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The Role of Speech Recognition Technology in Fostering Cognitive Engagement in Students

by

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Abstract

Speech recognition technology, which allows for the conversion of speech to text, is commonly used with individuals who struggle with writing due to cognitive, physical, or sensory issues. While there is initial support for the positive impact of speech recognition technology on specific writing outcomes (e.g., skilled writing), limited attention has been given to examining the cognitive mechanisms by which it exerts influence. One possible avenue to consider is the link between speech recognition technology and student cognitive engagement, defined as an investment in the work of learning. With evidence to suggest that certain technology use increases student engagement (e.g., interactive whiteboards, writing pads), it is possible that the use of speech recognition technology helps students to become more cognitively invested in their writing. Findings from this case study identify: (a) the extent to which students utilizing speech recognition technology are cognitively engaged in their writing; (b) necessary conditions to elicit cognitive engagement; and (c) the impact of speech recognition technology on student writing. Comparison is made between students identified as engaged and non-engaged in the writing task, with examination given to possible differences in the learning environments and student and teacher perceptions toward the use of speech recognition technology. This study provides insight into important factors to consider when using speech recognition technology in order to maximize the impact of this technology on student learning.

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CHAPTER ONE: INTRODUCTION

Introductory Statement

Cognitive engagement is described as "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012, p. 726) and has emerged as an important variable to consider in relation to positive learning outcomes (e.g., academic achievement). While research has provided evidence that cognitive engagement can be positively impacted through students' use of certain technologies, such as interactive whiteboards, desktop computers, and writing pads (Beeland, 2002; Mama & Hennessy, 2010; Swan, Kratcoski, van't Hooft, Campbell & Miller, 2007), the impact of speech recognition technology on cognitive engagement has yet to be examined. Rather, more limited attention has been given to the impact of speech recognition technology on writing products (e.g., quantity and quality; e.g., Higgins & Raskind, 1995; Higgins & Raskind, 2000; Raskind & Higgins, 1999; Quinlan, 2004; O'Hare & McTear, 1999; Quinlan, 2004), and motivation (Communication, Access, Literacy, and Learning Scotland, 2008). The examination of the relationship between speech recognition technology and cognitive engagement is important as it serves as the first step in investigating the link between speech recognition technology, cognitive engagement, and achievement. As well, it provides insight into the conditions necessary to facilitate engagement in students.

Following research conducted by Mama and Hennessey (2010) which examined student engagement in relation to technology use, the present study investigated three questions: 1) To what extent are students who are utilizing speech recognition technology cognitively engaged in their writing 2) What are the necessary conditions to elicit cognitive engagement and 3) How does speech recognition technology impact student writing? Using a case study design with mixed methods of data collection, comparison was made between students identified as cognitively engaged and non-cognitively engaged in terms of the Survey of Motivation to Engage in Writing (Hawthorne, 2008) and in fulfilling the conditions for successful technology integration

(Communication, Access, Literacy, and Learning Scotland, 2008; International Society of Technology in Education, 2008). In this regard, surveys were given, learning environments were compared and student, teacher, and administrative perceptions of speech recognition technology were considered. Through this research, insight is provided into the role which speech recognition technology plays in student learning and the conditions necessary to elicit cognitive engagement. This information may be valuable for policy makers, educators, and school psychologists who intend to introduce speech recognition technology in their own schools. Researchers may also be interested in preliminary data on the relationship between speech recognition technology and cognitive engagement.

Context of the Study

Inclusive education is stated as being broadly adopted around the world (Mitchell, 2010). Although the term inclusive education has varied definitions (Institute for Research on Inclusion and Society, 2008), Ainscow (2007) conceptualizes it to mean when children with disabilities are being placed and provided services in general education settings. More locally, Canadian Ministries of Education have begun to make the commitment to inclusion. For instance, in 2010 through "Action on Inclusion," the Alberta Ministry of Education made the commitment to an inclusive classroom philosophy (Alberta Education, 2012). In 2009, Ontario also made the commitment to this philosophy through the "Equity and Inclusive Educational Strategy" (Ontario Ministry of Education, 2013) as did Manitoba in 2005 through "The Philosophy of Inclusion" (Manitoba Education, Citizenship and Youth, 2006) and various other provinces have undertaken similar commitments. As inclusive practices are more broadly being adopted, the result is greater student diversity in the classroom. Student diversity presents itself in classrooms through varying levels of cognitive and physical ability between pupils (Leeman & Volman, 2001). The levels of needs between students can range from requiring no additional classroom support to requiring full time assistance in the classroom. Therefore, today's teachers are tasked with the responsibility to cater to a wide range of students with largely diversified needs. In doing so, it is important that attention is

given to barriers to learning that may exist for certain students, particularly those with identified learning disabilities or challenges.

The Center for Applied Special Technology (CAST), an educational research and development organization that aims to increase the learning opportunities for all students (Center for Applied Special Technology, 2013), suggests that three main barriers exist for students identified with learning disabilities who are provided services in general education settings. These barriers include the mode in which materials and instruction are represented, how students are enabled to perform their learning, and the method by which students become engaged in their learning (Baglieri & Shapiro, 2012). Given these barriers, one method of addressing the diversity in today's classroom is through the use of appropriate digital technology (Baglieri & Shapiro, 2012). The use of technology allows course work to be presented to multiple modalities and as such can play upon the strengths of the student when teaching.

As technology integration in the classroom becomes a more readily available option for educators, it becomes apparent that there are a vast number of digital technologies which teachers can utilize in order to support students in inclusive learning environments. Examples of technologies being more widely used in the classrooms include interactive whiteboards (IWBs), electronic classroom response systems (e.g., clickers), wireless writing pads, cameras, laptops, and iPads (Bartsch & Murphy, 2011; Cavanaugh & Dawson, 2011; Getting & Swainey, 2012; Lewin, Scrimshaw, Soekh & Haldane, 2009; Smith, Hardman & Higgins, 2006; Swan et al., 2007). A number of these technologies have been utilized within inclusive classrooms and have been found to improve learning outcomes for students (Quenneville, 2001). For example, computers make it possible for students who struggle with handwriting to produce printed work which is neat and legible (Quenneville, 2001) and increased use of these assistive technologies during cooperative learning activities can help to circumvent specific disability related barriers and thus enhance student participation (Quenneville, 2001). Additionally, technology use has also been found to

influence student engagement in their learning (Beeland, 2002; Bulger et al., 2008; Mama & Hennessy, 2010; Morgan, 2008).

Of the various technologies that are being adopted in today's classroom, one of particular interest is speech recognition technology (also known as voice recognition). Speech recognition technology converts speech to text in what is called dictation mode (Zhao, 2007) and is being used as an assist for individuals who have difficulty with note taking or captioning speech due to cognitive, physical or sensory issues (Wald, 2008). This technology enables users to control a computer through their speech rather than a keyboard or mouse (O'Hare & McTear, 1999) and has the capability to adapt to its user's phonetic characteristics (Holmes & Silvestri, 2012). Due to this technology's capabilities, it can be classified as an assistive technology which is defined as "any technology that can assist, increase, maintain, or improve the functional capabilities of individuals with disabilities" (Holmes & Silvestri, 2012, p. 82). Currently, a number of different companies produce the voice recognition software (e.g., Dragon Naturally Speaking by Nuance Communications and TalkitTypeit2 by Xpressions Media; Yoder, 2011), with various versions being used in classrooms (O'Hare & McTear, 1999).

The value of speech recognition technology has been examined in relation to the writing of students who have been diagnosed with a learning disability. Research has indicated that it has been found to improve writing products (Higgins & Raskind, 1995; Higgins & Raskind, 2000; Higgins & Raskind, 2004; O'Hare & McTear 1999; Raskind & Higgins, 1999; Quinlan; 2004), text production (O'Hare & McTear, 1999; Quinlan, 2004), and motivation (CALL Scotland, 2008; Hwang, Shadley, Kuo & Chen, 2012). While research findings support achievement gains when students with specialized needs use speech recognition technology, assessing the success of this technology should seek to explore multiple measures of accomplishment. More specifically, while evaluating the academic outcomes resulting from the use of speech recognition technology is of importance, there is a need to better understand the underlying mechanisms that impact achievement. One

possible mechanism by which speech recognition technology may impact achievement is through increasing student engagement.

Student engagement has proven to be a meaningful construct, with students who demonstrate engagement performing more on-task activities (Bulger et al., 2008) and showing greater academic achievement (Fredericks et al., 2004; Greene & Miller, 1996). A component of student engagement, titled cognitive engagement, narrows in on the investment that students place in their learning, and their ability to strategically think and place relevance on their work to everyday life (Appleton 2012; Wilms, Friesen & Milton, 2009). Cognitive engagement has been specifically evaluated in its relation to student achievement and research has indicated that cognitive engagement has been found to meaningfully influence positive learning outcomes in students (e.g., academic achievement; Fredricks et al., 2004; Greene & Miller 1996; Greene et al., 2004; Miller et al., 1996; Nystrand & Gamoran, 1991). As there is evidence to suggest that increased cognitive engagement results in improved academic performance (Greene & Miller, 1996; Greene et al., 2004; Miller, Greene, Montalvo, Ravidran & Nichols, 1996; Nystrand & Gamoran, 1991) and that technology use influences student engagement (Beeland, 2002; Bulger et al., 2008; Mama & Hennessy, 2010; Morgan, 2008), it would seem reasonable to conclude that speech recognition technology may also influence how students engage in learning and in turn influence academic achievement.

Statement of the Problem

To date, the link between student engagement and some types of technology have been examined (e.g., interactive whiteboards, desktop computers, projectors, cameras, writing pads) but the link between cognitive engagement and speech recognition technology has yet to be studied. A closer examination into the relationship between cognitive engagement and speech recognition technology would serve as the initial step in investigating the speech recognition technology, cognitive engagement, and achievement link. Through an examination of this relationship, insight

may also be gained into the necessary conditions to facilitate cognitive engagement in students utilizing speech recognition technology and serve as another means of determining success.

Significance of the Study

A study examining the relationship between speech recognition technology and cognitive engagement in writing is important for several reasons. Firstly, a closer examination into the relationship between cognitive engagement and speech recognition technology can serve as the initial step in investigating the speech recognition technology, cognitive engagement, and achievement link. Secondly, although research has indicated that speech recognition technology has an impact on positive learning outcomes such as improvements in lower level and skilled writing (Graham, Harris, MacArthur & Schwartz, 1991; Higgins & Raskind, 1995; O'Hare & McTear, 1999; Rashkind & Higgins, 1999), it has yet to explore how the manner in which it is implemented helps students to become cognitively engaged in their writing. Through an examination of what the International Society for Technology in Education (2008) and Communication, Access, Literacy, and Learning Scotland (2008) provide as necessary conditions for successful technology and speech recognition technology integration, this study will provide insight as to if and how these conditions may influence engagement. Thirdly, this research will also contribute to knowledge of whether speech recognition technology may influence cognitive engagement in writing in students.

Practical implications within schools may result from this research. For instance, knowledge of the necessary conditions to elicit cognitive engagement in writing for students using speech recognition technology may provide a framework for educators to follow. Similarly, any barriers to successful implementation of this technology that are found in this study can help educators to avoid similar problems in the future. Furthermore, knowledge of the different ways in which this technology influences student learning will provide insight in to the many ways in which students are impacted through the introduction of speech recognition technology. This insight can prepare

educators for the range of experiences that their own students may encounter when using this technology.

Lastly, educational policies may be influenced by this research. Through a presentation of the benefits and drawbacks that speech recognition technology has to offer from the viewpoint of staff and students, administrators may decide to adopt or decline using this technology. It may also impact what administrators consider to be best practice in the implementation of this technology.

Definitions

The following definitions will serve to provide information regarding five terms which will be used throughout this thesis document.

Cognitive engagement: "The investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012, p.726).

Inclusive education: When children with disabilities are being placed and provided services in general education settings (Ainscow, 2007).

Lower level writing skills: Grammar, spelling, (Graham et al., 1991) and text production (O'Hare & McTear, 1999; Quinlan, 2004; Garrett et al., 2011).

Skilled writing: Writing that has the critical components of ideas, organization, voice, word choice, sentence fluency, and conventions (Gansle & Vanderhayden, 2006)

Speech recognition technology: A technology which converts speech to text and is used as an assist for those who, for cognitive, physical, or sensory reasons, have difficulty with note taking or captioning speech (Wald, 2008).

Delimitations

Due to the widespread implementation of speech recognition technology within the research school, this study was confined to a specialized school in southern Alberta intended for students

who were diagnosed with learning disabilities. The student population focused on in this study consisted of grade 7 students who had received training in speech recognition technology during grade 6. Their length of experience with speech recognition technology (minimally one year) allowed the research focus to be on the impact of the technology on writing as opposed to any issues which might be linked with learning the technology. Students who had not attended this specialized school since grade 6 were not included in this study because of the different training they may have received at their prior school or their late training which may have differed from the students who were trained in grade 6 at this location. Furthermore, teacher interviews were confined to English Language Arts teachers and teaching assistants as well as Social Studies teachers and teaching assistants, as these classes were heavily centered on writing and because English Language Arts classes had been used in a prior study investigating student engagement in writing (Hawthorne, 2008).

Additionally, although this present study looked at the influence of speech recognition technology on writing, an objective writing measure was not used. This was due to students beginning their usage of speech recognition technology in grade 6 and selection of students in this study being restricted to those who had used this technology for at least a year. As such, a pre and post writing measure was not used. However; student and teacher views on how speech recognition technology had impacted their own or their students writing were collected.

Limitations

There are three limitations within this study that are important to consider. For instance, because qualitative research is described as "fundamentally interpretive," (Creswell, 2003, p. 182) the data is left to the interpretation of the researcher. Due to this, the personal interpretations which were brought to qualitative data analyses were inescapable (Creswell, 2003), and as such were an important limitation to consider. Additionally, this study heavily relied on a number of self-report measures (e.g., focus group interviews, Survey of Motivation to Engage in Writing). Thus, it is

important to consider the likelihood that participants' thoughts or feelings may have been influenced by problems of inhibition and self-presentation. Not to mention, despite the fact that there is truth to be told, some people may simply have chosen not to tell it (Hollander, 2004).

Chapter Summary

The study of the relationship between speech recognition technology and cognitive engagement in writing has been structured into five chapters.

- Chapter One : Introduction
- Chapter Two: Literature Review
- Chapter Three: Research Design
- Chapter Four: Findings
- Chapter Five: Discussion

CHAPTER TWO: LITERATURE REVIEW

Relevant literature pertaining to the use of speech recognition technology and its impact on student learning (e.g. reading, lower level writing, skilled writing, and motivation) are examined in this chapter. Additionally, cognitive engagement has been presented in conjunction with its impact on student writing. Lastly, the relationship between technology and engagement and speech recognition technology and cognitive engagement are offered.

Speech Recognition Technology and Student Learning

Speech recognition technology has various purposes within the classroom environment. More specifically, it has been cited as a support for preferred learning and teaching styles, an assist for those who for cognitive, physical, or sensory reasons find the process of note taking to be difficult, and also as a method of captioning speech for deaf learners (Wald, 2008). Raskind and Higgins (1998) have provided an overview of assistive technology as it relates to postsecondary students with learning disabilities and suggested that speech recognition technology is most appropriate for students who are able to demonstrate intact oral language abilities that exceed their written language abilities (King & Rental, 1981; Myklebust, 1973). Particular ways in which speech recognition technology can be incorporated into academic work includes through speaking to write essays, proof reading (with text read out in their own voice), and speaking to correct errors (CALL Scotland, 2008). Additionally, for those students who are unable to use a keyboard or who prefer to dictate directions verbally, speech recognition technology can be used to complete tasks such as saving files or even quitting programs (Zhao, 2007). Due to the capabilities of speech recognition technology, it is not surprising that Zhao (2007) suggests that there has been an increase in interest in using this technology to support students with disabilities. Researchers examining the effectiveness of speech recognition technology have primarily focused on its impact on writing quantity and quality. Specifically, the use of speech recognition technology has been evaluated in terms of influence on grammar, spelling, and text production (Graham et al., 1991; O'Hare &

McTear, 1999; Quinlan, 2000) with more limited research completed on the impact on skilled writing (e.g., word choice; Higgins & Raskind, 1995).

Impact of speech recognition technology on writing. A number of studies have examined the impact of speech recognition technology on what has been termed lower level writing skills (e.g., grammar, spelling, and text production; Garrett et al., 2011, Graham et al., 1991; O'Hare & McTear, 1999; Quinlan, 2004). O'Hare and McTear (1999) investigated whether dictation software enabled students to more quickly and accurately produce word processed documents than when using more traditional means such as a keyboard and mouse. This study utilized a sample of second year secondary students with reading ages ranging from 8.3 years to 12.9 years. They found that students were able to input text up to five times more quickly and with greater accuracy when using the speech recognition software as compared to a keyboard and mouse (O'Hare & McTear, 1999). Additionally, they noted that the accuracy of the speech recognition was improving with use (O'Hare & McTear, 1999). Overall, the authors concluded that speech recognition software is a viable method for completing presentable documents and that further research should be conducted to evaluate the educational applications of this technology (O'Hare & McTear, 1999).

Using a sample of five high school students who were found to have fine motor impairments, not diagnosed with a speech articulation or voice production disorder, not receiving any visual impairment aid, and also not currently utilizing speech recognition technology, Garrett et al. (2011) investigated the effects of speech recognition technology on written production rate. Prior to intervention, Garrett stated that both handwriting and typing rate were collected, students were trained in the use of speech recognition technology and had to demonstrate competency using Dragon Naturally Speaking with 100% accuracy over three trials. Calculation of written production rate occurred by removing words that were incorrect within the students' writing sample, obtaining the count of characters, and dividing it by the time given to complete the writing task (five

minutes). Results indicated that in terms of written production rate, all participants had longer written passage lengths (Garrett et al., 2011).

Quinlan (2004) similarly found that speech recognition technology increased text generation in student narratives. The study utilized a sample of fluent (no discrepancy between oral and written language production) and less fluent writers (a discrepancy between oral and written language production) aged 11 to 14. Participants were asked to compose four narratives, with handwriting and speech recognition technology, both conditions with and without advanced planning (Quinlan, 2004). After using speech recognition technology, it was found that for the less fluent writers, speech recognition technology increased the length of their passages (Quinlan, 2004). It is concluded that advance planning and speech recognition technology may each support text generation of students (Quinlan, 2004).

In regards to spelling, Raskind and Higgins (1999) evaluated whether or not 39 participants aged 9 to 18 years old with a learning disability (previously identified and with deficits of two years or more in reading comprehension, phonological analysis, and or spelling on the Stanford Diagnostic Reading Inventory-III) showed improvements with the use of speech recognition software. Of the students, 19 participated in two training sessions and used the software for 50 minutes a week for 16 weeks while the control group (n=20 students) was given general computer instruction (Raskind & Higgins, 1999). Results indicated that the experimental group did better than the control in terms of their spelling (as measured by the Wide Range Achievement Test-3), suggesting an increase in lower level writing skills. Similar to their 1999 study, Higgins and Raskind (2000) utilized another sample (n=39) of students aged 9 to 18 with a learning disability to examine the effects that speech recognition technology had on spelling. Those in the speech recognition condition showed improvements in their spelling according to the Wide Range Achievement Test-3 compared to those in the control condition who received computer instruction on keyboarding (Higgins & Raskind, 2000).

Impact of speech recognition technology on skilled writing. In addition to studies examining the impact of speech recognition technology on lower level writing skills (e.g., grammar, spelling, and text production), researchers have also sought to examine the relationship between speech recognition technology and what is termed skilled writing (e.g., ideas, organization, voice, word choice, sentence fluency, and conventions; Gansle & VanderHayden, 2006). Although there are several studies on the impact of lower level writing skills, there is less evidence of the effectiveness of speech recognition technology on improving quality of writing. Of the studies conducted in this area, the impact on writing quality, however, has not consistently been found.

As examples of the inconsistent results within this area is the work of Higgins and Raskind (1995) and Quinlan (2004). Higgins and Raskind (1995) compared the effectiveness of using speech recognition technology, a human transcriber, or no assistance on the written composition performance of post-secondary students diagnosed with a learning disability. Twenty-nine students were asked to participate in three conditions (using speech recognition technology, dictating the essay to a human transcriber, or without assistance) to complete three separate essays (Higgins & Raskind, 1995). In addition to demonstrated improvement in lower level writing skills (e.g., punctuation, capitalization, grammar, and spelling), speech recognition technology also allowed students to use "their more extensively developed oral vocabularies" (Higgins & Raskind, 1995, p. 167). In contrast to Higgins and Raskind, the earlier detailed Quinlan (2004) study above also touched on skilled writing pertaining to the quality of story development. It was found that speech recognition technology did not significantly improve quality, defined in this study as global text development (Quinlan, 2004).

Partially accounting for such inconsistencies in research results may be that skilled writing is a considerably complex task as suggested through seminal work by Hayes and Flower (1980) within their cognitive model of written composition. Within this model, Hayes and Flower (1980) inferred that three writing processes interact during skilled writing: planning, translating, and

revising. More specifically, the planning process is described as the point in which ideas are generated, organized, and goals are set (Hayes & Flower, 1980) whereas Beringer et al. (1992) describe the translating process as consisting of the transformation of ideas into the working memory in the form of language representation and then into written language. The revision process is detailed as consisting of evaluation and the implementation of changes at the word, sentence, or text level (Chanquoy, 2009).

Interestingly, all three aspects of skilled writing have been found to have differing rates of development. It was found that although transcription and text generation are first to emerge in grades 1 to 3, advanced planning and revision do not begin to develop until grades 4 to 6, and are not fully operational until grades 7 to 9 (Berninger, Cartwright, Yates, Swanson & Abbott, 1994; Berninger, Whitaker, Feng, Swanson & Abbott, 1996; Beringer et al., 1992). In terms of revising skills, developmental level is also influential, with research indicating that it is not until grades 7 to 9 that revision of text leads to improvement at the word, sentence, and text levels (Berninger et al., 1996). Similarly, Limpo, Alves and Fidalgo (2013) found that from grades 4 to 9, there is a growing trend in the ability for students to both plan and revise their work. The cognitive model of written composition may help to explain the inconsistency in previous research on the effectiveness of speech recognition technology on quality of writing, as speech recognition technology may not in itself, be able to exert influence on the quality of writing. The influence may be more indirect, through the provision of cognitive resources, freed up through improvements in lower level writing skills. This suggests that additional input is likely needed to see improvements in this complex skill area, and provides insight into why more of an impact is witnessed with lower level writing skills.

