and teacher formative feedback to reach a wider audience, and thereby benefit the entire class (S. Louca, personal communication, April 11, 2010). In other instances, students regularly use digital tools to access and analyze a variety of media texts for their intended purpose, message, and audience. Students are given their choice of appropriate technology to create media works such as podcasts,

digital stories, or websites for assessment (R. Lee, personal communication, April 11, 2010). When teachers use Moodle and other digital tools for teaching and learning, students have the foundation to achieve success in literacy because the intended learning outcomes are constructively aligned (Biggs, 1999, 2003) with and assessed using the same technology and new literacies that are used during instruction.

As Ontario teachers in technology learning center classrooms integrate more and more ICT into their instruction and formative assessment (T. Wright, personal communication, January 6, 2011), computer-based testing (CBT) is also on the rise in other classrooms to meet the demands of high stakes assessments such as the No Child Left Behind (NCLB) and National Assessment of Educational Progress (NAEP) programs in the United States (Wang, Jiao, Young, Brooks, & Olson, 2008). The benefits of using CBT include immediate scoring and reporting of students' test results, greater test security and efficiency, and more flexible scheduling (Bennett, 2001, 2002; Boo & Vispoel, 1998; Klein & Hamilton, 1999; Parshall, Spray, Kalohn, & Davey, 2002; Schmit & Ryan, 1993). Nonetheless, prior to realizing these benefits, research should first substantiate the impact of test mode effect on achievement results (International Test Commission, 2005). Despite the increased popularity of using CBT over PBT in education, discrepancies exist between researchers regarding the interchangeability of results between these two modes (Gallagher, Bridgeman, & Cahalan, 2002; Wang et al., 2008).

Researchers have conducted interchangeability studies to determine if students perform equally on tests with comparable content but differing formats (Camilli &

Shepard, 1994). While some claimed that CBT scores can be seen as equivalent to PBT scores (Bergstrom, 1992; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans, Tannehill, & Martin, 1995; Johnson & Green, 2004; Neuman & Baydoun, 1998; Wang, Newman, & Witt, 2000); others concluded that results between these two test modes are not interchangeable (Godwin, 1999; Mazzeo & Harvey, 1988; Mead & Drasgow, 1993; Pommerich & Burden, 2000). A search of peer-reviewed K-8 test mode comparability literature from 2004 to 2010 revealed three studies (i.e., Hargreaves, Shorrocks-Taylor, Swinnerton, Tait, & Threlfall, 2004; Horkay, Bennett, Allen, Kaplan, & Yan, 2006; Pomplun, Ritchie, & Custer, 2006) that provide direct implications for future test mode research. In addition to questioning the interchangeability of results on varying test modes, recent studies also raised concerns regarding the comparability of the design of CBT instruments. The number of items on computer-based instruments (Hargreaves et al., 2004), and limitations of on-screen formats (Gaskill & Marshall, 2008) can negatively impact student results. Furthermore, computer anxiety and prior experience using technology can influence computer-based test scores (Pomplun et al., 2006).

In addition to the interchangeability issue, researchers are beginning to link student engagement with achievement. Klem and Connell (2004) summarized decades of scholarly literature by stating that higher levels of engagement have been linked with improved performance in schools. One way to engage learners in teaching and learning is to offer them the choice of how they can be assessed.

Few recent peer-reviewed studies have been conducted on the impact of K-8 students' assessment preferences on achievement. Furthermore, current empirical evidence involving university-level students is inconclusive (von Mizener & Williams, 2009). Although some studies have found no significant relationship between university level students' assessment preferences on their achievement (Flowerday, Schraw, & Stevens, 2004; Furnham & Chamorro-Premuzic, 2005), other researchers have reported significant differences in achievement on students' preferred assessment format (van de Watering, Gijbels, Dochy, & van der Rijt, 2008; Whithaus, Harrison, & Midyette, 2008). Overall, these mixed results further supported the rationale to examine the effect of assessment mode preference on student achievement in this mixed methods test mode investigation.

Although CBT may be more convenient, it is unclear whether CBT and PBT provide interchangeable measures of student achievement, and if student performance on CBT depends on teacher and student prior experience using new literacies and the Internet, and students' assessment preferences (Pomplun et al., 2006). Before mandated shifts in educational assessment practice can be made at the local, provincial, and district level, questions around computer attitudes and use, test mode interchangeability, and student assessment mode preferences must be addressed. As presented in the sections that follow, the two phases of this sequential explanatory design addressed these concerns. Classroom teachers can gain awareness of how technology is being used by Grade 6 technology learning center teachers and students. Then, teachers can reflect on the implications for their own practice. Moreover, the Grade 6 reading achievement data

from this study confirm the interchangeability of reading achievement results between computer-based and pencil-paper reading tests, as well as between students' preferred and nonpreferred test modes. At the district level, these findings can help inform the design of local professional learning programs on how to teach and assess new literacies and help foster more positive attitudes among educators toward the integration of technology in the classroom. Finally, provincial Education Quality and Accountability Office (EQAO) officials who may be considering administering its annual grade 3, 6, and 10 literacy tests on the computer can learn about the interchangeability of different reading test modes on student achievement. More detailed information regarding the significance of this research problem in my local district follows in Section 2.

Problem Statement

Prior to this small scale study, it was unclear whether converting pencil-based tests into computer-based tests would produce student achievement results that were interchangeable. In addition to test mode interchangeability concerns, discrepancies also existed between some researchers concerning the impact of student assessment preference on achievement (von Mizener & Williams, 2009). It is unclear whether their achievement might improve or decline when students select their preferred mode of assessment. Moreover, other researchers have raised concerns regarding student readiness when completing computer-based assessments (Choi & Tinkler, 2002; Horkay et al., 2006; Olsen, Maynes, Slawson, & Ho, 1989; Pomplun & Custer, 2004). Higgins, Patterson, Bozman, and Katz (2010) found that adult students who had little prior computer experience or who preferred taking tests using traditional pencil-paper methods

were disadvantaged by having to take a CBT. Even though students may not have prerequisite keyboarding skills, more and more tests are being administered using the computer (Pomplun et al., 2006) for reasons of convenience in meeting the increasing demands of high stakes testing across the United States and western Canada (Taylor, 2006; Wang et al., 2008).

In Ontario, increased school district accountability based on individual school achievement data has also become the focus (Campbell & Fullan, 2006). One might predict that similar to their U.S. and western Canadian counterparts, policy makers and educational leaders in Ontario may be considering making the same shift toward CBT in elementary and secondary schools. There are not enough empirical studies on the interchangeability between CBT and PBT test modes (International Test Commission, 2005) and the impact of student choice on achievement (Arce-Ferrer & Guzman, 2009; Flowerday et al., 2004). Therefore, it is important to understand students' and teachers' prior experiences and attitudes regarding technology, along with the impact of student assessment preference on achievement (Sterling, 2010) prior to embracing the shift to CBT to administer high stakes EQAO reading tests in Ontario. Further test mode research to investigate the impact of different test modes on reading scores is also warranted (Wang et al., 2008).

In this study, I examined test mode effects by comparing student reading scores (dependent variable) across test modes (CBT and PBT; independent variable). By offering students the choice between CBT and PBT for Test 1, I investigated the impact of students' assessment preferences by comparing their preferred reading test mode score

and their nonpreferred reading test score (independent variable). Student Opinion Survey data uncovered factors that influenced a particular test mode preference. This information, when compared with the quantitative data, can inform teachers and educational decision makers as they consider integrating CBT into K-8 education.

Nature of the Study

This mixed methods study investigated teachers' and students' prior experiences and attitudes regarding technology, the effect of reading test mode (CBT and PBT) interchangeability and students' test mode preference on achievement, and the factors that influenced students' test mode preferences. This investigation used a sequential explanatory design; therefore, quantitative data collection preceded qualitative data collection. In the quantitative phase, data regarding teachers' and students' prior attitudes and experiences using technology at home and at school were collected using Computer Attitudes and Use Surveys (see Appendices A, B). Then, based on students' test mode preferences, by administering Reading Test 1 and Reading Test 2 in CBT and PBT formats (see Appendices C, D), I collected data regarding the impact of students' assessment preferences and the interchangeability of test modes (CBT and PBT) as measured by student achievement results. In the qualitative phase of the study, I focused on detailed qualitative, open-ended responses from the Student Opinion Survey (see Appendix E) to uncover the factors that influenced students' assessment mode preferences.

To understand the problem and research questions, a purposeful sampling method was used. The purposefully selected population for the study comprised two Grade 6

technology learning center teachers and all of their students (48 altogether) from two different elementary schools in southwestern Ontario, Canada. O'Dwyer, Russell, Bebell, and Tucker-Seeley (2008) suggested that future technology impact studies should first identify settings where computer technology use is likely to be high (i.e., technology learning center classrooms), and then draw research participants from particular classrooms. This investigation met these criteria because the research population stemmed from two technology rich environments within the technology learning center program. Therefore, technology use during literacy teaching and learning was high.

The two part data collection procedure for the mixed methods study, as shown in Table 1, took place on two separate days that were 2 weeks apart.

Table 1

Procedure for Mixed Methods Study

Day 1 on Week 1	Day 2 on Week 2
Quantitative Phase One: Computer Attitudes and Use Surveys (teachers and students)	Quantitative Phase One: Reading Test 2 (students only)
Quantitative Phase One: Reading Test 1 (students only)	Qualitative Phase Two: Student Opinion Survey (students only)

In the quantitative phase, teachers and students completed an online Computer Attitudes and Use Survey during morning recess. Then, as part of regular literacy instruction, I administered two reading tests. Reading Test 1, herein called Test 1, was in the students' preferred test mode (CBT or PBT), followed by Reading Test 2, herein called Test 2, in the alternate mode. In the final phase, I collected qualitative data by having students complete an online Opinion Survey during recess.

Teachers and students first completed the Computer Attitudes and Use Survey to gauge their prior experiences and attitudes toward technology use at home and school. Zhao and Frank (2003) defined technology use as the application of a technology function to solve practical problems. Levin and Bruce (as cited in Lei and Zhao, 2007) established a detailed four part taxonomy of educational technology use: technology as media for inquiry, technology as media for communication, technology as media for construction, and technology as media for expression. In their study of middle school students, Lei and Zhao (2007) determined that students also use technology at home for entertainment purposes when they play games, surf online, or create websites for fun. Therefore, in this investigation, I considered using technology to imply accessing the computer to browse the Internet, read text onscreen, conduct research, play games, and engage in online threaded discussions found in free web-based chat rooms and blogs, or teacher-directed Moodles for entertainment purposes and school work.

Following data collection using the Computer Attitudes and Use Survey, and as part of the regular literacy program, I had students complete Test 1 and Test 2 in CBT and PBT format. Lightstone and Smith (2009) found that student choice between computer and traditional paper pencil university tests was a predictor of performance. Offering student choice with connections to real life literacy helps students stay engaged in their learning (National Council of Teachers of English [NCTE], as cited in Sterling, 2010). The Ontario Ministry of Education (2009) recommended fostering ownership of authentic assignments and topics by providing choice and involvement in decision-making to increase student engagement and make literacy learning relevant to today's

learner. Increased engagement can lead to improved achievement (Guthrie & Humenick, 2004). Therefore, to examine the role of choice and help fill the test mode gap at the K-8 level (Arce-Ferrer & Guzman, 2009), students were given the choice to complete their first round of testing in either CBT or PBT format, and then completed the second round of testing in the alternate mode.

Prior to taking Test 1, I had students record their preferred test mode (CBT or PBT) in writing on a ballot that I collected. Based on students' assessment preferences, I administered the appropriate number of CBT and PBT formats of Test 1 to students on the same day that I collected data for the initial Computer Attitudes and Use Survey. Once all of the students had completed the first test, I returned to their classrooms the following week to administer Test 2 to students in the alternate mode of assessment on day two of the data collection.

The two reading tests were comprised of questions from EQAO reading tests from previous years. For the computer-based format of either Test 1 or Test 2, students accessed a web-based version of one narrative and one informational reading passage, and used the computer keyboard and mouse to complete a variety of multiple-choice and short answer reading comprehension questions taken from previous EQAO tests. In the PBT mode, students read a paper-based version of the same reading passages, and completed the same reading comprehension questions using pencil and paper. The EQAO creates testing instruments based on item, content, and sensitivity reviews to ensure the difficulty of the assessment is similar each year (EQAO, 2008).

During the qualitative phase of the study, all students completed an online Student Opinion Survey. The follow-up surveys generated narrative data regarding students' reasons for selecting their preferred mode of assessment. Qualitative phase data were analyzed in conjunction with the Computer Attitudes and Use Survey results of teachers and students, and students' reading test results. A detailed description of the quantitative and qualitative data collection methods used during this study is discussed in Section 3.

The strategy used in this investigation classifies as a sequential explanatory design because quantitative data collection and analysis preceded the collection and analysis of qualitative data (Creswell, 2003; see Figure 1).

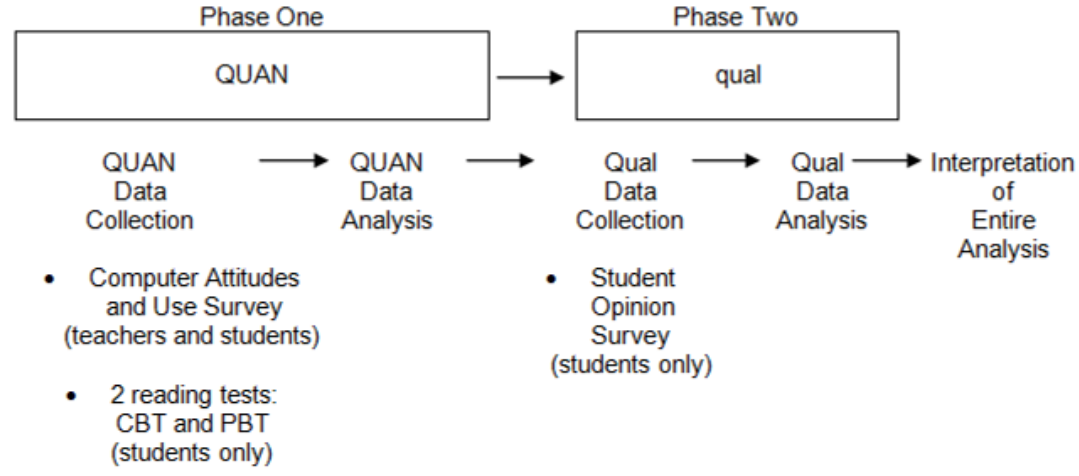

Figure 1. Sequential explanatory design diagram. Adapted from "*Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.)," Creswell, 2003, p. 213. Copyright 2003 by Sage Publishing. Adapted by permission (see Appendix F)

There were more quantitative than qualitative data collected in this study. Therefore, the sequential explanatory strategy was selected so that the qualitative phase data was used to interpret the findings of a primarily quantitative study. Creswell (2003) confirmed that having qualitative data to substantiate the quantitative findings (i.e.,

computer attitudes and use, students' test mode preferences, and reading test results) strengthens mixed methods studies. The sequential explanatory model was also easy to follow because the steps fell into clearly defined, separate stages that were easy to describe and to report (Creswell, 2003). The quantitative phase and qualitative phase methods were integrated during the interpretation phase. More information regarding the rationale for selecting the purposeful sample and this particular design is discussed in Section 3.

Specific Research Questions

Four research questions guided the mixed methods sequential explanatory inquiry. Question 1 was answered using the online Computer Attitudes and Use Survey and Question 2 and 3 were answered using the two reading tests. Question 4 was addressed during the online Student Opinion Survey in the final qualitative phase of the study.

1. What were the prior experiences and attitudes of teachers and students about technology use at home and at school?
2. Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms?
3. Were the reading achievement results for the students' preferred test mode significantly different from the students' nonpreferred test mode?
4. Which reading test mode did students prefer, and what factors influenced students' preferred test mode?

Hypotheses

The hypotheses for Research Question 2 were:

$H_0$1: There would be no significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center program classrooms.

H_a1: There would be a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center program classrooms.

The hypotheses for Research Question 3 were:

$H_0$2: The reading achievement results for the students' preferred test mode would not be significantly different from the students' nonpreferred test mode.

H_a2: The reading achievement results for the students' preferred test mode would be significantly different from the students' nonpreferred test mode.

Research Objectives

The main goal of this mixed methods sequential explanatory study was to investigate (a) teachers' and students' prior experiences and attitudes about technology, (b) the impact of test mode (CBT and PBT) interchangeability and test mode preference on achievement, and (c) the factors that influenced students' test mode preferences. The quantitative Computer Attitudes and Use Surveys addressed the first research question, and uncovered how teachers and students from technology-rich technology learning center classrooms felt about and used technology at home and at school.The quantitative Test 1 and Test 2 instruments addressed the hypotheses for research questions 2 and 3.

Following the quantitative phase of the study, qualitative data were gathered using the online Student Opinion Survey.The two open-ended questions on the final survey instrument revealed the factors that impacted students' preferred test mode, and how students felt about being able to choose their preferred mode of assessment. Further information regarding the role that the Computer Attitudes and Use Survey and the Student Opinion Survey played in the sequential explanatory design is discussed in Section 3.

Purpose of the Study

Although some educators may think that cloning the questions from a pencil-paper test onto an alternate test format like the computer should produce the same results, prior to this small scale study, the interchangeability of CBT and PBT modes as measured by student achievement results was unclear. Similarly, although some researchers found significant differences in achievement when assessing students using their preferred test mode (van de Watering et al., 2008; Whithaus et al., 2008), others have discovered no relationship between students' assessment preferences and achievement (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005). The purpose of this mixed methods study was to uncover the interchangeability of test modes (CBT and PBT) and the effect of student assessment mode preference on the reading achievement results of Grade 6 students who regularly used technology at school. Such an investigation addressed current gaps in the K-8 reading test mode and student assessment preference literature. Quantitative computer attitudes and use data and student reading achievement results from the quantitative phase substantiated qualitative findings

about factors contributing to students' assessment preferences from the qualitative phase. Results of this investigation can inform elementary teachers and educational decision makers who are considering the shift from traditional pencil-paper to computer-based tests to measure reading achievement.

Theoretical Base

As a computer resource teacher for 4 years, I observed that student engagement increased when teachers purposefully integrated information and communications technology (ICT) into teaching and learning. Increased engagement can translate into improved performance (Klem & Connell, 2004). Recent conversations with fellow technology learning center colleagues confirmed that classroom instruction and assessment needs to keep pace with the changing face of literacy (A. Harrison, R. Lee, S. Louca, & A. McNaughton, personal communication, April 11, 2010). These technology learning center colleagues stated that students in technology learning center classrooms were more motivated, and the quality of their work improved when teachers taught, and students learned to use emerging digital tools and electronic texts. However, while teachers in technology learning center classrooms changed their literacy practice to include aligning computer-based instruction with computer-based assessment, district and province-wide reading tests in Ontario were still being administered using traditional pencil-paper methods. technology learning center faculty reported a disconnect between how today's learners read using a range of digital tools and electronic texts, and the way their reading was assessed (A. Harrison, R. Lee, S. Louca, & A. McNaughton, personal communication, April 11, 2010). A review of the literature revealed that computer-based

assessment had indeed surfaced in classrooms that see the value in connecting what and how to teach, with how to assess (Jones, 2007). The relationship between computer-assisted teaching and learning, and student achievement in reading can be explored in theories of new literacies (Leu et al., 2004; Leu & Zawilinski, 2007).

In collaboration with educators and leaders from 25 districts of education across the province, the Ontario Public School Boards' Association (OPSBA; 2009) emphasized that today's learner has no recollection of a world without the Internet and that many of the texts that students interact with have shifted from print to electronic format. Therefore, to meet the needs of 21st century learners, teachers need to adopt new approaches to teaching and learning (OPSBA, 2009). Leu et al. (2004) of the New Literacies Research Lab at the University of Connecticut developed the new literacies theory to help educators rethink their definition of literate activities and literate practices, which characterize effective modern-day reading comprehension (Leu et al., 2004).When teachers purposefully integrated ICT and the new literacies of the Internet into their reading programs, students' reading scores improved (Espinosa, Laffey, Whittaker, & Yanyan, 2006; Silvernail & Gritter, 2007; Slavin, Cheung, Groff, & Lake, 2008; Vogel, Vogel, Cannon-Bowers, Muse, & Wright, 2006).

In an interview with Mokhtari, Kymes, and Edwards (2008), the Connecticut New Literacies Team further emphasized the importance of figuring out how to assess the new literacies. However, getting teachers to assess reading using dynamic digital texts is not easy because many do not fully understand how "online reading comprehension requires [them to teach] additional, new reading comprehension skills" (Mokhtari et al., 2008, p.

356). Although changing practice to include ICT and new literacies may pose a challenge for some teachers, others are intentionally aligning the intended learning outcomes of revised literacy standards, with new ICT-embedded approaches to instruction and assessment (A. Harrison, R. Lee, S. Louca, A. McNaughton, personal communication, April 11, 2010). The two technology learning center teachers in this study fell into the second category; by virtue of their enrolment in the technology learning center program, they intentionally integrated new literacies into their teaching. This reading test mode study tested the promise of new literacies theory by investigating the impact of test mode interchangeability and student assessment mode preference on student achievement in two Grade 6 technology learning center classrooms in Ontario, Canada.

Operational Definitions

Comparability: Comparability between test modes exists if comparable test subjects (e.g., students of equal grade level and ability) from different groups (e.g., classrooms and test administration modes) perform equally on the same test items (Camilli & Shepard, 1994).

Information and Communications Technology (ICT): Technologies that involve the use of computer hardware, software, or related equipment, and digital applications as a primary method for communicating, creating, disseminating, storing, or managing information teaching and learning in the classroom (Tinio, 2003). An example of ICT would be a free online program called Audacity that allows students to audio record their response to something they have read. Student audio clips could then be uploaded into the class online class Moodle (another example of ICT) for others to read and provide

feedback. ICT was a variable for this study and was examined more closely during the quantitative phase of this investigation.

Interchangeability: For the purpose of this study*, interchangeability* refers to the ability for computer-based and pencil-paper test results to be interchangeable, substituted or equivalent (Wang et al., 2008).

Reading achievement: Students' achievement scores in relation to the provincial standard (EQAO, 2010b) in Grade 6 reading as outlined in the Ontario language curriculum (Ministry of Education, 2006a). Reading achievement results from the two reading tests of varying modes (CBT and PBT) and test mode preferences (preferred test mode and nonpreferred test score) formed the dependent variable in this study (Wang et al., 2008).

Using technology: Accessing the computer to browse the Internet, read text on-screen, conduct research, play games and engage in online threaded discussions found in free web-based chat rooms and blogs, or teacher-directed Moodles for entertainment purposes and school work (Lei & Zhao, 2007).

Assumptions

A fundamental assumption was that ICT was purposefully and comprehensively integrated into literacy teaching and learning in both technology learning center classrooms invited to participate in this study. Another assumption of this study was that students answered both surveys and the two reading tests truthfully and with equal diligence. A third assumption was that each of the reading tests measured similar literacy skills and at the same level of difficulty. A final assumption was that my actions as the

researcher did not affect the way teachers and students behaved or responded during the investigation in a way that impacted the reliability of this research.

Limitations

The purposeful sampling procedure of this study decreased the generalizability of findings beyond Grade 6 technology learning center settings in the current study district. Therefore, results were not generalizable to all elementary grades, classrooms, or school districts. Consequently, the size of the small sample is referenced in the limitations section of this research report. A comprehensive description of the research participants and treatment is also provided to make it possible to generalize the results to the situations with the similar demographics, treatment programs, and school levels.

To control for inter-rater reliability, a single teacher, not participating in the study, and previously trained to score EQAO assessments marked all the reading tests. A generic rubric for each type of open reading response described student responses at different levels of performance and maintained between-item and year to year consistency (EQAO, 2008). Answers to multiple-choice questions and exemplars of varying student responses to open-ended reading prompts were used for scoring purposes. EQAO (2008) confirmed that "Rigorous scoring procedures ensure the reliability of the assessment results" (p. 4). Means and standard deviations of the results obtained from the online Computer Attitudes and Use Surveys were analyzed.

A threat to validity was the discrepancies that might arise in the reading test evaluations. For example, Briggs (as cited in Mogey, Sarab, Haywood, van Heyningen, Dewhurst, Hounsell & Neilson, 2008) concluded that secondary school students with the

most legible and neatest handwriting received significantly higher grades on national English exams. In this case, the external rater may have been influenced by the appearance of the Grade 6 students' handwritten responses to the short and long reading comprehension questions on the PBT. To reduce the impact of students' handwriting on their achievement, another colleague not participating in the study converted all pencil-based responses to electronic format before the external rater graded the tests. Then these, along with the responses from the computer-based responses in Moodle, were printed and made available to the external rater for grading. Approval to use former Grade 6 EQAO assessments, which have already published strong reliability and validity ratings, assisted in ensuring validity.

The applicable expected limitations for this study may have included the Hawthorn effect, research resistance, and attrition. The Hawthorn effect may have come into effect as a result of students responding under the influence of being a participant in a study. Research resistance may have also occurred if students resented losing their recess or part of their lunch hour due to their participation in the study. Finally, attrition (the loss of participants that cannot be replaced) may have occurred if participants withdrew during the study. All 48 students who provided assent and parental consent participated in the entire research study.

Scope

This research produced results bound by Grade 6 technology learning center teachers' and students' attitudes and experiences using ICT at home and at school, students' assessment preferences, and students' reading achievement results obtained in

the latter half of a 10 month academic year (i.e., March-May). Therefore, findings were neither generalizable to different prior experience using computers, grade level teachers, age groups of students, nor to different time frames in the year (i.e., testing reading at the beginning of the school year).

Delimitations

This study confined itself to two teachers and 48 Grade 6 students from two publicly funded elementary schools in southwestern Ontario, Canada. Furthermore, only teachers and students from the current study district's technology learning center program were included in this study due to their regular use and access to ICT in the classroom. Therefore, regional demographics, students' socioeconomic status, as well teacher and student readiness and prior experience using technology may have affected the findings. My familiarity with the technology learning center program from which the purposeful sample was drawn may have affected the results; therefore, any bias in interpreting the results has been stated beforehand.

Significance of the Study

Despite the demand for education to keep up with technology, educators and leaders need to be critical as they expand e-Learning to include CBT. The results of this small scale study can help fill the gaps in the research on K-8 test mode interchangeability and student assessment preferences. Even though CBT in education is on the rise, researchers question the comparability of results from CBT and PBT. Student performance on CBT may depend on assessment mode preferences, and how adept students can use new literacies of the Internet and computers. Keeping pace with how

ICT is changing the face of classroom literacy practice is challenging. The Canadian Council on Learning (2009) confirmed that Canada is well-known for its robust technological infrastructure; commitment to ensuring accessibility; and quality learning materials. However, despite its position in the global market, Charpentier, Lafrance, and Paquette (2006) cautioned that Canada is starting to trail behind the efforts of other countries in the e-Learning sector, including the use of computer or web-based assessments in classrooms. The Canadian Council on Learning (2009) further explained that nations "that foster ICTs' potential as learning tools are making an investment in their citizens' prosperity and well-being. Societies that fail to take advantage of their potential may well be left behind" (p. 1). Should individual provinces within Canada, or the country as a whole, choose to expand e-Learning offerings to include online assessment at the elementary level, discrepancies regarding students' prior experiences using computers, assessment mode preferences, and the interchangeability of results between CBT and PBT will need to be addressed. Results from this mixed methods study addressed the gaps in the K-8 reading test mode research that focused on the interchangeability of achievement results between CBT and PBT, and the effect of student assessment mode preferences on achievement.

This study has professional application at the local level. Findings from the Computer Attitudes and Use Survey revealed how Grade 6 students and teachers regard and use technology at home and at school. Results of the test mode portion of the study described the impact of offering students choice between CBT and PBT on reading achievement. Data from the Student Opinion Survey uncovered how students felt about

being offered a choice between CBT and PBT to assess their reading comprehension. Classroom teachers might compare how technology learning center teachers and students regularly used technology during literacy teaching and learning, and reflect on the implications for their own practice. The reading test mode data uncovered the impact of embedding choice between test modes in Grade 6 literacy programs. Then, at a district level, staff development officers might design professional learning programs that expose K-8 educators to a range of technologies available to teach and assess new literacies, and thereby foster a more positive attitude toward the integration of technology in the classroom.

