Spring 2016

The effect of using a tablet and a meta-cognitive strategy to improve reading comprehension skills for students with SLD

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THE EFFECT OF USING A TABLET AND A META-COGNITIVE STRATEGY TO IMPROVE READING COMPREHENSION SKILLS FOR STUDENTS WITH SLD

by

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A thesis submitted in partial fulfillment
of the requirements for the Doctor of Philosophy
degree in Teaching and Learning (Special Education) in the
Graduate College of
The University of Iowa

May 2016

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PH.D. THESIS

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ACKNOWLEDGMENTS

I owe a debt of gratitude to a number of people who have supported me in several ways since I started my academic life and throughout my doctoral journey. I would like to take this opportunity to thank each one of them.

First, I extend a special thanks to my wonderful mom, Fatmah Alqahtani. Thank you for your love, words of encouragement, prayers, and inspiration. Life would have been difficult without hearing your voice every Sunday from thousands of miles away.

Second, heart-felt thanks go to all of my professors who have inspired me to reach my potential. I am grateful to my advisor, Dr. John Hosp, for guiding me through this challenging doctoral program process. His enlightening suggestions, constructive criticism and continuous support have helped clarify my ideas and strengthen my arguments. Special thanks are also owed to the other members of my committee: thank you to Dr. Youjia Hua and Dr. Suzanne Woods-Groves for helping me enhance my research, writing, and presentation skills. My gratitude goes, as well, to Dr. Catherine Welch for giving me the opportunity to work and develop my statistical skills at the Iowa testing programs and for helping me to obtain my master's degree in statistics and measurement. I would like to thank Dr. Allison Bruhn and Dr. John Achrazoglou for providing valuable feedback and help throughout my dissertation process.

I would also like to thank Mrs. Brenda Parker for providing me the opportunity to conduct my research in her school. I am also grateful for Mr. Kyle Paulson for volunteering a great part of his time to carry out my interventions and help me collect my data.

Finally, this dissertation would not have been possible without the help and support of my friends and colleagues. I would like to express my gratitude to my friends Jay Gorsh and Erica Kaldenberg for acting as advisors and for providing additional guidance and assistance throughout my doctoral program. I am indebted to Josephine Fernando for her support and assistance throughout my program and to Abdullah Alwahbi for volunteering hours of his time to score and check my dissertation results; his support has been invaluable.

ABSTRACT

Students with specific learning disabilities (SLD) have difficulty with most reading skills, including reading comprehension (Hulme & Snowling, 2011). Improving reading comprehension skills requires efficient interventions that consider both meaning- and code-based skills simultaneously. Using a single-subject multiple-baseline design across participants, with alternating treatment design, this study compared two reading interventions (repeated reading vs. tablet text-to-speech) combined with a meta-cognitive strategy (question generation).

Three fourth-grade and third-grade students who had been diagnosed by their school as having reading difficulties (reading one to two grades behind their expected reading levels) participated in the study. Using the index of narrative complexity (Labov, 1973; Petersen, Gillam, & Gillam, 2008) as a major dependent variable, two participants showed improvement in reading comprehension skills as measured by visual analysis and the effect size between means. However, there were slight differences for the RAAC intervention over the tablet intervention for one participant. The time required to administer the tablet intervention was shorter than the time required to administer the RAAC intervention (an average of 12.73 minutes for the RAAC vs. 5.45 minutes for the tablet), which is an important consideration when deciding to use an intervention.

PUBLIC ABSTRACT

Students with specific learning disabilities (SLD) who struggle with reading at the early elementary school grades are at risk of having delayed reading skills and may struggle when they move to the upper grades. Students in the early grades read to learn reading; however, they need to read to learn school subjects as they move toward the upper grades. Thus, this study tested reading comprehension interventions appropriate for young learners. One method to help these students improve their reading skills is to teach them a comprehension strategy that directs their attention to what they are reading. At the same time, it is important to address the reading skills that are necessary to identify letters and words (i.e., decoding and fluency skills).

This study compared two reading interventions (repeated reading vs. tablet text-to-speech) combined with a comprehension strategy (question generation). Three times per week, each student received an intervention. In the first intervention, the students were required to read a passage (average of 100 words) three times. Before and after reading the passage, participants were asked to read and answer five generic questions. In the tablet intervention, the participants were asked to follow the same procedures, but they were required to listen to the passage on the tablet only once. The results of the study showed that two participants improved their reading comprehension skills with slight differences between the interventions. Also, the time required to administer the tablet intervention was shorter than that of the RAAC intervention.