Impact of speech recognition technology on reading. The impact of speech recognition technology has been found to extend beyond improving lower level and possibly skilled writing. In fact, this technology has been shown to also impact reading (Raskind & Higgins, 1999; Raskind & Higgins, 2000). The earlier detailed Raskind and Higgins (1999) study regarding spelling also

sought to evaluate the success of speech recognition software in improving reading in students with learning disabilities. Participants were aged 9 to 18 years old with 19 (of the 39) participating in two training sessions and 16 weeks of utilizing this software (for 50 minutes per week) (Raskind & Higgins, 1999). The control group was given general computer instruction in place of speech recognition technology (Raskind & Higgins, 1999). Results indicated that after 16 weeks of using speech recognition technology, the group utilizing it did better in terms of their word recognition and reading comprehension (as measured by the Wide Range Achievement Test-3) (Raskind & Higgins, 1999). Similar improvements for both word recognition and reading comprehension have been found for both speech recognition technology that utilized discrete speech (a need to pause between saying words) and continuous speech recognition technology (no need to pause between saying words) (Higgins & Raskind, 2000).

In a subsequent study, Higgins and Raskind (2004) evaluated the effectiveness of two programs, a speech recognition based program (SRBP) and a computer text based automaticity program (AP), to improve the reading and spelling of 28 students diagnosed with a learning disability. Twenty-eight students with reading and spelling difficulties, aged 8 to 18, participated in both programs for the period of 17 weeks and were then compared to a group of 16 students diagnosed with a learning disability who did not participate in either program (Higgins & Raskind, 2004). The SRBP program required students to read stories of their choosing and after each paragraph they were instructed to listen to the text and follow along as it was read back to them by the computer, then to read it independently (Higgins & Raskind, 2004). If students had any trouble decoding a word they simply had to click on it to have it pronounced to them (Higgins & Raskind, 2004). Students worked on a computer using the speech recognition based program for 25 minutes twice a week for 17 weeks (Higgins & Raskind, 2004). In terms of the AP, it was utilized three days a week for 50 of the 100 minute classes for 17 weeks (Higgins & Raskind, 2004). Students were paired with a teacher, other student, or a computer to practice reading sight words and text passages in this program (Higgins & Raskind, 2004). When on the computer, students listened to the

computer read the passages then they read aloud while trying to keep up with highlighted text (Higgins & Raskind, 2004). Both programs showed improvements over the control group (who participated in neither program) in terms of word recognition (as measured by the silent portion of the Formal Inventory Form A) and reading comprehension (as measured by the word recognition task on the Wide Range Achievement Test-3). The SRBP indicated improved performance of the target group in terms of phonological elision (a task which measures the ability for a student to first say a word, and then say what is left after neglecting elected sounds) and non-word reading efficiency tasks on the Comprehensive Test of Phonological Processing (CTOPP).

Impact of speech recognition technology on motivation. While the majority of studies have focused on the impact of speech recognition technology on achievement outcomes, more limited work has been conducted related to motivation. Research completed by Communication, Access, Literacy and Learning (CALL) Scotland (2008), evaluated how this technology influenced student motivation and found that it was the students who found the technology to be useful who reported gains in their skills, whereas those who did not find speech recognition to be helpful, reported no changes (CALL Scotland, 2008).

While Hwang et al. (2012) investigated student perceptions and behavioural intentions of using speech recognition technology, student motivation for future use also became apparent. Participants of this study included 19 undergraduate students in the control group and 25 in the experimental group. Classes took place for two-hour increments either in person or online on a rotation. Speech recognition technology was used only by the experimental group (Hwang et al., 2012). Results of the study indicated that there were moderate improvements in the experimental group's performance over the control group in terms of homework accomplishments and that once the experimental group became familiar with speech recognition generated texts and used them as tools in their learning; they outperformed the control group (Hwang et al., 2012). Interestingly,

most of the students in the experimental group (who saw improvements over the control group) expressed an interest in using the technology in their learning in the future (Hwang et al., 2012).

While there is initial support for the positive impact of speech recognition technology on lower-level writing outcomes, reading, motivation, and possibly skilled writing, limited attention has been given to understanding the influence speech recognition technology may exert on underlying cognitive factors. In particular, one possible avenue to consider is the link between speech recognition technology and cognitive engagement. Research has indicated that certain technology use is influential to engagement (e.g., interactive whiteboards and writing pads; Beeland, 2002, Swan et al., 2007) and thus it is possible that speech recognition technology may too be influential to cognitive engagement in students who utilize it.

Cognitive Engagement and Student Learning

While speech recognition technology has been examined in relation to a number of learning outcomes, little attention has been given to the impact of speech recognition technology on cognitive engagement. Cognitive engagement has emerged as an important variable to consider in relation to positive learning outcomes (e.g., academic achievement). The following section provides a description of what cognitive engagement is, identifies two conceptualizations, identifies engagement patterns in grades 6 through 12 students, and then discusses some of the work surrounding cognitive engagement and student learning.

Cognitive engagement has been defined by numerous researchers. Two prominent models have been proposed by researchers in the fields of education (e.g., Wilms, Friesen & Milton, 2009) and psychology (i.e., Appleton, 2012). Wilms, Friesen, and Milton (2009) conceptualize what they term intellectual engagement as "a serious emotional and cognitive investment in learning using higher order thinking skills (such as analysis and evaluation) to increase understanding and solve complex problems, or construct new knowledge" (Wilms et al., 2009, p. 43). The framework for studying this model is centered on family background and student characteristics (e.g.,

socioeconomic status, family structure, and students' sex and grade) as well as classroom and school learning climate (e.g., effective learning time, teacher/student relations, classroom discipline, expectations for success, and challenging lessons; Wilms et al., 2009, p. 10). Although the authors of this model did not link it with any specific literature or research base, many of the components were supported by extant literature (e.g., Fredricks, Blumenfeld & Paris, 2004; Newmann, 1992).

Similar to the Wilms et al. (2009) conceptualization is one provided by Appleton (2012) and colleagues (Appleton, Christenson, Kim & Reschley, 2006). Informed by the work of Fredricks et al. (2004), Appleton (2012) asserts that cognitive engagement is "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (p. 726). This model focuses around context as influencing student cognitive engagement. More specifically, family (e.g., academic and motivational support for learning, goals and expectations, learning resources in the home), peers (e.g., educational expectations, shared common school values, attendance, academic beliefs and efforts, peer aspirations for learning), and school (e.g., school climate, instructional programming and learning activities, mental health support, clear and appropriate teacher expectations, goal structure, teacher student relationships) were identified as influential to student cognitive engagement (Appleton, Christenson, Kim & Reschly, 2006). This model is also linked with a specific literature base pertaining to motivational and learning literature and ecological systems perspective (e.g., Broffenbrenner, 1995; Finn, 1989; Fredricks et al., 2004; McPartland, 1994; Newmann, 1992; Pintrich & DeGroot, 1990).

Through a closer examination of both models, it became evident that a number of characteristics are shared. These include an investment in learning, an incorporation of both the motivational (emphasis on psychological investment in learning) and learning (an emphasis on strategic thinking) literatures, a perception of relevance to everyday life, and an ecological systems perspective (Appleton, 2012; Wilms et al., 2009). The similarities across the models suggest that the perception of what cognitive engagement encompasses is largely the same.

In terms of age-based expectations for cognitive engagement, a number of researchers have provided insight (Appleton, 2012, Eccles et al., 1993, Wilms et al., 2009). Wilms et al. (2009) found that in a sample of 32, 322 students, intellectual engagement (akin to cognitive engagement), was highest in grade 6 and declined until about grade 9, where engagement then remained consistent (Wilms et al., 2009). In fact, engagement was found to be highest in elementary schools (62% of students), with decreases in middle schools (44%), and then again (30%) in secondary schools (Wilms et al., 2009). Interestingly, it was found that decreases in attendance through to grade 9 paralleled the decreases in intellectual engagement (Wilms et al., 2009). Appleton (2012) found a similar trend, with grade 6 students exhibiting greater levels of average cognitive engagement as compared to grades 7 and 8 students. Similarly, Eccles et al., (1993) indicated that student levels of engagement in secondary schools decrease across time. Thus, it appears that engagement varies across grade levels, with the height of engagement existing in the late elementary school years.

Evidence for the contributions of cognitive engagement in relation to academic achievement has been established in a number of studies. Greene and Miller (1996) conducted a study examining college students' academic achievement, self-reported goal orientation, as well as their perceived ability and cognitive engagement while studying. The Motivation and Strategy Use Survey was used to determine goal orientation and cognitive engagement. Academic achievement was defined as student scores on the midterm examination (Greene & Miller, 1996). Using path analysis, a causal model was supported in which perceived ability and learning goals were found to meaningfully influence cognitive engagement, which influenced midterm achievement (Greene & Miller, 1996). Similarly, a study by Nystrand and Gamoran (1991) documented that substantive engagement, which is similar to cognitive engagement with its focus on sustained commitment to areas of academic study, was positively related to a test of achievement in literature among eighth grade students (Fredricks et al., 2004).

In addition to examining cognitive engagement globally, several researchers have examined specific components of cognitive engagement. For example, the metacognitive strategy of self-regulation is viewed as one indicator of cognitive engagement (Appleton et al., 2006; Chiu et al., 2012; Te-Wang & Eccles, 2011). One study specifically attended to metacognitive strategies and their relation to cognitive engagement (Miller et al., 1996). Miller et al. examined the meta-cognitive strategy of self-regulation in addition to persistence and effort (measures of cognitive engagement) and their relation to academic achievement. Their study included 297 high school seniors in grades 10 to 12 in the mid-south who were registered in geometry, algebra II, trigonometry, pre-calculus, or advanced placement calculus. Miller et al. gave participants the Attitude Towards Mathematics Survey to garner more information on self-perception and regulation, cognitive strategies, persistence, and effort. Additionally, they were given the Student Engagement in Academics self-report scales to determine self-regulation, deep and shallow cognitive engagement, strategy use, persistence, and effort. Academic achievement in this study was based upon percentage grade in their class. Through multiple regression analyses Miller et al. found that self-regulation, persistence and effort (which are three measures of cognitive engagement), were significant contributors to the explanation of variance in achievement.

Self-efficacy is stated to reflect cognitive factors, which in turn influence achievement (Greene, Miller, Crowson, Duke and Akey, 2004). Greene et al. (2004) gave 220 high school seniors the Survey of Classroom Goal Structures and the Approaches to Learning Instrument to indicate mastery goals, performance approach goals, perceived instrumentality, and cognitive strategies. Academic achievement was measured by the percentage of course points earned. Path analysis indicated that self-efficacy had a relationship to achievement and included confidence related to the cognitive strategies (Greene et al., 2004).

Technology and Student Engagement

Among the context factors that have been proposed as influencing student engagement, a number of researchers have investigated the relationship that exists between technology and student

engagement (e.g., Beeland, 2002; Bulger et al., 2008; Mama & Hennessy, 2010; Morgan, 2008). Both Bulger et al. (2008) and Morgan (2008) examined how at-task behavior (engagement) was influenced by working with technology. More specifically, Bulger et al. (2008) used a university population (139 freshman students from the University of California) to decipher if an interactive lesson in a technology-equipped classroom versus a traditional lecture-based classroom would lead to a difference in student engagement levels. Students were placed either in a 110 minute traditional classroom with computers but no student centered interactive activity or a 110 minute interactive classroom with computers and a student centered interactive activity that required the use of the computers. Engagement was measured by the number of off-task and on-task activities documented by the computer during a lesson (Bulger et al., 2008). In the traditional lecture classroom, participants performed significantly more off-task than on-task internet actions, suggesting a lack of student engagement (Bulger et al., 2008). In sharp contrast to this group, the interactive classroom condition demonstrated that participants performed significantly more on-task than off task actions, thus, indicating that interactive simulation resulted in increased student engagement levels (Bulger et al., 2008). Similarly, Morgan (2008) found that when using technology (interactive whiteboards) with 226 grades 7 to 8 students, there were more at-task behaviors during instruction in the classroom.

In addition to the studies investigating at-task behaviors as a measure of engagement with technology, self-reporting measures have also been used to demonstrate the impact of technology on engagement. Beeland (2002) investigated the influence of interactive whiteboard technology on engagement through questionnaires given to 197 middle school students and 10 of their teachers. Beeland stated that each of the 10 teachers taught using an interactive whiteboard and then gave all of their students the Student Attitude Questionnaire to fill out to determine their perceptions towards the use of interactive whiteboards in the classroom (e.g., I enjoy learning with a whiteboard, I feel comfortable using a whiteboard). Engagement was considered to be an "agree" or higher on survey items. Results of this study indicated that the use of interactive whiteboards

affected student engagement as no responses on the survey were rated less than "agree" with the average amongst all students found to be 3.48 (between agree and strongly agree) (Beeland, 2002). Additionally, teacher survey results indicate that of the 10 qualities listed, none were rated below a six (on a one to seven scale with seven being the highest score) (Beeland, 2002). Overall, this study indicated that interactive whiteboards could be used in the classroom to increase student engagement in the learning process.

Mama and Hennessy (2010) chose to utilize three case studies taken from a broader study examining the link between the degree of technology integration (e.g., desktop computers, interactive whiteboards, and projectors), teacher attitudes, and student engagement. Case studies were selected from one classroom of six-year-olds and two classrooms of twelve-year-olds which were identified as having a low, medium, or high integration of technology (Mama & Hennessy, 2010). Student engagement was assessed through thematic analysis on interviews done prior to and after lessons to determine student engagement. Mama and Hennessy (2010) found that teachers' perceptions of the technology fulfilling their lesson objectives worked to constrain or increase the integration of that technology. Additionally, the level of technology integration appeared to be directly related to the teachers' input into the lesson activities, which in turn is argued to influence student engagement (Mama & Hennessy, 2010).

A mixed methods study conducted by Swan et al. (2007) used structured classroom observations, student self-reports, teacher interviews, and student focus groups to gain insight into the effects of technologies which were designed for whole class use (e.g., a camera, a writing pad, and a student response system all linked to presentation software) on the engagement of third grade students. It was found that the use of technologies designed to support group participation during classroom activities, increased student engagement in those particular activities (Swan et al., 2007). This indicated that whole class engagement can be increased by technologies that afford greater participation to all students in the classroom (Swan et al., 2007).

It should be noted that some of the studies investigating the relationship between technology use and student engagement lacked an in-depth description of the design of the learning tasks presented to the students or how technology was used within the learning environment (Bulger et al., 2008; Morgan, 2008). This made it difficult to see how technology influenced learning and left the reader only with knowledge that use, rather than the manner in which it was used, affected student engagement. Although some studies did detail the design of the learning tasks (Mama & Hennessy, 2010) or how the technology was used in the learning environment (Mama & Hennessy, 2010; Swan et al., 2007), the research is still quite limited in scope. Future research should seek to explore not only how the presence of technology can influence engagement but also how the manner in which technology is utilized in the student's learning environment may also influence engagement.

Speech Recognition Technology and Cognitive Engagement

Given the links that have been found between the use of certain technologies and cognitive engagement, it becomes of interest whether speech recognition technology might also influence cognitive engagement in writing in students. As previously stated, researchers have examined the role of speech recognition technology on certain writing outcomes and motivational levels, but have yet to explore how this technology or the manner in which it is implemented helps students to become cognitively engaged in their writing. With the perceived benefits of both technology integration and cognitive engagement becoming evident through the research, the need to consider cognitive engagement as a measure of success becomes imperative.

It is possible, for example, that the use of speech recognition technology may indirectly impact student achievement by serving to increase cognitive engagement. Through alleviating writing related barriers, students who had previously allocated time to the act of writing are afforded the time to more critically and strategically think about their work, and through doing so may find themselves more invested in their writing tasks. Specifically, it may be that greater focus on the task as opposed to the writing process may consequently influence cognitive engagement.

Although research has not yet examined the impact of speech recognition technology on student cognitive engagement, Bulger et al., (2008) did point to technology use (e.g., interactive whiteboards) as influencing at-task behaviors and subsequently engagement.

As attention is given to this area, there are two important considerations. Firstly, the measurement of cognitive engagement in writing and secondly, the necessary conditions to facilitate cognitive engagement when using speech recognition technology. Investigating the extent to which students are cognitively engaged provides researchers with a basis to begin investigating the factors which may play a role in student cognitive engagement. Additionally, measurement not only provides information on overall cognitive engagement, but also pinpoints the specific components which comprise it (e.g., strategic thinking, intrinsic motivation, goal setting etc…). This allows for a more in-depth analysis as to the differences between engaged and non-engaged students. Through awareness of conditions which are conducive to cognitive engagement, there is a greater chance for successful implementation and use of speech recognition technology, which may impact student investment and refinement and deployment of strategic thinking.

Assessing cognitive engagement in writing. An important area to consider in examining cognitive engagement in writing is how best to measure levels of student engagement. While engagement has been examined through a number of qualitative approaches (e.g., on task behaviours; Bulger et al., 2008, Morgan, 2008), self-report measures are most commonly used (Appleton et al., 2006; Appleton, 2012; Greene et al., 2004; Hawthorne, 2008; Miller et al., 1996). Of the researchers investigating cognitive engagement, a number of different survey and rating scale measures have been utilized, with cognitive engagement typically comprising one area or subscale. Greene and Miller (1996) chose to use the Motivation and Strategy Use Survey, a 54 item survey, with 38 questions specifically on cognitive engagement. Other areas of focus on this survey included learning goal orientation (four items), performance goal orientation (four items), and perceived ability (eight items; Greene & Miller, 1996). Wilms et al. (2009) measured student engagement through questions related to social engagement (two items on frequency of

participation in sports and school clubs and six items on sense of belonging), academic engagement (based on three aspects of attendance), and intellectual engagement (akin to cognitive engagement). Intellectual engagement was measured through 10 statements specific to enjoyment, interest, and motivation to do well in math and language arts, as well as the relevance students' see their classes as having to everyday life. Similarly, Appleton (2012) created a survey which was comprised of 38 questions. Of these questions, 19 questions were regarding affective engagement (e.g., teacher-student relations, peer support at school, and family support for learning), and 16 were specific to cognitive engagement (e.g., control and relevance of school work, future aspirations and goals, and intrinsic motivation).

While cognitive engagement is commonly measured at a domain-general level, a number of researchers have developed measures to examine subject-specific changes in cognitive engagement (e.g., Attitudes Towards Mathematics Survey; Miller et al., 1996). With respect to writing, the Survey of Motivation to Engage in Writing by Hawthorne (2008) provides a measure of seven aspects of engagement in writing. These include: self-concept for writing, self-efficacy for writing, affective feelings about writing, effort regulation, self-regulation, the value placed on writing, and task environment. These seven areas are then used to compute three composite scores in the areas of self-belief, regulation, and affect. Although Hawthorne (2008) does not identify the survey specifically as a measure of cognitive engagement, review of the instrument does support it as a measure of cognitive engagement given its alignment with theory. Of these three composite scores, Hawthorne's regulation subscale is most closely related to the construct of cognitive engagement as proposed by Wilms et al. (2009) and Appleton (2012). Similar to their conceptualizations of cognitive engagement, the factor titled regulation considers the relevance of school to future aspirations, goal setting, strategizing, and self-regulation.

In addition to the similarities between the composite regulation and cognitive engagement, Hawthorne's composites of affect and self-belief also have many other similarities to the conceptualization of cognitive engagement provided by Appleton (2012). For instance, the

composite titled affect (described as the overall disposition of liking or not liking writing) is said to reflect aspects of interest, values, and personal goals (Hawthorne, 2008). Personal goals and interest in writing can be equated with the motivational literature (e.g., places importance on learning goals and motivation to learn) used by Appleton (2012) to conceptualize cognitive engagement. Not to mention, within the Survey of Motivation to Engage in Writing, of the items in the composites affect and regulation, five items reflect intrinsic motivation, eight items reflect strategic thinking, four reflect relevance to future endeavors, and five items are representative of goals, all components of cognitive engagement in the Appleton (2012) model. Moreover, the composite titled self-belief has 17 items which are representative of self-efficacy and self-concept (e.g., I write better than most kids in my class, I feel confident in my ability to express my ideas in writing), which are related to academic beliefs and efforts, components which Appleton (2012) suggests influence cognitive engagement. It is apparent, that the Survey of Motivation to Engage in Writing bears many similarities to the cognitive engagement model provided by Appleton (2012) and, as such, provides a useful tool for those seeking to assess cognitive engagement in writing.

Conditions to Examine in Relation to Technology Use

As part of examining the impact of speech recognition technology on learning, attention is required to the conditions by which it is being implemented. Research has indicated that the integration of technology is a more complex step then the sporadic incorporation of technology in the classroom setting (Valcarcel, 2010) and that having technology available in classrooms does not necessarily translate into positive educational outcomes (Keengwe & Onchwari, 2011). In fact, Dias and Atkinson (2001) suggested that the teaching pedagogy, rather than the technology itself determines effective technology integration. Similarly, Friesen and Clifford (2002) stated that the introduction of new technology "should never be about pouring old wine into new bottles," (p. 1) but rather, technology use should facilitate tasks at a level of complexity which would be impossible without it. Other researchers have expressed similar sentiments, suggesting that those

investigating the efficacy of technology should consider the environment it is offered in and the individual using the technology (CALL Scotland, 2008; Holmes & Silvestri, 2012).

Possible conditions include the environment it is offered in, with a focus on the importance of taking teacher, parental, and student investment into account (CALL Scotland, 2008; Holmes & Silvestri, 2012). Holmes and Silvestri (2012) add that the efficacy of speech recognition technology differs depending on the individual using the technology and that future research should address the assistive technology needs of students and the conditions that interact with successful use (e.g., individual preferences, range of tasks which it can be used for, and the context; Holmes & Silvestri, 2012).

Successful implementation of technology has been investigated by various organizations (Communication, Access, Literacy, Learning Scotland, 2008; International Society for Technology in Education, 2008). The International Society for Technology in Education (ISTE) is a nonprofit organization committed to empowering learners through the ISTE standards for learning, teaching, and leading in the digital age (ISTE, 2014). ISTE members have for 20 years monitored research on the effectiveness of technology in education and on the resulting student outcomes (ISTE, 2008). Through this monitoring, they described a "convincing trend" (ISTE, 2008, p. 3) as emerging; more specifically, when technology is implemented appropriately, the integration has positive effects on achievement. In fact, of studies not showing statistically significant effects of educational technology on student achievement, ISTE (2008) cited the need for the correct implementation of technology into teaching and learning as being the common denominator. It was suggested that policy makers and practitioners should focus on seven key conditions for successful technology implementation (ISTE, 2008): ongoing professional development, the technology supporting the curriculum objectives, allowing for student collaboration, adjustable to address student ability, integrated as the lesson is taught, allowing for students to design and implement projects, and used where technology innovation is supported.

Professional development is considered to be effective when it is consistent and on-going, as to keep teachers up to date with the latest applications, resources, and programs available (ISTE, 2008). In terms of technology in alignment with curricular objectives, ISTE (2008) posited that objectives be fulfilled as they would be should no technology be used. In terms of providing the opportunity for student collaboration, Kulik (2003) found that collaboration was effective in increasing the amount of information available to students and that it encouraged critical thinking skills, through ideas and information being shared amongst students.