This test mode study has implications for positive social change that relate to improving the development of individuals and organizations in Canada. When considering the impact of test mode interchangeability and preferences, local and national educational leaders can make more informed decisions when contemplating the shift toward CBT to measure student achievement in elementary schools. Policies could be developed to ensure that initial teacher training institutions and school districts provide teachers with the necessary training on how to engage students, and effectively use technology to plan, instruct, and assess in the classroom. Overall, the results of this small scale study provide evidence to support changes in 21st century literacy instruction and assessment. Eventually, improved classroom practice helps to prepare Canadians for the future by providing them with skills that can lead to a competitive advantage in the global economy.

Summary and Transition

Section 1 presented the research problem pertaining to the increased use of CBT to measure student achievement in spite of discrepancies among researchers regarding the effect of students' assessment preferences on their achievements and the interchangeability of CBT and PBT as measured by student achievement results. Gaps in the K-8 reading test mode and student assessment preference literature were also identified. Before following the trend toward CBT in K-8 settings, Section 1 explained that not only should educational leaders in Ontario ensure that students have the prerequisite skills they need to complete CBT; they must also be fully aware of the impact of test administration modes on student achievement. Section 1 also introduced the theory of *new literacies* (Leu et al., 2004) that guided this inquiry. The two part sequential explanatory design was illustrated by outlining how the two sets of quantitative results from the teacher and student Computer Attitudes and Use Surveys, and Test 1 and Test 2 were analyzed in conjunction with the qualitative data from the Student Opinion Survey. Section 1 discussed the local and professional significance of this study, and concluded with a description of this study's potential to promote social change by improving the quality of teacher professional learning programs, and informing the implementation of CBT to measure student achievement.

Section 2, the literature review, expands on the theory of new literacies, and presents current test mode and assessment preference research findings and gaps. Literature related to the methods used in this study is discussed, along with findings related to the use of differing methodologies to investigate the impact of reading test

mode interchangeability and student assessment preferences on student achievement. Section 2 also supports the research purpose, questions, and hypotheses of this test mode investigation. A detailed description of the population and two-part sequential explanatory mixed methods design is then described in Section 3. Section 4 of this research report establishes the sequential strategy, presents data in an appropriate manner, and describes the system used for keeping track of the data and emerging understandings. Findings from both phases are presented using tables and figures, and outcomes are logically and systematically summarized in relation to their importance to the research questions and hypotheses. Section 5 interprets the research findings, and describes implications for social change and recommendations for further study.

Section 2: Literature Review

Introduction

In this section, I review the theoretical and empirical research on new literacies studies, CBT and PBT, and the role of student choice in assessment mode. This review will provide contextual information for the variables examined in this study and the methods employed to analyze them. This review will also highlight the research gap.

I began this literature review by searching recent and seminal peer-reviewed research and published dissertations in the Education Research Information Center (ERIC), Education Research Complete, and ProQuest Central databases at Walden University. I conducted my searches using the following key words: *K-8, reading, test mode, interchangeability, ICT, new literacies, computer-based testing, literacy, assessment, student assessment preference, student choice*, *achievement*, and *Canada*. I also examined the reference lists of each source to retrieve related sources, expanded on the ideas I presented in previous unpublished manuscripts and doctoral coursework (Sterling, 2008; 2010), and reviewed course textbooks for guidance on the sequential explanatory design. During this search, I attempted to locate peer reviewed journals and empirical evidence published no later than 2006. The reference list for this research report is extensive, however, due to uniqueness and emerging nature of this inquiry many of the works cited date back more than a few years ago. Therefore, earlier studies had to be incorporated into this review. Using the aforementioned criteria, I retrieved more than 75 peer-reviewed references that form the basis of the literature review that follows.

New Literacies Theory

Adopting new approaches to literacy assessment is supported by the theory that literacy in the 21st century requires a new way of teaching and assessing literacy. Educators have to make complex decisions about which tools and literacies to focus to create literate societies for the future (Luke & Freebody, 1999). These sentiments underscore the importance of integrating technology into teaching and learning in modern classrooms.

Literacy instruction in some classrooms involves a combination of face-to-face and virtual learning. When students work and learn together within social environments that extend beyond the walls of the classroom, students develop in new ways both cognitively and socially (Russell,1999). Johnson, Levine, Smith, and Smythe (2009) concluded that technology profoundly impacts "how people work, play, learn, socialize, and collaborate" (p. 6). Findings from the pan-Canadian Young Canadians in a Wired World (Media Awareness Network, 2005) study also confirmed that of the more than 5,000 student respondents in Grades 4-11, 94% have Internet access in the home, 86% have email accounts, 41% have an MP3 player, 37% have their own computer with Internet access, 23% have their own cell phone, and 22% have a webcam for personal use. In response to these trends, Lankshear and Knobel (2003) labelled a new field of sociocultural scholarship as *new literacy studies*. The rapidly changing face of information requires *new literacies* to "fully exploit their potential in what Reinking (1998) has called our post-typographic world" (Leu et al., 2004, p.1). These new forms of literacy will demand a new form of literacy teaching.

Researchers have concluded that literacy is in a state of evolution rather than revolution connected to new technologies (Zhao & Frank, 2003). In other words, traditional reading and writing are not being replaced; rather, traditional literacy is changing and becoming integrated in multimodal media that are dynamic and interactive on the digital screen (Burns, 2008). As more technology makes its way into classrooms, evidence to support the new ways of using technologies has surfaced (Coiro, 2007; Coiro, Knobel, Lankshear, & Leu, 2008; Kist, 2005; Knobel & Lankshear, 2007; Yelland, 2007). For example, online reading comprehension tasks create opportunities for teachers to capture and assess individualized performance or collaborative performance (Castek & Coiro, 2010). Providing students with timely feedback can improve the quality of their schoolwork. Integrating online participatory cultures in literacy classrooms also helps prepare learners for work outside of school because they realize that "authorship is no longer a solitary nor an original enterprise" (Alvermann, 2008, p. 17). Therefore, integrating ICT and new literacies thinking into the literacy component of education can improve student achievement and help students develop the necessary collaboration skills they will need for the future.

Despite the advancements in the field from these studies, continued investigation into the nature of new literacies and how they evolve and develop is still warranted (Coiro et al., 2008). Increased access to ICT and new literacies in schools does not necessarily equate to effective ICT use by teachers and students in classrooms. Despite the investment and influx of ICT in schools, some researchers argue that teaching and learning looks the same as it did before computers (Christensen, Horn, & Johnson, 2008).

As this study focused on how Grade 6 students interact with digital technology at home and at school, this investigation addressed the gap in new literacies research.

Benefits to Integrating ICT in Assessment

Researchers have emphasized that the role of technology to support traditional literacy achievement in middle school classrooms only supplements the existing curriculum (Labbo & Place, 2010); it does not change teacher practice or equip students with the new literacies they will need for the future. Consequently, there is considerable interest in learning environments that foster teaching and learning to use new literacies, such as those found in the current study district's technology learning center program classrooms (Dillenbourg, Eurelings & Hakkarainen, 2001; Koschman, 1996; Koschman, Hall & Miyake, 2001; Stahl, 2002). The Canadian Council on Learning (2009) is exploring hybrid and blended learning settings that combine traditional classrooms with e-Learning components, along with the development of communities of learners. Aside from equipping students with the critical skills that they will need for the future world of work and life, ICT embedded assessment improves student engagement and motivates learning (Trucano, 2007). Furthermore, when introduced and monitored effectively, e-applications such as threaded discussions, online tests, self-evaluations, and the assessment of e-learner processes and products by tutors, peers, or an expert make learning more relevant for learners (Olfos & Zultanay, 2007), and helps foster more inclusive learning environments in classrooms (Milton, 2008). As they relate to this reading test mode investigation, online threaded discussions such as the online course management systems offered in Moodle described in Section 1, provide opportunities for

students to develop their reading skills further as they make postings about what they and others have read. As learners become more skilled in using meta-cognition or thinking about thinking, Russell (as cited in Sterling, 2009) found that students began to see themselves more as constructivists or producers, rather than mer consumers of information and knowledge in school. Therefore, e-Learning environments can provide ongoing opportunities for students to reflect on their role in the learning process (Fountas & Pinnell, 2001).

When teachers integrate ICT in their classrooms, a student's commitment to learning also increases (Becta, 2002) and learners become eager to work using ICT on their own time, before and after school (Ministry of Education, 2009). Reed, Shallert, Beth, and Woodruff (2004) have also found that classrooms that support learner self-regulation and increased autonomy improve students' motivation to engage in academic tasks. This increase in engagement tends to increase motivation, achievement, and retention of knowledge and skills (Burns, 2008). Furthermore, when students use ICT they work more independently during regularly timetabled sessions and take more responsibility for their learning (Harris & Kington, 2002). Although some researchers reported that ICT embedded instruction and online knowledge building forums improve students' problem solving skills and conceptual understandings (Chan & van Aalst, 2004), others question the long- and short-term impact of technology student achievement (Cox & Marshall, 2007).

Measuring the Impact of ICT on Student Achievement

When research findings support the impact of using ICT in schools, educators can more readily perceive the value of shifting their practice to include more new literacies. However, researchers confirmed that measuring the impact of computer-assisted learning is problematic for a variety of reasons (Sey & Fellows, 2009). From the outset, most ICT studies lack the scale and rigor to arrive at a more clear understanding of the impact of ICT on teaching and learning (Cox & Marshall, 2007). Given the trend of bringing more and more ICT into classrooms, Cox and Marshall (2007) suggested that researchers focus on several important issues to inform future ICT implementation budgets and policies: understanding how 21st century learners think and the different effects of specific types of ICT uses, understanding the impact of curricular design and implementation on students and teachers, and selecting appropriate research instruments and interpreting results. This investigation focused on the majority of these aspects by surveying how 21st century learners perceived technology, identifying the effect of integrating computer-based assessment into literacy teaching and learning, and selecting an appropriate two part mixed methods approach.

In addition to ensuring that studies are rigorous, ICT impact researchers need to define the focus of the research. As Cox and Marshall pointed out, "researchers have sometimes measured the 'wrong' things" (Cox & Marshall, 2007, p. 70). In some cases, researchers fail to identify how technology is being by students and teachers in the classroom (Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999), or "there may be a mismatch between the methods used to measure effects and the nature of the learning promoted by the specific uses of ICT" (Trucano, 2005, p. 6). The

Consortium for School Networking Implementation (COSN; 2008) on Moodle illustrated the challenges associated with researching ICT use in schools.

Although the COSN study set out to focus on how technology supported K-12 teaching and learning, results depicted more about the challenges associated with implementing Moodle in the classroom than about how Moodle was used. Furthermore, the COSN report does not show a significant link between Moodle use and student achievement (Sterling, 2008). Future scholarly inquiry into how ICT supports learning requires a more multifaceted approach to analyzing online instruction and assessment in classrooms (Cox & Marshall, 2007). This investigation uncovered how technology was used by teachers and students by way of the Computer Attitudes and Use Surveys. The mixed methods approach also investigated how online assessment impacted student achievement by comparing reading achievement results on CBT and PBT.

Despite its limitations, the COSN Moodle study (2008) did point to gaps in the research that are addressed in the current inquiry. For example, the student survey in the quantitative phase provides details about how Moodle was accessed by students at home and at school. Similarly, the teacher survey revealed how educators integrated the tool into their literacy instruction. During the reading test portion of this study, Moodle was used to administer the computer-based reading tests, with subsequent comparisons of student achievement results from the computer-based format with the paper-pencil achievement results.

Computer-based Testing in Education

Although policy makers recognize the need and potential for ICT and e-Learning to support 21st education, more tests are administered using the computer for reasons of convenience across the United States and western Canada (Taylor, 2006; Wang et al., 2008). I will now review CBT in education and explore two main challenges regarding its implementation: student readiness and test mode interchangeability.

Trends

Computer-based testing is also referred to as *e-Assessment*. As its name implies, e-Assessment involves the use of ICT, as opposed to traditional paper-based tests, to measure and improve student achievement (Wang et al., 2008). Web quests, threaded discussions, online portfolios, pod casting, computer simulations, and digital video are all forms of e-Assessment (Buzzetto-More & Alade, 2006). In the past, CBT was used for professional licensing, training and certification purposes (Park, 2003). University students reported that e-Assessment is easier than pencil-paper assessment, has a positive impact on their achievement, and provides a more accurate measure of what they know and are able to do (Howell, 2003; Park, 2003). Only recently has CBT made its way into elementary and secondary school settings.

Although researchers in over 300 studies have examined test administration mode effects from the past 25 years, Wang et al. (2008) reported that of the 42 independent experiments that focused on K–12 students, and the comparability of CBT and PBT reading test scores, only 23 studies involved K-8 students. With no Canadian test mode studies meeting the criteria of this extensive review, Taylor (as cited in Sterling, 2008)

stated that further research to substantiate a shift from PBT to CBT in Canada is imperative. Two years later, aside from studies being conducted by independent research corporations, scholarly gaps remain in the Canadian reading test mode literature. An extensive search of peer reviewed journals and dissertations showed that one company, Castle Rock Research Corporation, has three technology-based assessment research projects underway in only three out of Canada's 10 provinces and three territories. The projects involve piloting computer adaptive assessment systems in Alberta, creating computer-based formative assessments in British Columbia, and developing "a curriculum-specific online assessment tool that helps determine a student's strengths and areas of growth in order to assist in the teaching and learning process" in Ontario (Castle Rock Research Corporation, 2008, p. 1). Considering the vast and diverse nature of Canada's population and international pressures to homogenize how nations carry out large scale assessment (Volante, 2008), additional test mode research is warranted. Despite the small scale nature of this study, findings helped to address this need by adding to the K-8 test mode research in Ontario.

Concerns Regarding Test Mode Comparability

Discrepancies that exist in the test mode comparability research pose further challenges for educators and leaders considering the shift toward CBT to measure student achievement. Even though some researchers claimed that CBT scores are equivalent to PBT scores (Bergstrom, 1992; Bodmann & Robinson, 2004; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans et al., 1995; Johnson & Green, 2004; Neuman & Baydoun, 1998; Wang et al., 2000), others concluded that

results between these two test modes are not interchangeable (Godwin, 1999; Mazzeo & Harvey, 1988; McLaren, 2004; Mead & Drasgow, 1993; Pommerich & Burden, 2000; Wallace & Clariana, 2005). Benefits of using CBT at the postsecondary level include immediate scoring and reporting of students' test results, greater test security, efficiency and flexible scheduling (Whitelock & Brasher, 2006); however, CBT has yet to impact K-8 assessment significantly (McDonald, 2002).

Student Readiness

Further inconsistencies exist among test mode research findings regarding the impact of individual student readiness on computer-based test results. For example, varying levels of prior experience and anxiety, or students' attitudes regarding e-Assessment may alter the impact of CBT on elementary students (McDonald, 2002). In other words, some researchers found that K-8 students who have not yet developed their keyboarding skills are negatively impacted by CBT because they have to type their answers using a keyboard (Horkay et al., 2006).

From this research, it seems that younger students with less keyboarding experience and practice using the Internet might be negatively impacted by CBT. Researchers found that CBT are more difficult than PBT for primary students (Choi & Tinkler, 2002; Olsen et al., 1989; Pomplun & Custer, 2004). Conversely, Grade 7 students who presumably have more experience using technology might find CBT easier; however, in their examination of CBT and PBT comparability findings over five years, Gaskill and Marshall (2007) found that participants from 15 high schools in British Columbia, Canada achieved significantly better results in the *paper mode* for reading

multiple-choice. These findings might suggest that tactile comprehension strategies used by readers are not currently supported when the test is completed on-screen (e.g., when students are unable to underline or highlight important parts of the passage as they read). Conversely, when it came to the electronic mode for reading constructed-response, the Grade 7 students performed better. This study falls short of detailing the prior teaching strategies and assignments involving the use of computers between the participating schools. Notwithstanding the limited generalizability of the findings, Gaskill and Marshall (2007) concurred with Pomplun, Ritchie, and Custer (2006) that teachers need to provide students with adequate time to practice and gain familiarity with computers prior to administering CBT.

Researchers have also examined the impact of CBT and PBT in secondary schools. Early findings suggested that, just like university students, secondary school students found CBT easier than PBT (Kim, 1999). Other studies further concluded that students were more engaged and motivated when they used the computer to write, and they produced higher quality written work (Goldberg, Russell, & Cook, 2003). In a study of Grade 8 students, Russell and Haney (1999) found that students performed much better when they used computers to learn to write and could keyboard 20 words per minute or more. As students' keyboarding skills decreased, so did the positive impact of administering the test on the computer. Therefore, these findings suggest there may be skills that students should have before K-12 districts shift from PBT to CBT to measure student achievement.

Student Assessment Preferences

When combing the test mode literature, several studies did include questionnaires that asked students of their preference, if given the choice, of completing a test on the computer or on paper (Glassnapp, Poggio, Poggio, & Yang, 2005; Higgins, Russell, & Hoffman, 2005; O'Malley et al. 2005; Pomplun, Custer, Russell, & Plati, 2002; Suhr, Hernandez, Grimes, & Warschauer, 2010; Wang, Young, & Brooks, 2004; Way, Davis, & Fitzpatrick, 2006). For example, in one test mode investigation involving Grade 4 students who were part of a laptop and portable writing device program, Russell and Plati (2002) found that more than three-quarters of students preferred to take a test on-screen as opposed to taking the test on paper. When participants in test mode studies completed tests in computer-based and pencil-paper formats, those who preferred to take tests on screen typically achieved better results on the computer-based tests (van de Watering et al., 2008). However, in these designs, the student did not have the chance to choose his or her preferred test mode; the test mode was the treatment that was controlled by the researcher. Asking students about their assessment preferences but then assigning different test modes is not the same as allowing students to choose their preferred mode of assessment and reporting on their achievement.

Gaps in the Literature

A review of current literature revealed very few journals that have published findings about the impact of students' assessment preferences on achievement (Baeten, Dochy, & Struyven, 2008). Moreover, the scant published works on this topic have exclusively focused on university level students' assessment preferences (Whithaus et al.,

2008). Only when the literature search criteria for this review were broadened to include K-12 action research from the past 5 years, did articles emerge depicting the impact of high school and middle school students' assessment preferences on their achievement.

In ninth grade English classes, Greene (2010) experimented with offering controlled choice during assessment. As opposed to assigning all students the same culminating task for the Romeo and Juliet unit, Greene provided learners with a list of options from which they could select their mode of assessment (e.g., creating a sonnet, designing a poster or playbill, creating and presenting a three-dimensional representation). Students could also put forth proposals for assessment formats not included on the list. Through an analysis of individual student interviews, impromptu class conversations, and structured surveys, Greene discovered that embedding controlled choice into her assessment practice resulted in improved achievement, and increased student motivation. In another action research project, four teachers employed choice strategies to increase students' motivation in their seventh grade classrooms (Birdsell, Ream, Seyller, & Zobott, 2009). Students were able to choose their groups, the curriculum, their assignment, and their preferred mode of assessment. Even though all four teachers reported an increase in positive student behaviors and self-motivation, the link to improved student achievement was not apparent. In all, these findings point to the need for additional research on the impact of student assessment preferences and test mode interchangeability on K-12 student achievement.

In addition to conclusions drawn from seventh grade and ninth grade teacher action research, findings from formal peer reviewed assessment preference research

conducted with university level students also informed this investigation. On the one hand, with the exception of students who preferred and completed multiple-choice formats, Furnham and Chamorro-Premuzic (2005) found no relationship between British undergraduate students' preference for essay type exams, oral exams, or continuous assessment assignments on their achievement. Other researchers drew similar conclusions regarding the limited effects on achievement of undergraduate students choosing academic activities (Flowerday et al., 2004). However, data from other postsecondary test mode interchangeability studies revealed different results. For example, one study of 210 first year university students found that students performed significantly better on their preferred assessment formats (van de Watering et al., 2008). Similarly, when students were given the choice between writing a State University exit exam on the computer and using pencil-paper, students who chose the computer performed 3% higher than those who were not offered a choice and used pencil-paper (Whithaus et al., 2008). Therefore, discrepancies exist regarding the impact of postsecondary student assessment preferences on their achievement, and the interchangeability of achievement scores on varying test modes.

Literature Related to the Method

When combing the literature, I did not locate any mixed methods designs for K-8 reading test mode and student assessment preferences research. It was not until I expanded my literature search to include mixed methodologies from other disciplines that I found two studies to inform this study method: one across-stage model conducted by (Ke, 2008) and one sequential explanatory design conducted by Lee et al. (2008).

The quantitative phase of the first study comprised gathering student demographic information using a survey, administering three instruments to measure math learning outcomes as a pretest and posttest, and randomly assigning fifth grade students to six experimental groups: three pencil-paper worksheet drill groups and three computer-based game playing groups (Ke, 2008). Throughout the experimental group stage, in-field observations were made while students solved math problems; therefore, the first mixed method design is classified as a concurrent nested strategy (Creswell, 2003). The second mixed method strategy that was found in the literature used a sequential explanatory design to explore the effects of pacing on academic test performance. In the quantitative phase of the study, Lee et al. (2008) randomly assigned participants to their testing conditions: half in the computer-paced testing group and half in the student-paced testing group. Quantitative data collection was then followed by conducting individual open-ended interviews with 21 college student participants regarding the testing environment. In both cases, qualitative data gathered using in-field observation and individual interviews helped researchers interpret quantitative results. More specifically, quantitative student achievement data alone would not have uncovered how the meaningful integration of relevant educational games increased student motivation, or the positive impact of computer-paced testing on student anxiety.

This mixed methods study included close-ended measures in the form of Computer Attitudes and use Surveys, Test 1 and Test 2, followed by open-ended measures, namely, the student opinion survey. Creswell (2003) stated that quantitative data provide numeric estimates of attitudes and behaviors of participants in their natural

settings. In this case, the teacher and student USEIT surveys and EQAO reading tests that have been widely used in research (EQAO, 2007, 2008, 2009, 2010; Russell et al., 2003) were adapted to provide numeric estimates of how participants viewed and used technology, and the impact of CBT and PBT on student achievement in two Grade 6 technology learning center classrooms. Just as qualitative data in the two mixed methods studies discussed here provided additional insight regarding how technology supports mathematics instruction (Ke, 2008) and college level testing Lee et al. (2008), the qualitative data gathered from the follow up Student Opinion Survey enhanced the credibility of the results from the Computer Attitudes and Use Survey and Test 1 and Test 2.

Literature Related to Differing Methodologies

An extensive review of the literature revealed that very few quantitative or qualitative peer reviewed studies have been published regarding the impact of K-8 student test mode preference on achievement (Baeten et al., 2008). Therefore, this section refers to differing methodologies from the K-8 *test mode interchangeability* literature. It then presents test mode comparability and student assessment mode preference findings from research involving postsecondary students.

Quantitative Methodologies

The quantitative K-8 test mode literature showed that most researchers used experimental and quasi-experimental repeated-measures designs where they randomly assigned students to take parallel tests a second time within a short time frame under different conditions (CBT and PBT; Hargreaves et al., 2004; Horkay et al., 2006; Wang

et al., 2008). However, when the same test questions are administered a second time in another format, researchers found that results were consistently higher in the second round due to practice and familiarity effects (Pomplun et al., 2006; Shuttleworth, 2009).

In other large scale quantitative K-8 test mode studies, researchers used survey methodologies to ask students whether they preferred taking tests using CBT or PBT (Pomplun et al., 2002; Suhr et al., 2010; Wang et al., 2004; Way et al., 2006). However, the participants in these quantitative designs did not take an assessment in their preferred test mode; rather, the test mode was assigned by the researcher. As a result, the impact of students' assessment mode preference on achievement was not truly measured, nor was there enough data generated regarding the factors that influenced test mode preference.

When I expanded the literature search to include test mode studies that involved older students, I found several quantitative designs where researchers allowed participants to select and take assessments in their preferred test mode (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005; van de Watering et al., 2008; Whithaus et al., 2008). Unlike the K-8 studies, these quantitative methodologies involved embedding university student test mode choice in the research design, and comparing the achievement results of students in treatment groups (those who given the choice between CBT and PBT) with students in a control group (who were not offered a choice and used pencil-paper). Although some researchers found no relationship between university students' assessment mode preference and their achievement (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005), others found that students performed significantly better on their preferred assessment formats (van de Watering et al., 2008).

Overall, these quantitative studies employed experimental designs that involved comparing the results of a control group of students who used pencil-paper methods with another group of students who used CBT (Pomplun et al., 2006; Shuttleworth, 2009; Wang et al., 2008). In some cases, the test mode studies involved large sample sizes which increased the generalizability of the results (i.e. Gaskill & Marshall, 2007; Hargreaves et al., 2004; Horkay et al., 2006; Pomplun et al., 2002; Suhr et al., 2010; Way et al., 2006).

Qualitative Methodologies

There were no purely qualitative studies found in the test mode or student assessment preference literature. To examine the literature related to qualitative methodologies related to this study, I referred to the qualitative portions of mixed methods designs from other subject disciplines. Ke (2008) employed field observations and Lee et al. (2008) used face to face interviews to uncover narrative data that could be triangulated with quantitative achievement data. These researchers claimed that without the student perception data gained from the qualitative methods, valuable insights and lessons regarding the role that technology can play to support mathematics and university level testing would have been missed (Ke, 2008; Lee et al., 2008).

Summary and Transition

Section 2 provided an overview of new literacies theory to understand how teacher practice needs to respond to how information and communications technologies and the Internet are changing the way we access, use, and exchange information (Johnson et al., 2009; Media Awareness Network, 2005). This literature review also revealed that

this mixed methods study is relevant in light of increased trends to use CBT in K-8 contexts despite discrepancies that exist among researchers regarding test mode interchangeability, student readiness, and the possible impact of student assessment preferences on student achievement. An examination of the literature related to the methods used in this study and differing methodologies showed that this mixed methods sequential explanatory design is the most suitable approach to investigate the research problem.

Section 3, the methodology, outlines how the mixed methods sequential explanatory design involved gathering quantitative and qualitative data to investigate computer attitudes and use at home and at school, students' assessment mode preferences, and the impact of CBT and PBT on Grade 6 reading achievement. Section 4 in this research report offers interpretations of the results. Section 5 also provides final details, draws conclusions, and presents implications for future test mode and student assessment mode preferences research.

Section 3: Research Method

Introduction

This study investigated the impact of varying test modes and students' test mode preferences on their achievement in reading. A mixed methods sequential explanatory design was suitable because it brought together quantitative and qualitative findings to foster an understanding of the unique relationship that exists between the dependent and independent variables in a study (Briggs & Coleman, 2007).

In this sequential explanatory study, quantitative data were collected using two data collection strategies. In the quantitative phase, the Computer Attitudes and Use Surveys were used to gather information regarding Grade 6 learning technology center teachers' and students' attitudes toward and prior experience using technology at home and at school. Also in this phase, data from Test 1 and Test 2 in computer-based and pencil-paper format revealed whether achievement results are interchangeable on two equivalent reading tests administered in differing modes (CBT and PBT) and the impact of students' test mode preference for Test 1 on achievement. In the qualitative phase, data were gathered through an online student opinion survey that explored why students chose CBT or PBT for Test 1, and which test mode they preferred overall. Qualitative results assisted in explaining and interpreting the quantitative findings. In all, mixing quantitative data resulting from the Computer Attitudes and Use Surveys and Test 1 and Test 2 with text information from the student opinion survey provided a deeper understanding of test mode (CBT and PBT) interchangeability and the impact of student assessment mode (CBT or PBT) preference on achievement.

This methodology section begins by further clarifying the intent of mixing qualitative and quantitative data in a single study, and outlines the research design and approach to explore the impact of student assessment mode preferences (CBT or PBT) and the interchangeability of test modes (CBT and PBT) on Grade 6 technology learning center student achievement in reading. The setting and sample section include a description of the population, sampling method, sample size, specific eligibility criteria and characteristics of the sample. Section 3 also clarifies the connections to the research questions, and describes the data analysis and validation procedures that were used. Finally, the measures I employed to protect participants' rights and my role in data collection and analysis are summarized.

Research Design and Approach

The paragraphs that follow provide an overview of the strategy for data collection, multiple forms of data collection and analysis, justification for using the research design, and when and where the quantitative and qualitative approaches were integrated.

Strategy for Data Collection

The purpose of a sequential explanatory design is to converge and confirm findings from quantitative and qualitative data sources and strengthen the mixed methods study (Creswell, 2003). There were more quantitative than qualitative data collected in this study; therefore, the data from the qualitative phase could be used to interpret the findings of a primarily quantitative study (Creswell, 2003).

Multiple Forms of Data Collection and Analysis

The multiple forms of data collection and analysis that were used in this mixed methods approach are shown in Figure 1. Quantitative data (denoted by QUAN) in quantitative phase of the study were collected from the online Computer Attitudes and Use Survey and Test 1 and Test 2 in CBT and PBT formats. Quantitative data analysis was conducted using Statistical Package for Social Science (SPSS) 10.0 software to generate descriptive statistics of the survey data, and paired-sample *t* tests were used to analyze the reading test results. Achievement results from Test 1 and Test 2 will be returned to students at the conclusion of the study when the research report is shared with the study district.