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CHAPTER ONE

INTRODUCTION

All learners should develop skills for academic success, especially those with a specific learning disability (SLD). According to the National Center for Learning Disabilities (NCLD), there are 2.4 million students with SLD in schools, representing 41% of all students who receive special education services ("National Center for Learning Disabilities," 2014a). In the most recent statistics, the U.S. Department of Education reported that 6.4 million students ages 3–21 received special education services in the 2011–2012 academic year ("National Center for Education Statistics," 2014). Thirty-six percent had a SLD. Among these students with a SLD, only 63% graduated from high school ("National Center for Learning Disabilities," 2014c).

The majority of students with a SLD have difficulties in most academic skills. These difficulties may present in reading (Swanson & Sachse-Lee, 2000), writing (Graham & Perin, 2007), and mathematics (Rivera, 1997), which may result in difficulties in content areas such as science, social studies (Scruggs, 2013), and history (Okolo & Ferretti, 2013). Students with a SLD also often do not make academic adequate progress in their classrooms. For example, Klingner, Vaughn, Hughes, Schumm, and Elbaum (1998), investigated the effectiveness of inclusive settings for elementary-age learners with a SLD and found these students did not improve their skills even though they received special education support.

The most prevalent challenge for students with a SLD is reading skills ("National Center for Learning Disabilities," 2014b). According to the National Assessment of Educational Progress (NAEP), 33% of fourth-grade students were below the basic level in reading, while 66% were below proficiency in 2013 (NAEP). Although there has been progress, the improvement is not promising. The majority of this population includes students with a SLD. In

addition, at least 80% of these students have serious reading issues (Kavale & Reese, 1992). In a meta-analysis, Fuchs, Fuchs, Mathes, Lipsey, and Roberts (2001) found that students with a SLD have severe reading problems compared to poor readers who do not have a SLD. The authors stated that 73% of reading scores of poor readers fall above reading scores of students with a SLD and that this gap increased with age.

Students with a SLD perform inadequately in most reading skills including phonological awareness, decoding, fluency, and comprehension (Kameenui & Carnine, 2002). However, taking into consideration that *reading comprehension* means the ability to think about what is being read to derive meaning from the words (Cunningham & Allington, 2007), difficulty with this skill is the most prevalent issue (Vaughn, Levy, Coleman, & Bos, 2002). For example, 10.3% of school-age students have deficits in reading comprehension (Hulme & Snowling, 2011), and 90% of students with a SLD have difficulty with reading independently and with reading comprehension (Vaughn et al., 2002).

These statistics show the importance of reading comprehension for students with a SLD. Weakness in comprehension becomes more problematic for students when they shift from learning to read to reading to learn at the third and fourth grades. Reading comprehension affects all other academic areas (Berkeley, Scruggs, & Mastropieri, 2010; "National Reading Panel," 2000). Thus, failing to master this skill will lead to weak outcomes for other academic skills that require reading, such as science and social studies (Scruggs, 2013).

In addition, reading difficulties in third grade might lead to dropping out of high school (Hernandez, 2011). Third grade is a time when students are shifting from learning to read to reading to learn; they shift from reading narrative texts to expository texts (Paris & Hamilton, 2009). Reading difficulties may be a growing issue for students with a SLD.

Students with a SLD show improvement in their reading skills when certain teaching strategies are provided. For example, structured systematic reading comprehension strategies improve reading comprehension skills for all students (Swanson & Sachse-Lee, 2000) and for students with a SLD (Berkeley et al., 2010; Jitendra, Burgess, & Gajria, 2011). Researchers have used a variety of approaches; however, cognitive and meta-cognitive strategies were most effective for enhancing reading comprehension skills (Berkeley et al., 2010) because reading comprehension requires higher-order thinking skills.

Teaching cognitive and meta-cognitive strategies helps students improve reading comprehension by thinking about what they are reading. Meta-cognitive strategies include comprehension monitoring, self-questioning, and question generating ("National Reading Panel," 2000), which force students to think deeply about their reading (Solis et al., 2011). Once students learn a meta-cognitive strategy, they start to pay attention to their reading process and become better readers. Another approach to improving reading comprehension is to address other reading skills such as fluency (O'Connor, White, & Swanson, 2007; Therrien, 2004), vocabulary (Xin & Rieth, 2001), phonological awareness (Jimenez et al., 2003), and listening to text instead of reading it (Higgins & Raskind, 2000; Higgins & Raskind, 2004; Moorman, Boon, Keller-Bell, Stagliano, & Jeffs, 2010).