In addition to these conditions, adjustability of technology is also stated to be crucial. Having the technology being adjustable to student ability, allows applications to be tailored to the needs of each student. Furthermore, ISTE (2008) stated that this adjustability allows for students to better communicate their learning to teachers. Integration of technology was also identified as needing to occur within the daily learning schedule for success to result (ISTE, 2008). Specifically, Kulik (2003) found that computer simulations were effective when teachers spent an adequate amount of time on using them for core learning. Similarly, Middleton and Murray (1999) found that teachers who frequently and more purposefully integrated technology into instruction, had students demonstrate greater achievement than students whose teachers used low levels of technology.

The condition of being able to design and implement projects is also important to ISTE (2008). Moreover, real world applications of these projects, was stated as being more effective than using technology solely for drill and practice activities (ISTE, 2008). Lastly, the use of technology in a supportive environment is another important condition to note. It has been found that educational planning that demonstrates effective use of technology, has been linked to improvements in student achievement (ISTE, 2008).

In addition to ISTE, CALL Scotland is a service and research unit within the University of Edinburgh that helps pupils in education to access the curriculum and work alongside classmates through the use of technology. Similar to ISTE, CALL Scotland identified certain conditions as

influential to success with technology. With a specific focus on speech recognition technology implementation, they determined that the suitability of the technology was crucial and specifically stated, that the right technology, sufficient time, and suitable training (measures of success provided by the BECTa project), are influential to success with this technology in particular. More specifically, the report found that speech recognition technology was found to suit some but not all writers and CALL Scotland (2008) suggested that when speech recognition technology is not found suitable by the student, a lack of success may result. In regards to sufficient time, it was found that the students who opted to continue using speech recognition technology were the students who had more frequent practice with staff (CALL Scotland, 2008). In fact, practicing once a week or more following training, made the student twice as likely to successfully use speech recognition technology as compared to students who practiced less often (CALL Scotland, 2008).

It should be noted that successfully introducing this technology requires a fair bit of energy and commitment from teaching staff, parents, and the students (CALL Scotland, 2008). In addition to the conditions provided by ISTE (2008) and suitability conditions provided by CALL Scotland (2008), it becomes important to also examine teacher and student attitudes towards technology implementation. Research has shown that for technology to enhance student learning, teachers need to be both interested and willing to use it (Keengwe & Onchwari, 2011). CALL Scotland (2008) also identified the condition of student attitudes as one of the best measures of successful implementation of speech recognition technology. Due to the multiple ways in which speech recognition technology can be used it is important to consider how this technology is utilized and the attitudes of students, teachers and school administrator(s) towards integration.

With respect to training, primary focus has been given within the literature to the initial training components. The focus here is on ensuring accurate speech recognition through the creation of a speaker profile specific to the user's speech patterns and accent (Zhao, 2007). Although use of speech recognition technology is possible without training to a specific individual

voice, training is strongly recommended to attain a high level of accuracy (CALL Scotland, 2008). Typically, such training is completed in a small group setting or one-to-one with an instructor (CALL Scotland, 2008). Some programs require that the user read single words aloud on the screen, while others require the user read complete sentences word-by-word (Raskind & Higgins, 1999) to achieve accurate recognition.

While there is not an established and agreed upon training regimen, Raskind and Higgins (1999) chose to introduce the technology, familiarize users with it, and follow up with a second session dedicated to mastering the techniques of correcting errors in speech recognition. Alternatively, Barksdale (2000) suggested implementing a number of steps to successfully train new users in the use of this technology. First he suggested that the students practice the reading scripts aloud without using a computer for one day a week for five weeks under the supervision of an adult, and that "whisper coaching" (having an adult whisper the sentences or phases in the student's ear to help with pronunciation) is used when necessary (Barksdale, 2000). Lastly, if time permits, students with reading deficits should practice their speech recognition for 30 minutes a day for several weeks and then recreate their user profile to increase student confidence (Barksdale, 2000). Training sessions of shorter time periods have also been found effective. A study completed by Communication Access Literacy and Learning (CALL) Scotland (2008) had ten training sessions consisting of approximately 50 minutes each for both students and staff to learn how to use speech recognition software. It should be noted that some students found that they did not necessarily need to complete all sessions and that eight to nine sessions provided the confidence needed to use the program (CALL Scotland, 2008).

Through an examination of the seven conditions provided by ISTE (2008) (e.g., ongoing professional development, the technology supporting the curriculum objectives, allowing for student collaboration, adjustable to address student ability, integrated as the lesson is taught, allowing for students to design and implement projects, and used where technology innovation is

supported), and the conditions of suitability and student attitudes towards speech recognition technology by CALL Scotland (2008) (e.g., the right technology, sufficient time, suitable training and student attitudes), relating to successful technology integration, researchers may see how cognitive engagement may result.

Purpose of the Study

This study examined the extent to which students utilizing speech recognition technology are cognitively engaged in their writing, the impact on student writing when using speech recognition technology, and the necessary conditions to elicit cognitive engagement. Although, it is clear that technology use influences cognitive engagement, the Survey of Motivation to Engage in Writing is not sufficient to encompass the impact which speech recognition technology has on learning or the necessary conditions needed to facilitate cognitive engagement. It is apparent that while technology use has in fact influenced positive learning outcomes, such as lower level and skilled writing (O'Hare & McTear, 1999; Quinlan, 2004) and student engagement (Beeland, 2002; Bulger et al., 2008; Mama & Hennessy, 2010; Morgan, 2008), less attention has been paid to the environment that technology is utilized in. This is problematic considering that researchers have identified the need to evaluate how individual preferences, range of tasks, and even context can affect successful use of technology (Holmes & Silvestri, 2012).

Knowing that successful implementation and positive outcomes may be aligned with investment and perceived usefulness (characteristics closely associated with cognitive engagement; CALL Scotland, 2008), it becomes important to evaluate the necessary conditions to facilitate these characteristics to enable successful use of this technology in writing tasks. Specifically, it will be important to consider the role of the student, teachers, and school administrator(s) in addition to the classroom context in which speech recognition technology is being implemented in. Due to the multiple ways in which speech recognition technology can be used, it is also important to consider how this technology is utilized and the attitudes of students, teachers, and school administrator(s)

towards integration. Through an examination of the necessary conditions for successful technology use provided by the ISTE (2008), the conditions for successful use of speech recognition technology set forth by CALL Scotland (2008), and speaking to staff about their attitudes surrounding the use, in addition to the Survey of Motivation to Engage in Writing, necessary conditions for cognitive engagement in writing may become apparent.

Chapter Summary

In this chapter, previous research pertaining to the impact of speech recognition technology on student learning and on cognitive engagement was presented. In addition, the construct of cognitive engagement was introduced and research findings regarding the impact of cognitive engagement on student writing were shared. Lastly, the literature review was concluded through a discussion regarding the relationship between technology and engagement, speech recognition technology and cognitive engagement, and conditions for successful use of speech recognition technology.

CHAPTER THREE: RESEARCH DESIGN

This chapter presents the methodology of a case study that examined the extent to which students utilizing speech recognition technology were cognitively engaged in their writing, the necessary conditions to elicit cognitive engagement, and the impact of speech recognition technology on student writing. The study was designed to compare factors that differed between students identified as engaged and non-engaged in the writing task, with examination given to differences in the learning environments and to student and teacher perceptions toward the use of speech recognition technology. The design of this study was used to provide insight into factors to consider when using speech recognition technology in order to maximize the impact on student learning.

Research Design Overview

The study utilized a case study approach using mixed methods procedures to gain insight into speech recognition technology and its relation to cognitive engagement in writing in students. Case study research involves "the study of a case within a real-life context or setting" (Yin, 2009, p. 97) and includes the investigation of real life contemporary case(s) through the process of in-depth data collection involving multiple sources of information (Creswell, 2013). This case study investigated the phenomena of cognitive engagement in writing in students utilizing speech recognition technology. The case study approach is familiar amongst social scientists, has a long distinguished history across multiple disciplines (Creswell, 2013), and provides an in-depth picture of the phenomenon being studied. Additionally, this approach is used to investigate the boundaries between phenomenon and context that are not clearly evident (Yin, 1984), as was the case with the relationship between cognitive engagement in writing and speech recognition technology.

In addition to investigating relationships which are not clearly evident, Merriam (1998) suggested that this method offers "a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon" (Merriam, 1998, p.

562). Such is the case with the relationship between cognitive engagement in writing and speech recognition technology. Additionally, a case study can result in a "rich and holistic account of a phenomenon" (Merriam, 1998, p. 562). Through the participants' accounts of how speech recognition technology had impacted their (or their students') cognitive engagement and learning, survey data, and classroom observations, there is a better understanding of this relationship. Furthermore, case study research allowed for multiple data collection procedures to be used (Stake, 1995). In fact, the use of multiple data collection procedures (e.g., use of both qualitative and quantitative means) is a common approach used in the study of the relationship between engagement and technology (Mama & Hennessy, 2010; Swan et al., 2007).

Case study methodology was used by researchers investigating engagement in relation to technology integration (Mama & Hennessy, 2010). Previous research investigating the relationship between engagement and technology have also utilized both quantitative (e.g., surveys) and/or qualitative (e.g., interviews and focus groups) means (Beeland, 2002; Mama & Hennessy, 2010; Swan et al., 2007). Due to the desire to address both qualitative and quantitative inquiries, mixed method data collection was used in the study. Mixed methods approaches originated in 1959 by Campbell and Fiske who used multiple methods of data collection to study the validity of psychological traits and focused on collecting and analyzing both quantitative and qualitative data in a single study (Creswell, 2003). Although this approach calls for extensive data collection and is time intensive due to analyses of both text and numeric data (Creswell, 2003), the use of both qualitative and quantitative data served to provide a more in-depth analyses than either method employed independently.

Research Questions

The intent of the study was to investigate the following research questions:

1. To what extent are students cognitively engaged in writing when using speech recognition technology?

2. What are the necessary conditions to elicit cognitive engagement in writing with students who are using speech recognition technology?
3. How does speech recognition technology influence student writing?

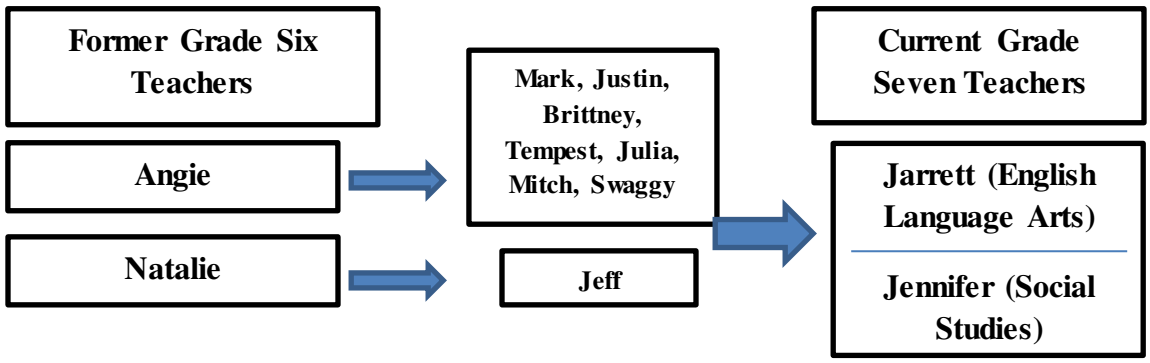
Participants

A convenience sample was used which consisted of students at a specialized southern Alberta school intended for primary and secondary students who had been diagnosed with a learning disability. Invitation to participate in this study was extended to eight seventh graders across two classes who had consistently utilized speech recognition technology in their learning since grade 6 at the school. Grade 7 students were the targeted population due to the length of time that they had used speech recognition technology in their learning (minimally one year). This ensured that the technology was impacting their writing as opposed to issues with learning to use the technology. In this regard, students must have attended this specialized school since grade 6 and been trained in the use of speech recognition technology within the same year. For the eight students who met the inclusionary criteria, student assent and parental consent was obtained and all eight were included in the study. The eight students were from two classes and shared the same grade 7 English Language Arts and Social Studies teachers and teaching assistants. With respect to the preceding grade 6 year, seven participants were previously in one of the grade 6 classrooms while only one was in the other grade 6 classroom. Besides the above criteria, students needed to both give assent and have their guardian(s) give their consent to participate in this study.

In addition to the student participants, invitations were also extended to and accepted by the grade 7 English Language Arts teacher, the grade 7 Social Studies teacher as well as four generalist grade 6 teachers (two current and two former). Further, four teaching assistants (one former grade 6 teaching assistant, one current grade 6 teaching assistant, and the teaching assistants to the two grade 7 teachers), the assistive technology specialist at the school (n=1), and the principal (n=1) participated in the study. Teachers and teaching assistants were recruited based upon whether they

had a current student (grade 7) or past student (grade 6) who met the inclusion criteria and if they were teaching in the year in which speech recognition technology is first administered to students (current grade 6 teaching staff). The assistive technology specialist and principal were also recruited to gain additional insight into the research questions. Informed consent forms were received from all staff members included above. Figure 3.1 shows the relationship between teachers and students. It should be noted that pseudonyms are used below.

Figure 3.1 *Teachers in relation to students*



Methods of Data Collection

The study utilized a variety of data collection methods. The Survey of Motivation to Engage in Writing (Hawthorne, 2008) was used to gather data pertaining to engagement in writing. Focus group interviews were then conducted with three groups of students, those who scored in the top quartile on the survey, those who scored in the middle two quartiles, and those who scored in the bottom quartile as per Hawthorne (2008) scoring criteria. Student participants (n=8) completed a survey and participated in focus groups. Additionally, interviews with teachers (n=6), their respective teaching assistants (n=4), the assistive technologist (n=1), and principal (n=1) occurred at the school at a time convenient for the participants.

The survey of motivation to engage in writing. The purpose of the Survey of Motivation to Engage in Writing (Hawthorne, 2008) was to identify the participating students' levels of cognitive engagement in writing (Appendix A). The survey provided a measure of seven aspects of engagement in writing (e.g., self-concept for writing, self-efficacy for writing, affective feelings

about writing, effort regulation, self-regulation, the value placed on writing, and task environment) which were computed to create three composite scores (self-belief, regulation, and affect).

As the Survey of Motivation to Engage in Writing was created to evaluate general engagement in writing (e.g., inclusive of motivational components), a second C-score was calculated for this study using 20 item specific to cognitive engagement[1] (e.g., control and relevance of school work, future aspirations and goals, intrinsic motivation; Appleton, 2012). The remaining 20 items were considered by the researcher to reflect aspects of motivation, which are influential to cognitive engagement (e.g., self-efficacy; Appleton, 2012). As such, the entire Survey of Motivation to Engage in Writing was used to determine cognitive engagement in student participants and the 20 items included in the C-scores were specific to cognitive engagement. The C-score was developed in order to compare it to the overall survey score to ensure that the Survey of Motivation to Engage in Writing measured engagement as opposed to motivation.

The survey was administered to two groups of four students. Administration took place during assigned Library periods; with one group administered the survey on Tuesday and the other group administered the survey on Thursday of that same week. The researcher read aloud all 40 questions. This was done to ensure that no matter the reading level of the student, the questions would be presented correctly. Specific steps were taken to attempt to control for response bias. More specifically, amongst the factors known to increase socially desirable responding are speed instructions (Sutherland & Spilka, 1964) and distraction (Paulhus, Graf & Van Selst, 1989) and as such Paulhus (1991) suggested that these factors should be minimized. In alignment with this, students were given as much time as needed to answer each item prior to the researcher moving on to the next question. Additionally, students were requested to turn off their iPods and mobile devices while completing this survey.

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[1] The C-score was researcher generated for this study, with the 20 survey items included in this score selected by the researcher based on their alignment with the literature on cognitive engagement.

Based upon the Survey of Motivation to Engage in Writing cut scores established by Hawthorne (2008), students were placed into one of three focus groups. The Engaged group consisted of three students who scored above 130. The Non-Engaged group (described as reluctant writers; Hawthorne, 2008) consisted of two students who scored 99 or below. A third group was created which consisted of three students who scored between 100 and 130 and were titled the Neutral group. It should be noted that Hawthorne (2008) did not use the sample of students who scored within the neutral range in his own study.

Focus group interviews. A focus group is "a face to face interview in which a number of people are interviewed at the same time and share ideas with the interviewer and each other" (Stangor, 2007, p. 104). A focus group interview was utilized with these students as a method of generating collective views and obtaining a rich understanding of participants' beliefs and experiences (Gill, Stewart, Treasure & Chadwick, 2008). Additionally, the group dynamic presented in focus group interviews are often deeper and richer than those obtained from interviews (Thomas, MacMillan, McColl, Hale & Bond, 1995). Focus group interview questions were created by the researcher and in alignment with the seven necessary conditions for successful technology integration set forth by the ISTE (2008) as well as four conditions for successful use of speech recognition technology (sufficient training, suitable training, suitable technology, and student attitudes) provided by Communication, Access, Literacy and Learning Scotland (2008). It should be noted that one ISTE (2008) condition, professional development within the school, was not inquired upon with the students. The researcher's supervisors reviewed the focus group interview questions prior to the interviews to ensure that they adequately encompassed the research objectives. A series of semi-structured questions regarding the conditions set forth by ISTE (2008) and CALL Scotland (2008), as well as well as questions pertaining to teacher attitudes towards implementation of speech recognition technology, parental support, home use, favorite student aspects, and barriers were included (Appendix F).

A semi-structured interview format was chosen as an appropriate method of data collection, as interviews provided a means to examine the key research questions but also allowed the freedom to diverge in order to pursue ideas that were presented (Gill et al., 2008). Questions were phrased to facilitate openness and encourage participants to elaborate. Millward (2012) stated that this strategy provides attentiveness and listening amongst participants' with them feeling more open to respond as they wish. While asking these questions, the researcher attempted to maintain focus through ensuring that specificity, range, and depth were met. Specificity is defined as the extent to which small details are sought out in participants' responses, range of coverage is the skill of the moderator in transitioning discussion, and depth is the process of eliciting more in-depth responses through expanding on responses (Millward, 2012).

Prior to the focus group interview beginning, the researcher explained that the interview would have a duration of approximately 30 minutes and that the students would be asked how speech recognition technology had influenced their learning. Students were also advised that due to the nature of focus group interviews, anonymity could not be guaranteed, but that the information would be protected so that it is not identifiable. As such, students were then asked to provide pseudonyms and a discussion occurred around the importance of maintaining the confidentiality of the focus group after it concluded. Participants were also made aware that the focus group interviews would be recorded to ensure accuracy and that all recordings would be protected until deleted at the completion of this study. Through providing the students information on what to expect, it was more likely that there was greater honesty (Gill et al., 2008). Focus group interviews occurred with the three groups of students. Through separating the students into these groups, the researcher was better able to distinguish if and how conditions for cognitive engagement differed for the Engaged (top quartile), Neutral (middle two quartiles), and Non-Engaged (bottom quartile) groups, as well as why they felt they were or were not engaged. Separation of students into three groups was also in alignment with Krueger (1994) who suggested that participants should share similar characteristics (e.g., cognitive engagement in writing).

In regards to the number of participants, the optimum number of students to be included in a focus group varies, but Krueger and Casey (2000) suggested that smaller groups show greater potential. As such, the three focus groups were an appropriate size. Focus group interviews were completed within a private office space in the school. This was in alignment with suggestions provided by Millward (2012). Millward recommended that the location should be easy to reach and avoid posing any difficulties for the participants. The duration of the focus group interviews was 30 minutes, as it is advised that focus groups involving children should not exceed an hour (Millward, 2012).

Interviews. In addition to the student focus groups interviews, semi-structured interviews took place with the current grade 6 teachers (n=2), previous grade 6 teachers (n=2), current grade 7 Social Studies teacher (n=1), current grade 7 English Language Arts teacher (n=1), the respective teaching assistants (n=4), the assistive technologist (n=1), and principal (n=1). It should be noted that interviews with the current grade 6 teachers served to provide insight into speech recognition technology itself as opposed to its relation to specific students. Additionally, teachers and their respective teaching assistant were interviewed together and the interview with one of the previous grade 6 teachers had occurred using e-mail as she was on maternity leave. Similar to the focus group interviews, the researcher derived questions by incorporating the necessary conditions for successful technology integration set forth by the ISTE (2008), the necessary conditions for successful speech recognition technology incorporation by CALL Scotland (2008), and additional questions pertaining to teacher attitudes towards implementation, training, expectations of students, perceived necessary conditions, and barriers to success (Appendices B through E). These questions only differed from the student focus group interview questions in terms of age appropriate wording and that the additional questions focused on expectations and training, as opposed to parental support, home use, and favorite student aspects. These semi-structured interview questions allowed a closer examination into whether speech recognition technology was utilized in a manner which supported the necessary conditions proposed by ISTE (2008) and CALL Scotland (2008) and

helped to indicate the essential circumstances to elicit cognitive engagement in students using speech recognition technology. A semi-structured interview format was chosen as an appropriate method of data collection as the interviews examined key research questions while also providing the ability to diverge to pursue a new idea as it was presented (Gill et al., 2008). This form of interview also allowed participants to elaborate on information that was important to them and may not have been considered by the researcher (Gill et al., 2008).

Considerations were made to ensure that the interview process went smoothly. Leech (2002) suggested that it is beneficial to restate what the respondent has just said to ensure that the correct meaning is interpreted. Additionally, prompts were provided to serve the purpose of keeping the conversation alive (Leech, 2002). Participating staff members were advised that the purpose of the interview was to gain insight into how speech recognition technology had influenced their students, the classroom environment, the impact which speech recognition technology had on student writing, and the necessary conditions to facilitate cognitive engagement in writing. The principal and assistive technologist were also asked about training, support, and policies surrounding speech recognition technology in the school. Participants were also asked to provide pseudonyms. Due to the small number of teachers and small population of one principal and one assistive technologist, there is the possibility of their information being traced back to them. Due to this, staff participants were made aware of the limits to confidentiality in this study during the consent process. Staff members were also made aware that the interviews were being recorded to ensure accurate documentation of information and that these recordings would be kept secure until they are deleted at the completion of the study. The interviews took no longer than 45 minutes.

Classroom observations. In addition to focus groups and interviews, 50 minute classroom observations took place twice in each of the current grade 6 classrooms as well as twice in both the grade 7 English Language Arts and Social Studies classrooms (Appendix G). Each classroom observation was done globally, with attention paid to fulfillment of six observable conditions for

successful technology integration as specified by ISTE (2008). Ongoing professional development (one of the seven conditions) was not included as it is not observable. Observation of the ISTE (2008) conditions was conducted by dividing the 50 minute class periods into 16 minute increments. During each 16 minute increment, the researcher recorded the occurrence of these conditions and how they were fulfilled. Figure 3.2 is an example of how classroom observation data was collected.

Figure 3.2 *Example of Classroom Observation Protocol*

Curriculum Objective	**Yes/No**	**How was it used to meet this objective?**
Was SRT used to support the curriculum objective?		
Student Collaboration	**Yes/No/No student collaboration in lesson**	**How did SRT facilitate this collaboration?**
Did SRT allow for student collaboration?		