In the qualitative phase, qualitative data (denoted by qual) were collected by administering the online follow-up Student Opinion Survey. Student responses to the open-ended reflection questions were coded using open coding, followed by axial coding to find trends and patterns.

Justification for Using the Design and Approach

The sequential explanatory design was chosen because this two phase design allowed me to involve a purposeful sample of teachers and students from two sixth grade technology learning center classrooms and schools in south western Ontario, Canada to study the research problem. In the quantitative phase, I gathered background information regarding teachers' and students' prior experiences and attitudes regarding technology. Then, I explored the impact of test mode interchangeability and student assessment mode preference on student achievement by providing students with a choice between PBT and

CBT, and administering two reading tests in varying modes (PBT and CBT). The qualitative phase of the study allowed me to gather additional information regarding the factors that influence students' assessment mode preferences. Overall, data gathered from a variety of quantitative and qualitative sources allowed me to cross validate the findings.

Four criteria were considered for selecting the sequential explanatory mixed methods strategy of inquiry: implementation, priority, integration and theoretical perspective (Creswell, Plano Clark, Gutmann, & Hanson, 2003). Creswell (2003) explained that implementation refers to collecting quantitative and qualitative data sequentially or concurrently. In terms of implementation in this study, both quantitative and qualitative data were collected in phases sequentially, with quantitative data collection preceding qualitative data collection. Priority refers to whether or not one approach is weighted or takes priority over the other. Creswell (2003) also distinguished priority in mixed methods studies using the terms major forms and minor forms of data collection and analysis. As this study was mainly focused on teachers' and students' use of technology at home and at school, and the impact of varying test modes and student assessment preferences on student achievement, priority was given to the quantitative methods first. Moreover, the Computer Attitudes and Use Surveys and Test 1 and Test 2 made up the major form of data collection and analysis, and the qualitative Student Opinion Survey was the minor form of data collection and analysis. Integration represents the forth criteria for selecting a mixed methods strategy and refers to the stage in the research process where the two types of data are mixed (Creswell, 2003). Here, the quantitative and qualitative approaches were integrated during the interpretation of the

entire analysis following the qualitative phase. The final criterion to consider when selecting a mixed methods strategy is the theoretical perspective, which refers to the larger theory or perspective that guides the design. In the current study, new literacies theory was the theoretical perspective that informed this design, and assisted in explaining and interpreting results.

I obtained permission to adapt the widely used and reliable teacher and student USEIT surveys to create the student and teacher Computer Attitudes and Use Surveys for this study. These instruments provided quantitative data regarding Grade 6 technology learning center program teachers' and students' attitudes about prior experiences using technology at home and at school. Findings provided valuable profile information of the research participants to help describe the context for the study in this final research report. Other test mode researchers have gathered and used demographic information of participants to aid in the final analysis (Ke, 2008; Russell et al., 2003; Wang et al., 2008), therefore the Computer Attitudes and Use Survey included questions pertaining to teacher and student gender and socio-economic status (number of books in the home). Gaps exist in student assessment mode preference research (Baeten et al., 2008), therefore, adding a choice component to the test mode study, set this study apart from previous test mode studies and helped fill the gap in the student assessment mode preference literature. EQAO test questions and booklets are available online as public domain, and are widely used as part of regular Grade 6 literacy practice to prepare students for province wide EQAO testing each spring. Therefore, student responses to questions taken from previously validated EQAO reading tests for Test 1 and Test 2

formed the second set of data in the quantitative phase. Finally, the Student Opinion Survey in the qualitative phase was used to substantiate the quantitative survey and reading test results as well as provide factors that influenced students' preference between CBT and PBT.

Integration of the Quantitative and Qualitative Approaches

Integration of the quantitative and qualitative data deepened understanding of the data and strengthened the reliability of the findings. Closed-ended questions on the quantitative Computer Attitudes and Use Survey revealed data regarding participants and helped define the context for the study. Test 1 and Test 2 data provided quantitative measures of student achievement. Conversely, open-ended data from the qualitative Student Opinion Survey revealed qualitative data regarding the factors that influence a student's preference of one test mode over another.

Data collection for this mixed methods study began once I received final approval from Walden University's IRB and the study district, and obtained signed voluntary assent and consent forms from all research participants and/or parents. Walden University IRB approval number for this study was 08-04-11-0074989. The study was scheduled to take place in two separate Grade 6 technology learning center program classrooms and schools over a 2 week time frame. Data collection was conducted in quantitative and qualitative phases. Integration of the two types of data took place during the final interpretation following the qualitative phase. During interpretation, I used open coding and then axial coding to locate patterns or themes in the qualitative data related to the

research question. Then, I compared the qualitative findings with the quantitative survey data and reading test results collected during the quantitative phase.

Setting and Sample

As described on its website, the study district covered a geographic area of more than 1,761 square kilometers (over 676 square miles) and was the third largest publically funded school district in southwestern Ontario, Canada. At the time of the investigation, it had an enrollment of over 116,000 students and employed over 8,000 full time K-12 teachers in the 2010-2011 school year. More than 77,000 students were in grades K-8, and more than 40,000 made up the secondary student cohort.

Socioeconomic and demographic information about the research setting and sample was based on the most recent Census Canada data available from 2006. The regional municipality of this study district had the fifth highest median family income in Canada and the second highest in Ontario (Regional Municipality of York Community and Health Services Department, 2008); however, the number of low income households had grown from 9.95% in 2001 to 12.6% in 2006 (Statistics Canada, 2007). A wide range of cultures were represented in the study district. Over 16 % of all students in the region did not speak French or English as their first language at home. The top five unofficial languages spoken in homes were Chinese Languages, Italian, Russian, Persian (Farsi) and Tamil (Regional Municipality of York Region Community and Health Services Department, 2008). Statistics Canada (2007) confirmed that the study district was also characterized as the fastest growing Census division in Ontario, and the third fastest in

Canada, largely due to population increases in its immigrant population. This study district's total visible minority population characteristics are shown in Table 2.

Table 2

Visible Minority Populations

	Number	Percentage
Chinese	138,575	42.00%
South Asian	80,595	24.43%
West Asian	20,860	6.32%
Black	20,770	6.29%
Filipino	17,150	5.20%
Other	12,715	3.85%
Korean	10,860	3.29%
Southeast Asian	10,110	3.06%
Latin American	8,560	2.59%
Arab	7,400	2.24%
Japanese	2,360	0.72%

Note. From Statistics Canada (2007).

Population

The population for this study was four teachers and approximately 120 students from four different elementary schools located in southwestern Ontario, Canada. The selected schools were involved in the study district's technology learning center program. Moreover, each of these four schools had a Grade 6 technology learning center program teacher on staff with above average access to learning technologies and professional development opportunities. Grade 6 technology learning center program classrooms made up 4% of the participants in the learning center program.

Sample Population

The purposeful sample was used to select two teachers and 48 students from Grade 6 technology learning center program classrooms in two elementary schools in south western Ontario, Canada. Appropriate samples provide greater insight into the phenomenon from the population being studied (Merriam, 2002). Therefore, this sampling method was appropriate for studying computer attitudes and use, the impact of using technology for reading assessment and student assessment mode preferences because participants in the technology learning center program regularly integrated ICT into teaching and learning of reading. Furthermore, all participants had prior keyboarding experience and knew how to use Moodle.

Sampling Method and Frame

Participant selection was not random because criteria were based on the teachers' and students' enrollment in the technology learning center program and classrooms. Herek (2009) also explained that with purposeful sampling, research populations are partly chosen due to their availability or because they volunteered. In this case, technology was a focus on each school's plan for improvement and each site hosted a Grade 6 technology learning center program classroom, therefore, the principals at the two study schools granted me permission to access and seek the voluntary participation of Grade 6 technology learning center program teachers and students through letters of cooperation.

Although there were a total of four Grade 6 technology learning center classrooms that existed, to bind this study within my time limits and means the purposeful sample for

the study comprised two Grade 6 teachers and their students (48 altogether) from two of the four elementary schools. Technology learning center classroom teachers and students regularly integrated technology into teaching and learning. Therefore, purposeful sampling was appropriate because participants from technology-rich settings helped to shed light on the potential impact of varying test modes and student assessment mode preferences on student achievement in reading. Furthermore, selecting technology learning center classroom teacher and student participants that related to new literacies theory was crucial for later data analysis.

Sample Size Description and Defense

When appropriate sample sizes are obtained, researchers concluded that inferences can be made about the entire population from the interpretations and conclusions drawn from the data (Creswell, 2003; Herek, 2009). An online sample size calculator (Raosoft Inc., 2010) helped determine that the appropriate student sample size for each school is 21.5 students each, based on a 5% margin of error, and 95% confidence rate. Thus, a total of 48, or 24 per class, was a large enough sample with 95% confidence for generalization to the schools with similar situations and demographics.

Eligibility Criteria and Characteristics of Study Participants

The decision to involve sixth grade classrooms as opposed to other grade levels was partly based on the availability of, and permission to adapt two standards-based EQAO reading assessments that already existed for Grade 6 from previous years. Province-wide EQAO literacy tests also existed for Grade 3 and Grade 10. However, involving grade 10 students in this study instead of sixth graders would not have

addressed the gaps in K-8 research on the impact of test mode interchangeability and students' assessment preferences on student achievement described in Section 2. Moreover, I chose to involve Grade 6 students over Grade 3 because they may have found it easier to justify their assessment mode preferences when completing the open-ended Student Opinion Survey in the qualitative phase. Finally, Grade 6 students were presumed to have had more experience than Grade 3 students using technology because they were older.

Student Participants. Students eligible to participate in the study had informed voluntary assent and the permission of a parent or guardian, and were enrolled as full-time students in the grade classrooms of the technology learning center program teacher participants at both schools. Students who were enrolled in technology learning center program classrooms were characterized as having regular access to a variety of technology tools as a regular part of literacy learning at school.

Teacher Participants. To be eligible as a teacher participant for this study, teachers had the support to participate of their principal at their school; were active members of the current study district's technology learning center program; and had Grade 6 teaching responsibilities including the instructing and assessing of literacy to their homeroom students. The technology learning center program faculty had *above average access* to teacher training and a variety of technology tools at school. More specifically, technology learning center program teachers had access to release time during their work day to attend ICT professional learning sessions that were designed and delivered by the school district's curriculum department at least three times a year. In

addition to attending board designated in-service training, technology learning center program teachers also had access to two additional personal professional learning days based on their individual interests and needs. Furthermore, instead of having to share the use of a media cart equipped with an LCD projector, laptop, and speakers among 3-4 teachers like their non-technology learning center program colleagues, Grade 6 technology learning center program teachers received additional hardware to support teaching and learning of new literacies, and were not obligated to share their technology with other faculty.

Role of Researcher in Data Collection

I had a direct role in collecting data during both phases of this sequential explanatory design. My specific roles in the quantitative and qualitative phases are described in the following section.

Quantitative Phase: Computer Attitudes and Use Survey. I had a direct role collecting data outside of instructional time for the first quantitative survey to be used in this study. Whereas, the two technology learning center teachers completed the online teacher Computer Attitudes and Use Survey on their own time, I directly oversaw quantitative data collection with student participants using the Computer Attitudes and Use Survey in the computer labs of both schools during morning recess. Over the course of the data collection, no students were absent therefore I did not have to arrange follow up data collection opportunities during a subsequent recess break. I printed off and photocopied the teacher and student survey responses and have stored them in a secure cabinet in my home office for 5 years.

Quantitative Phase: Reading Tests. I also had a direct role collecting the second set of quantitative data in the quantitative phase. More specifically, I collected data during regular literacy instruction using Test 1 based on students' assessment mode preference (CBT or PBT) and Test 2 in the alternate test form. At the end of each data collection period, I verified that all student participants had completed Test 1 prior to completing Test 2. Once again, no students were absent during the data collection for Test 1 and Test 2.

Following the quantitative data collection using Test 1 and Test 2, I printed off students' computer-based responses from Moodle and coordinated having an Ontario certified teacher not participating in the study transcribe the hand-written responses to electronic format. I then arranged the evaluation of all reading test responses using previously validated rating scales and exemplars (see Appendices G, H) by another Ontario certified Grade 6 teacher who had participated in EQAO marking in the past. I photocopied and have stored a duplicate set of all original handwritten and computer-based reading test responses in a locked cabinet in my home office for 5 years.

Qualitative Phase: Student Opinion Survey. I also had a direct role collecting qualitative data outside of instructional time for the final survey used in this study. More specifically, I directly oversaw data collection using the Student Opinion Survey in the computer labs of both schools during recess. All students were present for the final stage of data collection. As with the quantitative data sets, once all students had answered the final open-ended online survey, I printed out two copies of their responses: one for my analysis, and one that I have stored in a locked cabinet in my home office for 5 years.

Connection to the Research Questions

In this mixed methods sequential explanatory study, I investigated whether the test mode (independent variable) and students' preferred test mode (independent variable) significantly impacted student achievement in reading (dependent variable). Data in response to the research questions in this study were collected sequentially, with quantitative data collection preceding qualitative data collection.

Research Questions

Results from the two surveys and reading tests helped address the goals and research questions of this study:

1. What were the prior experiences and attitudes of teachers and students about technology use at home and at school?
2. Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms?
3. Were the reading achievement results for the students' preferred test mode significantly different from the results from the students' nonpreferred test mode?
4. Which reading test mode did students prefer, and what factors influenced students' preferred test mode?

The independent variables were the test mode (CBT or PBT) and students' preferred test mode. The dependent variable was students' reading achievement results on

both reading tests. Varying the test mode (independent variable) addressed the second research question of this investigation.

The hypotheses for Question 2 were:

$H_0$1: There would be no significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms.

H_a1: There would be a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms.

The hypotheses for Question 3 were:

$H_0$2: The reading achievement results for the students' preferred test mode would not be significantly different from the results from the students' nonpreferred test mode.

H_a2: The reading achievement results for the students' preferred test mode would be significantly different from the results from the students' nonpreferred test mode.

In all, research Questions 1-3 were answered with three quantitative instruments in the quantitative phase of this study: Computer Attitudes and Use Surveys, and the CBT and PBT formats of Test 1 and Test 2. Then, Question 4 was answered using a follow up open-ended online Student Opinion Survey in the qualitative phase. Hatch (2002) explained that triangulation helps to strengthen the interpretations and conclusions drawn from the research; therefore, I triangulated results from the quantitative and qualitative

phases of the sequential explanatory design for interpreting and communicating the results. More specifically, I discussed themes generated by the multifaceted data analysis as they related to the four research questions of this investigation.

Context and Sequential Strategies of the Study

Sequential explanatory designs include two parts: quantitative data collection followed by qualitative data collection. This mixed methodology allowed me to gather insight from numeric and descriptive data (Creswell, 2003). Qualitative data were used to expand on and support the quantitative findings, thereby strengthening the mixed methods study. The quantitative phase of the design began with an online Computer Attitudes and Use Survey to investigate teachers' and students' prior experience and thoughts regarding computer use at home and at school, followed by Test 1 and Test 2 in computer-based and pencil-based format to measure the impact of test mode (CBT and PBT) interchangeability and students' test mode preferences on student reading achievement. In the qualitative phase, the design focused on qualitative data from a follow up Student Opinion Survey.

Prior to beginning data collection for this sequential explanatory mixed methods design, I verified the logistics of the computer-based instruments on my own and with the assistance of a fellow Walden University Doctor of Education candidate. The paragraphs that follow provide details regarding (a) the quantitative sequence and instrumentation, (b) the data that comprised each variable in the quantitative phase of the study, and (c) the qualitative sequence for this study.

Quantitative Sequence and Instrumentation

The quantitative phase of this mixed methods design included two quantitative data collection instruments: the Computer Attitudes and Use Survey, and Test 1 and Test 2.

Computer Attitudes and Use Survey

Instrument Name and Description. There were two versions of the first quantitative instrument used to collect quantitative data: the teacher and student Computer Attitudes and Use Survey. The survey instruments were based on Russell et al. (2003) previously published and validated teacher and student USEIT surveys. In the original study, teachers and students completed the state-wide paper-based surveys by selecting and filling in bubbles to match the appropriate answer using a No. 2 pencil. This was not be the case with the technology learning center teacher and student participants in this study; data from the teacher and student Computer Attitudes and Use Surveys were collected electronically using a free online data collection tool called, Surveymonkey.

Prior to adapting the USEIT teacher and student surveys for administration online, I obtained permission from the publishers (see Appendix I). As the original USEIT surveys were developed in 2003, some of the technologies referred to on the surveys were out of date. To update the survey for this study, questions on the computer attitudes and use teacher and student surveys reflected more current technologies found in technology learning center classrooms: TV/VCRs were replaced by laptop/LCD projectors; modems or a phone lines to access the Internet were replaced with digital

subscriber line (DSL)/wireless access; and, SmartBoard™ and mobile technologies were added to the teacher and student surveys. In addition to listing outdated technologies, the original teacher USEIT survey was much longer than the student survey, and included information that did not pertain to the research questions in this study. Hence, the two participated technology learning center teachers did not complete the original teacher USEIT survey; rather, the survey for the two technology learning center teacher participants was based on the student survey. To adapt the student survey for teacher participants, I had to change the wording of some questions to reflect the teacher audience. For example, whereas a question on the student survey asked, "How hard is it to complete homework that must be done on a computer," the teacher survey used in this study asked, "How hard is it to complete work that must be done using a computer?" Overall, each teacher and student Computer Attitudes and Use Survey comprised 24 questions and took approximately 15 minutes to finish.

Instrument Type and Data. The initial quantitative surveys included multiple-choice and Likert scale questions in an online Surveymonkey survey. The Computer Attitudes and Use Surveys produced descriptive statistics to help define the context of the study and profile of research participants.

Concepts Measured. The teacher and student Computer Attitudes and Use Survey measured concepts from eight main areas: "demographics, access at home, access at school, use at home, use at school, specific uses of computers, computer-related skills, [and] computer-related beliefs" (Russell et al., 2003).

Calculating and Rating Scores. Data for the Computer Attitudes and Use Survey were obtained from teacher and student responses to questions on the initial quantitative data collection tool. Survey responses on the multiple choice and Likert scale items were categorized and analyzed descriptively. Results were reported in relation to the first research question: What were the prior experiences and attitudes of teachers and students about technology use at home and at school? SPSS software was used to generate descriptive statistics regarding the demographics, and attitudes toward and prior experiences using technology at home and at school of teacher and student participants.

Instrument Reliability and Validity. The reliability and validity of both Computer Attitudes and Use Survey instruments were not a concern because the content and questions on the survey had been adapted from the previously validated and reliable teacher and student USEIT surveys (Russell et al., 2003). To address concerns regarding incorrect survey logistics that might arise when updating and converting questions from the original teacher and student USEIT surveys, I field tested the initial quantitative instruments prior to commencing data collection.

Instrument Completion Process. Teacher and student participants were informed about the quantitative Computer Attitudes and Use Survey instruments on the assent/consent forms, and during a presentation that was held at both schools prior to the quantitative phase data collection. At each meeting, I described the purpose and scope of the study and read the student assent forms aloud to ensure the informed consent of the 10-11 year old student participants. The student, parent and teacher assent/consent forms were distributed, and I emphasized that my contact information was provided should

parents have had any concerns regarding their son or daughter's participation in the study.

The first quantitative instrument was administered on day one during week one of the study. As the online Computer Attitudes and Use Survey took only 10-15 minutes to complete, students had ample time to complete it during the morning recess break. To complete the quantitative survey instrument, participants required access to a computer and the Internet. The two Grade 6 teachers completed the teacher version of the online survey on their own by using a networked computer in each technology learning center classroom in each school, and accessing the Surveymonkey link that I sent them via email. Teachers logged into Surveymonkey using their name, and then read through and answered each survey question. Once all questions had been completed, teacher participants exited the teacher Computer Attitudes and Use Survey, closed the Internet browser, and shut down the computer.

In collaboration with the principal, the computer labs in each study school were reserved for collecting quantitative phase student online survey data. I bookmarked the student Computer Attitudes and Use Survey address on each student computer in the school computer lab ahead of time. During a morning recess break, I supervised students as they launched Internet Explorer and opened the bookmarked survey. Students logged into Surveymonkey using their name, and then read through and answered each survey question. Once all questions were completed, student participants exited the survey, closed the Internet browser, shut down the computer, and went outside for the remainder of the regularly scheduled teacher supervised recess break.

All quantitative student surveys were completed frame in their entirety and within the data collection time, therefore no follow up data collection opportunities were necessary. Following the completion of the Computer Attitudes and Use Surveys by all 48 students, I distributed and collect one paper-based ballot per student on which students recorded their name and indicated their test mode preference for Test 1 in writing: computer-based or pencil-paper.

Availability of Raw Survey Data. Original Computer Attitudes and Use Survey data were securely stored on the Surveymonkey server; however, I printed out and stored a duplicate hard copy of the original teacher and student Computer Attitudes and Use Survey responses to act as back up. Original data have been locked in a filing cabinet in my home office for 5 years.

Reading Test Instruments

Instrument Name and Description. Following the completion of the initial online quantitative Computer Attitudes and Use Survey, all Grade 6 technology learning center students completed the second set of quantitative instruments in the study: two reading tests of varying computer-based and pencil-based modes, herein called Test 1 and Test 2. Whereas the EQAO administers the province-wide Grade 6 reading instruments exclusively using pencil-paper methods, here Grade 6 students took one of the two reading tests on the computer using an online course management tool called, Moodle; the other reading test was completed using pencil-paper methods.

The two quantitative reading test instruments were based on reading passages and comprehension questions taken from previous EQAO language testing booklets (EQAO,

2006, 2007, 2008, 2010). Test 1 and Test 2 each contained two reading passages, and a total of 18 questions: 14 multiple choice, and four short answer questions. EQAO tests (i.e., Test 1 and Test 2) have been designed to be completed within 50 minutes. However, in keeping with EQAO guidelines, in this study, students could take up to 100 minutes, or the entire the literacy block, to complete each assessment providing the test was completed during one continuous sitting on the day on which Test 1 or Test 2 were administered.

Instrument Reliability and Validity. As was the case with the Computer Attitudes and Use Survey instruments, the reliability and validity of Test 1 and Test 2 in this study were not a concern because these testing instruments were based on previously validated quantitative data collection tools. Each year, the EQAO creates testing instruments based on item, content, and sensitivity reviews to ensure the difficulty of the assessment is similar (EQAO, 2008).

Type of Instrument and Data. Test 1 and Test 2 took the form of either a pencil paper or computer-based reading comprehension test. Each reading test instrument was divided into two parts: a long narrative text (650-700 words) followed by 10 four item multiple-choice and two open-response questions, a short nonnarrative informational text (300-350 words), followed by four 4 item multiple choice and two open-response questions.

Concepts Measured. The quantitative Test 1 and Test 2 instruments required Grade 6 students to demonstrate knowledge, application, and thinking appropriate for the grade level reading. More specifically, the concepts measured on Test 1 and Test 2 in this

study included understanding explicitly and implicitly stated information and ideas, and making connections between information and ideas in a reading selection and personal knowledge and experience (EQAO, 2011b).

Calculating and Rating Scores. Test 1 and Test 2 each had a total score of 174. Each of the 14 multiple choice questions was worth 1 point and was scored using multiple choice answer keys from the EQAO website. Each reading open-response item on the quantitative instruments was scored according to an item-specific rubric and was worth a maximum of 40 points. The open-response rubrics provided evaluation criteria and described the type of student responses that received one of the following grades: well below grade level (10), below grade level (20), at grade level (30), and exceeding grade level (40; EQAO, 2011). All levels of student performance were used in the dependent variable for this study.

The procedure for scoring the reading tests involved logging into Moodle, printing off, and photocopying each student's computer-based reading open responses. One set of CBT responses was safely stored in the locked cabinet in my home office, and the other set was forwarded to the external rater for scoring. Prior to sending the PBT responses for scoring, I duplicated and forwarded students' handwritten responses (48 altogether) to one Ontario certified teacher not participating in the study for transcribing. The transcriber used a word processor to convert handwritten responses to the reading open-response questions to electronic format. Individual student data were saved in a separate file using the students' participant numbers. This step helped eliminate any bias on the part of the external evaluator toward hand-written responses. Transcriptions of

student responses on the 48 pencil-based reading tests were emailed to me and I saved the data in two folders (School A and School B) on my laptop. Two hard copies of the transcribed student reading open-responses were made: one for back up and one for manual scoring. The transcriber forwarded the paper copies of the handwritten responses to me in a sealed envelope. Next, I forwarded the paper print outs of all transcribed and computer-based student test results to the external rater for scoring.

Manual scoring of all 96 reading tests (48 sets of Test 1 data and 48 sets of Test 2 data) was done by a second certified teacher not participating in the study, who has been previously trained to score EQAO assessments. I provided the external rater with an electronic spreadsheet via email for tracking results, one hard copy set of Test 1 and Test 2 responses per student, and multiple hard copies of necessary multiple choice answer keys and scoring guides downloaded from the EQAO website. Once completed, the external rater (a) emailed me the School A and School B achievement data tracking spreadsheets, (b) placed all paper copies of the marked scoring guides, and Test 1 and Test 2 responses in two sealed School A and School B envelopes, and (c) sent the raw data and scoring materials via board courier to my attention. I retrieved both envelopes and photocopied an additional set of all materials for analysis.

Instrument Reliability and Validity. The reliability and validity of both Test 1 and Test 2 instruments were not a concern because questions on the tests had been taken from validated Grade 6 EQAO province-wide reading assessments from previous years. To ensure year-to-year comparability, EQAO uses an assessment blueprint, equates each instrument year to year, and uses field-test items (EQAO, 2007).

Instrument Completion Process. Student participants learned about the quantitative Test 1 and Test 2 instruments during the same presentation at School A and School B where I described the study, and thoroughly reviewed the student, parent and teacher assent/consent forms prior to data collection. I administer Test 1 in the first week of the study, and Test 2 on day 2 during week 2 of the study.

Unlike other test mode studies that involved predetermining or randomly assigning CBT and PBT formats during data collection, the test mode sequence here (i.e., CBT followed by PBT or PBT followed by CBT) was not predetermined. Instead, the format of Test 1 was based on students' test mode preference (CBT or PBT), and data for Test 2 were be gathered using the alternate test mode format. For example, if Student A selected to take Test 1 on the computer, Test 2 was completed using pencil-paper. Therefore, to complete Test 1 and Test 2, each technology learning center student required access to a computer, the Internet, and Moodle, and a pencil, an eraser, and paper copy of Test 1 or Test 2. I maintained the student tracking sheets and class sets of the paper-based testing instruments ahead of time. In collaboration with the principal of School A and School B, I reserved ample computers in the classrooms of School A and School B for me to use to collect the quantitative phase reading test data.

Prior to collecting data for the quantitative Test 1 and Test 2 instruments, I recorded the information from the student ballots onto the Test 1 column of each technology learning center class' tracking sheet. This first list of students' preferred test formats for Test 1 determined the alternate test mode for Test 2. The format of the

alternate test mode was recorded in the Test 2 column of each technology learning center class' tracking sheet.

I collected data for Test 1 on the same day as I collected data for the Computer Attitudes and Use Survey on day one during week one of the study. Due to the availability of mobile wireless laptop carts in School A and School B, I collected data in the actual technology learning center classrooms for Test 1 during a regularly scheduled literacy block of 100 minutes. Based on students' test mode preferences for Test 1, students either completed the pencil-paper or computer-based version of the quantitative reading test in Moodle first. To complete Test 1 on the computer, student had to launch Internet Explorer and log onto Moodle using their student login number. Pencil paper test takers completed Test 1 at their classroom desks.

Once I distributed the paper-based copies of the quantitative instrument, students were instructed to print their name at the top of the test. Once all students taking Test 1 on the computer logged onto Moodle, I reviewed the instructions found at the beginning and end of Test 1 with the entire class. All students read and completed all of the questions on Test 1. Once everyone completed the first reading test, paper copies of the test were handed to me and student participants using the computer exited the online reading test, logged out of Moodle, closed the Internet browser, and shut down the computer. Following data collection for Test 1, students proceeded with regular literacy block activities with their technology learning center teacher. I followed the same process in each classroom of School A and School B when I collected data for Test 2 on day 2 during week 2 of the study. More specifically, in week 2, I returned to the school and

during regular literacy instruction, I followed the same procedure outlined above to have students complete the second reading test on the computer using Moodle or using pencil paper. On that same day, I supervised students as they completed an open-ended online Student Opinion Survey during recess.

Test 1 or Test 2 were both completed within the data collection time frame; therefore, no follow up data collection opportunities were necessary. Once all student participants completed the quantitative Test 1 and Test 2 instruments, I arranged for the data to be transcribed and scored.

Availability of Raw Test Data. Prior to scoring the data, I logged onto Moodle to access and print off the 48 computer-based tests and responses (i.e., 24 copies of Test 1 data and 24 copies of Test 2 data). Hard copies of these data from Moodle were photocopied and stored in a locked cabinet in my home office for 5 years. Electronic data were automatically backed up on the secure Moodle server, however, as an extra precaution, I also backed up and stored the 48 computer based test results on a password protected portable hard drive in my home office for 5 years. Hard copies of the 48 pencil-paper tests and responses (24 copies of Test 1 and 24 copies of Test 2) were photocopied and stored in a locked cabinet in my home office for 5 years. A discussion of the data that comprised each variable in the quantitative phase of the mixed methods study follows.

Data Related to Each Variable

The independent variables in this study comprised three forms of quantitative data: descriptive statistics obtained from the teacher and student Computer Attitudes and

Use Surveys; student reading achievement data on the CBT and PBT; and student reading achievement data on their preferred and nonpreferred tests.

The dependent variable was comprised of only one form of quantitative data: student achievement data on quantitative phase Test 1 and Test 2. These quantitative data were analyzed and triangulated with the qualitative phase survey data during the interpretation stage of the study.

Qualitative Sequence

Gaining Access to Participants

In accordance with the current study district's policies and procedures, to conduct external research involving data collection in May 2012, I submitted an application in November 2010. In January 2011, the application was accepted pending final Institutional Review Board approval.

In compliance with the Institutional Review Board and the study district guidelines, prior to conducting the sequential explanatory design, appropriate permissions needed to be granted to access research participants. Neither principal played a role in selecting teacher participants from School A or School B; rather each principal granted me permission via letters of cooperation to access and invite the two Grade 6 technology learning center program teachers to volunteer to participate. Pending the voluntary participation of each teacher, I invited the voluntary participation and informed assent/consent of the Grade 6 technology learning center programstudents at School A and School B.

Research Study Participants

Technology learning center classroom teachers in the current study district were engaged in a program aimed at investigating how instructional technologies and new literacies support student learning. As such, they were often encouraged and involved in professional learning and action research to advance scholarly inquiry in the field of new literacies and education.

As an employee of this study district, and a member of the 2011-2012 district-level technology learning center program team, I had access to the names, grades, and locations of all technology learning center program teachers via the school board's secure intranet website. To gain access to two technology learning center program teachers from School A and School B for this study, I consulted the 2011-2012 technology learning center program database for the names of all Grade 6 classroom teachers and found that four possible Grade 6 technology learning center program classrooms existed. To properly engage community research study partners, I sent emails to all four school administrators requesting permission to seek the voluntary permission of two of their Grade 6 technology learning center program teachers and their students in this study. Two principals replied by forwarding their electronic signatures on a letter of cooperation; therefore, I emailed the other two administrators to thank them for their consideration and inform them that I had already obtained permission from two administrators for my study.

Establishing Research-Participant Relationships

As an employee of this study district, I already had a professional working relationship with the principals at School A and School B. Furthermore, as a fellow technology learning center program teacher, I already had professional relationships with the Grade 6 technology learning center program teachers from School A and School B. I did not know the students in either Grade 6 technology learning center program classroom.

Research Study Participants

To establish researcher-participant relationships, upon final IRB approval, I invited the voluntary participation of research participants by email and face-to-face. I emailed the two Grade 6 technology learning center program teacher participants to (a) further introduce myself, (b) outline the steps involved in the research process, (c) define my expectations regarding the nature of the involvement of the teacher participants, and (d) respond to any questions they may have. I also wrote the students a letter to introduce myself and inform them of the face-to-face meeting that I conducted at School A and School B. During the meeting, I addressed any questions that students had, described the scope and purpose of the study, and outlined the potential benefits for the technology learning center program participants. Aside from providing a general overview of the study, the primary purpose of the face-to-face meeting was to distribute and review the student and teacher assent/consent forms to ensure participants' voluntary informed consent. During the meeting, I emphasized that my contact information was provided if

parents had any questions or concerns regarding their son/daughter's involvement in the study.

Data Triangulation

Qualitative data for the open-ended Student Opinion Survey were collected using the computers and Internet access in the classrooms of School A and School B. Prior to having students begin the final qualitative survey, I emphasized that the more detail they provided for each answer, the more information I would have to analyze and interpret. Internet Explorer was preloaded onto laptops. Student participants logged into the bookmarked Surveymonkey survey; entered their names; read over the instructions on their own; and completed the Student Opinion Survey which included the following two sets of questions: (a) Which test mode (computer-based or pencil-paper) did you pick for the first reading test? Why? (b) Which test mode (computer-based or pencil paper) did you like more? Why?

Electronic data from the qualitative phase online survey instrument were exported from the Surveymonkey website, saved in the School A and School B folders on my personal laptop, and securely backed up on the password protected portable hard drive in my home office for 5 years. Qualitative phase data were printed for coding and analysis, and a photocopy of the 48 sets of raw student opinion survey data were stored in the locked cabinet with all of the other hard copies of original data from the research study.

To cross validate quantitative and qualitative results, quantitative data including descriptive statistics from the quantitative phase teacher and student Computer Attitudes and Use Survey data, students' reading test mode preferences for Test 1, and the two-

tailed *t* test results were triangulated with the qualitative trends and themes results from the open-ended Student Opinion Survey. In other words, qualitative data regarding students' reasons for selecting their preferred mode of assessment helped to understand the impact that student assessment mode preference and test mode had on student achievement in reading. Furthermore, examining the research questions from multiple sources provided insight to strengthen the overall interpretations and conclusions for this research report.

Data Analysis and Validation

Mixed methods research requires data analysis within qualitative and quantitative approaches, as well as between the two approaches (Creswell, 2003). Therefore, this subsection identifies the data analysis procedures that were used following the type of strategy chosen for the two phases of the sequential explanatory design: QUAN → qual.

Quantitative Phase

Following the quantitative phase data collection, statistical software was used to generate descriptive statistics from the teachers and student Computer Attitudes and Use Survey. Then I conducted paired-sample *t* tests to analyze the Test 1 and Test 2 data.

Quantitative Research Question 1. The first research question that guided the initial quantitative method of the study was: What were the prior experiences and attitudes of teachers and students about technology use at home and at school?

Data Analysis Procedure. Data regarding teachers' and students' computer attitudes and use at home and at school were collected using two separate online surveys. Using SPSS software, I used descriptive statistics to create charts to describe teachers'

and students' current computer attitudes and use at home and at school (O'Dwyer et al., 2008).

Quantitative Research Question 2. The following research question guided the first of two quantitative approaches in the study: Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students?

The null hypothesis for Question 2 was the belief that there was no significant difference in the reading achievement results on computer-based and pencil-based reading tests of Grade 6 in two different technology learning center classrooms. Conversely, the alternative hypothesis for Question 2 was that there was a significant difference in the CBT and PBT reading achievement results of Grade 6 students in two different technology learning center classrooms.

Quantitative Data Analysis Procedure. The answers to multiple choice questions and reading open-responses on Test 1 and Test 2 were totaled and compared in relation to the test mode (CBT and PBT) used for each quantitative reading test, students' test mode preference, and achievement results on the CBT and PBT. SPSS software was used to analyze the quantitative reading test data.

I tested these hypotheses for each test cohort (Test 1 and Test 2) using paired-sample *t* tests to analyze the mean achievement score for the same group of students for each mode (CBT and PBT). A paired-sample *t* test was used because as the test mode literature showed, there were two competing predictions regarding the interchangeability of CBT and PBT. One group of researchers concluded that results on CBT and PBT were

not significantly different; therefore CBT and PBT modes were interchangeable (Bergstrom, 1992; Bodmann & Robinson, 2004; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans et al., 1995; Johnson & Green, 2004; Neuman & Baydoun, 1998; Wang et al., 2000). Other researchers claimed that CBT and PBT yielded significantly different results; hence, CBT and PBT were not interchangeable (Godwin, 1999; Mazzeo & Harvey, 1988; McLaren, 2004; Mead & Drasgow, 1993; Pommerich & Burden, 2000; Wallace & Clariana, 2005).

Quantitative Research Question 3. The next research question informed the second of two quantitative approaches in the study: Were the reading achievement results for the students' preferred test mode significantly different than the results from the students' nonpreferred test mode?

The null hypothesis was the belief that there was a significant difference between the first round and second round of reading achievement results of students in two Grade 6 technology learning center classrooms. Conversely, the alternate hypothesis was that there was no significant difference between the first round and second round of reading achievement results of students in two Grade 6 technology learning center classrooms.

Quantitative Data Analysis Procedure. I tested these hypotheses using another paired-sample *t* test to compare the mean student achievement score for the preferred mode on the first test with the nonpreferred mode on the second round of testing of the same group of students. A paired-sample *t* test was helpful in addressing the discrepancies that existed among researchers regarding the impact of students' assessment preferences on their achievement. Some believed there to be no significant

relationship between students' assessment mode preferences and their achievement (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005), while others reported increased engagement (Birdsell et al., 2009; Greene, 2010) and significantly higher student achievement results for learners who were able to select their preferred mode of assessment (van de Watering et al., 2008; Whithaus et al., 2008).

Analysis Approaches. In this sequential explanatory design, an initial within quantitative approach analysis of the teacher and student Computer Attitudes and Use Survey data, student test mode preferences and Test 1 and Test 2 achievement data occurred following quantitative phase data collection. Then, after the qualitative phase, a between quantitative and qualitative approach analysis of all research data occurred during the final interpretation.

Validity of Quantitative Data. The validity of the first set of quantitative data (i.e., descriptive statistics generated from the teacher and student Computer Attitudes and Use Survey data) was verified when compared with the quantitative student reading achievement data, and student test mode preferences. The validity of the second set of quantitative data (students' reading test scores) was not a concern because a paired-sample *t* test measured whether the test score means from a within-subjects test group (i.e., all 48 students from both classes) varied over two test conditions (i.e., CBT or PBT). Furthermore, the two sets of paired-sample *t* test scores, along with the descriptive statistics from the initial quantitative survey, and the themes that emerged from the qualitative phase survey data were verified by triangulating the data from these multiple sources during the final data analysis and interpretation.

Qualitative Phase

Data Analysis Procedures. In addition to measuring computer attitudes and use, and comparing student test scores, I was also interested in why students choose one test mode over another. O'Dwyer et al. (2008) recommended that researchers examine the classroom as a hierarchical organization within which technology-use occurs. This approach provides a unique opportunity to see whether students' attitudes influence how their teachers teach and think which in turns affects other students in the classroom. Therefore, I analyzed individuals from both classrooms using a hierarchical approach focusing on the relationship between technology-use and achievement (Raudenbush & Bryk, 2002; Goldstein, 1995; Kreft & De Leeuw, 1998).

Research Question 4. The final research question that guided the qualitative phase of the study was: Which reading test mode did students prefer more, and what factors influenced students' preferred test mode?

Analysis Approaches. Qualitative phase data were first analyzed using a within qualitative approach whereby themes and trends generated from the first open-ended question were verified with themes and trends from the second open-ended question on the Student Opinion Survey. Researchers suggested that summarizing the main points within each open-ended response helps guide the analysis by helping to identify underlying themes in the data (Rubin & Rubin, 2005). Hence, I began the coding process by looking at the research questions and developing broad categories and codes. The Division of Instructional Innovation and Assessment-University of Texas (2010) suggested that coding student responses and summaries involves physically marking

different related data units using numerous codes without worrying so much about the variety of categories. As mentioned by Rubin and Rubin (2005), the initial coding of the qualitative data in this study resulted in changes to the codes and the creation of new codes. When working through the analysis toward synthesizing and summarizing the data, I was open to new concepts and themes that surfaced as provided additional insights to the central research question.

After coding the data manually, I sorted the data units that had the same code across research subjects into single computer files and summarized them using as little judgment as possible. Each summary contained the main points in the text that were associated with the coded category for each student. The next phase of the qualitative data analysis entailed ranking, comparing, weighing, and combining data units. Following the qualitative data analysis guidelines set by Rubin and Rubin (2005), the last stage of data analysis involved integrating, checking, and modifying the data to ensure they accurately reflected the themes that arose and the amount of importance placed on each item. Interpreting the Student Opinion Survey data in this way helped to more closely align common themes. A between qualitative and quantitative approach analysis of all research data occurred following qualitative phase data collection during the final interpretation.

Validity of Qualitative Data. Factors that influenced a student's particular test mode preference emerged from the final open-ended survey.Triangulating this thematic data with the descriptive statistics from the Computer Attitudes and Use Survey and the two sets of paired-sample *t* test scores confirmed their validity.

In addition to triangulating the data to check for validity, I was actively involved throughout the sequential explanatory design and allocated adequate time for data collection.

Measures for Ethical Protection of Participants

The paragraphs that follow are divided into two main sections: ethical requirements, and role of the researcher. The ethical requirements section describes how this mixed methods investigation met mandatory ethical review criteria as outlined by Walden University's IRB (with approval number 08-04-11-0074989) and the study district's external research committee. The section concludes with an examination of my role as the researcher in data collection and analysis in terms of past and current professional relationships with participants. The impact of these relationships on data collection and my experiences are discussed.

Ethical Requirements

Creswell (2007) emphasized the importance of remaining sensitive to ethical considerations throughout the research process. Hatch (2002) presented a series of questions to ask in thinking about ethical issues that included why, where, who, and how a study affects participants involved in the research.

Protection of Instructional Time. As outlined in the application to conduct external research in the study district, I kept interruptions to students' regular literacy instruction to a minimum. To this end, I limited data collection for the research study to two days separated over a two week time span. Preparing students to write EQAO reading tests using practice tests from previous years was a regular part of Grade 6

literacy instruction across Ontario, therefore the reading test portion of the study was part of the technology learning center teachers' normal practice. I collected data for Test 1 and Test 2 during the regular 100 minute literacy block. So as not to interrupt instruction during survey data collection, I collected data for the student Computer Attitudes and Use Survey and Student Opinion Survey during recess.

Minimal Disruption to Daily Flow of the School. During the 2 day data collection, I ensured there was minimal disruption to the daily flow of instruction at the school level. To this end, I collected the student Computer Attitudes and Use Survey and Student Opinion Survey data during recess, and the quantitative research activities during the reading test portion of the study were the same as teachers' normal instruction.

Minimal Emotional Impact on Students. The fact that the questions on the Computer Attitudes and Use Survey, and the reading passages and questions from previous EQAO reading tests were previously validated meant there was very little risk of causing teachers or students additional emotional stress. Nevertheless, changing the test from pencil-paper to computer-based format might have proven to be emotionally stressful for participants. To address this concern, I asked a fellow Walden University Doctor of Education candidate to take each computer-based instrument to verify the survey logistics ahead of time. No adjustments to the electronic instruments were required.

Non-use of Violent Materials. All quantitative data collection instruments were previously tested for content validity and reliability. Therefore, the test contents were approved for use in the study district and did not contain violent material.

Confidentiality. I replaced student names with codes as early as possible in data processing to ensure confidentiality. I described the plan for disseminating the results to the study district, school administrators, and research participants following the study. My telephone number and email address were included on the consent forms in the event that parents/guardians wished further information, and I personally thanked all parties for their consideration of the request. In addition to the consent/assent forms, prior to commencing the study, I communicated the data collection timeline in a formal letter to the principal, teachers, students, and parents/guardians.

Political Nature of the Study. This study did not run the risk of being political in nature as it focused on student reading achievement as compared to standards outlined in the language arts curriculum used in elementary schools.

Bias or Conflict of Interest. To avoid bias and conflict of interest, I involved teachers and students from two different schools where I had never worked. Conflict of interest was not a concern because I belonged to the same Elementary Teacher's Federation of Ontario (ETFO) union and did not have authority over the two technology learning center teaching colleagues invited to participate in the study.

Protection of Rights of Research Subjects. Hatch (2002) explained that students are especially vulnerable as research participants in school settings because they are seen as a captive audience. Therefore, I distributed and reviewed the consent/assent forms during face-to-face information sessions at each school site before data collection began. When reviewing the student assent forms with all research study participants, I ensured that they understood they would not be penalized should they have opted out of being

part of the study. I was responsible for collecting and tracking participate consent and assent forms.

Clear Procedures for Obtaining Informed Consent. Researchers need to maintain confidentiality and assure there is minimal psychological stress for participants, especially when involving students under the age of 18 who are vulnerable (Hatch, 2002). In accordance with proper protocol for conducting external research in this study district once the technology learning center teachers voluntarily agreed to involve their students in the study, arrangements were made for me to have face-to-face meetings with student participants from School A and School B. During each meeting, I distributed and thoroughly reviewed the consent/assent forms with teacher and student participants prior to data collection to ensure their voluntary consent and understanding of exactly what the study entailed. I also described how the data were only used for the purposes of this investigation, and backed up onto a secure hard drive. As the study involved 10- and 11-year olds, the student assent forms were written using grade appropriate language , and were read aloud to minors. I was responsible for distributing and collecting the consent/assent 3 weeks after the meeting. When I collected and tracked the signed consent/assent forms, I made a duplicate set of hard copies to be stored in a secure cabinet in my home office for up to 1 year following the study.

Plan for Sharing Results with Community Partners. As stipulated on the study district's application to conduct external research and Walden University's IRB application, after the completion of the study, I will share the results with school district,

and the students and teachers involved in my study so they can possibly benefit from a discussion of the findings.

Role of the Researcher

Before I began data collection, I obtained permission from Walden University's IRB and the study district. Then, I contacted the two school principals and secured their permission to invite the two technology learning center teachers to participate. Then I contacted the two Grade 6 technology learning center teachers and 48 students from School A and School B for the investigation. I distributed corresponding consent/assent forms to ensure informed consent. All forms were collected 3 weeks following a face-to-face meeting at each school site. During the sessions, I described the purpose, benefits, and design of my study, and ensured and documented that teacher and student participants fully understood the study and were willing to engage in research.

Over the course of my 20 year career, I have been an instructional technology resource teacher; therefore, I had experience using Moodle, and creating online data collection tools using Surveymonkey.com. I also had previously taught Grade 6; therefore, I had experience preparing students to write provincial EQAO tests. Based on my prior experience administering EQAO tests, I recognized that having testing materials ahead of the testing period alleviated stress. Therefore, I kept both technology learning center teacher participants up to date via email regarding research study timelines, and assumed full responsibility for photocopying, distributing, and collecting all assent/consent forms and test materials.

During the study, I had a direct role collecting student data using the quantitative phase Computer Attitudes and Use Survey, and Test 1 and Test 2. I was also directly involved in backing up all electronic data from the Surveymonkey or Moodle websites, and securely storing raw data in School A and School B folders on my personal laptop, and on a password protected portable hard drive in my home office for up to 5 years. I stored photocopies of all original hard copy data in a locked cabinet data in my home office for up to five years. Prior to the qualitative phase, I coordinated having a certified teacher transcribe all student handwritten reading open-responses into electronic format for the external rater to grade, along with the student responses downloaded and printed from Moodle. Test scores were calculated using the EQAO multiple choice answer keys and scoring rubrics, and marks were recorded on a student tracking sheet that I provided. I will return the graded tests to student participants following the entire study. In the qualitative phase of the study, I had a direct role collecting data using the online Student Opinion Survey. Throughout the study, I was directly involved in analyzing the data using within and between approach designs.

Whereas the wide range of experiences I had developing online assessment tools and implementing technology in the classroom aided in creating the four computer-based instruments and collecting data in this study, admittedly, I had no prior experience conducting an original research study of my own. Given that I was solely responsible for coding, analyzing, and eventually interpreting all of the data gathered throughout this investigation, I sought the guidance of members of my doctoral committee. Moreover, I

shared preliminary findings and conclusions with my chair and co-chair early in my interpretation for their feedback.

At the present time, I am employed with the current study district. I hold a position in my board as a full time elementary teacher, however I had never worked in School A or School B. Therefore, I had never taught in the same school setting as the two technology learning center teacher participants, and never taught any of the students participating in the research study.

In addition to my school-based role, I had served on the leadership team for the study district's technology learning center program for 3 years. In that capacity, I designed and delivered professional development sessions for fellow technology learning center teachers on how to effectively integrate ICT into their classrooms and roles. Therefore, I also had previous professional relationships with the two Grade 6 technology learning center colleagues I had invited to participate, but I did not know their students or their students' parents. My familiarity with the technology learning center program from which the purposeful sample was drawn may have affected the results; therefore any bias in analyzing or interpreting the results was stated beforehand.

This mixed methods study met the ethical requirements outlined by the study district and Walden University's IRB. The data collection procedures described in this section protected the rights and well-being of its population in accordance with accepted research ethics, and did not evaluate an individual. Data collection procedures ensured that the anonymity of participants and confidentiality of data were protected and consistent with the study district's Freedom of Information Protection of Privacy

(FOIPOP) policy. Participants were clearly notified of procedures for providing informed consent. Finally, I was prepared to follow appropriate protocol to deal with sensitive issues arising during the research.

Conclusion

Section 3 provided background information to justify using a sequential explanatory design for the mixed methods study. It described how, prior to data collection, I verified the logistics of the computer-based instruments on my own and with the assistance of a fellow Walden University Doctor of Education candidate. Section 3 also presented the multiple forms of data that were collected in the quantitative phase which preceded the qualitative phase, and explained how integration took place after data collection, during interpretation. Details regarding the Grade 6 technology learning center teacher and student sample from School A and School B were presented, and the sample size was defended. I also provided an overview of the procedure I used for data collection and data analysis, along with details regarding steps I will took to gain access to participants and establish research-participant relationships. Data triangulation, analysis, and validation were described. Section 3 concluded with a detailed discussion of the measures I took to ensure the ethical protection of participants, and the role I played as the researcher throughout my study.

Section 4: Results

Introduction

This section presents the findings for each research question through an analysis of the quantitative and qualitative data collected. Section 4 begins with a description of the strategy used in this study; a discussion of the tracking systems used for data and emerging understandings; and an examination of how the findings related to each research question. Upon receipt of appropriate letters of cooperation from two elementary school principals, two Grade 6 technology learning center teachers and their 48 students were invited to attend a face-to-face presentation to learn about the study and ensure informed consent. Following the meeting, the student, parent and teacher assent/consent forms were collected.

This investigation aimed to uncover the interchangeability of test modes (CBT and PBT), and the effect of student assessment mode preference on the reading achievement results of Grade 6 students who regularly used technology at school. Findings intended to close gaps in the K-8 reading test mode and student assessment preference literature in Canada. Test mode and student assessment preference researchers (Bergstrom, 1992; Bodmann & Robinson, 2004; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans et al., 1995; Horkay et al., 2006; Johnson & Green, 2004; Neuman & Baydoun, 1998; van de Watering et al., 2008; Wang et al., 2000) have identified key factors that influence achievement on students' preferred and nonpreferred and computer-based and pencil paper tests:

- student readiness
- motivation and engagement
- test order

These factors, along with familiarity, achievement, format and peer influence surfaced as themes in the qualitative Student Opinion Surveys data. These were analyzed in conjunction with descriptive statistics and Test 1 and Test 2 achievement data to address the four research questions of this study.

The following four research questions guided the research design:

1. What were the prior experiences and attitudes of teachers and students about technology use at home and at school?
2. Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms?
3. Were the reading achievement results for the students' preferred test mode significantly different from the students' nonpreferred test mode?
4. Which reading test mode did students prefer, and what factors influenced students' preferred test mode?

Question 1 was answered using the online Computer Attitudes and Use Survey for teachers and students, and questions 2 and 3 were answered using student achievement data from the two reading tests. Data in response to Question 4 were collected using the online Student Opinion Survey in the final qualitative phase of the study.

Strategy

This mixed methods approach used a sequential explanatory design. There were more quantitative than qualitative data collected in this study; thus, the data from the qualitative phase helped to interpret the findings of a primarily quantitative study (Creswell, 2003).

Quantitative Data Tracking System

Computer Attitudes and Use Surveys

Surveymonkey.com was used to collect and track data for the teacher and student Computer Attitudes and Use Surveys. Quantitative results were collected, tracked, and backed up online. Then, the data were exported as Microsoft™ Excel files. Teacher and student names' were replaced with numeric codes. Raw data were backed up on a portable hard drive, printed, and stored in a locked cabinet for safe keeping. Statistical Package for Social Science (SPSS) 10.0 software was used to generate descriptive statistics to describe the demographics of the teacher and student participants, and their prior experiences and attitudes about technology use at home and at school.

Test 1 and Test 2

Moodle is the web-based course management tool that was used to collect data for the computer-based versions of the two reading tests. Test 1 and Test 2 data were collected, and the reading responses for each student were downloaded and extracted as separate Microsoft™ Word files. Student names were replaced with numeric codes, and results were printed for grading. Pencil-paper reading responses for both tests were

transcribed and also saved as individual Microsoft™ Word files. Hard copies of students' reading responses were printed and graded by an external rater.

Overall reading test results were tracked using Microsoft™ Excel. Raw quantitative reading test data were backed up on a portable hard drive, photocopied, and stored in a locked cabinet for safe keeping. SPSS software was used to conduct paired-sample *t* tests to analyze and compare individual student achievement scores on computer-based and pencil-based modes, and preferred and nonpreferred test modes.

Qualitative Data Tracking System

Surveymonkey.com was used to collect data for the qualitative Student Opinion Survey. Data obtained from the open-ended questions were exported from the Internet as Microsoft™ Excel files. Student names were replaced with numeric codes. Responses were then printed for coding and analysis. Raw qualitative data were backed up on a portable hard drive, photocopied, and stored in a locked cabinet for safe keeping.

Findings

In this subsection, the quantitative and qualitative findings are presented in order of the four research questions that guided this investigation.

Question 1

Permission to adapt the USEIT Survey (Russell, O'Brien, Bebell, & O'Dwyer, 2003) was received prior to administering the online teacher and student Computer Attitudes and Use Surveys. Findings addressed the first research question: What were the prior experiences and attitudes of teachers and students about technology use at home and at school? Teacher data is presented first, followed by student data.

Teacher Demographics

Teacher participants for the study comprised of two Grade 6 teachers from two technology learning center classrooms in the two suburban communities in southwestern Ontario. Table 3 depicts the demographic data for teacher participants.

Table 3

Demographics of Teacher Respondents

Teachers (n=2)		
Gender	Females	1
	Males	1
Teaching Experience	More than 5 years	2
Years in technology learning center program	Less than 1 year	1
	1-2 years	1
Number of technology learning center classroom visits	None	2
Attendance at district-lead technology learning center professional learning activities	Twice a year	2
Accessed personal technology learning center professional learning activities	None	1

Therefore, one male and one female technology learning center teacher participated in the study. Both teacher participants were new to the technology learning center program, but not new to the teaching profession. Both reported that they regularly participated in technology learning center professional learning activities.

Teacher Access to Technology at Home

One of the teacher participants had three or more computers at home, and the other had two computers at home. Both teachers accessed the Internet on a wireless network, and shared the computer with 2-3 people at home. Both teachers reported

spending more than 2 hours using a computer at home on a typical day. Therefore, when asked to indicate how difficult it was to access computer(s) at home, both teachers indicated that it was never difficult to access the home computer(s). One of the teachers had had a home computer for more than 3-4 years, whereas the other had had computers at home for as long as could be remembered.

Teacher Access to Technology at School

Compared with non technology learning center classrooms in their school, both teacher participants had access to a range of additional instructional technology for use in their classrooms. One of the teacher participants did not have access to a laptop at school, whereas the other had access to 2-3 laptops. Both teacher participants had access to an LCD projector/media cart and a document camera, while only one of them had access to a SmartBoard™ at school. Both teachers had access to an iMac™, whereas only one teacher reported having access to iPods™ or iPads™ at school.

Uses of Instructional Technology for Teaching

Teacher surveys indicated that both teacher participants made daily use of LCD projectors and document cameras. Only one of the two teachers made daily use of the SmartBoard™. Neither teacher reported using PDAs such as the iPad™ or iPod™ or digital cameras in class.

When asked how much time was spent using technology on a typical day, both teacher participants indicated they used technology for over 2 hours a day in school. Data regarding how often the two technology learning center teachers designed technology-embedded assignments for students are presented in Table 4. Given that there were only

two teacher participants in this study, the Mean and Standard Deviation were not reported in Table 4.