Evaluation of if and how these conditions occurred was central to determining if speech recognition technology was being successfully used. In addition to recording the occurrence and specific actions taken to meet the six conditions, consistency of conditions across the three 16 minute increments were also noted. During the observations, the researcher took on the role of a non-participant, and observed without participating.

Methods of Data Analysis

Using the Survey of Motivation to Engage in Writing, an engagement total score was calculated for each participant based on the entire 40 item survey (maximum score of 200). Level of engagement was determined using the cut scores provided by Hawthorne (2008) with total scores

greater than 130 representative of Engagement, scores of between 100 and 130 indicative of the Neutral group, and scores of 99 or less representative of Non-Engagement. Descriptive statistics were completed through the use of the program SPSS. Use of this survey provided insight into research question one, indicating the extent to which students who utilized speech recognition technology were cognitively engaged in writing and also allowed researchers to then inquire further through qualitative means as to processes which helped or hindered their cognitive engagement in writing. In addition to this analyses, a second score was calculated based upon 20 items in the survey which were considered by the researcher to be most directly relate to cognitive engagement (e.g., control and relevance of school work, future aspirations and goals, and intrinsic motivation; Appleton, 2012) as opposed to the 20 items related to self-efficacy and self-concept which Appleton (2012) considers influential to cognitive engagement. The researcher titled this score the C-score and a score of 65 or above replicated the average 3.27 on a five point scale which Hawthorne used to indicate engagement in the entire Survey of Motivation to Engage in Writing. This score was calculated to determine if students who were found to be cognitively engaged on the entire Survey of Motivation to Engage in Writing would also be found to be cognitively engaged when looking at the 20 items directly related to cognitive engagement.

Analyses of both the interviews and focus group interviews occurred through a number of different steps. All individual and focus groups interviews were first transcribed by the researcher as to prepare it for analyses. Following the steps outlined by Creswell (2013), once the data was organized (e.g., transcriptions from the focus group interviews with cognitively engaged students, transcriptions from grade 6 teacher interviews etc…), reading and memoing of the data occurred, and was followed by the coding of information that was found in the different subsets of data. Coding of data occurred through the use of a program called NVivo where the researcher had the ability to search for similar words amongst the data set and highlight key points (QSR International, 2013). Once coding was completed, themes were identified. Themes are defined as "broad units of information that consist of several codes aggregated to form a common idea" (Creswell, 2013, p.

186). Lastly, the data was interpreted by the researcher and one supervisor, generalizations were formed about what was learnt and an in-depth picture of the cases through the use of narratives, tables and figures was presented. Figure 3.3 is an example of the themes present from staff interviews regarding the ISTE (2008) condition of ongoing professional development.

Figure 3.3. *Example of the themes of ongoing professional development across staff interviews*

Assistive Technologist	**Grade Six**	**Grade Seven**	**Principal**
-Variety of skills amongst staff	-Training available	-Training available	-Would like that teachers learn to use it
-Curiosity differs amongst staff	-Preference to have A.T work with students	-Preference for A.T to work with students	-A.T as a support to learn
-Offered as needed	-Basic knowledge	-Basic knowledge	
		-Limited knowledge	

Themes:

- Available training
- Training as a non-issue
- Knowledge of the program (basic→non-existent)

Analyses of classroom observations occurred through reviewing the classroom observation data. Classroom observation data was summarized to determine if and how the conditions set forth by ISTE (2008) for successful technology use were being met during the class period. Classroom observation data provided additional information into the relationship between these conditions and cognitive engagement in writing when compared to student engagement data from the Survey of Motivation to Engage in Writing. Figure 3.4 is a sample of how consistency of the condition of speech recognition supporting curriculum objectives was determined.

Figure 3.4. *Sample of classroom observation summary*

Was SRT used to support the curriculum objective? **(Social Studies)**	*Beginning 1/3*	*Middle 1/3*	*End 1/3*
	-Students were explained the task and asked to use SRT to complete it -Students used SRT to support their creation of a PowerPoint on two Fathers of Confederation.	- Students continued to use SRT to support their creation of a PowerPoint on two Fathers of Confederation -Students appeared to create one or more PowerPoint slides.	-Students continued to use SRT to support their creation of a PowerPoint on two Fathers of Confederation -During the last five minutes the students went back into class to take notes and did not use SRT to do so (e.g., notes to take were on the interactive whiteboard)

Overall, four methods of data collection were used (e.g., The Survey of Motivation to Engage in Writing, focus groups interviews, interviews, and classroom observations) to answer the three research questions. Through investigating the research questions through four different methods, the researcher was able to obtain viewpoints across both staff and students. Table 3.1 indicates the data points used for analyses of the three research questions.

Table 3.1. *Methods of Data Collection*

Area of Study	Data Source					
	Interviews					Classroom Observations
	Students	*Teachers*	*Teaching Assistants*	*Assistive Technologist*	*Principal*	
Q1: To what extent are students cognitively engaged in writing?	•	•	•	•	•	
Q2: What are the necessary conditions to elicit cognitive engagement in writing?	•	•	•	•	•	•
ISTE (2008) conditions						
Professional development		•	•	•	•	
Used to support curriculum objectives	•	•	•	•		•
Integrated into instruction	•	•	•	•		•
Opportunity to design and implement projects	•	•	•	•		•
Technology innovation is supported	•	•	•	•	•	•
Opportunity for student collaboration	•	•	•	•		•
Adjustable to student ability	•	•	•	•		•
CALL Scotland (2008) conditions						
Sufficient student training	•	•	•	•		
Suitable student training	•					
Suitable technology for student	•					
Student intent to use in schoolwork	•					
Q3: How does speech recognition technology influence student writing?	•	•	•	•	•	

Reliability and Validity

The Survey of Motivation to Engage in Writing was previously field tested by Hawthorne (2008). Field testing took place over a period of 18 months with an initial pilot study being

conducted with a sample of 99 grade 10 students from four secondary schools within Auckland (Hawthorne, 2008). A second amended 95 item version of the survey was then administered to two grade 10 cohorts in two separate secondary schools. Field testing indicated that there was a normally distributed range of student responses, suggesting that the survey was able to successfully measure a range of levels of engagement (Hawthorne, 2008). Additionally, the survey scales were found to reliably measure differences between reluctant and engaged writers (Cronbach's alpha score of .949). A 40 item version of the survey was created after it was found that some items did not load on any major factors or did not correlate significantly with items worded similarly and that the task environment scale within the survey was not effective in discriminating between engaged and reluctant students (Hawthorne, 2008). Through confirmatory factor analyses, the 40 item version of the survey with three contributing factors (e.g., self-belief, regulation, and affect) was found to have good reliability: .921 for self-belief, .893 for regulation, and .862 for affect. The three factors also explained 47.1% of variance before rotation and 43.1% after rotation. Confirmatory factor analysis also indicated that the hypothesized model was a good fit to the observed data (Chi square=1341, degrees of freedom 737, RMSEA= .057).

With respect to the qualitative components of this study, Creswell (2013) considered validation to be a strength of qualitative research due to extensive time spent in the field, the detailed descriptions provided, and the closeness of the researcher to the participants. Internal validity, or the how results match reality, was enhanced in this case study by performing three strategies suggested by Creswell (2013). Firstly, triangulation, "using multiple investigators, multiple sources of data, or multiple methods to confirm the emerging findings" (Merriam, 1998, p. 2444) was established through using three different sources of information (e.g., interviews, the Survey of Motivation to Engage in Writing, and classroom observations). Additionally, the researcher spoke to a variety of professionals within the school (e.g., teachers, teaching assistants, assistive technologist, and principal) and with students to obtain different perspectives on speech recognition technology. Secondly, external audits were done by one of the researcher's supervisors

to ensure that findings and interpretations were supported by the data. Thirdly, Creswell (2013) suggested clarifying research bias from the onset of the study as a validation strategy. Due to this, the researcher commented on past experiences within the school and biases that may shape her interpretations.

External validity is described as the extent to which findings can be applied to other situations (Merriam, 1998). Although generalizability is a criticism of qualitative research (Myers, 2000), Trochim (2006) suggests that rich descriptions can work to enhance transferability, or the degree to which the results of a qualitative research study can be generalized to other settings. Due to this, rich descriptions were provided regarding the three student groups (Engaged students, Neutral grouping of students, and Non-Engaged students), the classroom environments which were provided to students in grade 6 and presently in grade 7, as well as training and support within the school. This study was conducted in a specialized school for students with learning needs and the transferability of these findings to a general school environment is thus dependent on the extent to which students receive support at the administrative level (e.g., funding for technology, space to use it, and a primary support person), at the teacher level (e.g., consistency of use of speech recognition technology in the classroom, teacher motivation, and knowledge of speech recognition technology), and also at the student level (e.g., the prevalence of students utilizing speech recognition technology within the school). It is likely that although differences may exist in the level of support of speech recognition technology and the prevalence of use amongst students, rich descriptions may provide the context for others to yield suggestions to benefit their own current or future practices.

Creswell (2013) considered reliability in qualitative research to be "the stability of responses to multiple coders of data sets" (Creswell, 2013, p. 253). To ensure that the data was reliable, one of the researcher's supervisors reviewed the codes and themes to ensure that there was agreement. The researcher and one of her supervisors also met in person to discuss the broader themes which existed in the data set.

Ethical Considerations

As a researcher, it was of upmost importance to follow many ethical guidelines provided by the Canadian Code of Ethics for Psychologists. Principle I: Respect for the Dignity of Persons was maintained by following the belief that each person should be treated primarily as a person rather than a means to an end (Canadian Psychological Association, 2001). This included respecting their rights to privacy, self-determination, personal liberty, and protecting these rights throughout the research process (Canadian Psychological Association, 2001). In adhering to these rights, respect was given to the expertise and knowledge of others and appropriate language was used as to convey respect in both written and oral communications. Additionally, participants were fairly treated (e.g., working and acting in a spirit of fair treatment to others) and there was no discrimination (e.g., not practicing any form of unjust discrimination).

In addition, informed assent and consent was also obtained. This occurred through the process of obtaining consent to conduct research through the University of Calgary, the school, the participants and their guardian(s). Prior to conducting this study, this proposal was submitted to the University of Calgary Conjoint Faculties Research Ethics Board (CFREB) to obtain consent to conduct the research. The next step was to receive approval from the school in which the study took place. No approval was necessary from the school district as there was no district to seek approval from. It was the responsibility of the researcher to obtain informed assent from students, consent from their guardian(s), and consent from the school staff who wished to participate in this study. Potential participants were given information on the general purpose of the study, what it involved (e.g., a 30 minute focus group, a 20 minute survey, and a classroom observation) and information on any harm that may result (e.g., inconvenience). Participants were made aware that they may decline participation at any point in time and that due to the nature of focus groups and the small number of staff members participating, it would be impossible to ensure anonymity. However; their identities were masked to the best ability of the researcher.

As a researcher, freedom of consent was also respected. This included respecting the right for participants to discontinue participation in this study at any point in time. Additionally, the principle of respect was recognized by seeking and collecting information that was relevant to the purpose of the study to which assent and consent had been obtained, respecting the right of participants to personal privacy, and by taking necessary steps to ensure that records are kept safe (Canadian Psychological Association, 2001). All documents are kept in a locked filing cabinet and on a password protected computer.

In adherence to Principle II: Responsible Caring, the researcher discerned the potential harms (e.g., no foreseeable risks) and benefits involved and only engaged in activities which she was competent (e.g., giving the survey, classroom observations, and administering focus groups and interviews). The researcher also adhered to Principle III: Integrity in Relationships, by being accurate and honest with the results by maximizing objectivity and minimizing any bias. This was achieved by avoiding fabricating or falsifying data (Canadian Psychological Association, 2001). Additionally, if the researcher determined that the data which is published has been done in error, it is the responsibility of the researcher to correct this. Lastly, in accordance with Principle IV: Responsibility to Society, this research contributes to the discipline of psychology through acquisition and transmission of new ideas and adding to existing knowledge (Canadian Psychological Association, 2001).

Role of the Researcher

The Southern Alberta specialized school that was chosen for this study was the location where the researcher completed a psychology internship from May through June, 2013. Through this internship opportunity, the researcher was given the opportunity to meet the assistive technology specialist at the school and was given a presentation on the different technologies present within the school, including speech recognition technology. This brought forth the idea of

investigating the relationship which this technology has with student cognitive engagement (a topic the researcher had previously been interested in).

Due to previous experiences working within this school, certain biases were brought to the study. Although efforts were made to ensure that objectivity was maintained, pre-existing biases may have influenced the manner in which the data was collected and interpreted (Creswell, 2003). Thus, the researcher began this study with the perspective that the relationship between speech recognition technology and cognitive engagement is very complicated. The insight gained from the study may only brush the surface of this topic.

A major task in the study was to determine to what extent students were cognitively engaged in their writing, the conditions which may elicit cognitive engagement in students who utilize speech recognition technology, and also how this technology impacts writing. As an unobtrusive observer in the classroom, the researcher also gained insight into classroom practices and whether these classroom practices reflect the necessary conditions for successful technology use as provided by the ISTE (2008) and CALL Scotland (2008), and if these conditions were in fact crucial to cognitive engagement in writing.

Successes and Challenges of the Data Collection Methods

Successes of data collection methods. Collecting data through use of a survey, interviews, and classroom observations proved to be successful as each method of data collection complemented the others. For instance, knowledge of student engagement contributed to the separation of students into differing focus groups (Engaged, Neutral, and Non-Engaged groupings), and allowed the researcher to acknowledge differences and patterns between these groupings during classroom observations. Additionally, classroom observations corroborated the information provided by staff and students to the researcher. The interviews and classroom observations were also able to provide insight into not only if the necessary conditions by ISTE (2008) and CALL Scotland (2008) were met, but also ways in which they were or were not met.

Another successful aspect of data collection was the ease with which the staff and students spoke about their experiences with speech recognition technology. Staff and students were open to talking about both positive and negative aspects and experiences when using this technology and were able to describe the contexts to which they were accustomed to using it. This was helpful in framing the necessary conditions for student engagement in writing when utilizing speech recognition technology.

Challenges of data collection methods. Although data collection was largely successful, there were two challenges. The first challenge was arranging for the focus groups to occur. Due to the students being pulled from two separate classrooms on two separate schedules, there were a limited number of options as well as limited time to complete the focus group interviews. Students had to be pulled from their joint gym period, which occurred twice during the week. Due to the three groupings, one group of students had to be pulled out of gym for a portion of both classes. Another challenge was presented by students who were forgetful of their focus group interviews and took a bit longer to arrive at the office space. Although their interviews were comprehensive, it left the researcher with less time to follow up on ideas.

Summary

The study utilized case study methodology to gain insight into the following three research inquiries: the extent to which students are cognitively engaged in writing when using speech recognition technology, the necessary conditions to elicit cognitive engagement, and the impact of speech recognition technology on writing. A convenience sample consisted of eight grade 7 students, two current grade 6 teachers, the current grade 7 English Language Arts teacher and Social Studies teacher, the two previous grade 6 teachers, four teaching assistants, the assistive technologist, and the principal. The study utilized the Survey of Motivation to Engage in Writing (Hawthorne, 2008) as well as staff and student interviews, and classroom observations to gather data. Although there were some challenges with data collection (e.g., student promptness), there

was success as well (e.g., willingness of participants to share both positive and negative experiences with speech recognition technology). Overall, this study provided a more in-depth look into the impact of speech recognition technology on student engagement and writing.

CHAPTER FOUR: FINDINGS

Chapter Four presents an analysis of the data collected during this case study examining cognitive engagement in writing. Data was collected through use of the Survey of Motivation to Engage in Writing, classroom observations, as well as through interviews with the principal, teachers (n=6), teaching assistants (n=4) assistive technologist, and students (n=8). Interview data was coded using thematic analysis. A detailed description of the training and support provided to teaching staff and students is presented first followed by three themes which emerged from the data and mapped to the research questions: 1) student cognitive engagement in writing, 2) conditions for successful use of speech recognition technology, and 3) the impact of speech recognition technology on student writing. Subthemes are identified per each of the areas and with evidence from the data to support them.

Case Context

The study occurred within a private southern Alberta school intended for students with learning disabilities. The school housed grades 1 through 12 and had 220 students. Of the 220 students, 65 were currently utilizing speech recognition technology in their learning. The school philosophy of technology integration was described as very supportive by the principal, who stated that, *"the overall message to the teachers is quite naturally if the students need it, then they should be using it."* Starting in grade 6, all students were granted the use of laptops through shared laptop carts. Students who utilized speech recognition technology however; were assigned a specific computer trained to their voice profile, to use each time laptops were required. It should be noted that anything determined to be misuse of the laptop by teaching staff warranted a revocation of laptop privileges.

Aside from supplying the laptops, the school provided working space for speech recognition technology students both in the classroom (e.g., student desks or back offices) and in the hallways. School hallways were equipped with benches, desks, and couches for students who desired to work

outside of the classroom. It should be noted that students who were utilizing speech recognition technology were more than welcome to remain in the classroom, if they preferred. An assistive technologist on staff acted as the primary support for students utilizing speech recognition technology while also balancing teaching her own classes (eight classes a week). Her role with speech recognition technology included training students, troubleshooting with students, and also supporting students through visiting their classrooms to ensure speech recognition technology was being used effectively (e.g., not just typing while wearing the headset). Notably, due to the number of students utilizing speech recognition technology in their learning, the assistive technologist's role was largely in training and consultation with students who were experiencing difficulties and self-referred or were referred by a teacher. The assistive technologist did state that visits are made to students' classrooms as often as possible. In addition to the assistive technologist, each classroom had a teacher and a teaching assistant who was present for half of the day.

Support and Training

With research indicating that successful implementation of technology is partially dependent on suitable training (CALL Scotland, 2008) and the environment in which it is offered (CALL Scotland 2008, Holmes & Silvestri, 2012); it was pertinent to examine how the school encompassed speech recognition technology in addition to the training procedures which the school utilized. This offered insight into the technological support environment which the school offered as well as the staff and student perceptions of student preparedness to use speech recognition technology in the classroom. As mentioned in Chapter Three, information on training procedures was gathered from interviews with the assistive technologist, four grade 6 teachers (two former and two current), and two grade 6 teaching assistants (one former and one current).

Initial identification and selection. The introduction of and training in speech recognition technology occurred through a consistent and formalized process within the school. This typically occurred in the grade 6 year, but can also occur at a later grade if required. The first step described

by the assistive technologist Donna (pseudonym), and a former grade 6 teacher, Angie (pseudonym) was the identification of students who may benefit from the use of speech recognition technology. Two current grade 6 teachers, Rachael (pseudonym) and Charlotte (pseudonym) echoed this step and it seemed that there was consensus amongst the assistive technologist, and the three grade 6 teachers (two current and one former) that a recommendation is due to their perception of student weaknesses in written output. Angie elaborated on this describing how she uses individual program plans, psychological evaluations, as well as observations on the length of time it takes students to do letter formation, to determine who is a candidate for speech recognition technology. After determining that a student may benefit from using speech recognition technology, all four of the grade 6 teachers stated that a class discussion takes place to ensure that the students understand what the technology is and who it is intended for. Charlotte shared how she introduced speech recognition technology with her students.

> *"Well I have to introduce it to the whole class. They need to know that it will help with some learners but not with everyone…I have to explain to them that this is something that some of you will get but not all of you, because you have different needs…"*

Following classroom discussions, Donna discussed the process of setting up the prospective student's computer with the appropriate equipment such as the headset and the software itself. This is all completed prior to the student actually receiving formal instruction in the use of speech recognition technology. This ensures that when the student comes in for the formal training stage, the focus is purely on training and student inquiries.

Formal training. Once the preparation is complete, students are invited to begin training in the assistive technologist's office on an individual basis. She detailed that she uses the one training module that the program Nuance Dragon Dictation provides. The module begins by suggesting a number of settings such as the "teen setting," which recognizes that the student's voice may not be as clear as an adult's voice. This setting is frequently chosen for the students who use this program.

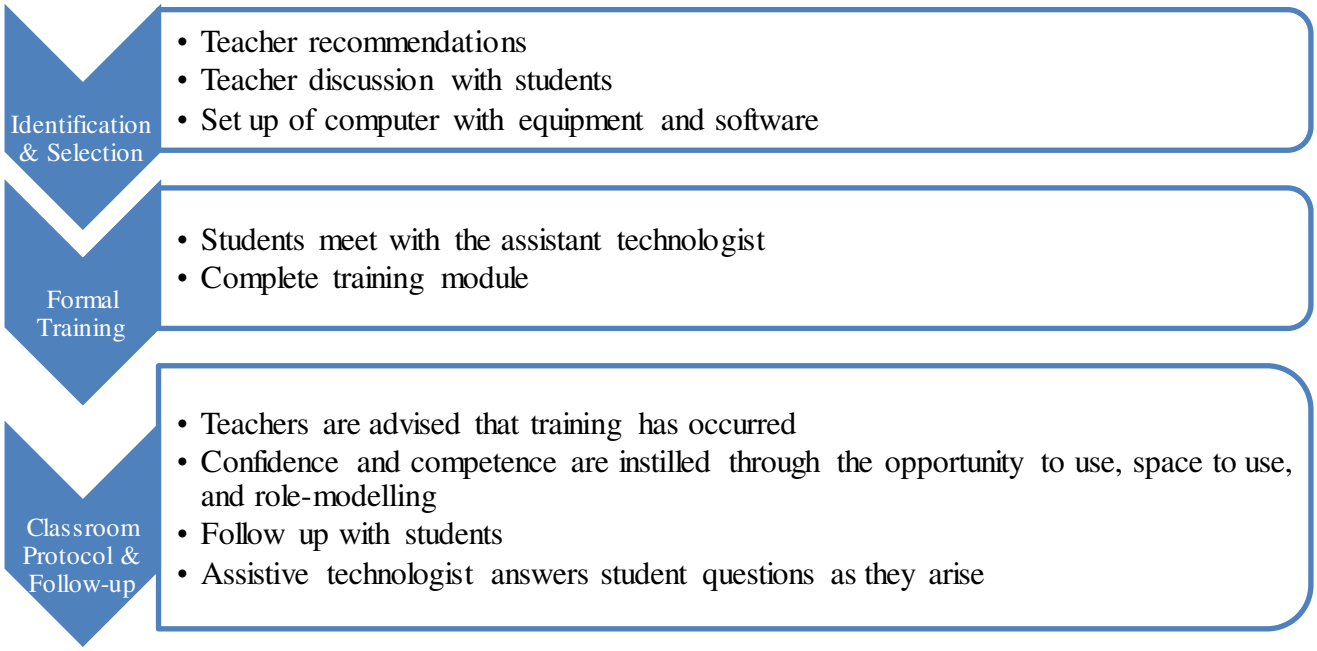
The module then involves having the students read a passage to set up the headset, followed by numerous sentences to train their voice to the program. Interestingly, the passages students read act both to familiarize the computer to their voice and also give students an understanding of how the program works. The assistive technologist described the typical training session as consisting of an entire 50 minute class period, with some students needing less than the allotted time slot and others requiring another training session. After the training session(s) are completed, Donna described the students as being ready to use speech recognition technology in their classes.

Classroom protocol and follow up. Following training a number of steps occur to ensure that students are effectively using speech recognition technology in their learning. Firstly, Donna stated that notification is provided to the students' teachers. Without this step, she advised that some of the students would never tell anyone that they are equipped to use the technology. Additionally, this awareness also inspires teachers to encourage student use of the technology in the classroom. Secondly, the two former and two current grade 6 teachers discussed the importance of inspiring confidence and competence in their students by providing adequate opportunity for them to practice using speech recognition technology (minimally one class period per week) and the space to use it comfortably and without feeling stigmatized. Teacher role-modelling is a step that one former grade 6 teacher and a current grade 6 teaching assistant felt strongly about. More specifically, Angie shared stories with her students about how staff members try and use it for report cards and Christa (pseudonym), a current grade 6 teaching assistant, specified how students often serve as role models to each other through being partnered up by the assistive technologist. Interestingly, the assistive technologist was also identified as playing a large part in role-modelling, as both current and former grade 6 teachers considered her the main resource for role-modelling of speech recognition technology. In addition to role-modelling, two grade 6 teachers (Angie and Rachael) as well as a current grade 6 teaching assistant, Christa, focused on the importance of reinforcing the benefits of using this software with their students. Christa stated that reinforcement in her classroom is largely through showing students writing samples prior to implementation of speech recognition

technology and their current work through use of the technology. Angie and Rachael stated that consistent verbal encouragement is something that they both use. The assistive technologist added that follow up with students is an important component to ensure that students are using speech recognition technology and that they are using it effectively.

All four of the grade 6 teachers and all three teaching assistants (Shirley (pseudonym), Collette (pseudonym), and Christa) made mention of how important the assistive technologist is in providing support to students through problem solving with them as needed. Students are visited regularly and specific visits are scheduled when teachers believe that one of their students may benefit from additional assistance. Although training appeared to have three distinct steps, Donna described it as continuous process. Figure 4.1 provides a summary of the steps which occur in the initial identification and selection, formal training, and classroom protocol and follow-up.

Figure 4.1 *Outline of Student Training*



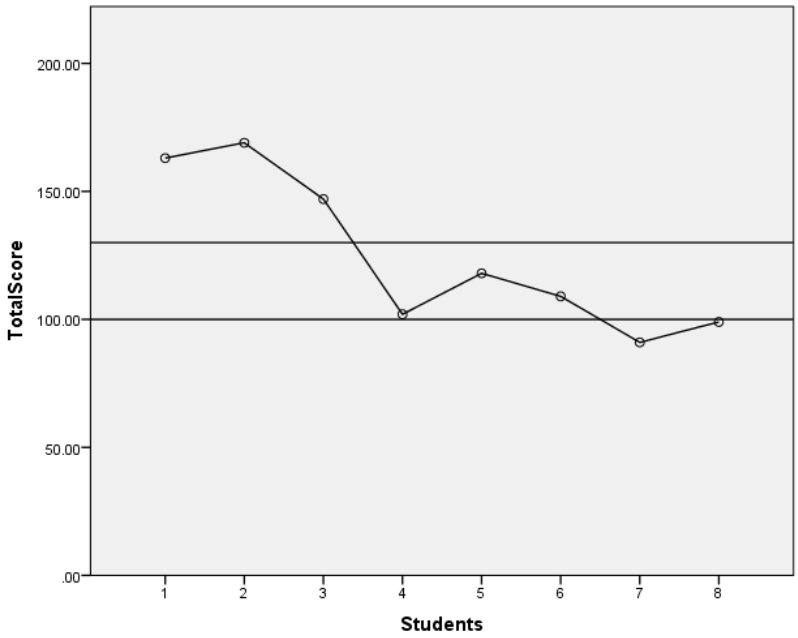
Cognitive Engagement in Writing

The question as to what extent are students cognitively engaged in writing when using speech recognition technology was an important area to investigate due to the possible influence it exerts over academic outcomes (Fredericks et al., 2004; Greene & Miller, 1996). An evaluation of

the extent to which students are cognitively engaged in writing occurred through the use of the 40 item Survey of Motivation to Engage in Writing and interviews with the assistive technologist, teaching staff, and students. Two major themes were identified in the process of data analyses. More specifically, that there were various levels of student engagement, and that there was inconsistency in the understanding of engagement by both students and educators. Detailed explanations of the results are provided below.

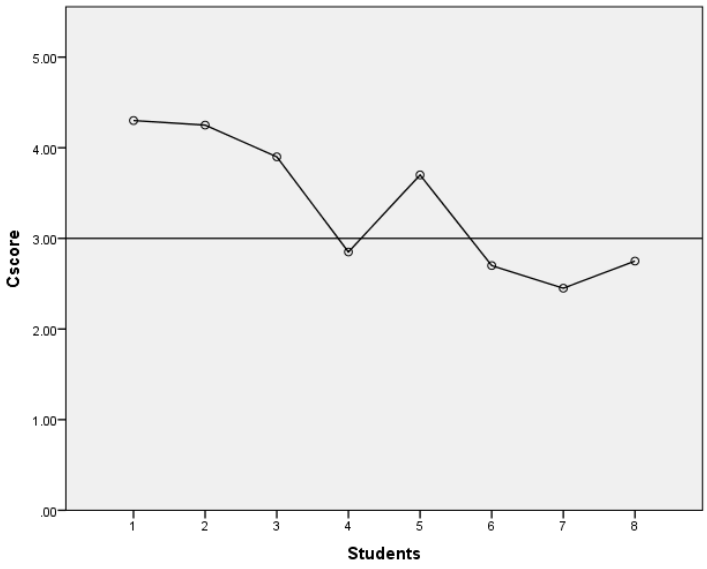
Levels of student cognitive engagement. Differing levels of student engagement were identified using the Survey of Motivation to Engage in Writing. The previously outlined cut scores determined student group placement and were as follows: scores which were greater than 130 were indicative of cognitive engagement and comprised the Engaged group, scores between 100 and 130 were described as the Neutral group (these middle two quartiles were not utilized in Hawthorne (2008) study), and scores of 99 or less were indicative of reluctance in writing and comprised the Non-Engaged group. Descriptive analyses determined that student scores varied considerably and that students fell into the Engaged (n=3), Neutral (n=3), and Non-Engaged (n=2) groups. The lowest score on the survey was 91 whereas the highest was 169. Additionally, the mean score across all eight participants was 124.75. Individual student scores are presented in Figure 4.2 below.

Figure 4.2 *Student Scores on the Survey of Motivation to Engage in Writing*



Calculation and analysis of the C-scores was also undertaken. As discussed in Chapter three, the researcher developed C-score was a more specific measure of cognitive engagement (versus general engagement measured by the entire survey). Of the Engaged grouping of students, all three were also considered to have an engaged C-score and neither of the two students in the Non-Engaged grouping were found to be engaged (their C-scores fell below 3.27). The only difference existed in the Neutral grouping, which had one student who was found to have an engaged C-score while the other two students did not. Individual student C-scores are seen below in Figure 4.3. It was found that although engagement varied across students, engagement did remain fairly consistent when considering the 20 items which the researcher believed were most closely related to cognitive engagement (C-scores), as opposed to the motivational items which were influential to it (e.g., self-efficacy; Appleton, 2012).

Figure 4.3 *Student C-Scores*



Analysis of the 20 items specific to cognitive engagement revealed that endorsement of any and all items specific to the C-score was limited to the Engaged grouping of students. More specifically, students in the Engaged group positively endorsed (agree or above) items reflecting both affect and regulation (e.g., mean scores of 4.18 for affect and 4.01 for regulation), the two components representative of the C-score. Interestingly, neither the Neutral nor Non-Engaged students were found to endorse overall affect (e.g., mean score of 2.28 for the Neutral and 2.72 for Non-Engaged students) or regulation (e.g., mean score of 3.38 for the Neutral and 2.57 for the Non-Engaged students). When looking, at the C-score items specific to strategic thinking, intrinsic motivation, and goal setting, a similar trend emerged. Future aspirations and goals, aspects of cognitive engagement in Appleton's (2012) model of cognitive engagement were evident amongst the Engaged students with a mean score of 4.20 over five items (e.g., When I do writing tasks, I like to have a set goal to work towards). Although the Neutral grouping had a mean score of 3.78, neither they nor the Non-Engaged students with a mean of 2.9 expressed overall agreement with statements pertaining to goal setting. Investment in learning through agreement to statements pertaining to intrinsic motivation (e.g., I like how writing makes me feel inside) were found across the Engaged student grouping (mean of 4.46), however; not across the Neutral (mean of 3.57) or

Non-Engaged students (mean of 2.9). Similarly, students in the Engaged grouping indicated the use of strategic thinking (e.g., I read over what I've written before I hand it in for marking), with an average score of 4.40 over eight items. The same could not be said of the other two groupings of students (Neutral grouping had a mean of 2.82 and the Non-Engaged group had a mean of 2.37). It is obvious that engagement levels differed across the three student groupings, with the Engaged grouping of students endorsing all components directly related to cognitive engagement.

Inconsistency in understanding of engagement by both students and educators. Student and staff perceptions of cognitive engagement were investigated to determine if they were in alignment with the scores obtained on the Survey of Motivation to Engage in Writing. Two interesting findings emerged. First, there appeared to be a disconnect between the teaching staff's and students' understanding of engagement, in addition to a disconnect between student actions and survey results reflecting engagement. Second, there was greater recognition of cognitive engagement in teaching staff who worked with students during the year of speech recognition technology's implementation.

Student perceptions of cognitive engagement were queried through focus group interviews about if and how they were engaged. The researcher provided students with a consistent description of cognitive engagement, "*when a student feels invested in their learning,*" and an example of engagement, "*a student who is invested may start looking over their work so that they might learn something new*" and asked whether they thought they were engaged. Students in the Engaged grouping all stated that they were engaged but when queried further were not able to provide an example of how. Within the Neutral group, two of the three students indicated engagement with only one student able to provide explanation as to why that was. More specifically, he stated that he was able to "*develop ideas more,"* while another student in this grouping said, "*I honestly don't know…"* Of the Non-Engaged students, one student indicated engagement and provided insight into why he felt this way, "*it makes you more aware of your writing…"* Due to the lack of explanation

or examples that the students could produce in direct response to questions about engagement, the researcher reviewed the interview transcripts to determine if other indicators of cognitive engagement were provided in response to other items.

On these additional items, two of the Non-Engaged students' reported an increased willingness to both edit and complete work using speech recognition technology. For instance, one of the Non-Engaged students stated how getting his ideas down was made possible through the use of speech recognition technology, suggesting that construction of new knowledge (another component of cognitive engagement; Wilms et al., 2009) was made possible through the use of speech recognition technology. The other Non-Engaged student indicated greater investment in his learning through a more thorough review of his work after it is completed.

For the Neutral group, two students commented on cognitive engagement processes. For instance, perseverance in completing tasks, which is representative of greater investment in the learning process (a component of cognitive engagement) was specified by one student who stated, "*If I didn't have Dragon I'd be at the first question and be like I'm bored… bye."* Another student in the Neutral grouping expressed the ability for her to "*get more detailed ideas down,"* thereby demonstrating her ability to construct new knowledge.

Similar to the Non-Engaged and Neutral students, the Engaged grouping also exhibited instances of engagement in their focus group interview. Specifically, one student identified how she had a greater willingness to edit and had become more serious about her work, demonstrating investment in her learning.

Teachers, teaching assistants, the principal, and the assistive technologist also provided insight into whether they believed that their students were cognitively engaged in writing through interviews. Views on engagement differed across staff and were not consistently reflective of engagement on the Survey of Motivation to Engage in Writing or instances of engagement noted in

student focus group interviews. Admittedly, the principal did not have data to support his claim. He believed that cognitive engagement should undoubtedly occur pending the struggle with writing be removed through the use of speech recognition technology. Similarly, the assistive technologist believed that speech recognition technology had the potential to impact cognitive engagement. She commented, *"I don't think it really changes everyone but I think that it does change some of them. I have students who will light up and say this is going to help me so much, so those students…they embrace it."*

In terms of teaching staff, it became apparent that the majority of the grade 6 teaching staff (e.g., the two former grade 6 teachers, Natalie and Angie, the current grade 6 teacher, Rachael, and grade 6 teaching assistants Hailey (pseudonym) and Christa) who taught during the year of speech recognition technology's implementation, had views on cognitive engagement which substantially differed from their grade 7 counterparts (The English Language Arts teacher Jarrett (pseudonym), the Social Studies teacher Jennifer, and their teaching assistants Shirley and Collette). More specifically, Natalie, Angie, and Rachael and their associated teaching assistants (Hailey, the teaching assistant to Angie, and Christa the teaching assistant to Rachael) stated that they do in fact feel that students are cognitively engaged in their writing. While Angie discussed a greater willingness for her students to learn and try new things, Rachael pointed out that cognitive engagement is present due to students becoming more personally connected to their writing. Hailey added that greater investment is evident through students wanting to take their work home to show their parents.

The views of Charlotte (a current grade 6 teacher) differed from the other grade 6 teaching staff. She described speech recognition technology as a means to an end and without the capacity to influence cognitive engagement at all. Interestingly, Jarrett, Jennifer, and Collette attributed maturity as the main determinant of engagement. Jennifer explained, "*I think it promotes it but our grade sevens are not there yet…"* while Jarrett stated that students are more so in an adjustment

period with both the technology and junior high expectations and it is not until grade 8 that engagement begins to develop. Collette added that engagement really becomes evident in grades 8 and 9. When directly asked about whether cognitive engagement was occurring, although the grade 7 teaching staff stated that cognitive engagement is not yet present, they did provide responses that suggested that speech recognition technology does support cognitive engagement. For instance, both teachers stated that speech recognition technology encouraged a flow of ideas, which is representative of cognitive engagement. This suggested a potential disconnect between what the grade 7 teaching staff perceived to be cognitive engagement and what was actually occurring.

Conditions for Speech Recognition Technology

Examining the necessary conditions to elicit cognitive engagement in writing with students using speech recognition technology was completed through using the ISTE (2008) and CALL Scotland (2008) conditions as a guide in collecting interview and observation data. Interviews were done with the principal, assistive technologist, teachers, teaching assistants, and students. It should be noted that the necessary conditions were examined at a more global level. This was due to seven of the eight students who were taught by the same grade 6 teacher and all of the students who were taught by the same grade 7 teachers. The following five themes were examined and discussed in light of study data: 1) training with speech recognition technology was readily available but seldom utilized, 2) speech recognition technology influenced student ability to meet curricular objectives, 3) multiple levels of support were needed, 4) speech recognition technology was perceived as suitable by teachers and students, and 5) barriers to successful integration of speech recognition technology. These themes are explained in greater depth below.

Training with speech recognition technology was readily available but seldom utilized. Teaching staff, the assistive technologist, the principal, and students commented on the training procedures with speech recognition technology during interviews. Four interesting findings emerged. It became evident that a consistent training protocol was not in place for teaching staff,

perceptions of basic knowledge were not always due to training, and additional training was not considered necessary by teaching staff due to a strong reliance on the assistive technologist. Although some students desired extra training or aide with troubleshooting, assistance was not consistently sought out. A detailed description of these findings is included below.

Success of student engagement using speech recognition technology requires that teachers have on-going professional development opportunities. From the interviews, all six teachers, all four teaching assistants, the principal, and the assistive technologist commented on the professional development which was offered by the school and the nature of the training provided. It should be noted, that professional development appeared to reflect training with technical aspects of the program as opposed to integration of speech recognition technology in the teaching and learning in the classroom. The assistive technologist's views on training were described as largely dependent on the teachers themselves. To elaborate on this, she explained that although basic training with the program is offered, it is not consistently required across the teaching staff. In fact, Donna suggested that curiosity regarding speech recognition technology is greater amongst some staff members more than others and that "*not everyone is interested in the technology of it."* Two grade 6 teaching assistants, Christa (current) and Hailey (former), the former grade 6 teacher Angie, and the grade 7 teacher Jarrett, supported the availability and use of professional development opportunities. Christa and Hailey stated that this training was available to them and obtained through workshops that the teaching assistants attended. As a former teaching assistant, Angie also obtained basic training in this manner. Jarrett described his training regimen as follows.

> *"Donna, (the assistive technologist) shows us some stuff at the start of the year when we don't have students. We just do some staff days and she does some stuff where she puts whatever the screen would look like on the SMART Board to show you some of the tasks."*

It seems that while training may be available through both structured yet non-mandatory professional development sessions and through ad hoc support from the assistive technologist to teachers, the only group to all report having received basic training was the grade 6 teaching assistants. Notably, despite the fact that only four members of the teaching staff had formal training, two additional current grade 6 teachers felt that they also had basic knowledge of speech recognition technology. Rachael stated that her knowledge was gained through support from the assistive technologist. *"Donna will educate us on if you have this error message… she will say do this and this first."* While both Rachael and Charlotte described knowledge as also being obtained from working directly with students. It was the majority of grade 6 teaching staff (five of the six) who identified having basic knowledge, as opposed to only one of the four grade 7 teaching staff. The assistive technologist validated this by suggesting that the teachers who work with the students when the technology is first implemented typically have a better working knowledge of the program due to problem solving with the students on a more regular basis.

In terms of interest in furthering training, although Rachel and Christa commented on the availability of training as needed, it appeared that additional training was not viewed as a necessity. Jennifer and Collette elaborated on why they felt that training was a non-issue. Collette explained,

> *"I personally don't feel that it is an issue because Donna is always accessible. I know that if I have trouble I can just go find her and if she's not available at that moment I know she will follow up."*

Charlotte was the only teacher who described an interest in furthering her training. She expressed a desire to more independently help students with any issues that arise from using speech recognition technology, as opposed to constantly seeking help from Donna. Although, Charlotte wished to reduce her dependency on the assistive technologist for support, it became evident that her and all of the teaching staff strongly depended on Donna to support their students. Reliance on the assistive technologist spanned across staff with and without training as well as those who

desired training and those who did not. Shirley stated, *"We just let Donna do it. I know she is the best so I just send them there."* The principal and Donna agreed with the dependence on her to support students. Donna explained, *"I would say a lot of it is left up to me because the teachers have their own job to do and there aren't many teachers who know how to use it."* The grade 7 teaching assistant Collette added that not only is Donna a central support, but that going to her encourages the development of self-advocacy skills in students.

This self-advocacy appeared to be limited in the students. For instance, the Engaged grouping of students reported that they would benefit from more training specific to troubleshooting and program details which would give them greater overall capability with the program. *"I know there is a way to underline it and capitalize it… like knowing how to make it bold instead of having to do it manually…"* However; it appeared that self-advocacy was limited to approaching Donna for troubleshooting issues as opposed to additional training in the intricacies of the program, if at all. More specifically, one student stated, *"If the problems are really getting on my nerves and are showing up more constantly then yeah I would (get help)"* The Non-Engaged students expressed a similar sentiment, expressing that they preferred to work through the program independently. One commented, *"we learn what we need to learn and I just sort of figure the rest out… we don't really ask for help most of the time…"*

It appeared that overall, training opportunities for both teaching staff and students were freely available as needed. However, the vast majority of teaching staff did not take advantage of these opportunities and a preference existed across all staff members for the support of the assistive technologist herself. Additionally, it seemed that students either sought assistance with technical issues (as opposed to program components), should consistent difficulties become present or would choose to not utilize assistance at all.

Speech recognition technology influenced student ability to meet curricular objectives. Through the use of speech recognition technology, students were better positioned with the tools to

express their understanding of curricular objectives and meet curricular standards. Teaching staff, the assistive technologist, the principal, and the students discussed in their interviews, their perceptions of technology being used in their own school to support these objectives. Additionally, classroom observations provided insight into if and how curricular objectives were supported during class periods. Unanimously, teaching staff, the principal, and the assistive technologist agreed that speech recognition technology was able to support learning goals in the classroom. The researcher viewed this first hand through observing students use of speech recognition technology across all of the grade 6 and 7 classrooms, to complete the assigned task (e.g., completing a MS PowerPoint presentation, completing a practice Provincial Achievement Exam, writing a poem etc...). Specifically, the culmination of data indicated that through removing the burden of writing through the use of speech recognition technology, curricular demands were met with greater ease due to improvement in six areas: more accurate assessment of student abilities, efficiency in writing, skilled writing, lower level writing skills, initiation and completion of written work, and collaborative work.

The assistive technologist and current grade 6 teacher, Charlotte emphasized the importance of speech recognition technology in meeting curricular objectives due to its ability to provide a more accurate assessment of where students stand in relation to expectations. The ability to speak out loud and produce the work, Donna proposed, provided a more accurate portrayal of where students stood in relation to expectations. Similarly, Charlotte shared that student use of speech recognition technology allowed for her to access their knowledge, and is subsequently good for assessment of her students. The former grade 6 teacher (Natalie), the principal, and the assistive technologist specified that curricular requirements may not be met at all, if not for the use of speech recognition technology in student learning. The principal shared that *"there are kids who would not complete certain grades. There are kids who would not graduate without it."*

Greater efficiency in completing work was recognized by the grade 7 English teacher Jarrett and unanimously across students in the Engaged, Neutral, and Non-Engaged groupings. More specifically, Jarrett shared that *"for some students who use it, if they were handwriting or just typing, they would maybe get a fraction of the input that they can produce with Dragon."* It was his belief that greater efficiency contributed to overall student success in achieving curricular objectives. In addition to the perceptions provided by Jarrett, students across the Engaged, Neutral, and Non-Engaged groupings unanimously agreed that curricular objectives where being met because speech recognition technology afforded them the ability to complete their work much faster. Interestingly, the greater efficiency in completing tasks had additional benefits to students. For instance, one Engaged student suggested that the faster completion of coursework had permitted him the ability to apply a greater focus across all subjects as opposed to just writing tasks. Additionally, two students specifically added that the greater speed at which their work can be completed takes away some of the burden of homework, while another focused on the reduction of stress. *"They took up more time so yeah…it does take some of the weight off."*

When asked if and how speech recognition technology impacted student writing and subsequent ability to meet curricular demands, a variety of responses were shared regarding skilled writing, amongst staff and students. The former grade 6 teacher Angie, current grade 6 teacher Rachael, grade 7 teacher Jennifer, as well as the grade 7 teacher Jarrett, and the two grade 7 teaching assistants Shirley and Collette believed that the quality of student writing was impacted through the use of speech recognition technology in their learning. More specifically, quality of writing was found to be increased through the enhanced ability for students to express ideas on paper by Angie and Rachel. Angie explained, *"The output is much higher quality…"* Additionally, Rachel and Collette noted that greater flow also contributed to what they believe to be improved writing skills in their students. Furthermore, Angie specified how students demonstrate better editing skills, which may subsequently influence overall writing quality. In alignment with views of

the above teaching staff, two of the students remarked on how speech recognition technology had helped them edit and had thus improved the overall quality of their work.