Table 4

Frequency of Technology-Embedded Assignment

	Never		Once or twice a year		Several times a year		Several times a month		Several times a week	
	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*
Reports and essays	(0.0)	0	(50.0)	1	(50.0)	1	(0.0)	0	(0.0)	0
Multimedia projects	(0.0)	0	(0.0)	0	(100.0)	2	(0.0)	0	(0.0)	0
Web-based publications	(50.0)	1	(0.0)	0	(50.0)	1	(0.0)	0	(0.0)	0
Pictures or artwork	(0.0)	0	(50.0)	1	(50.0)	1	(0.0)	0	(0.0)	0
Stories or books	(0.0)	0	(100.0)	2	(0.0)	0	(0.0)	0	(0.0)	0
Graphs or charts	(0.0)	0	(50.0)	1	(50.0)	1	(0.0)	0	(0.0)	0
Videos or movies	(0.0)	0	(50.0)	1	(50.0)	1	(0.0)	0	(0.0)	0
Podcasts	(0.0)	0	(50.0)	1	(50.0)	1	(0.0)	0	(0.0)	0

Overall, with the exception of one teacher who reported never assigning web-based publications, both teachers reported assigning all other technology-embedded projects only once or twice a year, or several times a year. Neither teacher reported assigning any technology-embedded projects several times a month or several times a week. Both teacher participants reported they were able to use technology for instruction as much as they would like. However, only one of the two teachers agreed with being able to use technology for assessment as much as he/she would like; the other neither

agreed nor disagreed with being able to use technology for assessment as much as he/she would like.

Student Demographics

Student participants for the study comprised 48 pupils aged 10-11 from two technology learning center classrooms in the two suburban communities in southwestern Ontario. As a proxy for cultural diversity, students were asked how many languages other than English were spoken at home. Demographic data and language diversity information for student participants are represented in Table 5 below.

Table 5

Demographics of Student Participants

Gender (n=48)	Female	(52.1%)
	Male	(47.9%)
Languages spoken at home	English	(37.5%)
	Cantonese	(16.7%)
	French	(12.5%)
	Tamil	(6.3%)
	Mandarin	(4.2%)
	Punjabi	(4.2%)
	Telugu Hindi	(4.2%)
	Farsi	(2.1%)
	Guajarati	(2.1%)
	Indonesian	(2.1%)
	Sinhalese	(2.1%)
	Spanish	(2.1%)
	Urdu	(2.1%)

Overall, within the student sample, there were slightly more girls (52.1%) than boys (47.9%), and 13 languages other than English were spoken at home.

As a proxy for social-economic status, students were asked how many books they had at home aside from their school books. All student participants reported having some books at home (100%), and some students (41.7%) had more than 50 books in their homes.

Student Computer Access and Internet Use at Home

Table 6 depicts student participants' access to computers and the Internet, and the number of people who share computer(s) in students' homes.

Table 6

Student Access and Use at Home

Length of time students have had computer(s)	Less than 1 year % *f* (1.9) 1	1-2 years % *f* (8.0) 4	3-4 years % *f* (10.0) 5	Forever % *f* (80.2) 38	Mean 3.9	Standard Deviation .8
Number of home computers	0 % *f* (0.0) 0	1 % *f* (3.9) 2	2 % *f* (35.4) 17	3 or more % *f* (60.7) 29	3.6	.6
Number of people who share home computer	Just one person % *f* (9.1) 4	2-3 people % *f* (50.0) 24	4-5 people % *f* (40.9) 20	6 or more people % *f* (0.0) 0	2.3	.6
Time using technology	15 minutes or less % *f* (6.3) 3	15-60 minutes % *f* (33.3)16	An hour or two % *f* (25) 12	Over two hours % *f* (35.4) 17	3.9	.973
Level of difficulty completing homework	Hard; computers always shared % *f* (3.9) 2	Easy; have access % *f* (33.6) 16	Easy; lots of access % *f* (62.5) 30	Never assigned homework using technology % *f* (0.0) 0	3.58	.577
Internet connection at home	Internet % *f* (32.1) 15	High speed % *f* (8.4) 4	Wireless % *f* (59.5) 29		3.3	.9

Therefore, computers were present in 100% of students' homes, and all student participants had a home Internet connection. All students used technology every day; more specifically, over one third of students used technology at home for over 2 hours daily. Even though student participants reported having to share the home computer(s) with more than one person, no students reported having difficulty accessing technology at home. The majority of the students (96%) reported that it was easy to complete homework that required the use of a computer; accessing technology at home was not a challenge.

Table 7 depicts the frequency and nature of students' use of computers at home.

Table 7

Students' Use of Computers for Specific Activities at Home

	Never		Once a month		Once a week		Couple times/week		Everyday		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*		
Listen to music	(10.4)	5	(16.7)	8	(10.4)	5	(29.2)	14	(33.3)	16	3.58	1.4
Access a class Moodle	(6.3)	3	(12.5)	6	(27.1)	13	(35.4)	17	(18.8)	9	3.48	1.1
Search Internet for school	(4.2)	2	(18.8)	9	(20.8)	10	(41.7)	20	(14.6)	7	3.44	1.1
Search internet for fun	(8.3)	4	(18.8)	9	(22.9)	11	(25.0)	12	(25.0)	12	3.4	1.3
Email	(16.7)	8	(14.6)	7	(14.6)	7	(27.1)	13	(27.1)	13	3.33	1.4
Play games	(4.2)	2	(29.2)	14	(14.6)	7	(33.3)	16	(18.8)	9	3.33	1.2
Chat/Instant Message	(29.2)	14	(10.4)	5	(8.3)	4	(18.8)	9	(33.3)	16	3.17	1.7
Write papers	(4.2)	2	(35.4)	17	(39.6)	19	(14.6)	7	(6.3)	3	2.83	0.9
Use social media	(50.0)	24	(4.2)	2	(4.2)	2	(12.5)	6	(29.2)	14	2.69	1.8
Computer programming	(37.5)	8	(22.9)	1	(12.5)	6	(18.8)	9	(8.3)	4	2.28	1.4
Create/edit photos	(60.5)	3	(34.2)	3	(13.2)	5	(10.5)	4	(7.9)	3	1.98	1.2
Create/maintain websites	(72.9)	5	(18.8)	9	(4.2)	2	(4.2)	2	(0.0)	0	1.4	0.8

The most frequent at home computer-based activities that sixth grade technology learning center student participants performed every day were using the computer for chat/instant messaging (33.3%), and listening to mp3/music (33.3%). Conversely, the majority of students reported they never used computers at home to create or maintain websites (72.9%), or create or edit digital photos/movies (60.5%). Interestingly, half of student participants also reported they never used the home computer for social media (50%).

Student Computer Access and Computer Use at School

Data regarding students' access and use of technology at school are depicted in Table 8.

Table 8

Students' Computer Access and Computer Use at School

Difficulty accessing computer(s)	Frustrating; not enough computers		Sometimes difficult		Usually easy		Always easy		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*	%	*f*		
	(4.5)	2	(22.9)	11	(50.0)	24	(22.9)	11	2.92	.79
Time on computer(s)	None		15 minutes or less		15-60 minutes		An hour or two		Over two hours	
	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*
	(0.0)	0	(20.8)	10	(64.6)	31	(14.6)	7	(0.0) 0	2.9 .598

Therefore, according to student participants, the technology learning center classrooms generally provided students with sufficient access to computers. Whereas more than 30% of students reported using technology at home more than two hours daily (see Table 7), most students (85.4%) reported they used technology at school for less than half of that time (i.e., only 15-60 minutes every day). Data indicated that teacher

participants used technology for instructional purposes for more than 2 hours a day, and did not assign technology-embedded assignments for students more than several times a year (see Table 4). Therefore, technology learning center students' exposure to technology at school exceeded their use of technology on a daily basis.

Information about how often student participants asked different people in school for help when they had problems with computers is shown in Table 9.

Table 9

People that Students Go to for Help When Using Computers at School

	Rarely		Occasionally		Usually		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*		
A teacher	(14.6)	7	(54.2)	26	(31.3)	15	2.17	.663
A friend/student	(14.6)	7	(41.7)	20	(43.8)	21	2.29	.713
Teacher librarian	(87.5)	42	(8.3)	4	(4.2)	2	1.17	.476
Computer Resource Teacher	(75.0)	36	(20.8)	10	(4.2)	2	1.29	.544
Information Technology Specialist	(85.4)	41	(10.4)	5	(4.2)	2	1.19	.491
Other adults	(64.6)	31	(29.2)	14	(6.3)	3	1.42	.613

Therefore, the majority of sixth grade technology learning center students reported that they relied least on the teacher librarian (87.5%), information technology specialist (85.4%) and other adults for help (64.6%) when using technology at school. Conversely, students reported occasionally or usually relying on a friend or another student (85.5%), and the teacher (85.5%) for help using computers at school.

In terms of where students used technology most at school, the majority of students (95.9%) reported they used computers most in their classroom, and only 4.1% reported they used computers in the school library. No students reported using computers

in the computer lab. This finding was consistent with earlier teacher data that described the wide range of technology tools available in technology learning center classrooms.

Data pertaining to the type and frequency of technology use at school are depicted in Table 10.

Table 10

Students' Computer Use at School

	Never		A couple times/year		Once/couple weeks		Every week		Daily		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*		
Computer	(4.2)	2	(37.5)	18	(29.4)	14	(16.7)	8	(12.5)	6	2.96	1.110
Laptop	(4.2)	2	(27.1)	13	(35.4)	17	(20.8)	10	(12.5)	6	3.10	1.077
LCD projector	(10.4)	5	(16.7)	8	(6.3)	3	(25.0)	12	(41.7)	20	3.71	1.429
Smart Board™	(47.9)	23	(12.5)	6	(2.1)	1	(2.1)	1	(35.4)	17	2.65	1.851
PDAs	(47.9)	23	(37.5)	18	(6.3)	3	(4.2)	2	(4.2)	2	1.79	1.031
Document camera	(41.7)	20	(12.5)	6	(4.2)	2	(8.3)	4	(33.3)	16	2.79	1.798
Digital camera	(45.8)	22	(52.1)	25	(2.1)	1	(0.0)	0	(0.0)	0	1.56	.542
Teacher's overall use	(0.0)	0	(2.1)	1	(2.1)	1	(18.8)	9	(77.1)	37	4.71	.617
Students' overall use	(0.0)	0	(2.1)	1	(18.8)	9	(43.7)	21	(35.4)	17	4.12	.789

Of all the devices available at school, fewer than half of student participants reported they never used SmartBoards™ (47.9%), PDAs (47.9%), and digital cameras (45.8%). This finding was consistent with earlier teacher data which indicated that only one of the two teachers had access to a SmartBoard™ in class. On a daily basis, just less than half of participated students (41.7%) reported they used LCD projectors, 35.4% reported they used SmartBoards,™ and one third (33.3%) of students reported using

document cameras. Therefore, technology learning center teachers used more technology in class than their students in class.

Students' Specific Uses of Computers

When asked where students learned new things involving technology, just under two thirds of student participants (60.4%) learned new things with technology at home, and 39.6% reported learning new things with computers at school. This finding aligned with earlier data from this study that students spent more time using technology at home than at school.

Table 11 depicts where students learned to do new things with technology and how often students used technology to perform certain tasks.

Table 11

Specific Technology Use at School

	Never		Almost never		Once a month		Once a week		Every day		Mean	Standard Deviation
	%	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*f*		
Send and receive email	(10.4)	5	(10.4)	5	(14.6)	7	(37.5)	18	(27.1)	13	3.6	1.284
Send and receive text messages	(25.0)	12	(10.4)	5	(10.4)	5	(14.6)	7	(39.6)	19	3.33	1.667
Write and edit homework	(0.0)	0	(12.5)	6	(20.8)	10	(39.6)	19	(27.1)	13	3.81	.982
Open or upload files	(2.1)	1	(2.1)	1	(20.8)	10	(45.8)	22	(29.2)	14	3.96	.874
Find information on the Internet	(0.0)	0	(4.2)	2	(8.3)	4	(37.5)	18	(50.0)	24	4.33	.808
Create a multimedia presentation	(10.4)	5	(20.8)	10	(50.0)	24	(16.7)	8	(2.1)	1	2.79	.922
Create a podcast	(35.4)	17	(37.5)	18	(18.8)	9	(4.2)	2	(4.2)	2	2.04	1.051
Play computer games	(6.3)	3	(14.6)	7	(16.7)	8	(33.3)	16	(29.2)	14	3.65	1.229
Work with spreadsheets	(27.1)	13	(29.2)	14	(20.8	10	(16.7)	8	(6.3)	3	2.46	1.237

Student participants reported they created podcasts (35.4%) and worked with spreadsheets and databases (27.1%) the least. Students used technology the most every day to find information on the Internet (50%) and send and receive text messages (27.1%).

Computer-Related Skills

Table 12 displays how student participants felt about their ability to perform certain tasks using technology.

Table 12

Students' Perception of Specific Computer Skills

	Not very good		OK		Pretty good		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*		
Send/receive email	(6.3)	3	(22.9)	11	(70.8)	34	2.65	.601
Send and receive text messages	(18.8)	9	(16.7)	8	(64.6)	31	2.46	.798
Write/edit schoolwork	(2.1)	1	(33.3)	16	(64.6)	31	2.62	.531
Open or upload files onto a server/network	(4.2)	2	(39.6)	19	(56.3)	27	2.52	.583
Find information on the Internet	(0.0)	0	(18.8)	9	(81.3)	39	2.81	.394
Create a multimedia presentation	(16.7)	8	(41.7)	20	(41.7)	20	2.25	.729
Create a podcast	(52.1)	25	(31.3)	15	(16.7)	8	1.65	.758
Play games	(6.3)	3	(16.7)	8	(77.1)	37	2.71	.582
Work with spreadsheets/ databases	(37.5)	18	(50.0)	24	(12.5)	6	1.75	.668

	Never use technology		Usually afraid of technology		Sometimes difficult to use		Use technology confidently		Mean	Standard Deviation
	%	*f*	*%*	*f*	*%*	*f*	*%*	*f*		
Personal use of technology	(0.0)	0	(2.3)	1	(43.2)	21	(54.6)	26	3.52	.545

The two computer skills that students participants reported they lacked the most were creating podcasts (52.1%) and working with spreadsheets/databases (35.5%). Conversely, the two computer skills that they were OK at included working with

spreadsheets/databases (50.0%), and creating multi-media presentations (41.7%). These findings aligned with teacher participants reporting they rarely assigned graphs and charts or multi-media projects during the school year (see Table 4). Finally, students reported they were best at finding information on the Internet (81.3%) and playing computer games (77.1%). Overall, more than half of students (54.6%) reported that they used a computer with confidence and with the exception of creating podcasts and working with spreadsheets, the majority of students could figure out how to do just about anything that they needed to do.

Student Computer Attitudes

Table 13 displays student participants' beliefs about using technology instead of pencil-paper in class.

Table 13

Students' Computer-Related Beliefs

	Never		Sometimes		Usually		Always		Mean	Standard Deviation
	%	*f*	%	*f*	%	*f*	%	*f*		
Create better work	(0.0)	0	(22.9)	11	(43.8)	21	(33.3)	16	3.10	.751
Write better	(4.2)	2	(20.8)	10	(37.5)	18	(37.5)	18	3.08	.871
Take short cuts	(29.2)	14	(64.6)	31	(6.3)	3	(0.0)	0	1.77	.555
Spend more time working with peers	(14.6)	7	(50.0)	24	(31.3)	15	(4.2)	2	2.25	.758
Understand things better	(4.2)	2	(27.1)	13	(45.8)	22	(22.9)	11	2.88	.815
Work harder	(6.3)	3	(31.3)	15	(35.4)	17	(27.1)	13	2.83	.907
Easy to copy from Internet	(18.8)	9	(25.0)	12	(33.3)	16	(22.9)	11	2.60	1.047
Get more confused	(47.9)	23	(45.8)	22	(4.2)	2	(2.1)	1	1.60	.676
Get more frustrated	(52.1)	25	(41.7)	20	4.2	2	(2.1)	1	1.56	.681

The majority of students believed that the quality of their work was usually or always better when they used technology (77.1%). Similarly, over half reported that technology usually or always seemed to help them understand things (68.7%). Just under two thirds claimed that they sometimes took short cuts and got lazy when they used technology (64.6%), and more than three quarters of students reported that they spent more time working with others when they used technology in class (85.5%). Almost all students reported rarely getting more confused (94.7%) or frustrated (93.8%) when using technology. These results supported the earlier finding that most students were familiar with and comfortable using technology at home and/or at school, because they used it for an average of 2 hours and 15 minutes a day.

Quantitative CBT and PBT data are now presented and analyzed using paired-sample *t* tests in response to Question 2 and Question 3 of this research study. The fiction and non-fiction reading passages and questions that comprised each test were taken from previously validated EQAO reading tests, and were available online in the public domain; therefore, copyright permission was not required.

Question 2

The second research question of this study: Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms? was addressed using data collected from Test 1 and Test 2.

Two hypotheses were formulated for Question 2:

$H_0$1: There would be no significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms.

H_a1: There would be a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms.

A paired-sample *t* test was conducted to compare sixth grade technology learning center students' achievement data on computer-based and pencil-based reading tests. There was no significant difference in the scores for computer-based test (M=126.10, SD=23.229) and pencil-paper reading test (M=127.50, SD=18.613) conditions; t(47)=-.484, p = .630. A summary of the paired-sample *t* test for the null hypothesis generated using SPSS software and is presented in Table 14.

Table 14

Summary of Paired-Sample t Tests Comparing Reading Achievement Scores between Computer-Based and Pencil-Paper Test Modes

	Paired Differences							
				95 % Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pair 1								
CBT-PBT	-1.396	19.967	2.882	-7.194	4.402	-.484	47	.630

These results suggested that the test mode (CBT vs. PBT) did not have a significant effect on technology learning center students' reading achievement. Specifically, this investigation confirmed that reading achievement did not improve or decrease when a technology learning center student took a reading test on the computer or using pencil-paper. Therefore, this analysis resulted in the acceptance of the null hypothesis and aligned with test mode researchers who claimed that CBT scores were equivalent to PBT scores (Bergstrom, 1992; Bodmann & Robinson, 2004; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans et al., 1995; Johnson & Green, 2004; Neuman & Baydoun, 1998; Wang et al., 2000).

Question 3

The third research question: Were the reading achievement results for the students' preferred test mode significantly different from the students' nonpreferred test mode? was also answered using student participants' achievement data gathered from Test 1 and Test 2.

Two hypotheses were formulated for Question 3:

$H_0 2$: The reading achievement results for the students' preferred test mode would not be significantly different from the students' nonpreferred test mode.

$H_a 2$: The reading achievement results for the students' preferred test mode would be significantly different from the students' nonpreferred test mode.

A second paired-sample *t* test was conducted to compare the student achievement data on their preferred and nonpreferred test modes. Once again, there was no significant difference in the scores for preferred test mode (M=124.15, SD=20.335) and

nonpreferred test mode (M=129.25, SD=21.666) conditions; t(47)=-1.800, p = .078. A summary of the paired-sample *t* test for the null hypothesis was generated using SPSS software and is presented in Table 15.

Table 15

Summary of Paired-Sample t Tests Comparing Reading Achievement Scores between Preferred and Non-Preferred Test Modes

	Paired Differences							
				95 % Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pair 2 CBT-PBT	5.104	19.646	2.836	-10.809	.600	-1.800	47	.078

These results suggest that students' test mode preference did not have an effect on technology learning center students' reading achievement. Specifically, this investigation confirmed that reading achievement did not improve or decrease when a technology learning center student was allowed to choose between taking a reading test on the computer and using pencil-paper. Therefore, this analysis resulted in the acceptance of the null hypothesis and confirmed the findings of assessment preference researchers who claimed there to be limited impact of student assessment preference on student achievement (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005).

A presentation and analysis of the qualitative data gathered from the Student Opinion Survey in response to the final research question of this study follows next.

Question 4

Qualitative data gathered from the two open-ended questions on the Student Opinion Survey were related to the fourth question of this mixed methods investigation: Which reading test mode would students prefer more and what factors influenced students' preferred test mode? Findings revealed student participants' opinions about why they chose one test mode over another.

To begin the coding process, broad categories and codes were derived from the two open-ended questions. The first survey question, Which test mode (computer-based or pencil-paper) did you pick for the first reading test? Why*?* resulted in broad categories:

- Choosing CBT over PBT or PBT over CBT;
- Familiarity with CBT or PBT;
- Handwriting and keyboarding skills;
- Access to technology; and
- Student engagement.

Initial coding resulted in making changes to the categories and coding structure. In some cases, additional categories were added (i.e., Computers seemed harder). In other cases, attitudinal sub-categories emerged (i.e., under the category Choosing CBT over PBT, students perceived there to be a benefit regarding the Format and Achievement). These additions added insights to the fourth research question. The same process was followed for coding the responses to the second open-ended question on the survey: Which test mode (computer-based or pencil paper) did you like more? Why?

After manually coding all 48 sets of qualitative responses to the first and second survey questions, data units with the same code were sorted across research participants into a single computer file and summarized. The summary contained the main points in the text associated with the coded category for each question of the survey. The next phase of the qualitative data analysis entailed ranking, comparing, weighing, and combining data units.

Survey Question 1 Results

The categories, subcategories, percentages, and frequencies generated from student participants' reasons for their reading test preference are presented in Table J1 (see Appendix J). When given the choice between modes for the first reading test, 79.2% of student participants reported they elected to take Test 1 using a pencil-based test (PBT) and 20.8% of students chose the computer-based test (CBT) format. These findings were consistent with and validated the quantitative reading test data as 38 out of 48 students chose to take Test 1 using PBT, and 10 out of 48 students chose to take Test 1 using CBT.

PBT for Test 1. Familiarity played the largest role in why student participants chose PBT over CBT for the first reading test. Just over half of students (52.6%) who chose to take Test 1 using pencil-paper reported they were more accustomed to taking paper-based reading tests in class: "It's what I am used to,", "We take most tests using pencil-paper," and "I am not used to taking tests on the computer." More than half of students (52.5%) reported that they chose PBT because they perceived that CBT seemed harder than PBT: "I write faster than I type," and "I am not a good keyboarder." Finally,

21% of student participants reported they chose PBT over CBT because they thought they would achieve better results on the PBT: "The pencil test is easier," "I can explain more on paper," "I give more detailed answers when I write," and "I do better using pencil-paper."

CBT for Test 1. According to student responses, engagement had the largest impact on why students chose CBT over PBT for the first test. Even though only 10 out of 48 students (20.8%) chose to take Test 1 on the computer, 100% of them reported they found technology more engaging than using pencil-paper; found the format of CBT easier; and expected to do better on CBT over PBT. One student even reported that working on computers "Helped me focus." Most students who reported they had better keyboarding skills chose CBT for Test 1 instead of handwriting.

Survey Question 2 Results

The second question on the Student Opinion Survey asked students: Which test mode (computer-based or pencil paper) did you like more? Why? Student responses to this final question of this investigation are presented in Table K1 (see Appendix K). Overall, more than half of student participants (60.4 %) reported they liked the CBT test experience more than PBT experience, 29.2% reported they preferred the PBT experience over CBT, and 10.4% reported they were Undecided about which test mode they preferred. These findings aligned with results from the initial quantitative survey that indicated that student participants engaged frequently with technology at home and at school. More specifically, the majority of students reported spending anywhere from 15

minutes to over 2 hours daily on the computer at home to complete a wide range of activities other than schoolwork.

CBT Preference. More than half of student participants (60.4%) chose CBT over PBT because they felt it was easier (meaning they would do better) and they preferred the format. In addition to reporting that taking the reading test on the computer was easier and provided more room to respond, almost two thirds of students (65.5%) claimed they preferred CBT because they liked keyboarding over handwriting. Similarly, student participants in this study also reported that they thought the work they did using the computer would result in higher achievement because it was neater and more organized.

PBT Preference. Less than one third of all sixth grade students (29.1%) reported they liked PBT more than CBT. For these students, the PBT format was more familiar; they felt they did not have adequate keyboarding skills to do as well on the computer; and they reported they explained themselves better and made fewer mistakes when they wrote the reading test on paper.

Conclusion

The first research question was answered by collecting and analyzing teacher and student data from the online Computer Attitudes and Use Surveys. Demographic information and descriptive statistics described participants' current computer attitudes and use at home and at school. Overall, male and female teachers and students were represented. There was a high level of cultural diversity among student participants as evidenced by students reporting speaking more than 13 languages other than English at home. All respondents reported having home access to the Internet and computers, and

despite most respondents reporting that they had to share computers with someone else at home; teachers and students reported they rarely experienced difficulty using technology to access or complete homework. At home, most teachers and students reported using technology from 15 minutes to over 2 hours everyday. Overall, teachers and students were confident users of technology. Teachers used technology almost twice as much as most students at school.

Reading achievement data from Test 1 and Test 2 were used to address the second and third research questions of this investigation to gauge the impact of test mode (CBT and PBT) and technology learning center students' assessment mode preference on reading achievement. The answers to multiple choice questions and reading open-responses on both reading tests were totaled and compared in relation to the test mode (CBT and PBT) used for each quantitative reading test, students' test mode preference, and achievement results on the CBT and PBT. Paired-sample *t* tests showed there were no significant differences in the scores for CBT and PBT conditions, nor in the scores for students' preferred versus nonpreferred test modes. Therefore, the analysis of quantitative technology learning center student reading achievement data resulted in the acceptance of both null hypotheses and supported the test mode interchangeability literature. Furthermore, the lack of significant difference between technology learning center students' preferred and nonpreferred test modes aligned with researchers who reported no significant relationship between students' assessment mode preferences and their achievement.

Data from the qualitative Student Opinion Survey were used to respond to the final research question of this study to uncover reasons why students chose one test mode over another.

Thematic Findings

A primary theme that emerged throughout the qualitative data analysis was that most student participants based their Test 1 choice on their ease of use and familiarity with pencil-paper testing at school or computers use at home. Other themes expressed by student participants were that they enjoyed using technology, and had regular access to technology at school and at home. Another common theme was that keyboarding skills were perceived by students to be essential to their success when using technology. Despite students' reported lack of keyboarding skills, CBT and PBT results were not significantly different. Moreover, those student participants with good keyboarding skills did not do significantly better or worse on either mode. Therefore, the final theme that emerged was that students shared the perception that using computers should lead to better academic achievement. In the end, the reading test data suggested there was no significant benefit to using CBT on reading achievement.

Evidence of Quality

In this mixed methods study, a number of strategies were employed to ensure the quality of data collection and data analysis. The data analysis procedure was first aligned with the research design. Then, to ensure the trustworthiness and authenticity (Creswell & Miller, 2000) of the qualitative findings, the following data validation strategies were used:

- Instrument Reliability,
- Triangulating data,
- Using rich and descriptive language to convey findings,
- Clarifying bias, and
- Peer debriefing.

Procedure Within Design

Data analysis for mixed methods investigations involved within quantitative, within qualitative approach, and between quantitative qualitative approaches (Creswell, 2003). Therefore, in this sequential explanatory design, descriptive and inferential numeric analysis was conducted using the quantitative data from the teacher and student Computer Attitudes and Use Surveys, Test 1 and Test 2, and student test mode preferences. The within qualitative approach involved analyzing themes generated from the qualitative student opinion survey. The between quantitative and qualitative approach involved analyzing "how the qualitative findings helped to elaborate on or extend the quantitative results" (p. 222).

Within Quantitative Approach. Data from the initial quantitative teacher and student Computer Attitudes and Use Surveys that were adapted from a previously validated survey instrument (Russell, et al., 2003) addressed Question 1. Descriptive statistics generated from the teacher and student Computer Attitudes and Use Survey data were verified by comparing findings with the second set of quantitative data collected from the student reading tests, and student test mode preference findings. For example, data from the initial teacher and student surveys indicated that both two teachers used

technology almost twice as much as most technology learning center students at school, and rarely assigned technology-embedded assignments to students more than 2-3 times a year. In other words, students were exposed to technology in class, but they did not use it very often or were not often assessed using technology in class. These findings helped explain why 85.4% of student participants chose PBT for their preferred test mode for Test 1.

Student achievement data collected from Test 1 and Test 2, which were comprised of previously validated and reliable reading passages and questions (EQAO, 2006, 2007a, 2008a, 2010a), addressed research Question 2 and 3. To ensure the validity of the reading test evaluations, inter-rater reliability was controlled by having an external rater score the tests. A single teacher who was not participating in the study and was previously trained to score EQAO assessments. To reduce the potential impact that students' handwriting could have had on their achievement, another colleague not participating in the study transcribed all PBT responses to electronic format before the external rater graded the tests. Statistical software was used to conduct paired-sample *t* tests to compare student achievement results. Paired-sample *t* tests were more rigorous than a one-tailed test; hence, there was enough evidence gathered from the two sets of reading achievement test data to reject both alternate hypotheses.

Within Qualitative Approach. The responses from the Student Opinion Survey were summarized and then coded. I compared the responses to the first and second question on the same qualitative survey instrument. Broad categories and codes were developed, and additional categories and subcategories were created. After coding the

data manually, data units with the same code were summarized, ranked, compared, and combined to align common themes. When the themes were crosschecked between the responses to each survey question, recurring themes emerged (i.e., ease of use and familiarity, engagement with technology, keyboarding skills, etc.). Hence, qualitative student opinion data that addressed the qualitative research Question 4 of this study were an appropriate data resource for a study that was "explanatory in nature" (Hatch, 2002, p. 134) and proved to be valuable in this and future test mode comparability studies.

Between Quantitative and Qualitative. To ensure the quality of the between quantitative and qualitative approach, data from all sources were triangulated. More specifically, the two sets of paired-sample *t* test scores, along with the descriptive statistics from the initial quantitative survey, and the themes that emerged from the qualitative phase survey data were crossexamined during the final data analysis and interpretation. Findings partially aligned with the new literacies theory, CBT in education and students' assessment preference research literature discussed in Section 2 of this paper. Themes that emerged from the qualitative surveys in this study included: students' ease of use and familiarity with pencil-paper testing at school; students experiencing enjoyment when using technology; students regularly accessing technology at home and at school; computer keyboarding being essential to success when using technology; and students' perception that work on the computer should result in improved achievement.

Instrument Reliability

Compared with the original USEIT study (Russell et al., 2003), the population involved in this study was much smaller. The respondents for the current study were two

Grade 6 technology learning center teachers and their 48 students. Nevertheless, the technical report for the USEIT survey reported "an inter-rater reliability of 75% and Cohen's Kappas ranging between .406 and .724" (Russell, O'Dwyer, Bebell, & Miranda, 2004, p. 33). Although the Grade 6 technology learning center student population was the focus of the study, the results have implications for nontechnology learning center educators and students.

Triangulation

Validity for this study was further established through the triangulation of data generated from all sources of data. Table 16 provides a matrix of overlapping themes drawn from the research literature, and data from the Computer Attitudes and Use Survey, Test 1 and Test 2, and Student Opinion Survey.

Table 16

Theme Results From Triangulation

	Research Literature	Computer Attitudes & Use Survey	Test 1 & Test 2	Student Opinion Survey
Familiarity with pencil-paper testing at school	√	√	√	√
Enjoyment when using technology	√	√	√	√
Regular access to technology at school and at home	√	√	√	√
Being able to type using a keyboard	√	√	√	√
Students' perception that work on the computer should result in improved achievement	√	√		√

Students' perception that work on the computer should result in improved achievement was not consistent with the student achievement data. Nevertheless, the

majority of the qualitative data from the student opinion survey aligned with the phenomenon from the Computer Attitudes and Use Survey; therefore, the voice of the student participants was accurately reflected in the data (Creswell, 1998). In all, the triangulation of data from the Computer Attitudes and Use Surveys, Test 1 and Test 2, and Student Opinion Survey provided valuable understandings of the findings.

Rich Description of Findings

While the quantitative data in this study were numerical, the qualitative data collected from the Student Opinion Survey were narrative. Rich descriptions of the findings provided insight regarding student participants' reactions to both testing environments, and their opinion regarding which test mode they preferred (Merriam & Simpson, 1995).

Clarifying Bias

To eliminate bias, a colleague not participating in data collection transcribed handwritten responses and an external rater evaluated both reading tests. I also avoided close involvement with teacher and student participants during data collection. Finally, any bias in analyzing or interpreting the results was clarified in the reflection subsection of Section 5 of this dissertation.

Peer Debriefing

During data analysis and interpretation, I engaged in peer debriefing with a teacher colleague. This individual reviewed and asked questions about the qualitative study to ensure that my tentative interpretations would resonate with people other than the researcher (Creswell, 2003).

Summary Analyses

This mixed methods study examined the impact of test mode (CBT and PBT) and student assessment preference on Grade 6 technology learning center students' reading achievement. The teacher and student Computer Attitudes and Use Surveys were adapted from the previously validated and reliable USEIT survey (Russell et al., 2003). Descriptive statistics revealed participants' demographic data and identified teacher participants' and students' attitudes and habits regarding technology use at home and at school. In general, data confirmed that all respondents had regular access to technology and the Internet at school and at home. Teachers participants used more technology than students on a daily basis at school, and students used technology for 15 minutes to over 2 hours daily. The paired-sample *t* tests involving the reading test data revealed no significant difference in student achievement between CBT and PBT modes or between students' preferred and nonpreferred test modes. The Student Opinion Survey allowed for the collection of qualitative data in response to two open-ended questions that asked students why they chose one test mode over the other for Test 1, and which test mode they preferred overall. Responses revealed students' choice in test mode was mostly influenced by perceived familiarity, engagement, regular access to technology, and keyboarding skills.

In general, the results of this study confirmed the research literature on the interchangeability of computer-based and pencil-paper testing methods. They also accepted both null hypotheses that there would be no significant difference between CBT and PBT modes, and students' preferred and nonpreferred reading test modes as

measured by student achievement. Even though the majority of the qualitative survey data aligned with themes in the research literature and supported the quantitative findings of this investigation, qualitative findings stemming from the Student Opinion Survey indicated a need for more clear instructions when asking students to pick their preferred test mode. Section 5 will interpret the findings presented in Section 4 and elaborate on how they can be the springboard for social change and further research.

Section 5: Summary, Conclusion, and Recommendations

Section 5 begins with a brief overview of the purpose, rationale, and design of the study, and reviews the four main research questions addressed in this investigation. An interpretation of the findings will precede a discussion of the implications for social change and recommendations for action. This final section of this research paper concludes with recommendations for further study and a reflection on the researcher's experience with conducting qualitative research.

Overview

The purpose of this mixed methods study was to investigate teachers' and students' prior experiences and attitudes regarding technology, the interchangeability of test mode results, the effect of students' test mode preference (CBT and PBT) on reading achievement, and the factors that influence students' test mode preferences. To realize the intent of the study, the purposefully selected population for the study comprised two Grade 6 technology learning center teachers and all of their students (48 altogether) from two different elementary schools southwestern Ontario, Canada.

A sequential explanatory design was used, whereby quantitative data collection preceded qualitative data collection. In week 1 of the study, quantitative data regarding participants' computer attitudes and use at home and at school were collected outside of instructional time using online teacher and student surveys. Then, based on students' test mode preferences, student participants completed Test 1 in CBT or PBT format as part of the regular literacy block. In week 2 of the investigation, students completed Test 2 in their nonpreferred test mode (PBT or CBT) during regular literacy time. Outside of

instructional time, data were collected for the final qualitative phase of the study regarding the factors that influenced students' assessment mode preferences and which test mode (CBT or PBT) they preferred more overall using open-ended questions on an online Student Opinion Survey. A thorough analysis and process for coding of data revealed qualitative findings.

Four main research questions guided this inquiry:

1. What were the prior experiences and attitudes of teachers and students about technology use at home and at school?
2. Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms?
3. Were the reading achievement results for the students' preferred test mode significantly different from the students' nonpreferred test mode?
4. Which reading test mode did students prefer, and what factors influenced students' preferred test mode?

Descriptive statistics in response to the first research question revealed that both teacher participants and all students were avid and confident users of technology at school and at home. With respect to research questions 2 and 3, the reading test data showed there was no significant difference neither in the reading achievement results between CBT and PBT modes nor between the results on students' preferred and nonpreferred test modes. Data from the final qualitative survey in response to Question 4 revealed that the vast majority of students preferred the CBT experience over the PBT

due to their perception that taking tests on the computer was more engaging and easier than using pencil-paper, and that they preferred keyboarding over handwriting. Altogether, these findings provide important data that are invaluable for educators and educational decision makers as they consider the integration of CBT in K-8 teaching and learning in Ontario and Canada.

Interpretation of Findings

Quantitative and qualitative findings of this study supported the themes and conclusions gleaned for each research question. Namely, data and evidence from the literature on new literacies, CBT in education and student assessment preference supported the themes developed in this inquiry. For instance, the computer attitudes and use data showed that the technology learning center teacher and student participants were avid users of technology at school and at home. However, in this case, students' comfort levels and their engagement with and experience using technology did not give students an advantage when they took reading tests on the computer. Reading test score data revealed that there was no significant difference in student achievement between test modes (CBT or PBT) or students' preferred and nonpreferred test modes which supported the literature on the comparability of CBT and PBT findings and lack of impact of student assessment preference on achievement. Finally, as reported in this research, the qualitative data confirmed that most students preferred computers over pencil-paper tests. To further interpret the findings of this investigation the research questions are addressed in more detail below.

Research Question 1

What were the prior experiences and attitudes of teachers and students about technology use at home and at school?

Descriptive statistics confirmed that 100 % of the technology learning center teacher and student participants had regular home access to the Internet and computers and rarely experienced difficulty using technology to assess or complete homework. These findings aligned with Russell et al. (2003) who found that a large majority of students had access to technology either at home or at school, or both, and were similar to the profile of young Canadians in a wired world (Media Awareness Network, 2005) that showed the increased importance and use of technology in everyday life at school and at work.

At home, teachers and students reported regular use of technology every day. Given that over one third of students reported spending more than 2 hours using technology at home on a daily basis, it was not surprising that other specific daily uses of technology included playing computer games, writing and editing homework, and opening and uploading files on a server or network. This trend supported findings from the Young Canadians in a Wired World survey (2005) that when given 1 hour of free time online, 72% of Canadian students in Grades 4-11 did schoolwork. At school, teacher and student data confirmed that technology learning center classrooms were equipped with regular access to technology. This aligned with the earlier finding that most students used technology anywhere from 15 minutes to over 2 hours a day, and seldom needed to seek assistance of teachers or peers when using technology. Therefore, the frequency

with which student participants used a computer related directly to their perception of how well they performed specific tasks.

The majority of students (85.4%) used technology at school for less than half of the time (i.e., only 15-60 minutes every day) that they used technology at home. This result was somewhat surprising given that the wide range of technology tools available in the technology learning center classrooms. The two teachers reportedly used technology almost twice as much as most students at school and rarely assigned technology-embedded assignments to students more than 2-3 times a year. In other words, despite their exposure to technology at school, technology learning center students still submitted assignments and took reading tests using traditional pencil-paper methods. This finding aligned with Christensen, Horn and Johnson (2008) who claimed that assessment and instructional practices in some technology-rich environments remain more traditional than one might expect.

In terms of their attitudes, the majority of technology learning center students believed that computers improved their achievement (77.1%), that technology helped them understand things (68.7%), and almost all students reported rarely getting more confused (94.7%) or frustrated (93.8%) when using technology. Consequently, the results of this study seem to align with the findings of the original USEIT study (Russell et al., 2003) that concluded that students' confidence with technology increased the more they were exposed to and used technology. These findings also supported the research literature on new literacies that found that technology and Internet use are changing the

way we access, use and exchange information (Johnson, Levine, Smith, & Smythe, 2009; Media Awareness Network, 2005) at work and at school.

Research Question 2

Was there a significant difference in the reading achievement results on pencil-paper and computer-based reading tests of Grade 6 students in technology learning center classrooms?

The second research question was addressed using student achievement data collected from two reading tests: one administered using Moodle on the computer, and one using pencil-paper methods. Quantitative analysis involved conducting paired-sample *t* tests to determine the impact of test mode (CBT and PBT) on student achievement. The findings revealed there was no significant difference in CBT scores (M=126.10, SD=23.229) and PBT scores (M=127.50, SD=18.613); t(47)=-.484, p = .630. Therefore, this analysis accepted the null hypothesis that there would be no significant difference in the reading achievement results on CBT and PBT of Grade 6 students in technology learning center classrooms. Consequently, these results were in line with the body of literature that suggested that CBT and PBT scores are interchangeable (Bergstrom, 1992; Bodmann & Robinson, 2004; Boo & Vispoel, 1998; Bugbee, 1996; Chin & Donn, 1991; Choi & Tinkler, 2002; Evans et al., 1995; Johnson & Green, 2004; Neuman & Baydoun, 1998; Wang et al., 2000).

According to new literacies theory, information technologies play an increased role in our everyday lives (Johnson et al., 2009; Media Awareness Network, 2005), and when purposefully integrated into reading programs, new literacies can help improve

student scores in reading (Espinosa et al., 2006; Silvernail & Gritter, 2007; Slavin et al., 2008; Vogel et al., 2006). Given that technology learning center students had regular exposure and were confident at using technology at home and at school (see Table 7, 8, 10, 11), I expected that their achievement on the CBT would be significantly higher. However, the reading test data showed that student participants' familiarity and engagement with technology on a daily basis did not translate into higher reading scores. Therefore, the lack of significant difference in students' reading achievement results between CBT and PBT modes called to question the impact of new literacies on student achievement, and challenged my assumptions as a researcher.

Research Question 3

Were the reading achievement results for the students' preferred test mode significantly different from the students' nonpreferred test mode?

The third research question was addressed using the student reading achievement data collected from their preferred and nonpreferred test modes: either CBT or PBT. Quantitative analysis involved conducting another paired-sample *t* test to determine the impact of students' assessment mode preference on their reading achievement.

Findings revealed there was no significant difference between students' preferred test mode (M=124.15, SD=20.335) and nonpreferred test mode (M=129.25, SD=21.666) conditions; t(47)=-1.800, p = .078. Therefore, as was the case with the quantitative data analysis for Question 2, this analysis accepted the null hypothesis that the reading achievement results for the Grade 6 technology learning center students' preferred test mode would not be significantly different from students' nonpreferred test mode. As

such, these results were consistent with those researchers who found there was limited significant impact of student assessment preference on their achievement (Flowerday et al., 2004; Furnham & Chamorro-Premuzic, 2005).

Given students' regular access to and use of technology in both technology learning center classrooms (see Table 8, 10, 11) and how engaging technology can be for today's learner (Burns, 2008; Trucano, 2007), I had predicted that almost all students would have chosen the CBT as their preferred mode for Test 1 and performed better on the first test. This was not the case as most students chose to take Test 1 using PBT and did not achieve significantly better results on their preferred mode. Once again, these results challenged my assumptions as a researcher. Moreover, the lack of significant difference in reading achievement scores between students' preferred and nonpreferred CBT and PBT modes did not align with researchers who claimed that student achievement improved when teachers integrated new literacies into their practice (Espinosa, Laffey, Whittaker, & Yanyan, 2006; Silvernail & Gritter, 2007; Slavin et al., 2008; Vogel et al., 2006).

Research Question 4

Which reading test mode would students prefer more and what factors influenced students' preferred test mode?

The final research question of this mixed methods investigation was addressed using an electronic survey that contained two open-ended questions. The qualitative questionnaire uncovered reasons why students selected one test mode over another for

Test 1, and determined which test mode experience students preferred overall: CBT or PBT.

Survey Question 1. The majority of students (79.2%) chose PBT over CBT as their preferred mode for Test 1 because they were more familiar with the format, thought they would do better on the pencil-paper test, and perceived computer tests to be more difficult. These results were surprising in light of technology learning center student participants' reported familiarity and confidence using technology at home and at school. Moreover, even though students perceived that the PBT format was more familiar and they would do better on PBT over CBT, their reading test scores did not improve when they took the test using traditional pencil-paper methods.

Survey Question 2. Even though 79.2% of student participants chose PBT as their preferred test mode for Test 1, almost two thirds of students (60.4%) preferred taking CBT over PBT overall. Students felt computers were easier and would achieve higher results. They also liked keyboarding over handwriting. This finding aligned with researchers who reported that students enjoyed using technology (Trucano, 2007) and perceived that work on the computer should result in improved achievement (Burns, 2008; Reed, Shallert, Beth, & Woodruff, 2004). However, neither the perceived benefits of taking PBT or CBT, nor the perceived disadvantages of taking a reading test in either mode, had a significant impact on students' reading achievement.

On a practical level, these results might provide teachers with new ideas on how to integrate technology into their practice. In K-8 classrooms where teachers and students have regular access to technology, the comparability of CBT and PBT results might also

incite teachers to integrate computer-based assessment in their literacy program. Students reported that they enjoyed the CBT mode more overall; therefore, elementary teachers might also consider expanding their traditional assessment practice to include offering technology-embedded assessment that could result in improved student engagement. Having the tools in the classroom is not enough. To achieve similar comparable results between test modes, as suggested by Pomplun et al. (2006), teachers will need to plan opportunities for students to practice and gain familiarity with computers prior to administering CBT just like the technology learning center students in this study.

Implications for Social Change

The overall findings from this investigation have the potential for positive social change on a variety of levels. More specifically, this small scale study which involved Ontario teachers and students who were adept at using new literacies of the Internet and computers at home and at school, indicated that the reading achievement results of Grade 6 technology learning center students were not significantly impacted by CBT and PBT modes or students' preference. It also showed that, when given the choice between CBT and PBT, student engagement increased and most students preferred the CBT experience over PBT regardless of their reading achievement level. The specific implications for social change are discussed in more detail below.

Data from the initial Computer Attitudes and Use Survey provided descriptive statistics regarding how Grade 6 technology learning center students and teachers felt about and used technology at home and at school. On an individual level, classroom teachers might compare how the technology learning center teachers and students

regularly used technology during the school day with how much they integrate technology in their program and plan instructional next steps. District officials might learn about how to equip classrooms with more technology and provide teachers with additional training to better engage and meet the needs of today's learners. Improved classroom practice might help equip Canadians with skills for the workplace of the future.

In addition to the insight gained from the teacher and student survey data about how technology was used for instruction in two Grade 6 technology learning center settings, student achievement data gleaned from the reading tests can inform technology-based assessment. Although limited to the population and design of the current study, the lack of significant difference in students' reading scores between CBT and PBT and their preferred and non-preferred modes might show new possibilities for computer-based assessment in individual teachers' practice. In other words, the interchangeability of the Grade 6 technology learning center test scores in this study may help reduce teacher concerns regarding the impact on achievement of their students' prior experience with the CBT format (familiarity) or adequate keyboarding skills (keyboarding). Where access to and experience using technology are not a barrier, the comparability of CBT and PBT results here might also help change how school districts and the Ontario Ministry of Education collect literacy achievement data in the future. Likewise, given there was no significant difference in the reading achievement results on students' preferred and nonpreferred test modes, educators and leaders might consider offering students the choice between PBT and CBT for classroom and district-level reading assessment to

increase engagement. Having the current research data might provide evidence to support changes in 21st century literacy assessment and increase confidence in public education.

The insight gained from the first question on the Student Opinion Survey might also lead to positive social change for individuals, institutions, and society as a whole. The reading data showed that just under two thirds of student participants chose PBT for the first test; however, some students chose the pencil-paper test format to get the harder test over with first and save the better test format until last. Therefore, when considering the shift toward CBT, teachers might help students see that student achievement results are comparable between PBT and CBT modes.

Trends in the qualitative data from the second open-ended question, Which test mode did you like better? Why?, further confirmed that the majority of students chose CBT as their preferred test mode for Test 1. Students perceived that computers were more engaging, that keyboarding was easier than handwriting, and that taking the reading test onscreen would be easier. However, students' beliefs in these benefits did not result in significantly higher achievement on the computer-based reading tests. Despite the insignificant impact of test mode and assessment preference on achievement, teachers might consider taking advantage of students' positive attitudes about technology by adopting CBT to help motivate and engage learners. At a district level, more engaged students may justify an increased investment in providing greater access and availability of hardware and tools, including computer-based assessments, to K-8 classrooms. Eventually, increased student motivation may translate into improved student achievement and graduation rates.

Recommendations for Action

The results and conclusions gleaned from this study will be compiled in an Executive Summary Report and emailed to the research services department of the current study district. Then, the reading achievement results and report will be shared with research participants at School A and School B during a face-to-face presentation. At the request of appropriate school board personnel, additional opportunities to share research findings may be arranged.

Data gathered from this investigation pointed to increased levels of student engagement when technology learning center learners were provided regular opportunities to use technology during learning and assessment. Teachers could benefit from reflecting on how often they integrate technology into instruction and plan more ways for students to interact with emerging digital literacies and tools to communicate understanding. They could ask and plan next steps in response to questions like: How often do I use model the use of technology for my students? How much access do I provide my students? What might happen if I use more technology in my practice? Similarly, having information about how engaged technology learning center students were when they used the range of different technology tools and tasks presented in the quantitative survey might inspire teachers to try new things with technology and improve the teaching and learning environment for their students. This may involve the need to acquire additional hardware or software tools. At a district level, adjustments may be required to school computer budgets, and curriculum and instruction leaders might design new professional learning programs that expose elementary teachers to different

technologies. These changes may translate into students having more access to effective technology-embedded instruction and assessment in the classroom.

The school district might consider sharing these research findings with its Grade 6 technology learning center teacher cohort. Results might encourage them to implement more CBT and offer students the choice of CBT and PBT modes across the district. Even still, the school district might choose to share findings with non technology learning center Grade 6 teachers who might then consider implementing more CBT and offer choice between PBT and CBT for reading assessment in their literacy program. Consequently, the teaching and learning environments in K-8 might improve.

As a member of the technology learning center leadership team, I am often asked to help teachers effectively integrate technology into their instruction and assessment. Although other Grade 6 teachers might not have the exact same technology tools available in their classrooms as the technology learning center classrooms, there are many strategies and lessons from this study that can be implemented to help teachers embed technology in their reading assessment program. This report could be shared across the district to help school administrators ensure that teachers are aware of the test mode interchangeability and student assessment preference research. If necessary, vice-principals and principals might arrange for additional teacher professional learning opportunities in these areas. To further assist the school board with exploring how to design and integrate CBT and student choice as part of the literacy assessment program, I will continue to work with the Curriculum and Instructional Support Service staff to design in-service educational opportunities for K-8 schools with and without technology

learning center classrooms in them. For example, arrangements could be made for technology learning center teachers who adopt computer-based assessment practice or offer students the choice of more technology-embedded assessments to share their practice with non technology learning center teachers to help scale up the innovation across the district. Eventually, with proper access to technology and resources, all teachers might be able to use computer-based versions of district reading assessments with their students based on their preferred testing mode. School board assessment and evaluation personnel could then track the impact of increased exposure to computer-based assessment on school and district-wide reading assessments. In time, Ministry officials might even invest in the development of technology-embedded assessments and offer schools the choice between administering annual EQAO literacy tests to Grade 6 and 10 students using CBT or PBT formats. Ultimately, improvements in student achievement and engagement could then be shared with parents and the wider educational community.

Recommendations for Further Study

The comparability of technology learning center student achievement results between CBT and PBT and lack of significant difference between students' preferred and nonpreferred test mode results have inspired me to undertake future investigation in this field. More specifically, in regular preparation for the provincial EQAO reading assessments each spring, I would like to replicate this study to examine the impact of offering students the choice between PBT and technology-embedded assessment in other Grade 6 technology learning center classrooms in my district.

This study also gathered descriptive statistics regarding technology learning center teachers' and students' computer attitudes and use as well as student opinion data. Given the limited population for this investigation (two technology learning center teachers and 48 of their students), studies involving more technology learning center participants would provide data that would be statistically significant and thereby increase the generalizability of the findings. Replicating this investigation using touch screen mobile devices, such as iPads™ in lieu of laptops might provide interesting results as more and more school districts adopt Bring Your Own Device (BYOD) policies (Crown in the Right of the Province of Alberta, 2012). A further extension of the current study might be to compare findings of additional Grade 6 technology learning center teacher and student participants with those of non technology learning center teachers and students. Such a study would provide interesting insight regarding the overall impact of the technology learning center program on student learning that may help substantiate the procurement of additional technology and professional learning resources to scale up the technology learning center model across the district.

Reflection

Developing and gaining approval for my mixed methods doctoral research study proposal, applying to conduct external research in my own school board, arranging opportunities for data collection that would not disrupt instructional time, and analyzing and interpreting results have made me truly appreciate the many steps that are involved in conducting a mixed methods doctoral research study. The process took much longer than I predicted, however, I understand that all of these steps are necessary to ensure the

protection and confidentiality of participants and maintain the rigour that is expected from scholarly inquiry.

Admittedly, when I analyzed, coded, and interpreted trends data it was sometimes challenging to remain open to new ideas and put my own biases to the side. For example, having never used CBT before in my own literacy program, I was sceptical of the interchangeability of PBT and CBT results. Given the amount of technology found in technology learning center classrooms, I fully anticipated that the majority of the student participants would have not only chosen CBT as their preferred mode for Test 1. Moreover, just like the students in this study, I predicted they would have done significantly better on the computer-based format over the pencil-paper test. As discussed throughout Section 4 and 5, my thinking changed as a result of this study because there was no significant difference between CBT and PBT and students' preferred versus nonpreferred test modes.

As a technology learning center teacher in the current study district, this study has made me curious about the impact on student learning of how technology is or is not being used within and beyond technology learning center program classrooms. I wonder if other teachers are seeing significant gains in student achievement when they use particular technology tools or strategies, or if increased student engagement is the main benefit that is realized in their classrooms. Offering choice is one way that many educators are personalizing the learning experience for students, and yet I wonder if people are measuring the impact of this strategy. Even though I found it personally somewhat disappointing that the results of this study did not point to significant

improvements in students' reading achievement when tests were completed on the computer or when students chose their preferred mode of assessment, the technology learning center students did express their engagement and preference for the computer test overall, and students' reading achievement did not significantly decline. If student achievement between CBT and PBT is indeed comparable, and students experienced increased engagement when they were able to use computers over pencil-paper assessments, it would follow that the use of technology-embedded assessment should become more mainstream, especially in cases where students lack motivation or are hard to reach. Further research into the benefits of technology-embedded instruction and assessment is warranted (Cox & Marshall, 2007) to investigate this theory.

Conclusion

As the trend toward using CBT in education continues to rise, inconsistencies exist regarding the interchangeability of results between pencil-paper and computer-based test modes. Educational assessment researchers also have mixed findings regarding the impact of student assessment preference on student achievement. Furthermore, very few empirical studies have been published on these topics in Canada. This study helped to fill the gaps in the Canadian K-8 test mode interchangeability and student assessment preference research.

Using the lens of new literacies theory, investigating the comparability of computer-based and pencil-paper results, and the impact of offering students the choice between two modes of assessment (CBT or PBT) was a major focus of this study. Despite the demand for education to keep pace with technology, educators and leaders need to be

critical as they expand their practice to include technology to support instruction and assessment. Although one might expect students' who perceived one test mode to be easier or advantageous over another to have performed better on their preferred test mode, with the technology learning center student participants involved in this investigation, the perceived benefits for PBT and CBT did not equate to significant improvement in reading achievement. Therefore, this study confirmed that test mode results between computer and pencil-paper modes are interchangeable, and that there is no significant difference between students' preferred and nonpreferred test mode. Offering students the option to take reading tests on computers did result in increased engagement and the majority of student participants reported preferring the CBT format more than pencil-paper. Together, these results might encourage educational decision makers to learn how to leverage technology to engage teachers and students in K-8 schools. Conducting similar research studies at a local level will inform their work as they consider the shift toward CBT. Depending on the outcome, teachers and leaders in school districts across Canada might realize the promise CBT with increased confidence.

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Appendices

Appendix A: Computer Attitudes and Use Survey (Teacher)

Computer Attitudes and Use-Teacher Survey Class "A"

Welcome to the Computer Attitudes and Use Teacher Survey for Class "A"!

DIRECTIONS:

Your Literacy@School classroom has been selected to participate in a study of educational technology. This survey asks questions about your use of computers in and outside of school.

In this survey, I use the term 'technology' to refer to computers or computer-related devices (such as LCD projectors, the Internet, handheld personal digital assistants [PDAs] etc.,).

Read each question carefully and respond as accurately as possible. When you are done, please exit the survey and close your Internet browser.