In terms of lower level writing skills, teaching staff and students indicated how speech recognition technology had made an impact. The current grade 6 teachers Rachael and Charlotte, the grade 7 teacher Jarrett and his assistant Shirley, as well as two students made mention through their interviews of how speech recognition technology had improved upon their lower level writing skills. Jarrett and Shirley mentioned that they had witnessed an improvement in spelling but quickly attributed the progress to the program itself. Both an Engaged and Non-Engaged student felt similarly, stating that their spelling errors had gone down due to the automatic insertion of periods and capitals. Text production is an area that Rachael and Charlotte felt had really improved in their students writing. In fact, Rachael considered text production the *"biggest improvement,"* while a student simply stated that her stories have increased in length. Improvements in both spelling and text production have the potential to influence overall student writing, and consequently student attainment of their curricular goals.

Completion of class assignments is achieved through both student design and implementation of projects. Speech recognition technology appeared to enable this process due to the routine use of it and the greater efficiency that it afforded to students. More specifically, both current and former grade 6 teachers as well as Christa expressed how speech recognition technology is used routinely in writing tasks to encourage student design and implementation of required tasks. Rachel elaborated, *"it is effective for the individual students and routine type stuff…"* similar to Angie's requirement that, *"anything that was going to be over a paragraph, the students should be using their Dragon for that."*

Interviews made clear that the principal, assistive technologist, and all of the teachers and teaching assistants felt similarly that speech recognition technology provided affordances so that students could express their ideas and initiate and complete their work. One of the grade 7 teachers,

Jennifer specified how speech recognition technology encouraged the flow of ideas to achieve this. *"They get a train of thought going and I think sometimes when they are physically writing they lose their train of thought and get bogged down."* The assistive technology, Jarrett, and the former grade 6 teacher Natalie, attribute this increased flow of ideas as contributing to greater student productivity overall. All of the students affirmed this notion, agreeing that the greater efficiency which speech recognition provides assists them in beginning and completing their work.

Classroom observations allowed for additional insight. In one particular observation, the task was for students to write a Bio-poem (see Figure 4.4). After the current grade 6 teacher, Charlotte provided direction for the assignment; the students who were using speech recognition technology demonstrated their ability to create a rough and final draft. While it is impossible to determine whether the students were more efficient in their work, student work on this project did demonstrate ability to both design and implement their class project. A former grade 6 teacher, Angie cautioned that many of the students have difficulty with task initiation. Due to this, observations pertaining to efficiency may not always be obvious to those who are not familiar with the students previous work habits. Overall, and consistently across teaching staff and students it was obvious that work initiation and completion is made more achievable through the use of speech recognition technology in the classroom. Figure 4.4 is an example of the Bio-Poem task which was observed in a grade 6 classroom.

Figure 4.4 *Bio-Poem Assignment*

I am someone who…
needs…
likes…
fears…
enjoys…

Collaborative student work through the use of speech recognition technology was inquired upon through interviews with the assistive technologist, teaching staff and students, as well as classroom observations. The idea of greater student participation in group work through the utilization of speech recognition technology was viewed as occurring by Donna, Angie, Natalie, Jennifer, Hailey, and Collette. Specifically, Angie and Hailey viewed collaboration as occurring due to the interest of non-speech recognition technology students in the workings of the program and subsequent partnership due to this interest. Others, such as Jennifer and her teaching assistant Collette believed that removing the writing barrier provided affordances to students, in that they could contribute to group work with fewer limitations and greater independence. Students in the Engaged group and two from the Neutral group, concurred that they now feel equipped to contribute their skills to collaborative group work. One student shared her experience, *"It kinds of makes you feel like you are doing something in the group because writing is usually the important part… sadly…"* Collaboration was also viewed as occurring through the use of Google Docs, with Donna suggesting that students work in partnership with each other and their teachers through the sharing of documents. Rachel also believed in Google Docs as providing a means for collaboration, but specified that this was a future goal that she did not believe was presently occurring. She stated, "*Dragon could work well with Google docs or apps and I know that there have been some glitches… so if those advances or changes happen that the program runs well in Google, it would be brilliant."*

Observations from the grade 6 classrooms indicated that even when collaboration was not intended, students often took it upon themselves to work together. In one instance, while completing a story in preparation of the provincial achievement exams, the researcher witnessed collaboration between two grade 6 students and their teacher, Charlotte. A student completed her story and wished to share it with her friend and did so over Google Docs. In addition to sharing the document with her friend over Google Docs, she also shared it with the teacher so that she could

read it over as well. The student added that her classmates and she frequently *"share documents with the teacher rather than printing them off…"*

In contrast to the views of the above staff and students, one student in the Neutral group and both of the Non-Engaged students explicitly stated that the use of speech recognition technology is confined to independent usage due to the problematic aspects of using speech recognition technology in a group. Two students expressed annoyance with having other voices intrude on the technology while completing group work while one added that to complete his work accurately with the software, his preference is to get his assigned portion and leave the group to work. Comparable to the students were the opinions of Jarrett, his respective teaching assistant Shirley, and a current grade 6 teacher, Charlotte who believed that speech recognition technology is less collaborative and more independent. Although opinions amongst both staff and students differed in terms of if they viewed speech recognition technology as providing opportunity for collaboration, student collaboration is an excellent way for students to share ideas and invoke new ideas and meet curricular demands. It appeared that even though collaboration may not always have been intended, speech recognition technology did provide opportunity for it and through collaboration allowed for ideas to be more easily expressed and shared amongst students.

Multiple levels of support are needed. Support of speech recognition technology within the school was investigated through interviews with the principal, assistive technologist, teachers, teaching assistants, students, and also through classroom observations. As mentioned previously, the principal cited the school as being largely supportive of any technology which caters to the learning needs of students. It appeared that the principal, teachers, teaching assistants, and the assistive technologist felt that this philosophy had largely been reinforced in their school due to support from administration, the assistive technologist, teaching staff, and by parents and students.

In terms of support, all of the teaching staff felt that various resources facilitated the use of speech recognition technology in the classroom. Rachael, Natalie, Charlotte, Jennifer, and teaching

assistants Christa and Hailey credited the school for providing them with the resources necessary to make speech recognition technology successful. Rachael stated that *"the administration sees the value and supports it. So they put funding towards the technology."* Natalie identified the spaces allocated within the school as being a great support for students. She stated *"students are given that quiet place in the school to work away from others, to be successful with Dragon…"* Angie, her respective teaching assistant Hailey, the current grade 6 teachers Rachael and Charlotte, the current grade 6 teaching assistant Christa, and the grade 7 teacher, Jennifer concurred, expressing how space to use speech recognition technology was critical. Jennifer added that students require sufficient spaces so that they are able to focus and not have other voices muffle the software's recognition of the students work.

Classroom observations provided additional insight into the support of speech recognition within the school. Each classroom that was observed had access to classroom laptop carts that could be utilized as needed by both students who used speech recognition technology and those who did not. In addition to the laptops, students were equipped with headsets and helpful "cheat sheets" for remembering the commands to the speech software. The spaces outside of the classrooms were equipped with benches, couches, and chairs for students to complete work. This appeared to support the space and the quiet needed for the software to accurately receive commands and produce the speech to text. In the classroom, similar quiet spots could be found in the back of the room, where students could close the door and work if they so desired.

In addition to the provision of funding in the form of the technology and space to use it, Natalie, Jarrett, and Shirley felt strongly about the contribution of the assistive technologist. Jarrett shared, "*I think we support it by allowing (the assistive technologist) full reign…"*. He continued by elaborating on why an assistive technologist is so critical, *"I think definitely you need someone in IT like (her) who can handle the training and monitoring of it, above a teacher or an educational assistant…"* Natalie added that the availability of the assistive technologist is crucial to supporting

students in addressing technical issues that they may experience. Overall, and as stated previously, the assistive technologist was described by all teaching staff as playing a central role in implementation and support of speech recognition technology.

Teaching staff also played an important role in supporting the use of speech recognition technology. Communication between staff members was considered by Angie to be imperative. She stated, "*…the communication is so good here. Not only does (the assistive technologist) communicate very well with who is using it and where they are at in their training, but between staff, we communicate very well…"* Consistency in use of speech recognition technology was also viewed as a valuable mechanism of support by Natalie, Collette, and Jennifer. Jennifer felt that providing *"time and space to practice…"* was helpful and Collette suggested that establishing a route was key to successful use. Classroom observations provided a similar picture of routine use, with direction to students including explicit mention that the project at hand be completed with a laptop or with the use of speech recognition technology. Students and teaching staff alike, considered technology integration to be primarily through their use of speech recognition technology with assignment based tasks. In fact, there was agreement of this amongst the Engaged, Neutral, and Non-Engaged student groupings. Observations in the classroom provided insight into use of speech recognition technology, with students abstaining from using the technology during class lectures and rather using it to complete their work once the task was assigned. This observation was consistent across all classroom observations in grades 6 and 7. No students attempted to use speech recognition technology in order to take notes during instruction, nor did teachers encourage it.

The current grade 6 teacher Rachael, and her respective teaching assistant Christa, as well as one student in the Engaged grouping pointed out how during exams, speech recognition technology is also permitted. Though this integration did not extend to note taking, it did provide students with another level of support. Justification for the support of speech recognition technology provided by

teaching staff was specified by Angie and Natalie. Angie stated, *"I am willing to have it used in my classroom because I see the benefit in the area of their confidence going up and the benefit of their work improving…it's a very successful strategy for students."* Natalie simply specified that staff buys in "*because you can see the results."*

Parental and student support of speech recognition technology was also considered to be an important component needed for successful use. Student buy-in was detailed as necessary for speech recognition technology to be successful by Jarrett, his teaching assistant Shirley and the principal, Connor (pseudonym). Jarrett elaborated on the success that students achieve when they buy into programs offered at the school. *"The students who buy into whatever we provide here at the school, the ones who meet us half way, are the ones who are successful with whether it may be… with technology or strategies…"* Parental support was identified by Rachael as being beneficial to her students. She explained, *"if you have parents on board and supporting it, then they are encouraging it at home…the partnership is huge…"*

Having many levels of support is important for students to get the best possible use out of speech recognition technology and to persist in its usage. Through administrative support which provided funding for the technology and the space to use it, support of the assistive technologist, support of teaching staff, and parent and student support, utilization of the technology is more seamless. Overall, multiple levels of support worked together to provide an environment for speech recognition technology to be successful.

Speech recognition technology was considered suitable by staff and students. Inquiring into whether speech recognition technology was considered suitable to the needs of students was done through observations and interviews with the teachers, teaching assistants, assistive technologist, and the students. It appeared that staff and students felt that the technology was appropriate due to it being adjustable to student ability, meeting student needs, and involving

appropriate training, which subsequently influenced student willingness to continue use of speech recognition technology.

The ability for students of varying abilities to utilize the same technology allows classrooms to use speech recognition technology across all students who may benefit from its usage. There was agreement across the assistive technologist, and teaching staff that speech recognition technology could work with any student. Angie, a previous grade 6 teacher, shared how she perceived the technology to extend across all student needs. *"I think it can fit a student that just needs to slow down, one that needs to speed up when they write… (Writing) only improves not matter what level they are at."* While the assistive technologist believed that accommodating student needs through the training process is really the equalizer. For instance, Donna whispering sentences to students allowed for those who were unable to read themselves to still train the software to their voices. Additionally, training students until they feel competent allows for all students to be prepared with the technology in the classroom.

All eight students shared the belief that any student could use speech recognition technology in their learning. One student stated, *"I think yes, a lot of kids could probably use it because it is such a simple aspect…With Dragon speak it's simple you can just talk and it goes on…"* Similar to the assistive technologist, they also believed that training was the equalizer. More specifically, two students recommended that sufficient training is needed for new students to understand the technology and another proposed that a basic knowledge of technology in general would be helpful to all new speech recognition technology students. Observations of the grade 6 and 7 students proved that students who were using the technology were at various levels of competency with the program. In the grade 6 classrooms while some students appeared to be knowledgeable and capable of directing the computer with commands, others referred to a cheat sheet of available commands to correctly direct the program. Observations of the grade 7 students demonstrated varying levels of competency as well. While some students were able to quickly set up their computers and

troubleshoot swiftly, others required assistance from fellow students or the assistive technologist to set up or fix computer errors. It was evident from both the grade 6 and 7 classes that despite the differing abilities in the use of the program, all students were able to utilize it through the assistance of others or through a cheat sheet of software commands provided to them.

The suitability of speech recognition technology to a student is also an important consideration to make. When asked if speech recognition technology was a good match, all eight students expressed contentment with using the technology in their learning due to the benefits it had afforded them. Six of the students across all three groupings attributed the good fit of the technology to the speed at which they were now able to write. The Neutral and Non-Engaged groupings commented further by stating that speech recognition technology works for them because it allows them to get their ideas down on paper. One student explained how her struggles had been helped through the use of speech recognition technology. *"You know, I have a lot of ideas but I can't get them down and I think that Dragon helps me get them down…"* Additionally, one student in the Non-Engaged grouping stated that speech recognition technology was a good match for him due the greater length and detail that he saw in his writing.

In terms of suitability of the training, all of the teachers, teaching assistants, and assistive technologist agreed that the students are equipped to use the technology through the provision of sufficient training on a continuous basis. While the assistive technologist felt that for the most part her students are well trained, one former grade 6 teacher Angie, suggested that the students really are the experts with the software. With the exception of students in the Engaged grouping, who as specified earlier suggested that additional training in the intricate details of the program would be beneficial, the Neutral and Non-Engaged groupings felt that the training they were provided was more than sufficient for them.

Not surprisingly, all eight students expressed that speech recognition technology was a good match for them and that it was a technology that they wished to continue to use throughout junior

high and high school. One student further commented on how speech recognition technology may also have applications in university and the workplace. He made sure to specify that use is conditional on future job prospects. More specifically, *"when you go to university and the workplace, are you going into mechanics or writing?"* Overall, it seemed that the suitability of speech recognition technology was made possible due to its adjustability to students, suitability of the technology, as well as the training which accompanied it.

Barriers to successful integration of speech recognition technology. When inquiring into the barriers which existed and limited successful implementation of speech recognition technology, it became apparent that enunciation, technical difficulties, and stigma were concerns of teaching staff and students. For instance, the three Engaged students detailed how the ability to use speech recognition technology in a lower voice would be incredibly beneficial, as they would be able to then take notes in class. The fear of disturbing others was what prevented the students from currently utilizing speech recognition technology in this manner. Additionally, a student in the Neutral grouping expressed his discontent with how when he is under the weather, the speech recognition software had difficulty recognizing his voice. Student annoyance was also expressed by the Neutral and Non-Engaged groups of students, when the software did not adequately capture the word they wished to use (e.g., dear used instead of the intended word deer). Similarly, teaching staff members, Angie, her teaching assistant Hailey, and current grade 6 teacher Rachael, stated enunciation as being problematic to the training period. More specifically, prolonging the time needed to successful train the program to the student's voice.

Technical difficulties existed as a primary area of concern for teaching staff and students. Unanimously, all eight students expressed their dislike for the technical problems which can occur during use. Technical problems were stated as including issues with the software not loading, the headset not being read by the computer, updates which occur randomly and freeze the computer, as well as the time it takes to boot up the computer in general. One particular student vividly described

his feelings when booting up took longer than anticipated. *"It takes time to boot up and it is not so much that I want to smash it, but I am ticked off a bit…"* Six of the teaching staff felt similarly (the two current grade 6 teachers Rachael and Charlotte, the current grade 6 teaching assistant Christa, the two grade 7 teachers Jarrett and Jennifer, and the grade 7 teaching assistant Collette), with Christa stating that technical issues are present almost daily. Some members of the teaching staff expressed more annoyance at technical issues than other. Christa indicated a great deal of frustration with speech recognition technology. *"It never works…it will just begin to get started and the computer won't log you in for some reason, and then the headset didn't click in."* Interestingly, although Rachael admitted that technical problems occur, she suggested that concerns may not always be genuine. *"Every time there is an assignment there is something with the computer, laptop, software, or piece of equipment. And sometimes it's legitimate and sometimes it's created."*

Further, Jarrett and Connor specified that if a student felt stigmatized he or she would be hesitant to use speech recognition software in their learning. Jarrett did note that he believed it had become a non-issue for his students as speech recognition technology is widely used within the school. The principal Connor added, *"there has to be no stigma attached to Dragon and I'm sure that Donna can tell you that in the olden days there certainly was and maybe even now…"* suggesting that although stigma may not presently be a concern, it presents itself as a potential barrier to be aware of.

Through the inquiry into conditions which may influence student cognitive engagement it became obvious that training opportunities are available as needed but that teaching staff and students remain hesitant to seek them out. Additionally, speech recognition technology has provided students with improvements in the areas of efficiency in writing, skilled and lower level writing, initiation and completion of tasks, as well as success with collaborative work, which inadvertently influences student ability to meet curricular demands. The benefits of using speech recognition technology do require that multiple supports be in place, including administrative

funding, support from the assistive technologist and teaching staff, as well as both parents and students being on board. Student and staff members' perception of speech recognition technology as suitable, exists due to the flexibility of the technology in meeting the needs of a variety of students, the technology itself, and the training surrounding it. Although, barriers do exist to successful integration, it appeared that speech recognition technology was perceived positively by students and staff.

Impact on Student Writing

Knowledge of the impact of speech recognition technology on student writing provides insight into the affordances which this technology can offer students. Through interviews, teachers, teaching assistants, the assistive technologist, the principal, and students provided insight into this inquiry. Using the definitions of skilled writing which includes ideas, organization, voice, word choice, sentence fluency, and conventions (Gansle & Vanderayden, 2006) and lower level writing skills that involve grammar, spelling, and text production (Graham et al., 1991; O'Hare & McTear, 1999; Quinlan, 2004), the following three affordances provided by speech recognition were discovered: skilled writing, lower level writing skills, and confidence.

As specified in detail in the previous section (speech recognition technology influenced student ability to meet curricular objectives) both teachers and students recognized the improvement in writing (e.g., skilled and lower level writing skills) through the use of speech recognition technology. In addition to improvements in student writing, student confidence was an area that was cited as being impacted. Angie, the former grade 6 teacher, and the grade 7 teacher Jarrett and his assistant Shirley spoke to this. Jarrett stated, *"they have all these great ideas in their head and previously they weren't able to get them down… now that they have taken the old school pen factor out, it just totally builds their confidence…"* Students did not specify this perceived increase in their confidence, instead solely commenting on their improved writing products.

The use of speech recognition technology appeared to influence a number of writing outcomes in students. Through these improvements and increased confidence which resulted from them, students were able to create a better writing product which was more representative of their abilities. As such, it appeared that speech recognition technology provided affordances to students which were reflected in the quality of their work.

Summary

Through analysis of the interview, observation, and survey data, eight themes stood out. There were differing levels of cognitive engagement amongst students and inconsistency in the understanding of engagement by both staff and students. Additionally, training was readily available but was seldom utilized, speech recognition technology was influential to students' ability to meet curricular objectives, multiple levels of support were necessary for speech recognition technology to be successful, speech recognition technology was largely perceived as suitable by staff and students, barriers existed to successful implementation, and that speech recognition technology impacts student writing outcomes (e.g., lower level and skilled writing).

CHAPTER FIVE: DISCUSSION

This case study investigated the relationship between speech recognition technology and cognitive engagement as well as the relationship between speech recognition technology and writing outcomes. The study investigated these relations as well as explored the necessary conditions to elicit cognitive engagement in writing with students. Perspectives from students, teaching staff, the principal, and assistive technologist were gathered, observations were recorded, and the Survey of Motivation to Engage in Writing was administered. Through employing mixed methods of data collection and analysis, findings were compiled into three sections: 1) cognitive engagement in writing, 2) conditions for speech recognition technology, and 3) impact on student writing. In this chapter, a discussion will occur surrounding the three research questions which will use the data and draw upon relevant literature. Further, implications with regard to school administrators, teachers, and school psychologists will be shared. The chapter is concluded with recommendations and directions for future research.

Discussion of Research Questions

Each of the three research questions will be discussed in this section. Focus will be given to examining the impact that cognitive engagement has on writing, successful practices, challenges to current practices, as well as the impact which speech recognition technology has on writing. Through an investigation into the results and literature, a closer examination into the impact of speech recognition technology on learning is presented.

Cognitive Engagement in Writing

While several researchers have found that technology use can impact student engagement in learning (e.g., Beeland, 2002), the relationship between speech recognition technology and student engagement in this case study was not straightforward. Results from the Survey of Motivation to Engage in Writing supported varying levels of student cognitive engagement, with students dispersed across the Engaged (n=3), Neutral (n=3), and Non-Engaged (n=2) groups. Although

seven of the eight students shared the same classroom and learning climate across two grades, individual variance in engagement is to be expected when consideration is given to the broader factors that have been proposed as contributing to cognitive engagement. With knowledge that the framework for cognitive engagement is centered around family background, student characteristics (e.g., socioeconomic status, family structure, students' sex and grade; Wilms et al., 2009) and peers (Appleton, 2012), in addition to the learning climates which were investigated in the classroom and the school, it was not surprising that students would have varying levels of engagement. In addition to these factors, consideration should also be given to other aspects which may also have played a role, such as student learning goals as suggested by Greene and Miller (1996), beliefs of self-efficacy (Greene et al., 2004), or perhaps even student self-regulation (Appleton, 2012; Chiu et al., 2012; Te-wang & Eccles, 2011). This suggests that a combination of factors likely interact to influence the extent to which speech recognition technology influences student engagement for the individual student.

While individual variance in levels of cognitive engagement was an expected outcome, what was surprising was the observed inconsistency in understanding of engagement by both students and school staff. When considering student perceptions of engagement, while only three students were found to be engaged as assessed using the survey measure, six of the eight student participants reported cognitive engagement during writing tasks. This discrepancy between assessed and reported levels of cognitive engagement may be due to limitations with the instrument used, given the relatively limited psychometric support for the Survey of Motivation to Engage in Writing at this time. However, the limited ability of the students to describe and provide examples of their own engagement, suggests that the assessed-reported engagement discrepancy may be due to a lack of understanding of what the term cognitive engagement encompassed or a lack of student awareness of their own engagement. As an example, even the three students who were assessed as and reported to be being cognitively engaged were not able to provide personal examples of cognitive engagement.