Computer Attitudes and Use-Teacher Survey Class "A"

Teacher Background Information

***1. What is your name?**

***2. How many years have you been teaching?**

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ More than 5 years

***3. How many years have you been in the Literacy@School (L@S) Program?**

- ◯ Less than 1 year
- ◯ 1-2 years
- ◯ 3-5 years

***4. How often do you attend board-directed L@S professional learning?**

- ◯ More than once a month
- ◯ Once a month
- ◯ Once every two months
- ◯ Three times a year
- ◯ Twice a year

***5. How many visitors have come to observe your L@S classroom during this school year?**

- ◯ None
- ◯ 0-1
- ◯ 2-3
- ◯ 4-5
- ◯ More than 6

***6. How many:**

	None	1	2-3	4-5	More than 5
... district-organized L@S professional learning sessions have you attended this year?	◯	◯	◯	◯	◯
... personal L@S professional learning days have you accessed this year?	◯	◯	◯	◯	◯

Computer Attitudes and Use-Teacher Survey Class "A"

***7. Compared with non L@S classrooms in your school, how many/what additional instructional technology has your classroom been allocated?**

	Qty 1	Qty 2-3	Qty 4-6	Qty More than 6	N/A
Laptop(s)	◯	◯	◯	◯	◯
LCD projector/laptop media cart	◯	◯	◯	◯	◯
Document camera(s)	◯	◯	◯	◯	◯
Smart Board™	◯	◯	◯	◯	◯
IMac™	◯	◯	◯	◯	◯
IPod(s)™	◯	◯	◯	◯	◯
IPad(s)™	◯	◯	◯	◯	◯

Other (please specify)

***8. Please respond to the following statement:**

	Strongly disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
In my classroom, I use technology as much as I would like.	◯	◯	◯	◯	◯
I use currently technology during assessment as much as I would like.	◯	◯	◯	◯	◯

***9. How often do you use each of the following devices when you teach?**

	Never	Less than once per week	Once per week	3 times a week	Daily
LCD projector	◯	◯	◯	◯	◯
Smart Board™	◯	◯	◯	◯	◯
PDAs (IPad™, IPod™, or other)	◯	◯	◯	◯	◯
Document camera	◯	◯	◯	◯	◯
Digital camera	◯	◯	◯	◯	◯

***10. How often do you ask students to create the following using technology?**

	Never	Once or twice a year	Several times a year	Several times a month	Several times a week
Reports and essays	◯	◯	◯	◯	◯
Multimedia projects	◯	◯	◯	◯	◯
Web-based publications	◯	◯	◯	◯	◯
Pictures or artwork	◯	◯	◯	◯	◯
Stories or books	◯	◯	◯	◯	◯
Graphs or charts	◯	◯	◯	◯	◯
Videos or movies	◯	◯	◯	◯	◯
Podcasts	◯	◯	◯	◯	◯

Computer Attitudes and Use-Teacher Survey Class "A"

***11. Which one of the statements below best describes your use of technology in your personal (non-teaching) life:**

- ◯ I never use technology.
- ◯ When I use technology, I am usually afraid it won't work properly or that I might break it.
- ◯ I use technology on my own, but sometimes have difficulty figuring out how to complete an unfamiliar task.
- ◯ I use technology with confidence and can figure out how to do just about anything I need to do.
- ◯ I am always looking for new ways to use technology.

***12. On a typical day, how much time do you spend using technology:**

	None	15 minutes or less	15-60 minutes	An hour or two	Over two hours
In school?	◯	◯	◯	◯	◯
At home?	◯	◯	◯	◯	◯

***13. How many computers, if any, do you have at home?**

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3 or more

Computer Attitudes and Use-Teacher Survey Class "A"

Computers at Home

***14. What type of internet connection do you have at home?**

- ◯ We have an Internet connection at home but I don't know much about it
- ◯ We use a DSL or high speed cable to connect to the Internet at home
- ◯ We access the Internet on a wireless network at home

***15. How many people share your home computer(s)?**

- ◯ Just one person uses it/them
- ◯ 2-3 people use it/them
- ◯ 4-5 people use it/them
- ◯ 6 or more people use it/them

***16. When you are at home, how difficult is it for you to get on your home computer when you want to?**

- ◯ Often difficult
- ◯ Sometimes difficult
- ◯ Never difficult

***17. How long have you had a computer at home?**

- ◯ Less than one year
- ◯ A year or two
- ◯ Three or four years
- ◯ As long as I can remember

Computer Attitudes and Use-Teacher Survey Class "A"

You are done!

Thank you for completing the teacher survey for my research study data collection (adapted with permission, Russell, O'Brien, Bebell, & O'Dwyer, 2003)

Please exit the survey, close your Internet browser, and log off the computer.

Thanks!

Appendix B: Computer Attitudes and Use Survey (Student)

Computer Attitudes and Use-Student Survey

Welcome to the Computer Attitudes and Use Student Survey for Class "A"!

DIRECTIONS:

Your Literacy@School classroom has been selected to participate in a study of educational technology.

This survey asks questions about your use of technology (e.g., computers, iPod™, iPad™, the Internet) and your teacher's use of technology.

Read each question carefully and respond as accurately as possible. When you are done, please exit the survey and close your Internet browser.

Student Background Information

***1. What is your name?**

***2. Whose class are you in?**

***3. Are you a boy or a girl?**

- ◯ Boy
- ◯ Girl

4. What languages (other than English) do you speak at home? (Please leave blank if no other language is spoken at home)

***5. About how many books of your own do you have at home, not counting your school books?**

	5 or fewer	6-25	26-50	51-100	More than 100
Books at home	◯	◯	◯	◯	◯

Computer Attitudes and Use-Student Survey

Computer Attitudes

***6. Where do you usually learn how to do new things with technology?**

- ◯ I never learn to do new things with technology
- ◯ At home
- ◯ At school

***7. When you need help with technology in school, how often do you ask for help from each of these people?**

	Rarely, if ever	Occasionally	Usually
A teacher	◯	◯	◯
A friend or another students	◯	◯	◯
The teacher librarian	◯	◯	◯
Computer Resource Teacher	◯	◯	◯
Information Technology Specialist	◯	◯	◯
Other adults in the school	◯	◯	◯

***8. Where do you use technology (computers, iPod™, iPad™, Smart Board™, etc.,) most in school:**

- ◯ In your classrooms
- ◯ In a computer lab
- ◯ In the library

***9. How hard is it complete homework that must be done using technology?**

- ◯ We are never assigned homework that has to be done using technology
- ◯ Easy, because I have technology at home to use
- ◯ Easy, because I have easy access to technology at home
- ◯ Hard, because everyone else is always using the technology at home
- ◯ Hard, because we don't have technology at home

Computer Attitudes and Use-Student Survey

***10. How often do you use technology to:**

	Never	Almost never	Once a month	Once a week	Every day
Send and receive email	◯	◯	◯	◯	◯
Send and receive text messages	◯	◯	◯	◯	◯
Write and edit homework	◯	◯	◯	◯	◯
Open or upload files on a server or a network (e.g., Moodle, DropBox, GoogleDocs)	◯	◯	◯	◯	◯
Find information on the Internet	◯	◯	◯	◯	◯
Create a multimedia presentation	◯	◯	◯	◯	◯
Create a podcast	◯	◯	◯	◯	◯
Play computer games	◯	◯	◯	◯	◯
Work with spreadsheets/databases	◯	◯	◯	◯	◯

***11. How well are you able to:**

	Not very good	OK	Pretty good
Send and receive email	◯	◯	◯
Send and receive text messages	◯	◯	◯
Write and edit schoolwork using technology	◯	◯	◯
Open or upload files onto a server or a network (e.g., Moodle, DropBox, GoogleDocs)	◯	◯	◯
Find information on the Internet	◯	◯	◯
Create a multimedia presentation	◯	◯	◯
Create a podcast	◯	◯	◯
Play computer games	◯	◯	◯
Work with spreadsheets/databases	◯	◯	◯

Computer Attitudes and Use-Student Survey

Computers at School

***12. How often does your teacher use technology when teaching?**

	Never	A couple times a year	Once every couple weeks	At least every week	Every day
Your teacher's use of technology	◯	◯	◯	◯	◯

***13. How often do you use the following devices in the classroom?**

	Never	Less than once per week	Once per week	3 times a week	Daily
Computer	◯	◯	◯	◯	◯
Laptop	◯	◯	◯	◯	◯
LCD projector	◯	◯	◯	◯	◯
Smart Board™	◯	◯	◯	◯	◯
PDAs (IPad™, IPod™, or other)	◯	◯	◯	◯	◯
Document camera	◯	◯	◯	◯	◯
Digital camera	◯	◯	◯	◯	◯

***14. How often do you use technology in class?**

	Never	A couple times a year	Once every couple weeks	At least every week	Every day
In class:	◯	◯	◯	◯	◯

***15. When you want to use a computer in school is it...**

- ◯ Always easy to find a computer
- ◯ Usually easy to find a computer
- ◯ Sometimes difficult to find a computer
- ◯ Frustrating because there are not enough computers

Computer Attitudes and Use-Student Survey

Computer Attitudes

***16. Which one of the statements below best describes your personal use of technology:**

- ◯ I never use technology.
- ◯ When I use technology, I am usually afraid it won't work properly or that I might break it.
- ◯ I use technology on my own, but sometimes have difficulty figuring out how to complete an unfamiliar task.
- ◯ I use technology with confidence and can figure out how to do just about anything I need to do.

***17. On a typical day, how much time do you spend using technology:**

	None	15 minutes or less	15-60 minutes	An hour or two	Over two hours
In school?	◯	◯	◯	◯	◯
At home?	◯	◯	◯	◯	◯

***18. When you are using technology (instead of paper and pencil) to work, do you:**

	Always	Usually	Sometimes	Never
Create a better-looking finished product (than if you didn't use technology)	◯	◯	◯	◯
Write better	◯	◯	◯	◯
Take short cuts and 'get lazy'	◯	◯	◯	◯
Spend more time working with other students in your class	◯	◯	◯	◯
Seem to understand things better when using technology	◯	◯	◯	◯
Work harder at your assignments when using technology	◯	◯	◯	◯
Find it easy to just copy things from the Internet	◯	◯	◯	◯
Get more confused when using technology to do things	◯	◯	◯	◯
Get frustrated more easily when using technology to do things	◯	◯	◯	◯

Computer Attitudes and Use-Student Survey

Computers at Home

***19. How many computers, if any, do you have at home?**

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3 or more

Computer Attitudes and Use-Student Survey

***25. How often do you use your home computer to:**

	Every day	Couple times a week	Once a week	Once a month	Never
Play games	◯	◯	◯	◯	◯
Chat/instant message	◯	◯	◯	◯	◯
Use social media tools (Twitter™, Facebook™, etc.,)	◯	◯	◯	◯	◯
Email	◯	◯	◯	◯	◯
Access a class Moodle	◯	◯	◯	◯	◯
Search the Internet for school	◯	◯	◯	◯	◯
Searching the Internet for fun	◯	◯	◯	◯	◯
Listen to mp3/music	◯	◯	◯	◯	◯
Write papers for school	◯	◯	◯	◯	◯
Computer programming	◯	◯	◯	◯	◯
Create/maintain websites	◯	◯	◯	◯	◯
Create/edit digital photos of movies	◯	◯	◯	◯	◯

Computer Attitudes and Use-Student Survey

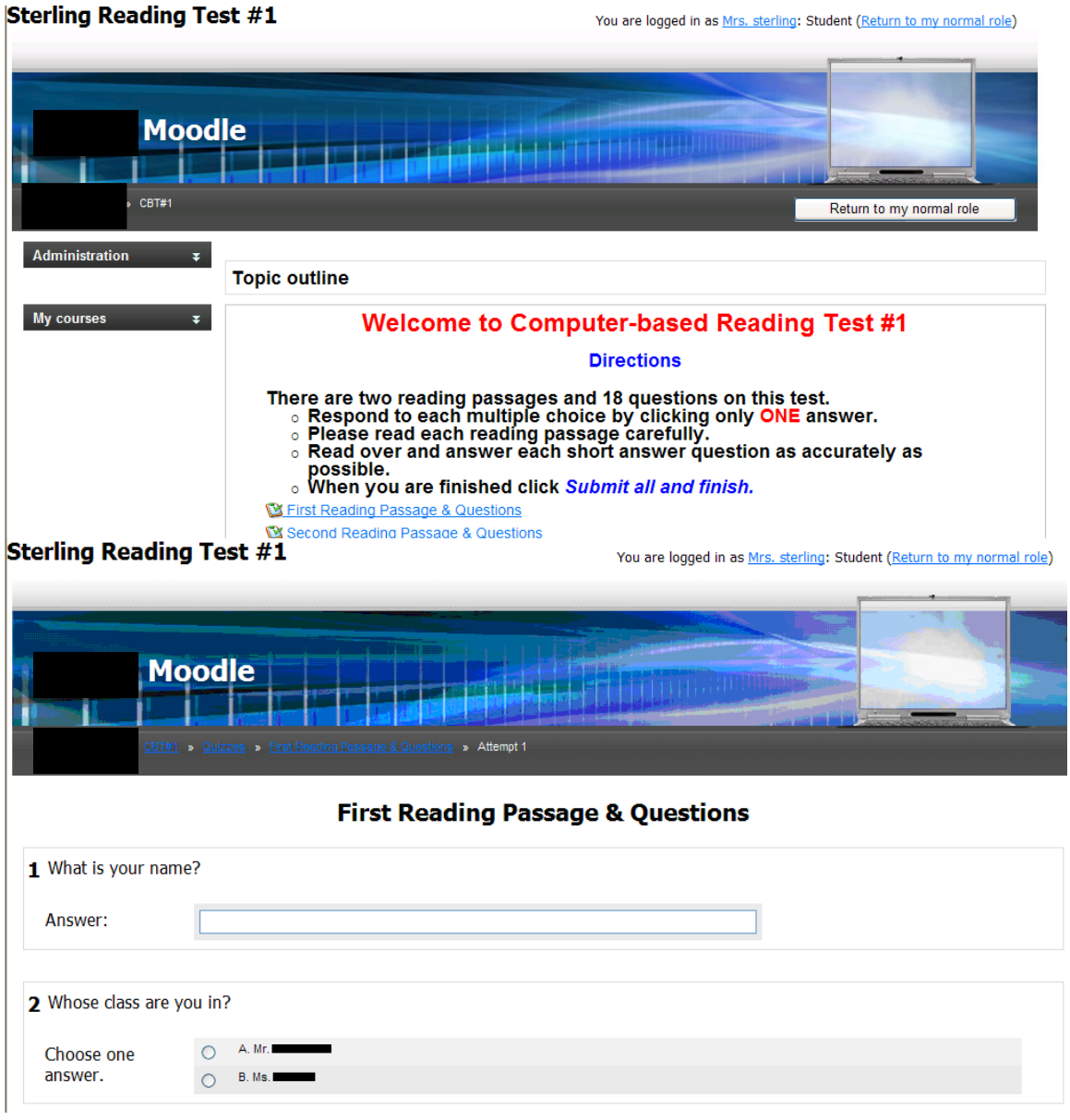
You are done!

Thank you for completing the first part of my research study data collection (adapted with permission, Russell, O'Brien, Bebell, & O'Dwyer, 2003)

Please exit the survey, close your Internet browser, and log off the computer.

Thanks!

Appendix C: Test 1



3

Marks:
1

Hannah's Great Day

When it was over, television crews rushed up to her with microphones and video cameras to do an interview for CBC News. 1

"What was it like?" a news journalist asked. 2

"I wasn't nervous," she replied. "I was very excited . . ." 3

* * *

The Empire Club is a group of Canadian leaders—lawyers, doctors, engineers, government officials, business owners and company executives—who help shape the future of Canada. When the Empire Club holds its regular meetings, 500 to 1000 members gather to hear guest speakers. Past speakers have included prime ministers, presidents, royalty and other world leaders. This year, Hannah Taylor, a nine-year-old girl from Winnipeg, Manitoba, was the youngest person ever to deliver a speech to the Empire Club. 4

Hannah founded an important Canadian organization. When she was five years old, she started the Ladybug Foundation to assist homeless people in Canada. Hannah made "ladybug jugs" from old baby-food jars to collect donations. By the time she was nine, Hannah had raised half a million dollars. 5

For the big event, Hannah dressed in a white blouse, red skirt and white knee socks, and she carried a red-and-black backpack with a ladybug design. Chatting with the adults seated at the head table, she seemed right at home. When the meeting began, Hannah was introduced as the guest speaker. She climbed up on a box behind the speaker's platform so people could see her, adjusted the microphone and began her 10-minute speech. 6

The audience could tell that she was an experienced public speaker. Hannah had first talked about homeless people to her class, then to the whole school. Eventually she was invited to speak at other schools and for other community organizations. Recently she had spoken in British Columbia, and now she was in Ontario. 7

"I know some people are afraid of homeless people," she told the audience. "But they're great people with sad hearts, wrapped in old clothes. Don't be afraid of them; be kind to them. If they're cold, share your mitts. If they're sad, give them a smile. If they're hungry, give them a sandwich." 8

Hannah had done enough public speaking to know how to talk to a crowd. She said she is often asked whether she will ever stop what she's doing. "No," she said. "I'll always help, and I'll always care, even when I'm 90." As the audience chuckled, she added, "I knew you'd like that." At one point in her speech, Hannah lost her train of thought. She paused, then shrugged and said, "Sorry, I got mixed up." 9

"Donations of food, clothing and money are good ways to help the homeless," Hannah said. "But mostly what you can do is be nice to them." Her inspirational speech moved some people to tears. 10

There were several dozen of Hannah's ladybug jars on a table outside the room. When the meeting was over, the jars quickly disappeared. Men in white shirts and neatly knotted ties and women in business suits crowding around the table picked up red-and-black jars painted like a good-luck ladybug. "Amazing kid," said one man, clutching his jar. When they were returned to the Ladybug Foundation, many jars contained a lot more than the spare coins Hannah originally had intended to collect. 11

"What was it like to speak to so many people?" the news journalist asked. 12

"I wasn't nervous," Hannah replied. "I was very excited, though, because I was getting my message out to millions of other people. When it started, I thought it would only be a family and school thing. But it's gotten very big, and I'm very glad that it has." 13

The conversation in paragraphs 1–3 occurred

Choose one answer.

- A. after Hannah finished her speech.
- B. during the meeting at the Empire Club.
- C. before Hannah started the Ladybug Foundation.
- D. while Hannah was chatting with the adults at the head table.

4 In this story, Hannah Taylor was a guest speaker at the regular meeting of

Marks: 1

Choose one answer.

- A. the CBC News.
- B. the Empire Club.
- C. the Ladybug Foundation.
- D. the Canadian Organization.

5 What is the main idea of this selection?

Marks: 1

Choose one answer.

- A. Children can make a positive difference.
- B. Public speaking can make people famous.
- C. Half a million dollars has been donated to homeless people.
- D. The Empire Club includes important members, such as world leaders.

6 In paragraph 5, the word "founded" means

Marks: 1

Choose one answer.

- A. started.
- B. helped.
- C. located.
- D. discovered.

7 Hannah raised half a million dollars by

Marks: 1

Choose one answer.

- A. selling ladybug jars.
- B. collecting donations.
- C. talking to the Empire Club.
- D. flying from British Columbia to Ontario.

8 In the sentence "Her inspirational speech moved some people to tears," the word "moved" means

Marks: 1

Choose one answer.

- A. felt an emotional response.
- B. decided against making a donation.
- C. changed their view of the foundation.
- D. hoped to attend future meetings with Hannah.

9 After Hannah talked to the Empire Club, members picked up the ladybug jars to

Marks: 1

Choose one answer.

- A. make donations.
- B. take them home.
- C. look at the ladybugs.
- D. admire the paintings.

10 Hannah can best be described as

Marks: 1

Choose one answer.

- A. playfull.
- B. restless.
- C. capable.
- D. suspicious.

11 In paragraph 11, why did one man refer to Hannah as an "amazing kid

Marks: 1

Choose one answer.

- A. He valued what Hannah was doing.
- B. He admired Hannah's ladybug jars
- C. He understood Hannah's frustration.
- D. He hoped to hear Hannah speak again.

12 This selection is an example of which form of writing?

Marks: 1

Choose one answer.

- A. letter.
- B. article.
- C. journal.
- D. procedure.

13 Explain why Hannah believed it was important to help the homeless. Use information from the selection to support your answer.

Marks: 4

Answer:

14 Explain how Hannah's Ladybug Foundation might influence other Canadians. Use information from the selection to support your answer.

Marks: 4

Answer:

Please click *Submit all and finish* below.

After you do this, click *CONTINUE* to return to the main page to click second reading passage and questions.

Save without submitting | Submit all and finish

Sterling Reading Test #1

You are logged in as Mrs. sterling: Student (Return to my normal role)

[redacted] Moodle

CBTA1 » Quizzes » Second Reading Passage & Questions » Attempt 1

Second Reading Passage & Questions

1

Marks:
1

Gordon Lightfoot, Canadian Musician

Canadian musician Gordon Lightfoot was born on November 17, 1938, in Orillia, Ontario. He made his performing debut at age five singing in a church choir. Lightfoot claims that it was the choirmaster who taught him how to enjoy and sing great music. He took piano and voice lessons and began winning amateur singing competitions. Just before he turned 13, Lightfoot performed on stage at Massey Hall in Toronto as one of the winners in the Kiwanis Music Festival. 1

As a teenager, Lightfoot continued to study the piano and taught himself how to play drums. He soon became a paid musician, travelling throughout Canada and playing with different bands. Lightfoot played numerous styles of music and began writing songs with lyrics about Canadian nature and history. 2

While he still enjoyed performing, by 1964 Lightfoot began gaining recognition as a songwriter, and other musicians started recording his songs. One of the most famous musicians to play his music was Elvis Presley. 3

He continued to write, perform and record his songs as he grew older. In 1970, Lightfoot was presented with the Order of Canada, Canada's highest national civilian honour. In 1975, Lightfoot wrote and recorded one of his most famous songs, about a shipping disaster in the Great Lakes, called "The Wreck of the Edmund Fitzgerald." This song is still played and is one of the most famous Canadian songs ever recorded. 4

Gordon Lightfoot has won many awards for his 20 original albums. He has been awarded 15 Juno Awards, Canada's top prize for music. In 1986 Lightfoot was inducted into the Canadian Music Hall of Fame. He also received a Governor General's Award in 1997 and had his name added to the Canadian Country Music Hall of Fame in 2001. In Ontario, he was awarded the highest provincial prize, becoming a member of the Order of Ontario. 5

Gordon Lightfoot's musical style changes depending on the story of each song. His music has a beautiful tone that helps the listener understand the meaning of his songs. Today all of Gordon Lightfoot's songs are referred to as classic Canadian music. 6

The fact that Gordon Lightfoot "taught himself" (paragraph 2) indicates that he

Choose one answer.

- A. could not afford lessons.
- B. did not like playing piano.
- C. had natural musical ability.
- D. travelled throughout Canada

2 What is the importance of calling Gordon Lightfoot a "paid musician" (paragraph 2)?

Marks: 1

Choose one answer.

- A. It demonstrates that his talent turned into a career.
- B. It shows that his songs are known throughout Canada.
- C. It emphasizes his desire to become a famous Canadian.
- D. It illustrates the fact that all musicians make a lot of money.

3 What prompted Gordon Lightfoot to write one of his most famous songs?

Marks: 1

Choose one answer.

- A. the Juno Awards
- B. a historical event
- C. the Order of Ontario
- D. a songwriting contest

4 Explain why Gordon Lightfoot is an important Canadian. Use specific details from the text and your own ideas to support your answer.

Marks: 4

Answer:

5 Explain how Gordon Lightfoot became successful. Use specific details from the text and your own

Marks: 4

Answer:

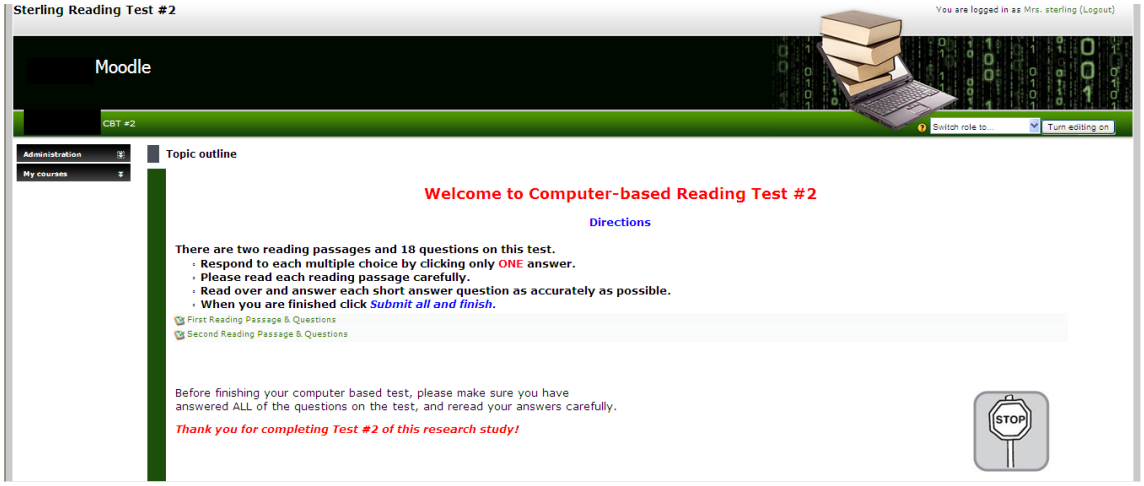
Before finishing your computer based test, please make sure you have answered ALL of the questions on the test, and reread your answers carefully.

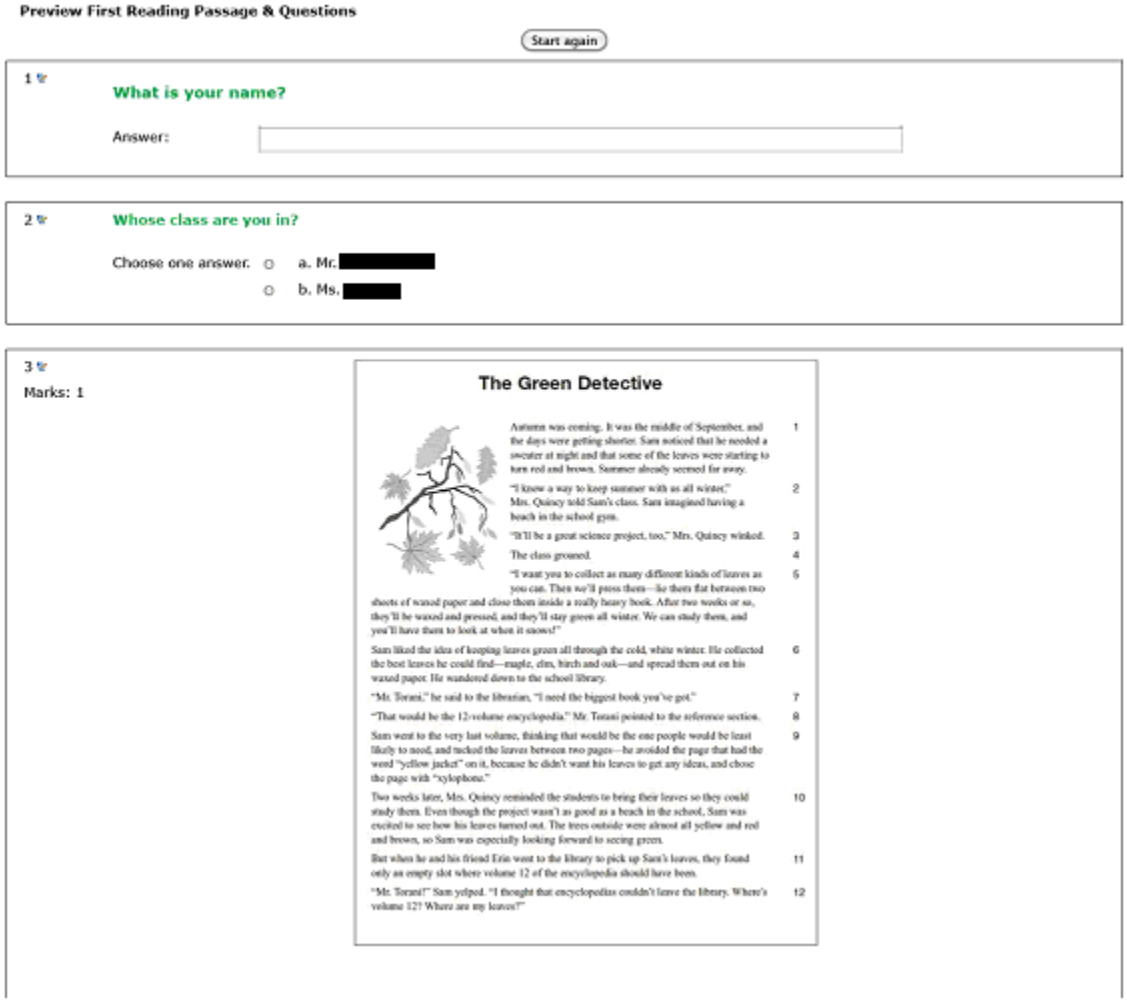
Thank you for completing Test #1 of this research study!

Click *Submit and finish* below to end this testing session.