The inconsistency in beliefs surrounding engagement across grade 6 and 7 teaching staff was also an interesting and unexpected finding. Specifically, the majority of grade 6 teaching staff was able to identify cognitive engagement in their students, through specifying the greater connection and investment which they believed students put into their work. In contrast, the grade 7 teachers did not feel that their students were capable of cognitive engagement in this grade, and instead credited maturity as the basis for student engagement, which they felt became more evident in later grades (e.g., grade 8). The differences in beliefs may be credited to improvements that grade 6 teachers witnessed in their students after implementation of speech recognition technology. As the grade 7 teachers received their students with a year's experience with the program; improvements may be less obvious or not apparent at all. Alternatively, another factor accounting for these differences may relate to differences in classroom conditions between the grade 6 and 7 teachers. Mama and Hennessy (2010) found that degree of technology integration was directly related to teachers input into the lesson activities, which in turn is argued to influence student engagement. This parallels research by Middleton and Murray (1999) who found that teachers who more frequently integrate technology into instruction see greater achievement in their students. It may be that the grade 6 teachers who consistently require students to use speech recognition technology for all writing related tasks, are placing greater emphasis on use and are thus seeing more behaviors indicative of engagement. This differs from the implementation of speech recognition technology used by the grade 7 teachers, who were not as stringent in its use for all writing related tasks (e.g., rough drafts of writing projects as opposed to final drafts).

While both of these are plausible contributors to engagement, it seems that perhaps, recognition of engagement could be limited due to possible decreased levels of engagement in grade 7 students. In examining cognitive engagement in grade 6 to 12 students, Wilms et al. (2009) found levels of intellectual engagement (akin to cognitive engagement) to be the highest in grade 6, declining until grade 9, and then remaining fairly consistent through to grade 12. A similar pattern found by Appleton (2012) seems to support decrements in cognitive engagement during the junior

high school years. Though no variable examined in the present study explained this decline, speculation may lead one to consider the role of other factors. For instance, Wilms et al., (2009) noted correspondence between decreasing attendance and intellectual engagement rates, which points to attendance as being a potential area of influence to consider. While further study of the developmental aspects of cognitive engagement is required, it is additionally possible that grade 7 students were less frequently demonstrating behaviors indicative of cognitive engagement (than did the grade 6 students) which subsequently made engagement more difficult for the grade 7 teachers to observe. This lack of recognition of the attributes closely related to cognitive engagement (e.g., greater investment; Appleton, 2012) may explain why acknowledgment of engagement is limited and attributed solely to maturity.

Overall, the relationship between speech recognition technology and cognitive engagement appears to be complex with a number of variables likely influencing the extent to which speech recognition technology affects engagement in each student (e.g., family background, student characteristics; Wilms et al., 2009). While differences in perceptions of engagement may exist between grade 6 and 7 teaching staff due to year of implementation of speech recognition technology or consistency of use in writing tasks, views of engagement may also be inconsistent due to outside variables not attended to in this study. Though further examination into these variables is beyond the scope of this study, an evaluation of the effective practices and challenges to current practices which are influential to student success with speech recognition technology are provided below.

Conditions for Speech Recognition Technology

Research question two was designed for the researcher to inquire into the necessary conditions to elicit cognitive engagement in students using speech recognition technology. By incorporating the ISTE (2008) guidelines in classroom observation protocols, as well as, inquiring about the ISTE (2008) and CALL Scotland (2008) conditions with both staff (the principal,

teaching staff, and the assistive technologist) and students in interviews, several successful current practices and challenges to current practices involving speech recognition technology to support student writing were identified.

Successful current practices. Successful practices within the school were documented by the researcher in three areas: 1) speech recognition technology was found to be influential to student ability to meet curricular demands, 2) multiple levels of support were needed and provided to students, and 3) the perception of suitability of speech recognition technology was unanimous across educators and students. A discussion about each of these areas is presented below.

Speech recognition influenced student ability to meet curricular objectives. In class, the ability to meet curriculum objectives is critical to student success. Speech recognition technology was found to support the work that students do in the classroom and simultaneously was found to provide a more accurate representation of student work. Specifically, curriculum objectives were stated as being met through greater efficiency, initiation and completion of written work, improvements in skilled and lower level writing, as well as success with collaborative work.

The increased efficiency which speech recognition technology afforded to students may be related to the ease of work that speech recognition technology provides. Through removing the barrier of writing, it may simply take less time and effort to achieve the desired writing product. Alternatively, efficiency may be linked to research completed by Morgan (2008), who found that the use of technology (e.g., interactive whiteboards) resulted in greater at-task behaviors. These behaviors may subsequently make the completion of projects at a quicker pace, more achievable.

The staff and students believed that this greater efficiency at which tasks could be completed also contributed to student ability to both design and then implement projects using speech recognition technology. This parallels research by O'Hare and McTear (1999) who found that dictation software enabled students to more quickly produce word processed documents. While classroom observations proved that students were able to initiate and complete tasks with speech

recognition technology, student and staff interviews made obvious that task initiation and completion is certainly made more achievable through the use of speech recognition technology in the classroom. Research by Quenneville (2001) found that technologies utilized within inclusive classrooms have been found to improve learner outcomes in students. By using speech recognition technology, students were participating in real world activities (e.g., writing reports, creating MS PowerPoint presentations) and able to successfully begin and complete these endeavours. Though this benefits students in meeting curriculum objectives, it also prepares them for tasks that they may encounter in school or places of work.

Positive writing outcomes were also found to be improved through the use of speech recognition technology. Specifically, and in terms of lower level writing skills, spelling and text production were found to be superior. For example, Rachael felt that text production was "*the biggest improvement.*" Although Raskind and Higgins (2000) found improved spelling to occur as a result of using speech recognition technology as evident through the Wide Range Achievement Test-3, the teachers and students in the present study attributed better spelling to the program itself (e.g., identifying errors). An increase in text production was also described to have occurred by both students and teaching staff in this present study. Increased text production as a result of speech recognition technology has been documented previously by a number of researchers (Garrett et al., 2011; O'Hare & McTear, 1999; Quinlan, 2004).

Although interview data from both staff and students supported development in the skilled writing area of sentence fluency, fewer improvements were noted in skilled writing than for lower level writing skills. Of the improvements found in skilled writing, it is consistent with research suggesting that aspects of skilled writing have differing rates of development (Berninger et al., 1992, 1994, 1996). Specifically, sentence fluency is surmised to begin in what is termed the revising stage, which consists of evaluation and implementation of changes at the word, sentence, and text level (Chanquoy, 2009). Advanced planning and revision begin developing in grades 4 to 6 and are not fully operational until grades 7 to 9 (Berninger et al., 1992, 1994, 1996) and might

explain why teachers and students were just beginning to recognize fluency as occurring. Alternatively, it may be that because skilled writing is a more complex process, it is a more difficult area in which to positively exert change. This suggests that more research needs to be done on the influence of speech recognition technology on specific aspects of skilled writing through a developmental framework.

Collaborative work through the use of speech recognition technology was considered to successfully help students in meeting standards by a number of staff and students as well. Three teachers suggested that group work was made possible through the use of speech recognition technology. Specifically, students who had previously been unable to contribute to writing were thus given the ability to actively contribute a writing piece to group work. Students from the Engaged and two from the Neutral group agreed that through the use of speech recognition technology, they felt equipped to contribute their skills to collaborative group work. Quenneville (2001) described increased use of assistive technologies during cooperative learning activities as a way to enhance participation, which is what the three above students stated as occurring. Additionally, Swan et al. (2007) stated that whole class engagement can afford greater participation to all students in the classroom. Greater participation was afforded to students using speech recognition technology through their ability to participate as a member of the student group with fewer restrictions.

The benefits of meeting curricular objectives through use of speech recognition technology are immense. With the suggestion that some students may not complete grades without the assistance of speech recognition technology, speech recognition technology may play a role in school completion in general. Additionally, by removing the constraints of writing, and seeing benefits in efficiency, initiation and completion of work, writing skills, and in collaborative work, greater focus across all subject areas may benefit students who previously allocated the majority of their time to completing writing tasks at the expense of their other subjects.

Multiple levels of support are needed and were provided. A philosophy supportive of technology integration was informative of how the school in this study facilitated the use of speech recognition technology. It became obvious that five supports were crucial to meeting the needs of students. These supports consisted of administrative support, support from the assistive technologist, teaching staff, and support of parents and students themselves.

The allocation of funding from administration provided for the technology, the space to use it, and the assistive technologist. Through the provision of resources to help students perform their learning, CAST (2012) suggests that learning opportunities for students are increased. Not to mention, without that initial level of support, the use of speech recognition technology would likely not have been a possibility. In fact, through the provision of speech recognition technology support to a large percentage of students, administration had created a perception of normalcy for those requiring this support. With research indicating that the environment which the technology is offered in as playing a role in effectiveness (CALL Scotland, 2008; Holmes & Silvestri, 2008), administration undoubtedly encouraged effective use through the provision of necessary resources (e.g., technology and space) and perhaps also, a culture of acceptance.

Teacher, parental, and student investment are also suggested as conditions which may impact overall effectiveness of technology integration (CALL Scotland, 2008; Holmes & Silvestri, 2008). When considering this, the large investment that the assistive technologist places in not only training and troubleshooting with staff and students, but also role-modelling, it seems that effectiveness undoubtedly is influenced through her persistence. Although teaching staff felt committed to using speech recognition technology in their classrooms to assist their students, teachers were often not very invested in the technology itself (will be discussed in challenges to current practices). However, grade 6 teachers did offer support in the form of communication amongst staff and through offering students consistent practice. CALL Scotland (2008) indicated that students who practiced once or more per week were twice as likely to be successful with using

speech recognition technology and that those who had more frequent practice, opted to continue using it. Through providing the time for students to hone in on their skills, teachers gave students the means to be successful with this technology, and consequently encouraged future use.

Parental investment, as mentioned earlier, impacts effectiveness of technology integration (CALL Scotland, 2008; Holmes & Silvestri, 2008) and as such is important form of support for students. Not to mention, with student attitudes being found to be one of the best measures of successful implementation of speech recognition technology (CALL Scotland, 2008), the investment which students placed in this technology, was critical. Overall, the support of speech recognition technology by administration, the assistive technologist, teaching staff, parents, and students was necessary for the successful implementation.

Speech recognition technology is perceived as suitable by staff and students. The perception of suitability of speech recognition technology by both staff and students was due to the adjustability of the technology to student needs, suitability of the speech recognition technology, and the suitability of training, all of which impacted students' willingness to continue in its usage. The capacity for students of varying abilities to utilize speech recognition technology was witnessed while observing students in class, and explained further through interviews with staff (the teaching staff and the assistive technologist), and students. Unanimously, staff and students agreed that this technology could work with any student. The capability for students of various abilities to utilize speech recognition technology in their learning, allowed for a number of students who may benefit from this technology to use it. In this regard, there is a greater likelihood that students will not be turned away, as speech recognition technology presents material in a mode which accommodates learner needs, which subsequently may contribute to increased learning opportunities (CAST, 2012).

As stated previously, student attitudes are one of the best measures for successful implementation of speech recognition technology (CALL Scotland, 2008) and unanimously,

students were supportive of using speech recognition technology in their learning. In fact, they unanimously agreed that speech recognition technology was a good match. Suitability of training is also an important consideration to make. Without the proper training, students may struggle to fully use the technology and may have adverse side effects as a result (e.g., frustration). It seemed that although some students sought additional training in the intricacies of the program, students agreed that training was sufficient. While student intent to further their use with speech recognition technology was shared, it was not surprising due to the goodness of fit of speech recognition technology into their learning.

Challenges to current practices. Though there were many instances of successful practices within the school, three current practices were identified as possible factors attenuating the degree to which utilizing speech recognition technology impacted cognitive engagement. A discussion of three practices are provided below: 1) professional development, 2) opportunity for collaboration, and 3) technology integration.

Professional development. In general, there was consensus amongst the school staff that the assistive technologist held primary responsibility for training and supporting speech recognition technology within the school. The availability of the assistive technologist to assist students on a regular and as needed basis provided both staff and students with the confidence to both use and have speech recognition technology used in their classrooms. Even amongst the relatively few teachers who had a basic knowledge of speech recognition technology and were trained, there was still a preference that the students be advised by the assistive technologist to maintain consistency in how to use the technology.

As a result of the general acceptance of the training and delivery model, individual teacher's limited basic knowledge of or formal training on speech recognition technology did not present as a concern among the staff members. However, following the assertion that "practitioners must effectively apply technology in the curriculum and throughout the school day" (ISTE, 2008, p. 7),

the lack of consistent knowledge with speech recognition technology across teaching staff likely limited the ways in which the technology was utilized within the classroom. At the most basic level, teachers knowledgeable about the technology are readily able to assist their students with troubleshooting and resolving technical difficulties, as opposed to the virtually exclusive reliance on support from the assistive technologist observed within this study. Certainly, staff and student interviews indicated a prevalence of technical difficulties which ranged from problems with the program itself to difficulties with enunciation, influencing training, and student work. The benefit of having trained teaching staff who can quickly remediate such issues within the classroom is increased student time on-task. Teaching staff may also be made more aware of and able to discern what Rachael stated as being student created concerns (e.g., task-avoidance) versus legitimate technical concerns, and then address the technical aspects and student issues more effectively. As such, there may be benefit to instituting mandatory training so that teaching staff could assist their students and remediate issues as they arise, rather than waiting for the issues to be resolved on the schedule of the assistive technologist.

Opportunity for student collaboration. While collaboration was identified as a positive condition in that it allowed for students to have enhanced participation in group activities and meet curricular objectives, it also presented as a challenge within the school in that there was a lack of consistent use of speech recognition technology in a collaborative manner. Nearly half of the students (two students in the Non-Engaged grouping, and one in the Neutral grouping) and teaching staff (three members) did not view speech recognition technology as being compatible with student collaboration, with some staff members positioning collaborative use as a future development. One of the Non-Engaged students shared, *"well for me it's like, group work with Dragon doesn't help that much…if someone is shouting something in the background and then it picks it up it's sort of annoying."* Interestingly, despite the viewpoints of some staff and students that speech recognition technology was not influential to collaborative work, it was apparent that some students were inadvertently working collaboratively with it, through sharing documents over Google Docs with

fellow students and teachers. While ISTE (2008) stated that technology use must be incorporated into a collaborative environment for it to be effective, it seemed that teachers and students were seemingly unaware of the many ways in which students were currently collaborating (e.g., sharing stories over Google Docs). Recognition and incorporation of the ways in which speech recognition technology could facilitate collaboration and encouragement of this collaboration may benefit students through greater critical thinking skills, and sharing of ideas to provoke new ideas.

Integration of speech recognition technology. The use of speech recognition was described as consisting primarily of use in examinations and assignments by staff and students. Classroom observations affirmed this, with speech recognition technology being used for the sole purpose of completing the task at hand (e.g., writing task). Though instruction did incorporate the use of speech recognition technology by directly instructing students to use it, it was not utilized when not otherwise instructed. This was viewed as problematic for some students who wished that they could use it for note-taking while the class took place. Referring back to the work of Dias and Atkinson (2001), they suggested that the teaching pedagogy as opposed to the technology itself determines effective technology integration. It seems that teachers currently do not use speech recognition technology effectively in terms of integrating it well to support the pedagogy being used in the classroom. This may be linked to the lack of consistent or mandatory training, with teachers currently having a limited knowledge of the program, as well as, limited opportunity to learn how to effectively integrate it to support student learning. With a lack of awareness as to how speech recognition technology functions, it would be difficult to incorporate it into instruction. Furthermore, Friesen and Clifford (2002) stated that use of technology should facilitate tasks at a level of complexity which would otherwise be impossible without it. Although, some students are able to use the program well and in many instances (e.g., to collaborate), the question of whether speech recognition technology is consistently used at a level of complexity greater than simply word processing remains. As such, increased integration of speech recognition technology requires

teacher training in skills that go beyond basic functionality and extend to incorporation into their teaching practices.

In reviewing the range of successes and challenges outlined above, what becomes evident is the need for technology integration to be considered in light of multiple conditions. In particular, the range of conditions examined in this study allowed for students to exhibit instances of investment in their learning, and to construct new knowledge. With knowledge that technology integration is a complex step which entails more than simple incorporation of the technology into the classroom (Valcarcel, 2010), it becomes crucial to evaluate the environment and the individuals who use it (CALL Scotland, 2008; Holmes & Silvestri, 2008).

Impact on Student Writing

The third area examined in this study concerned the impact of speech recognition technology on student writing. Through interviews with students, teaching staff, and the assistive technologist, speech recognition technology was reported to impact student writing in three areas. Lower level writing skills of spelling and text production were found to be influenced as was the skilled writing area of sentence fluency, as was previously detailed in the above section on curriculum objectives. Additionally, two of the teachers identified increased student confidence resulting from the use of speech recognition technology. It is possible that through increased confidence, students may also have increased motivation, a by-product of implementation of speech recognition technology found in a study by Hwang et al. (2012). The ability for students to create and present an improved writing product to their teachers appears to be beneficial not only to their grades, but also to their confidence. From a practical standpoint, if students are struggling in writing and speech recognition technology has been recommended to help them, being trained in speech recognition at the earliest grade possible may help to remediate the struggles which the students have faced with writing. This may occur due to technology circumventing specific disability related

barriers (e.g., fine motor difficulties) as suggested by Quenneville (2001) or software's adoption of its user characteristics through persistent use.

While this study contributes to the accumulating support for the use of speech recognition technology in improving writing outcomes, a surprising finding of this study was the apparent disconnect between writing outcomes and cognitive engagement. That is, while all teachers reported that speech recognition technology resulted in some level of improvement in writing outcomes, only three students were assessed as being cognitively engaged using the Survey of Motivation to Engage in Writing. Not to mention, engagement was not consistently recognized by either students or staff. While previous research has linked cognitive engagement to academic achievement (Greene et al., 2004; Miller et al., 1996), the influence of cognitive engagement on achievement outcomes was not as evident in this study. To account for the writing improvements in the absence of consistent levels of cognitive engagement, it may be that speech recognition technology is more compensatory in nature. More specifically, through easing the burden of writing it may improve upon the lower level skills, and increased confidence, which were both stated as occurring. Though an increase in skilled writing was mentioned (e.g., improvements in fluency), perhaps improvement in this writing area is more dependent upon increases in cognitive engagement and may explain why more cases of development in skilled writing were not evident.

Implications

The key findings of this study revealed that conditions conducive to successful implementation of technology allowed speech recognition technology to be used in a manner which supported positive learning outcomes (i.e., primarily improved lower level writing skills), with the relationship to cognitive engagement less clear. As outlined earlier, it is likely that factors outside of classroom and school conditions additionally need to be considered in understanding differing engagement levels between individuals. That is, the very construct of cognitive engagement points to the multiple areas of influence that could have affected cognitive engagement patterns (e.g.,

peers, family background, and student characteristics). While recognizing the multiple factors that need to be considered, the following section outlines implications of the study, with a focus primarily on conditions that affect the practices of school administrators, teachers, and school psychologists. Implications for each of the stakeholder groups will be discussed in the following sections.

School administrators. The implementation of speech recognition technology should not be taken lightly by school administrators who wish to introduce this technology to students and staff. There needs to be an allocated budget for student technology (e.g., computers or iPads), headsets, and the software itself. Additionally, with teacher interviews describing the necessity of student space to work and a consistent support such as an assistive technologist on staff, it is obvious that simply providing the technology to students is not sufficient. Prior to implementation, the principal and staff must ensure that students are supplied with sufficient space in hallways or classrooms to utilize speech recognition technology effectively, as suggested by ISTE (2008), while also ensuring that students do not feel stigmatized by leaving the room to complete their work. This can be achieved through creating an awareness and culture of acceptance of speech recognition technology at the school.

As ISTE (2008) suggests, a consistent support to students who is knowledgeable in the training and ongoing support of speech recognition technology must also be available. While one specified staff member may serve as the primary resource, it is important that all teaching staff be included in professional development initiatives to ensure students have ongoing and timely support to encourage their effective use of speech recognition technology. Ongoing support may exist through student help sessions held during the week with a knowledgeable staff member, or the ability to contact and meet with a staff member in the instance that technical difficulties occur. Overall, implications for administrators lie primarily in the ISTE (2008) condition of support of technology innovation. More specifically, support through allocation of adequate space, funding of

the technology, adequate professional development, people who can support students in learning and using the technology, and facilitating a culture of acceptance amongst staff and students.

Teachers. The implementation of speech recognition technology has four specific implications for teaching staff. First, teachers should be prepared with knowledge of the application of speech recognition technology and with problem solving techniques. Through doing this, student concerns with the software can be addressed efficiently. Additionally, knowledge of speech recognition technology can inform thoughtful integration to support academic work. If for some reason, this is not possible, it is of upmost importance to ensure that a support person is readily available to assist teachers and students as required. Without this support, frustration may occur and lack of use by students may result.

Second, teachers must also be supportive of the use of speech recognition in their classroom and both provide opportunity for student use and encourage student use. As mentioned previously, use of speech recognition technology at least once a week encourages successful integration (CALL Scotland, 2008) and as such, teachers should strive to have students consistently use this technology, especially with writing assignments. Additionally, use of speech recognition technology should be strongly encouraged by educators through providing adequate time and supporting students in successfully using it.

Third, observation of students who use speech recognition technology needs occur to determine if speech recognition technology is being used effectively. For instance, observation as to whether students are faking use of the technology (e.g., wearing the headset with the software open but still typing out their assignment) would be incredibly beneficial in identifying students who are resistant to training or lack knowledge of how to properly use the program. If teachers are aware of improper use, they can quickly address the problem or refer the student to the support person for further encouragement and support. Not to mention, they or the support person can specifically target the problematic use of the software or equipment.

Fourth, communication between staff is paramount to the success of speech recognition technology. Teachers across all subject areas must communicate about individual student competency and success with using speech recognition technology. Through individualized program planning and direct communication, teachers will always be aware of the student's current capabilities with the program. Additionally, this communication will encourage teachers across all subject areas to utilize speech recognition as required and may also inspire teachers to discuss their own applications of this technology amongst each other (e.g., how it is used, successful strategies, troubleshooting). Implications for teachers, who are implementing speech recognition technology, lie largely in providing support (e.g., through being open to and participating in training, consistently encouraging use, communicating with staff, parents, and students, and monitoring student progress), a condition for successful technology use by ISTE (2008).

School psychologists. Prior to providing a recommendation for speech recognition to be used by a student, school psychologists must have a working knowledge of how this technology is trained, used, and applied in the classroom. This can be achieved by working through the training manual and personally utilizing the software. Additionally, psychologists should inform themselves on ways in which speech recognition technology is being used in the classroom (e.g., note taking, assignment based tasks). Having a working knowledge of training, use, and application in the classroom will provide school psychologists with the knowledge to determine if speech recognition technology is a good fit to the student's needs and abilities, and will work with the tasks that the student intends to undertake with the technology. In addition to this, psychologists must be willing to investigate the current circumstances and school and classroom environments of the student. More specifically, once a need for speech recognition technology is identified, student willingness to even utilize the technology must be deciphered. Without this intent to use speech recognition technology, students may not commit to the training or use of it. Additionally, an investigation must occur into whether the student's school is currently facilitating the ISTE (2008) conditions for successful technology implementation. The school may not be knowledgeable of these conditions,

in which case, the psychologist must provide the conditions to the school and determine whether these conditions can be fulfilled. Implications for school psychologists largely exist in the additional step of determining if speech recognition technology is a good fit for the student and if it can be accommodated successfully at school and/or at home.