Save without submitting | Submit all and finish

Appendix D: Test 2





"Oh-oh." Mr. Torani looked worried. "I let three different classrooms take some of them. The books are scattered all over the school while students work on projects." 13

"Oh no!" groaned Sam. 14

"What are their projects about?" Erin asked. 15

"What does it matter? What am I going to do?" Sam put his head in his hands. 16

Erin turned to Mr. Torani. "What subjects?" 17

"Uh," said Mr. Torani, trying to remember. "Grade 3 is doing sound, Grade 4 is doing mammals, and Grade 5 is doing electricity." 18

Now Erin turned to Sam. "Quick! List some words at the end of the alphabet." 19

"'Xylophone?'" Sam said hesitantly. And then he realized why Erin was asking. "Oh! 'Yo-yo,' 'X-ray,' 'zoo.'" 20

"Hm—nope," said Erin. 21

Then the librarian figured out what Erin was trying to do. "'Youth,' 'zipper,' 'yam,'" he said. Erin shook her head. 22

All three of them started calling out words: "zigzag," "yodel," "yellow jacket," "zebra," "zither." 23

Erin gasped. "Repeat that second-last one, Sam!" 24

"'Zebra?'" he said, puzzled. "Oh, 'zebra!'" he exclaimed. 25

Mr. Torani pointed his finger in the air as if to say "Aha!" 26

"Mammals!" all three of them said in unison. "Grade 4!" 27

Sam and Erin ran up to the Grade 4 classroom. 28

Miss Linton looked surprised to see them. "Yes?" 29

Sam and Erin were out of breath. "Mammals," said Erin. "Encyclopedia," said Sam. 30

Miss Linton was confused. "What—?" she started to say, but just then Sam saw, on one student's desk, a drawing of what looked like a horse—with black and white stripes on it. 31

"Zebra!" he pointed. 32

The student whose drawing it was nodded. "I'm doing a project on them." 33

Sam saw the encyclopedia on the student's desk. He opened it to "xylophone." 34

There were his perfect green leaves. He and Erin smiled. 35

"Thanks, Green Detective," he said to Erin. "It's summer again!" 36

This piece of writing is an example of a

Choose one answer.
- a. play
- b. story
- c. poem
- d. journal

4 **In this selection, the seasons are changing from**

Marks: 1

Choose one answer.
- a. winter to spring
- b. autumn to winter
- c. spring to summer
- d. summer to autumn

5 **In paragraph 4, why does the class groan?**

Marks: 1

Choose one answer.
- a. They are not ready for summer to end.
- b. They do not want to do another project.
- c. They wanted a beach in the school gym.
- d. They want to choose their own science project.

6 **How does the class plan to preserve summer?**

Marks: 1

Choose one answer.
- a. by planting trees
- b. by pressing leaves
- c. by reading about leaves
- d. by putting a beach in the school

7 **What colour leaves is Sam looking forward to finding in the encyclopedia?**

Marks: 1

Choose one answer.
- a. red
- b. green
- c. brown

- d. yellow

8 **Why does Sam choose to place the leaves in the encyclopedia that has the word "xylophone"?**

Marks: 1

Choose one answer.

- a. because it is the biggest book
- b. because the word appears at the back
- c. because classes are not studying xylophones
- d. because that encyclopedia is unlikely to be used

9 **Which word means the same as "scattered" as used in paragraph 13?**

Marks: 1

Choose one answer.

- a. spread
- b. placed
- c. thrown
- d. missing

10 **What is the best meaning for the phrase "in unison" as used in paragraph 27?**

Marks: 1

Choose one answer.

- a. alone
- b. loudly
- c. quietly
- d. together

11 **In this selection, the sentence "It's summer again!" indicates that Sam is**

Marks: 1

Choose one answer.

- a. surprised that the time has passed.
- b. happy that he has found the leaves.
- c. relieved that the weather is getting warmer.
- d. disappointed that the leaves have changed colour.

12 **The main idea of this selection is how to**

Marks: 1

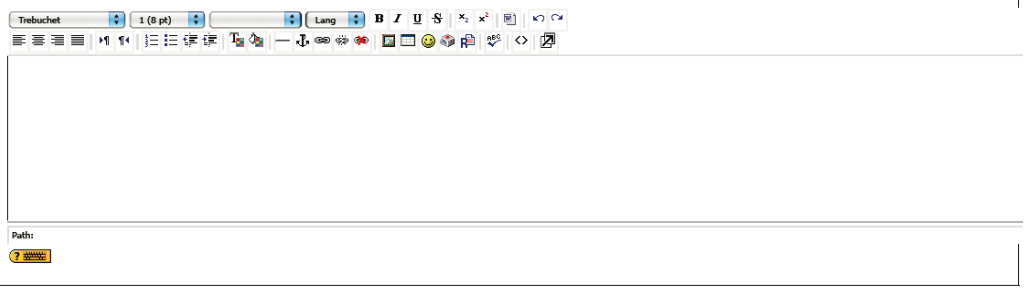
Choose one answer.

- a. do a library project.
- b. find missing leaves.
- c. use an encyclopaedia
- d. make summer longer

13 **Explain Sam's reaction when he realizes the encyclopedia is no longer in the library. Use specific details and examples from the text to support your answer.**

Marks: 4

Answer:



Save without submitting | Submit all and finish

Preview Second Reading Passage & Questions

Start again

1

Marks: 1

Popcorn Under Pressure

It looks like kitchen magic. You take a handful of dried corn kernels, small and hard as ladybugs. Throw them into a hot pan with a little oil, and soon they're jumping, spinning and exploding into shapes like freeze-dried clouds. That's popcorn. Don't forget to put on the lid. But why does popcorn pop?

Each kernel of popcorn has a hard outer shell around a pocket of starch. This pocket is called an endosperm, which means "inside the seed." If you could take off the shell, the starch in the endosperm would feel and taste a little like a raw potato. There's a lot of water in that starch; in fact, the perfect piece of popcorn is about 14% water.

When the popcorn is heated, the water in the endosperm turns to steam. Steam takes up more space than liquid water: the molecules of water in the steam are farther apart and move faster. It's the expansion of the steam that makes popped popcorn so big. A piece of popped popcorn can be 40 times as big as a kernel of unpopped popcorn.

But the expansion of steam is only half the story. When most things are heated, the water in them just boils away. That's why foods with a lot of water in them, such as mushrooms or tomatoes, usually get smaller when you cook them. Popcorn is different because of the hard shell. The shell keeps the hot steam inside the popcorn like air inside a balloon. The pressure builds up. You can picture the fast-moving molecules of steam pushing and hitting against the hard shell until the shell can't hold them in. Like a balloon, the shell flies apart all at once: it pops.

Popcorn is a tasty example of the science of pressure. It may not be magic, but it is magical.

What is at the centre of the corn kernel?

Choose one answer.

- a. oil
- b. starch
- c. steam
- d. potato

2 **What is the purpose of the colon in line 11?**

Marks: 1

Choose one answer.

- a. to introduce a list
- b. to connect an idea
- c. to indicate a long pause
- d. to separate contrasting ideas

3 **Read this sentence from line 15.**

Marks: 1

But the expansion of steam is only half the story.

What is the other half of the story?

Choose one answer.

- a. The shell gets harder as it cooks.
- b. Popcorn gets smaller when it is cooked.
- c. The shell cracks open from the pressure.
- d. The pot lid keeps the popcorn under pressure.

4 **The text as a whole answers which of these questions?**

Marks: 1

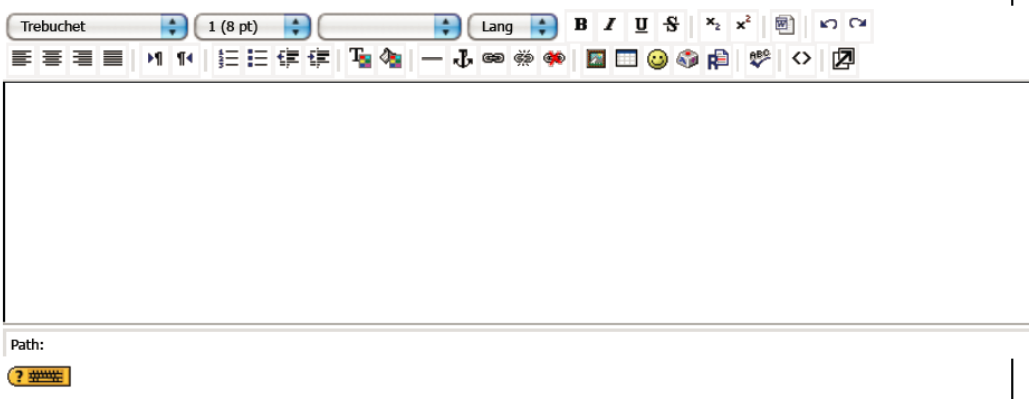
Choose one answer.

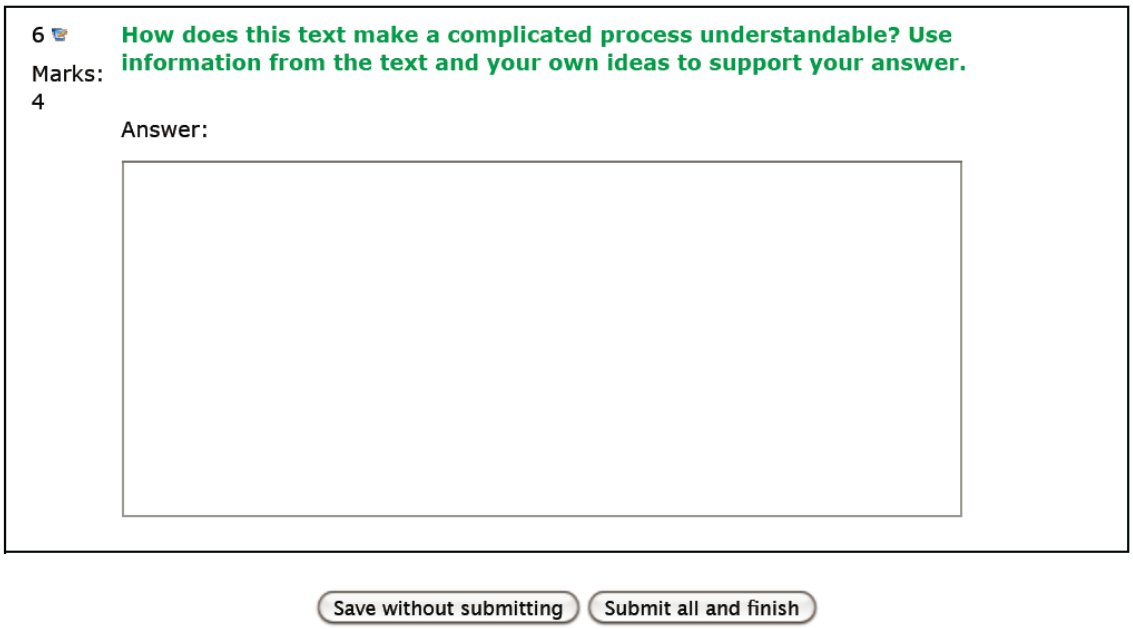
- a. What is an endosperm?
- b. Why does steam expand?
- c. How does pressure make a corn kernel explode?
- d. How does popcorn cook differently from tomatoes?

5 **Describe a safety issue related to popping popcorn. Use information from the text and your own ideas to support your answer.**

Marks: 4

Answer:





Used with permission. EQAO, 2006.

Before handing your test paper in to your teacher, please make sure you have answered all of the questions on the test, and reread your answers carefully.

Thank you for completing Test 2 of this research study!

Appendix E: Student Opinion Survey

Screen #1:
This short questionnaire is the final step in my study. I am hoping that your answer to this survey will help me understand why you picked one test format over another before you wrote the tests. Now that you have you completed both tests and you know your test results, I am also interested in which test experience you liked more.

There are only two questions in this survey, so I am asking you to provide very detailed responses. The more detail you give me, the more information I will have to analyze and interpret for my final research report.

Click the **NEXT** button to continue.

Screen #2
When you answer Question 1, think back to how you filled out the Student Computer Attitudes and Use Survey at the beginning of this study. Think about how you feel about using technology, and how you use it at home and at school.

Click the **NEXT** button to advance to and answer the first question.

Screen #3

Question 1:
Which test mode (computer-based or pencil-paper) did you pick for the first reading test? Why? (Please provide 5 detailed sentences or more)

Click **NEXT** to advance to see the instruction for the second question

Screen #5

Question 2
Which test mode (computer-based or pencil paper) did you like more? Why? (Please provide 5 detailed sentences or more)

Click **NEXT** to continue.

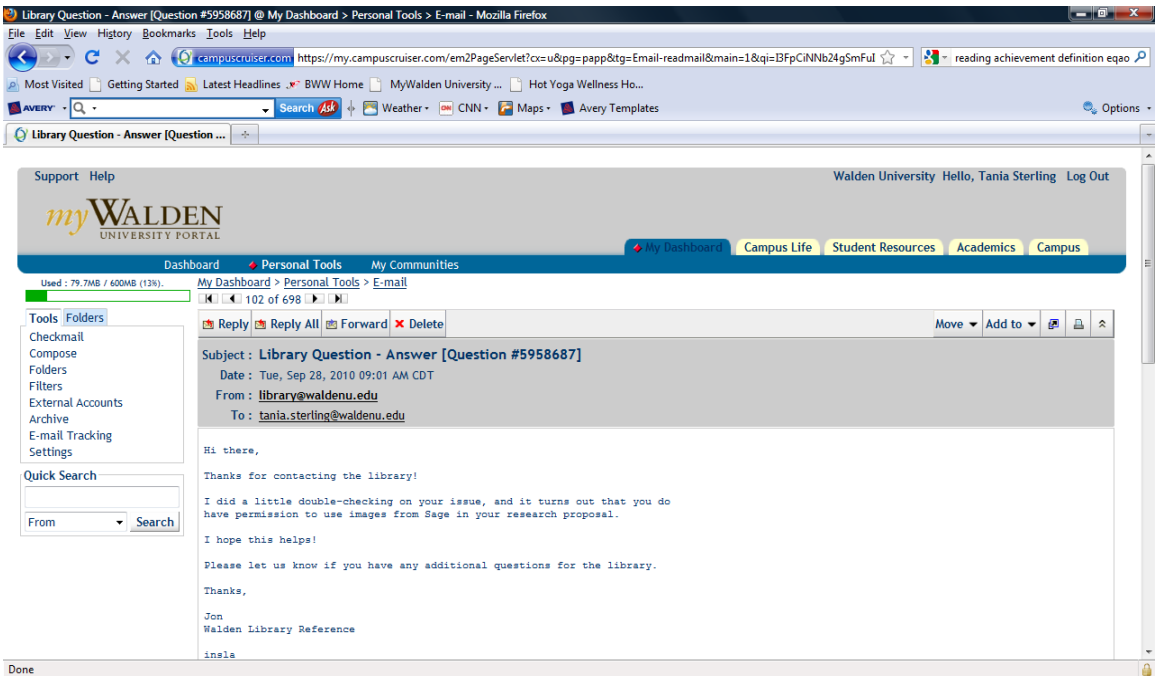
Screen #7

This marks the end of the entire study ☺

Thank you so much for your time and participation. I really appreciate your involvement and look forward to seeing you for the pizza party before the end of the year!

To exit the survey, please click the **SUBMIT** button below. Thanks again!

Appendix F: Approval to adapt and include sequential explanatory research diagram



Appendix G: Sample Scoring Guide Test 1

Short Non-Narrative Informational Reading Open-Response

(Gordon Lightfoot) Question 18

Explain how Gordon Lightfoot became successful. Use specific details from the text and your own ideas to support your answer.

Code	Descriptor
I	• *Illegible: cannot be read; completely crossed out / erased; not written in English* • *Irrelevant content: does not attempt assigned question* • *Off topic: no relationship of written work to the question* Typical responses: • do not attempt to answer the question OR • restate the question (e.g., Gordon Lightfoot became successful).
10	Response attempts to answer how Gordon Lightfoot became successful. The response either: • answers an aspect of the question OR • does not refer to the reading selection OR • provides inaccurate support.
20	Response indicates a partial understanding by explaining how Gordon Lightfoot became successful. The response provides: • irrelevant support from the reading selection OR • vague support from the reading selection OR • limited support from the reading selection. The response usually requires the reader to connect the support to what it is intended to prove.
30	Response indicates an understanding by explaining how Gordon Lightfoot became successful. The response includes: • some accurate and relevant support and • some vague or underdeveloped support. The response requires the reader to make some connections between the support and what it is intended to prove.
40	Response indicates an understanding by explaining how Gordon Lightfoot became successful and provides specific and relevant support from the reading selection to explain fully how Gordon Lightfoot became successful.

Appendix H: Sample Scoring Guide Test 2

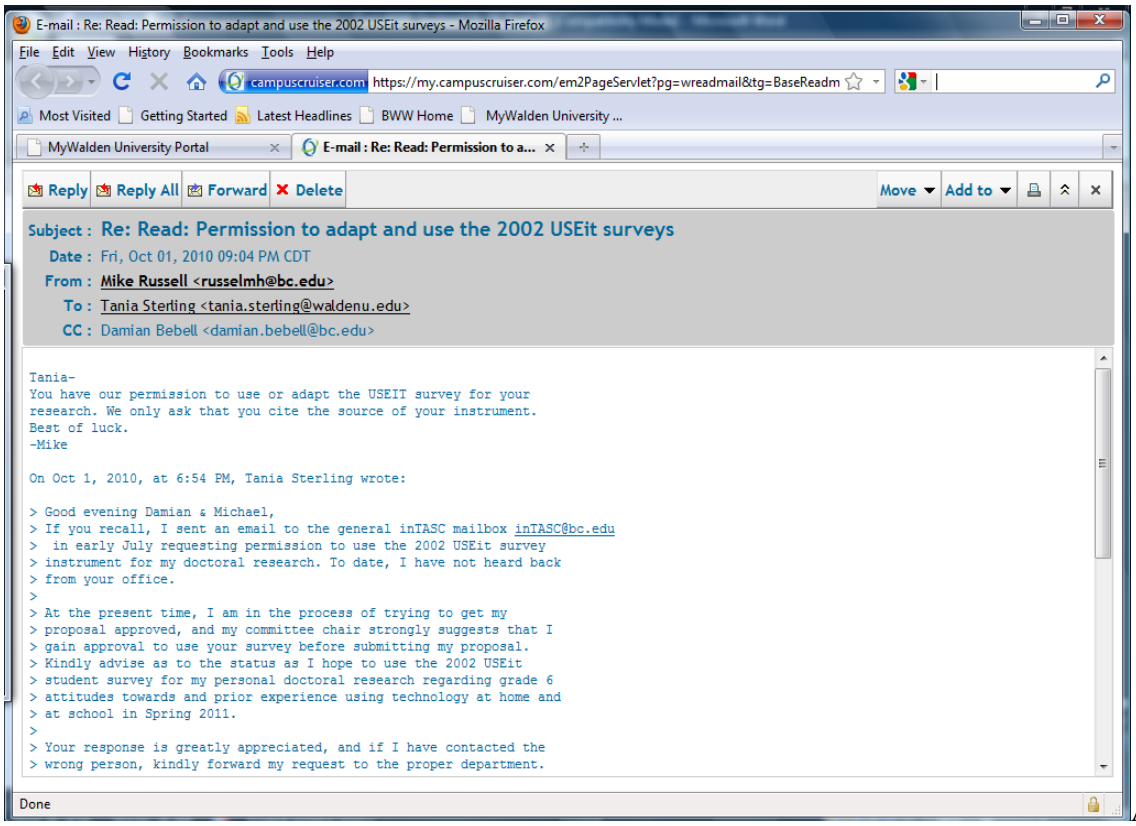
Long Narrative Reading Open-Response

(The Green Detective) Question 11

Explain Sam's reaction when he realizes the encyclopedia is no longer in the library. Use specific details and examples from the text to support your answer.

Code	Descriptor
B	• blank: nothing written or drawn in the space provided
I	• *Illegible: cannot be read; completely crossed out / erased; not written in English* • *Irrelevant content: does not attempt assigned question* • *Off topic: no relationship of written work to the question* Typical responses: • do not attempt to answer the question OR • restate the question (e.g., He knows the encyclopedia is not in the library.).
10	Response attempts to explain Sam's reaction when he realizes the encyclopedia is no longer in the library. The response either: • answers an aspect of the question OR • does not refer to the reading selection OR • provides inaccurate support.
20	Response identifies a reaction and indicates a partial understanding by explaining Sam's reaction when he realizes the encyclopedia is no longer in the library. The response provides: • irrelevant support from the reading selection OR • vague support from the reading selection OR • limited support. The response usually requires the reader to connect the support to what it is intended to prove.
30	Response identifies a reaction and indicates an understanding by explaining Sam's reaction when he realizes the encyclopedia is no longer in the library. The response includes: • some accurate and relevant support and • some vague or underdeveloped support . The response requires the reader to make some connections between the support and what it is intended to prove.
40	Response identifies a reaction and indicates an understanding by explaining Sam's reaction when he realizes the encyclopedia is no longer in the library and provides specific and relevant support from the reading selection to explain fully why he reacts that way.

Appendix I: Approval to use the USEIT Survey



A

Appendix J: Student Opinion Survey Question 1

Table J1

Qualitative Data Summary: Student Opinion Survey Question 1

Test 1 Preference: PBT

Students (*n*=38*)

Overall category	Subcategory	%	*f*
Familiarity			
	What I am used to	(26.3)	10
	Take most tests using pencil-paper	(13.2)	5
	Not a lot of practice taking tests online	(5.3)	2
	Not familiar with CBT	(2.6)	1
	I understand the format	(2.6)	1
	I like the old fashioned way	(2.6)	1
Computers seem harder			
	I am a slow typer; I am faster at writing than typing; keyboarding is hard for me; I can't type	(36.8)	14
	Lack of experience using technology	(7.9)	3
	Don't like to read on-screen	(2.6)	1
	Reading on the computer hurts my eyes	(2.6)	1
	I fall behind when we work on computers in class	(2.6)	1
Test order effect			
	Get the harder test mode done first (PBT);	(34.2)	13
	Save the best mode till last (CBT)	(15.8)	6
Achievement			
	Thought PBT would be easier	(10.5)	4
	I can explain more on paper; give more detailed answers when I write	(7.9)	3
	I do better using pencil-paper	(2.6)	1
Peer influence			
	A lot of people did PBT first; did what the class did	(13.2)	5

Qualitative Data Summary: Student Opinion Survey Question 1 (cont'd)

Test 1 Preference: CBT
Students (*n*=10*)

Overall category	Subcategory	%	*f*
Engagement			
	Fun	(70.0)	7
	Writing with pencil-paper is what we do everyday-PBT is boring	(70.0)	7
	I hate handwriting	(70.0)	7
	Computers make me happy; I love technology; Computers are cool	(30.0)	3
Format			
	CBT is easier	(40.0)	4
	CBT is faster	(40.0)	4
	Handwriting hurts my hand	(30.0)	3
	More space for my answers on CBT	(10.0)	1
Achievement			
	I do better work on computers	(60.0)	6
	Computers help me focus	(10.0)	1
	Able to edit better on computers	(10.0)	1
	Work on a computer is neater	(10.0)	1
	I can spell check my work on a computer	(10.0)	1
Familiarity			
	Faster typer than hand writer	(40.0)	4
	Use a lot of technology at home	(20.0)	2

**For Test 1, 38 of participated student chose PBT and 10 chose CBT.*

Appendix K: Student Opinion Survey Question 2

Table K1

Qualitative Data Summary: Student Opinion Survey Question 2

Overall Test Format Preference: CBT

Students (*n*=29*)

Overall category	Subcategory	Percentage	Frequency
Easier			
	Computers are easier for me		7
	Testing time went quicker		8
	Does hurt my hand; didn't get tired		5
	Easier to type than hand write		8
	I am more focused when I use computers		1
	Something different for a change		1
Format			
	More room than PBT		5
	Doesn't hurt my hand		4
Achievement			
	More room gives me more ideas		4
	Tells me where I made mistakes and I can fix them for better marks		3
	No messy handwriting; neater		2
	Could check my spelling		2
	I do better when I use computers		1
	I get my ideas out faster when I use computers		1
	Kept my work organized		1

Qualitative Data Summary: Student Opinion Survey Question 2 (cont'd)

Overall Test Format Preference: PBT

Students (*n*=14*)

Overall category	Subcategory	Percentage	Frequency
Easier			
	Faster		3
	Familiar		1
	Understood it better		1
	Easier to read on paper		1
	Didn't feel rushed		1
	Write faster than I can type		1
Format			
	Doesn't hurt my hand		4
	More clear to read		2
Achievement			
	I explain better on paper		4
	Easier to change answers before handing it in		3
	I make fewer mistakes when I write		1

Overall Test Format Preference: Undecided

Students (n=5*)

**Overall, 29 out of 48 student participants preferred CBT, 14 preferred PBT, and 5 were undecided as to which test format they preferred.*

Curriculum Vitae

Tania M. Sterling
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Education:

Doctor of Education – Teacher Leadership — Expected 2012
Walden University, Minneapolis, Minnesota

Masters of Education – Curriculum, Teaching & Learning/Educational Administration — 2007
Ontario Institute for Studies in Education/University of Toronto

Bachelor of Education-Junior/Intermediate — 1993
Brock University

Bachelor of Arts- French Language & Literature (Honours) — 1991
University of Western Ontario

Relevant Professional Experience:

Elementary Teacher — 2007-present
Teacher Librarian, Grade 3 Science & Technology, Social Studies, Literacy Coach, School Leadership Team, Interim Vice Principal, Grade 7 & 8 Mathematics

Online Teacher Professional Learning Instructor — 2011-present
Elementary Teacher's Federation of Ontario (ETFO)
Media Part 2 and Media Specialist courses

Program Manager and Project Manager (Secondment) — 2008-2010
York University
Facilitator of a province-wide K-8 online teacher professional learning community http://www.learningconnections.ca developed and hosted by Vice President's Research & Innovation (VPRI) Office

Education Officer (Secondment) — 2005-2006
Ontario Ministry of Education
Designed and directed teacher professional resources and guides to support implementation of mathematics, active learning, and media literacy

Special Assignment, Instructional Technology Resource Teacher 1999-
Peel District School Board 2005
Active member of Curriculum and Instruction Support Services; Sat on Learning Technologies Support Services advisory team; Designed and facilitated face-to-face teacher professional learning to integrate technology into teaching and learning

Elementary Teacher
French Immersion and French as a Second Language (Grade 4-8)

Elementary Teacher 1991-
Halton Roman Catholic District School 1998
Grade 6 & 7 French Immersion, Grade 4-10 French as a Second Language

Licenses and Certifications:

Media, Specialist	2011
Media, Part 2	2011
Media, Part 1	2011
Librarianship, Part 1	2008
Principal's Qualification Program, Part 2	2005
Principal's Qualification Program, Part 1	2005
Computers in the Classroom, Specialist	2002
Computers in the Classroom, Part 2	2001
Computers in the Classroom, Part 1	2001
French as a Second Language, Specialist	2000
French as a Second Language, Part 2	1996

Scholarly Work:

Wideman, H., Sterling, T. & Murphy, J. (2009). *Lessons learned from using a blended approach for teacher training: Learning Connections (Phase Four).* In I. Gibson et al. (Eds.), Proceedings of Society for Information Technology & *Teacher* Education International Conference 2009 *(pp. 2716-2722). Chesapeake, VA: AACE.*

Sterling, T. (2009). *Literature review: Computer-based testing of reading.* Proceedings of the Canadian Society for Studies in Education Conference 2009. Ottawa, ON: CSSE.

Other Publications and Contributions:

The School Library as a Learning and Leading Hub in David Booth's book, *Caught in the Middle* 2011

Lesson featured in Karen Hume's book entitled, *Tuned Out* 2011

Co-developer and featured educator in several Ontario Ministry of Education's Literacy and Numeracy Secretariat teacher professional webcasts:

- *Student Led Conferences,* 2010
- *Comprehending in Action-Synthesizing* 2009
- *Literature Circles* 2009

Expert Panel Member and lead writer for Junior Literacy and Numeracy initiatives for Ontario Ministry of Education:

- *Literacy for Learning: A report of the expert panel on literacy, 4-6* 2006
- *Targeted Implementation and Planning Supports [TIPS]* 2005
- *Think Literacy* 2004

Honors and Awards:

Winner of ETFO Graduate Studies Scholarship 2005
Winner of Dorothy E. Turville Travelling Fellowship Scholarship 1989

Professional Affiliations:

Member, Learning Connections 2007-present
Member, Advanced Broadband Enabled Learning (ABEL) 2007-present
Member, Ontario College of Teachers 1993-present
Member, Association of Supervision of Curriculum and Development 1993-present
Member, Educational Computing Organization of Ontario 1993-present