Future Research Directions

From the study, five themes emerged worthy of further investigation. Cognitive engagement across multiple contexts, different research designs and measures to expand on existing knowledge, the impact of student characteristics on cognitive engagement in writing through the use of speech recognition technology, instructional challenge, and varying research frameworks are suggested as the foci of future research studies.

Cognitive engagement across multiple contexts. Completion of a study which evaluates student cognitive engagement in writing while using speech recognition technology is recommended to take place in a variety of settings and grades. More specifically, the school in this current study was a specialized setting (e.g., intended for students with learning disabilities) which had a culture of acceptance surrounding implementation of speech recognition technology, due in large part to the number of students who were using this technology in their learning. It is questionable as to whether similar results would occur in a non-specialized school where fewer students may be utilizing speech recognition technology and where greater stigma may be associated with its use. Additionally, the support of students in a school that does not provide specific resources (e.g., space, assistive technologist) for the use of speech recognition technology may have different levels of teacher investment and/or school investment, and thus influence engagement. Furthermore, investigation across grade levels will provide insight into how engagement levels differ across elementary, junior high, and high school. Lastly, an investigation into home use and support of speech recognition technology would be beneficial. Through home

visits and parental interviews a greater understanding of the conditions necessary for engagement may occur. The following questions may be used to guide further research:

1. Do elementary and junior high students differ in the extent to which they are cognitively engaged in writing when using speech recognition technology?
2. Does home usage of speech recognition technology impact overall student cognitive engagement?

Research designs and measures. The research design employed in this study allowed for initial investigations into the existence of possible relationships between the use of speech recognition technology and student cognitive engagement and writing outcomes. Certainly, further experimental and longitudinal designs are warranted to more fully understand the degree and direction of relationships between these variables and to obtain insight into how engagement and written outcomes evolve. While writing outcomes were assessed in the current study using teacher and student reports, further inclusion of additional writing measures (e.g., PAL-II Reading and Writing, WIAT-III, writing samples) would allow for a more comprehensive examination of writing outcomes. Also requiring further attention in this area is the refinement of measures examining cognitive engagement within the writing domain. Due to the limited psychometric properties of the Survey of Motivation to Engage in Writing, additional psychometric support for this instrument or development of new instruments examining cognitive engagement in writing would be beneficial. These two questions may be used to begin this investigation:

1. How does speech recognition technology influence student written outcomes?
2. Does cognitive engagement decrease from elementary to junior high school?

Student characteristics. From this current study, despite seven of the eight students sharing the same teachers, no consistent conditions were identified as influencing engagement versus non-engagement in writing. Additionally, research inquiring into student characteristics which may

influence engagement would be helpful for school psychologists and teachers to determine which students would be the best candidates for the use of speech recognition technology and also the students who may need additional assistance with the technology. More specifically, an investigation into whether characteristics like gender, family structure, or socioeconomic status influence engagement in writing. The following two questions are proposed to guide further research:

1. Does socioeconomic status influence student cognitive engagement in writing?
2. Do differences exist in student cognitive engagement in writing between males and females?

Instructional challenge. As identified in the literature review, a criticism that could be levied against the extant research on engagement and technology is the lack of attention given to the task environment. The current study did not address this limitation, as task requirements were explored at a more general level (e.g., purpose of the task was examined as opposed to student perceived task difficulty). That is, the research design did not allow for examination of the impact of task difficulty on cognitive engagement. It would be of great benefit for future research to address cognitive engagement in relation to task. One means to address this is by attending to what Csikszentmihalyi (1997) described as flow, the deep absorption in an activity when it is intrinsically interesting to a student. It is suggested by Csikszentmihalyi that flow occurs when student abilities and the challenges of the tasks that they are asked to perform are in balance. Four general relationships between skills and challenge are stated as existing: High skill and low challenge, high skill and high challenge, low skill and low challenge, and low skill and high challenge (Csikszentmihalyi, 1997). Researchers who have based work on flow theory have advocated for the importance of also looking at the challenge of the task (Wilms et al., 2009). With research by Wilms et al. indicating that students who lacked confidence in their skills and those students who were confident but not challenged were less likely to be engaged, it becomes imperative to consider

instructional challenge in future research activities. The following question is proposed to guide this inquiry:

1. Does instructional challenge influence student cognitive engagement in writing?

Research frameworks. Future researchers should also consider adopting various frameworks that could allow for a deeper examination of the environmental conditions present within the classroom (e.g., teacher adoption and effective use of technology). For example, Social Learning Theory places emphasis on how patterns of behavior can be acquired through direct experience and states that people learn from one another, through imitation, observation, and modelling (Bandura, 1977). Applied to the study of speech recognition technology and cognitive engagement, the framework places increased attention on the importance of attending to what students observe within their environment with respect to innovative and effective practices with technology. Of particular interest is the consistency and manner in which speech recognition technology is modelled by teachers, as well as the extent to which it supports effective student use. Through giving attention to role-modelling, there is a greater likelihood that students will begin to demonstrate inventive usage of speech recognition technology in their own learning (e.g., searching the internet), which could influence overall student engagement in course work. The following question may be used to begin this investigation:

1. Does teacher role-modelling influence the extent to which students are cognitively engaged in writing?

Conclusion

Speech recognition technology is a commonly employed assistive technology within today's schools, with use primarily with students identified as having a learning disability. The present study provided initial work into examining whether speech recognition technology plays a role in improving cognitive engagement. The relationship between speech recognition technology and

cognitive engagement is complex, with multiple areas likely interacting to influence engagement in students (e.g., student characteristics). Although there is support for speech recognition technology as influential to writing outcomes, the relationship between speech recognition technology, cognitive engagement, and writing outcomes is less obvious. While further study is warranted, it appears that for students with long-standing difficulties in writing, speech recognition technology may be an important but not sufficient support for increasing cognitive engagement. That is, speech recognition technology may free up cognitive resources that the struggling writer would typically direct toward the production of lower level writing skills, such as spelling and text production (Garrett et al., 2011; Raskind & Higgins, 1999). This, in turn, allows cognitive resources to be redirected towards more complex and involved tasks involved in skilled writing (e.g., editing and revising work). It could be, then, that cognitive engagement is less required for successful execution of lower level writing tasks, but is imperative for successful execution of skilled writing.

As speech recognition technology assists primarily with these lower level skills (e.g., spelling, text production), it could be argued that the direct impact of this technology on cognitive engagement is minimal (but essential). In other words, speech recognition technology may provide the necessary foundation for cognitive engagement to emerge, but the technology alone is not sufficient. Rather, successful teaching pedagogy outside of speech recognition technology is likely needed.

Overall, the results from this study are promising in that they indicate that fulfillment of conditions conducive to student success with speech recognition technology, may help in removing disability related barriers, and constitute one important component in improving student writing and learning. Such conclusions are in alignment with direction recommended by the Center for Applied Special Technology (CAST), which suggests that the manner in which students with learning disabilities complete learning tasks, can act as a barrier. Speech recognition technology addresses this obstacle by removing the burden of writing and providing the tools for students to construct new knowledge through increasing the ease with which they can transfer their ideas to paper.

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APPENDIX A: SURVEY OF MOTIVATION TO ENGAGE IN WRITING

(Hawthorne, 2008)

M F

Name: _____ Ethnicity _____ Gender: 0 0

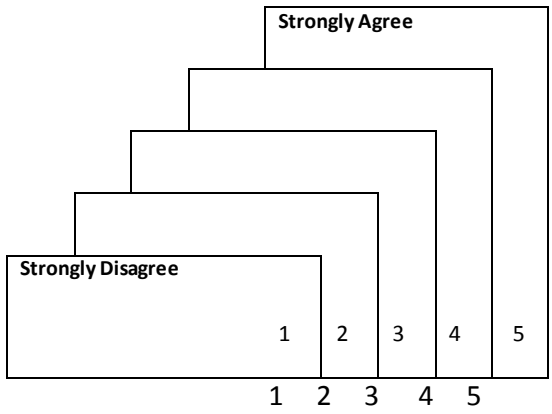
School: _____ Class: _____ Is English your first language: Yes 0 No 0

This questionnaire includes items that might be descriptive of you. Please read each question and then fill in the appropriate bubble. For example, if the first question always applies to you, then fill in the bubble numbered "5." Remember, we are interested in how you think you actually are, not how you would like to be. Use the scale below to answer the questions.

Rate the following questions as they relate to you at this time. The rating scale goes from 1 to 5 with the following anchors:

1 = Strongly Disagree 2 = Somewhat Disagree 3 = Unsure 4 = Somewhat Agree 5 = Strongly Agree

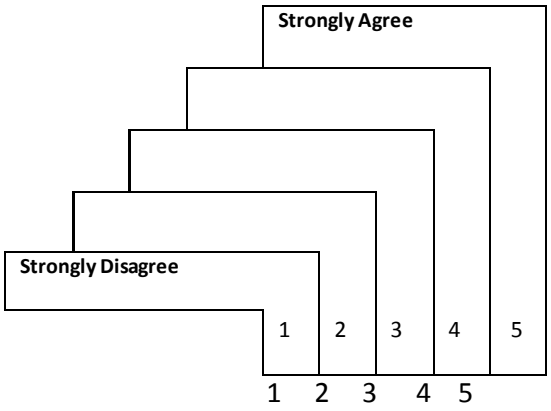
For each question, fill in *one* bubble completely with black/blue pen or pencil 0. If you change your mind, put an X through that response, 0 and fill in the *one* bubble you want to be counted.



1. *I enjoy writing* *1.* 0 0 0 0 0

2.	*I read over what I've written before I hand it in for marking.*	2.	0	0	0	0	0
3.	*When I write, I feel relaxed*	3.	0	0	0	0	0
4.	*Taking a writing course would be a fun activity for me.*	4.	0	0	0	0	0
5.	*I make sure I understand what we have to do before I start writing.*	5.	0	0	0	0	0
6.	*When I do writing tasks I like to have a set goal to work towards.*	6.	0	0	0	0	0
7.	*I would rather write an essay than fill in blanks on a worksheet.*	7.	0	0	0	0	0
8.	*I like how writing makes me feel inside.*	8.	0	0	0	0	0
9.	*I plan my ideas before I start writing.*	9.	0	0	0	0	0
10.	*I think writing is enjoyable.*	10.	0	0	0	0	0
11.	*I understand how to do most of the writing tasks we have to do in English.*	11.	0	0	0	0	0
12.	*Handing in a piece of writing makes me feel good.*	12.	0	0	0	0	0
13.	*Other kids think I am a good writer.*	13.	0	0	0	0	0
14.	*I have entered something into a writing competition at least once.*	14.	0	0	0	0	0
15.	*I put my sentences in a better order than the other students in my class do.*	15.	0	0	0	0	0

P.T.O.



16.	*I can write sentences and paragraphs better than most other people in my class can.*	*16.*	0	0	0	0	0
17.	*I like to check over my writing and fix up mistakes I find.*	*17.*	0	0	0	0	0
18.	*I feel confident in my ability to express my ideas in writing.*	*18.*	0	0	0	0	0
19.	*I don't like writing.*	*19.*	0	0	0	0	0
20.	*I get good marks for what I write in English.*	*20.*	0	0	0	0	0
21.	*I write better than most other kids in my class.*	*21.*	0	0	0	0	0
22.	*I like to organise my thoughts by writing them down.*	*22.*	0	0	0	0	0
23.	*I write as well as most people in this class.*	*23.*	0	0	0	0	0
24.	*I would enjoy submitting my writing to a magazine for publication.*	*24.*	0	0	0	0	0
25.	*I try to do the best that I can for each writing task we're asked to do*	*25.*	0	0	0	0	0
26.	*Getting a good mark for my written tasks is important to me.*	*26.*	0	0	0	0	0
27.	*The words I use in my writing are better than most other kids use.*	*27.*	0	0	0	0	0
28.	*Even if I think the writing task is boring I will try to do my best.*	*28.*	0	0	0	0	0
29.	*Trying hard in English this year will make me a better writer.*	*29.*	0	0	0	0	0
30.	*If I get confused while writing I make sure I get help.*	*30.*	0	0	0	0	0

31.	*I choose the words I use in my writing carefully to appeal to my audience.*	*31.*	0	0	0	0	0
32.	*It's easy for me to get good marks for my writing.*	*32.*	0	0	0	0	0
33.	*People in my family think I am a good writer.*	*33.*	0	0	0	0	0
34.	*My teacher thinks I am a good writer.*	*34.*	0	0	0	0	0
35.	*I brainstorm ideas before I start writing longer pieces.*	*35.*	0	0	0	0	0
36.	*I like to have my friends read what I have written.*	*36.*	0	0	0	0	0
37.	*Doing well in my writing assignments is important to me.*	*37.*	0	0	0	0	0
38.	*People seem to enjoy what I write.*	*38.*	0	0	0	0	0
39.	*I know how to structure an essay quite well.*	*39.*	0	0	0	0	0
40.	*I am a good writer.*	*40.*	0	0	0	0	0

THANK YOU FOR COMPLETING THIS SURVEY!

APPENDIX B: GRADE SIX TEACHING STAFF INTERVIEW QUESTIONS

• How do you begin to introduce and implement Dragon Dictation?	
• What strategies do you use to get kids confident and competent in their use of Dragon Dictation?	
• Do students have the opportunity to practice using Dragon Dictation with staff as required?	
• How do you support the use of Dragon Dictation in the classroom?	
• Do you role model the use of Dragon Dictation? If so, how?	
• Is Dragon supported in the school? Why or why not?	
• In your opinion, are there any barriers to successful implementation of Dragon Dictation?	
• In your opinion, what are the necessary conditions that need to occur for Dragon Dictation to be successful?	
• Do you feel that you were given enough training with Dragon Dictation to assist students as required? Explain your training.	
• To what extent do you feel that dragon is used to support curriculum objectives?	
• To what extent does the use of Dragon Dictation allow for greater student collaboration? Please explain.	
• In your opinion is Dragon Dictation adjustable to student ability? Why or why not?	
• To what extent do you integrate Dragon Dictation throughout your lessons?	
• To what extent does Dragon Dictation allow for students to begin and complete their projects?	
• Are you interested and willing to have students use Dragon Dictation in your classroom? Why or why not?	
• To what extent does the use of Dragon	

Dictation impact student writing? Please explain.	
• Extent to which students are cognitively engaged) Cognitive engagement is defined as "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012). • Do you feel that the use of Dragon Dictation impacts students' cognitive engagement in their writing? Please explain	
• What are your expectations for students using Dragon Dictation?	
• Do you feel that students are sufficiently trained in the use of Dragon Dictation? Why or why not?	
• Why is it that some students are more successful with Dragon Dictation than others? • Why do you think that is and what contributes to this?	
• Any other comments?	

APPENDIX C: GRADE SEVEN TEACHING STAFF INTERVIEW QUESTIONS

• Do you feel that students have sufficient training in the use of Dragon Dictation by the time they enter grade seven?
  • Do you have to do any additional training?
  • If so, explain.	

• Is Dragon supported in the school? Why or why not?	
• How do you support the use of Dragon Dictation in the classroom?	
• In your opinion, are there any barriers to successful implementation of Dragon Dictation?	
• In your opinion, what are necessary conditions that need to occur for Dragon Dictation to be successful?	
• Do you feel that you were given enough training with Dragon Dictation to assist students as required? Please explain your training.	
• To what extent do you feel that Dragon Dictation is used to support curriculum objectives in your classroom?	
• To what extent does the use of Dragon Dictation allow for greater student collaboration? Please explain.	
• Is Dragon Dictation adjustable to address student ability? If so, please explain.	
• To what extent do you integrate Dragon Dictation throughout your lessons?	
• To what extent does Dragon Dictation allow for students to begin and complete their projects?	
• Do students have the opportunity to practice using Dragon Dictation with staff as required?	
• Are you interested and willing to have students use Dragon Dictation in your classroom? Please explain.	
• To what extent does the use of Dragon Dictation impact student writing?	

Please explain.	
• Cognitive engagement is defined as "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012). • Do you feel that the use of Dragon Dictation impacts students' cognitive engagement in their writing? Please explain.	
• Why is it that some students are more successful with Dragon Dictation than others? • Why do you think that is and what contributes to this?	
• Any other comments	

APPENDIX D: ASSISTIVE TECHNOLOGIST INTERVIEW QUESTIONS

• How do you decide which students should begin using Dragon Dictation?	

• When students first begin using Dragon Dictation:
  • What does the training look like?
  • How long does it typically take to train a student?	

• What is the training regimen for teachers?	
• How often do students typically practice per week with a staff member when they first begin using Dragon Dictation?	
• Is Dragon supported in the school? Why or why not?	
• Cognitive engagement is defined as "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012). • Do you feel that the use of Dragon Dictation impacts students' cognitive engagement in their writing? Please explain.	
• In your opinion, what are necessary conditions that need to occur for this technology to be successful?	
• Do you find that Dragon Dictation is able to help support curriculum objectives in the classroom? Please explain.	
• Did you find that student use of Dragon Dictation allows for greater student collaboration? • If so, how?	
• To what extent is Dragon Dictation adjustable to address student ability?	
• To what extent is Dragon Dictation integrated into lessons?	
• Do you feel that Dragon Dictation allows for students to begin and	

complete their projects? Please explain. • In your opinion, are there any barriers to successful implementation of Dragon Dictation?	
• Do you feel that students have sufficient training in the use of Dragon Dictation? Why or why not? • Do students have the opportunity to practice using Dragon Dictation with staff as required?	
• To what extent does the use of Dragon Dictation impact student writing? • Please explain.	
• Any other comments?	

APPENDIX E: PRINCIPAL INTERVIEW QUESTIONS

• How does your school support the use of Dragon Dictation in the school?	
• How do you prepare teachers to support Dragon Dictation in the classroom?	
• What are your expectations for teachers who need to support Dragon Dictation within their classrooms?	
• What are your expectations for students using Dragon Dictation?	
• To what extent has the curriculum and instruction been aligned to meet the needs of those who currently utilize Dragon Dictation in their learning?	
• In your opinion, what are necessary conditions that need to occur for Dragon Dictation to be successful?	
• In your opinion, are there any barriers to successful implementation of Dragon Dictation?	
• To what extent does the use of Dragon Dictation impact student writing? • Please explain.	
• Cognitive engagement is defined as "the investment in the work of learning as well as the refinement and deployment of strategic thinking" (Appleton, 2012). • Do you feel that the use of Dragon Dictation impacts students' cognitive engagement in their writing? Please explain.	
• Any other comments?	

APPENDIX F: STUDENT FOCUS GROUP INTERVIEW QUESTIONS

• How was Dragon Dictation first introduced to you?	
• Tell me about what your training with Dragon Dictation was like.	
• Has Dragon Dictation influenced your writing? If so, explain.	
• Has Dragon Dictation influenced your learning in any areas other than writing?	
• Does Dragon Dictation influence your ability to begin and complete school work? If so, how?	
• Cognitive engagement is a term used to describe when a student feels invested in their learning. A student who is invested may start looking over their work so that they might learn something new. • In your opinion, has using Dragon Dictation helped you to become more cognitively engaged you in your writing? Why or why not?	
• Do you think that Dragon Dictation is a good match for you? Why or why not?	
• Is Dragon supported by your school?	
• How do you feel about the amount of training you were given when learning to use Dragon Dictation? • What about the kind of training?	
• Does Dragon Dictation support the work that you do in your classroom? For instance, writing an essay. How so?	
• Tell me about how using Dragon Dictation has affected your ability to work in partnership with other students. Provide some examples.	
• In your opinion, do you think that Dragon Dictation is able to be adjusted so that students of differing abilities can use it? If so, explain.	
• Tell me a bit about when and how you are using Dragon Dictation in the classroom. • (Query questions) Does your teacher ask you to use it or do you decide that for yourself?	
• Are there ways that you believe Dragon Dictation should be used in your class, but it's not?	
• What is your favorite thing about using Dragon Dictation?	
• What is your least favorite thing about using Dragon Dictation?	
• Do you use Dragon Dictation at home? If so, explain how it is used and supported.	
• Do you intend to keep using Dragon Dictation when	

doing your school work? Why or why not?	
• Any other comments?	

APPENDIX G: CLASSROOM OBSERVATION PROTOCOL

Data from each 1/3 of the class session

Teacher_____

Student participants in the class_____

Curriculum objective of the class_____

Technology Innovation	**Yes/No**	**How was technology innovation supported in the classroom?**
Was technology innovation supported in the classroom?		

Beginning and Ending Times

Part of Lesson	***Beginning Times***	***Ending Times***
Beginning 1/3		
Middle 1/3		
Ending 1/3		

Beginning 1/3

Curriculum Objective	**Yes/No**	**How was it used to meet this objective?**
Was SRT used to support the curriculum objective?		
Student Collaboration	**Yes/No/No student collaboration in lesson**	**How did SRT facilitate this collaboration?**
Did the SRT allow for student		

collaboration?		
Student Ability	**Yes/No**	**How was SRT adjustable to meet differing student abilities?**
Was SRT adjustable to meet differing student abilities?		
Integration	**Yes/No**	**How was it integrated during the lesson?**
Was SRT integrated during the lesson?		
Design & Implement	**Yes/No/No project design or implementation**	**How did SRT allow for students to design and implement projects?**
Did SRT allow for students to design and implement projects?		

Middle 1/3

Curriculum Objective	**Yes/No**	**How was it used to meet this objective?**
Was SRT used to support the curriculum objective?		
Student Collaboration	**Yes/No/No student collaboration in lesson**	**How did SRT facilitate this collaboration?**
Did SRT allow for student		

collaboration?		
Student Ability	**Yes/No**	**How was SRT adjustable to meet differing student abilities?**
Was SRT adjustable to meet differing student abilities?		
Integration	**Yes/No**	**How was it integrated during the lesson?**
Was the SRT integrated during the lesson?		
Design & Implement	**Yes/No/No project design or implementation**	**How did SRT allow for students to design and implement projects?**
Did SRT allow for students to design and implement projects?		

Ending 1/3

Curriculum Objective	**Yes/No**	**How was it used to meet this objective?**
Was SRT used to support the curriculum objective?		
Student Collaboration	**Yes/No/No student collaboration in lesson**	**How did SRT facilitate this collaboration?**
Did SRT allow for student collaboration?		

Student Ability	**Yes/No**	**How was SRT adjustable to meet differing student abilities?**
Was SRT adjustable to meet differing student abilities?		
Integration	**Yes/No**	**How was it integrated during the lesson?**
Was the SRT integrated during the lesson?		
Design & Implement	**Yes/No/No project design or implementation**	**How did SRT allow for students to design and implement projects?**
Did SRT allow for students to design and implement projects?		