Regardless of the teaching approach used, delivering these strategies is effective when combined with other tools (Vaughn, Swanson, & Solis, 2013) such as peer tutoring (Gersten, Fuchs, Williams, & Baker, 2001), explicit instruction (Rosenshine, 1995), and technology (Stetter & Hughes, 2010). For example, technological educational applications have been increasing since the 1980s. According to the U.S. Department of Education (ED), 97% of teachers had computers in their classrooms in 2009 ("Institute of Education Sciences," 2009).

Teachers used these computers for instructional purposes (e.g., deliver instruction, provide access to curriculum) for more than 40% of each day. Besides desktop computers, handheld devices (e.g., iPhone, iPad) have been increasing in schools dramatically. In 2012, Project Tomorrow reported that 26% of U.S. students in grades six to eight have tablets ("Project Tomorrow," 2015). This increased to 52% in 2013. In addition, 39% of teachers have tablet computers (Brenner, 2013). These technology tools have been used to support instruction and improve academic skills for students with an SLD.

Traditionally, teachers have been using desktop computers to support reading comprehension with techniques such as graphic organizers (Wade, Boon, & Spencer, 2010), reading text (Moorman et al., 2010), and engaging in reading activities (Kim et al., 2006). However, few studies have investigated using handheld devices to support academic skills for students with disabilities. Of these, the existing research has found promising results when using tablet computers to aid students with disabilities in areas such as spelling (Kagohara, Sigafoos, Achmadi, O'Reilly, & Lancioni, 2012), social skills (Blood, Johnson, Ridenour, Simmons, & Crouch, 2011), and math skills (Haydon et al., 2012). However, there is no published research on using tablet computers to teach reading skills to students with an SLD or other disability.

Purpose of the Study and Research Question

The purpose of this research is to extend the literature in reading instruction strategies for young learners with a SLD. Although there is a large body of research on reading comprehension instruction, few studies have investigated the teaching of meta-cognitive strategies while addressing lower order reading skills to improve reading comprehension. This approach is a combination of the two most used approaches in the literature on teaching elementary-age students with a SLD. For example, Hitchcock, Prater, and Dowrick (2004) combined graphic

organizers and repeated reading to improve fluency and reading comprehension. This approach hypothesized that reading comprehension cannot occur without mastering lower order skills. At the same time, mastering lower order skills does not result in reading comprehension without processing meta-cognitive strategies. In addition, followers of this approach believe that it is important to improve reading comprehension skills while students are still developing lower order reading skills.

Meta-cognitive teaching strategies might be more powerful when used with new assistive technology tools such as tablet devices (e.g., iPad). This study aims to investigate the role of using tablet devices to deliver instruction incorporating these teaching strategies for young learners with a SLD to improve reading comprehension. In particular, listening comprehension will be addressed to target lower order reading skills and question generation will be taught to target meta-cognitive processes. Listening comprehension will be delivered through the tablet text-to-speech feature, and question generation will be presented on the tablet screen.

To build upon the previous literature, it is important to compare it to an intervention that uses a similar approach. Reread-Adapt and Answer-Comprehend (RAAC) is an intervention that uses the same approach to improve reading comprehension for students with disabilities including those with a SLD (Hua et al., 2012; Schirmer, Schaffer, Therrien, & Schirmer, 2012; Therrien & Budin, 2008; Therrien, Wickstrom, & Jones, 2006). The main components in RAAC address fluency to target lower order skills and teach question generation strategies to target meta-cognitive processes. It addresses fluency by repeated reading and teaches meta-cognitive strategies by presenting question generation on paper.

To administer the comparison, text-to-speech in this study will be compared to repeated reading in RAAC. Other components in the study will remain the same. This study will answer

the following question: What are the effects of tablet text-to-speech combined with question generation strategies relative to the repeated reading combined with question generation strategies on reading comprehension for elementary-age learners with a SLD?

CHAPTER TWO

LITERATURE REVIEW

In this chapter, I will review reading comprehension theories, followed by describing in detail one of the most common reading theories. Then, I will review the definition of students with a specific learning disability (SLD), followed by the reasons why they face reading difficulties. Next, I will review reading instruction and reading comprehension strategies for students with a SLD. Then, I will review the role of assistive technology in supporting reading intervention for students with a SLD, followed by reviewing the tablet devices literature and uses in supporting people with disabilities. Last, I will review the current studies that examine reading comprehension strategies for elementary age learners with a SLD.

Theoretical Models of Reading

Reading comprehension is the ability to think about what is being read in order to derive meaning from the words (Cunningham & Allington, 2007). Students should understand what they are reading and make connections between words and ideas. Reading comprehension involves phonology, syntax, working memory, semantics, morphology, orthography, meta-cognition, and strategy (Cartwright, 2009). Also, there are many factors that affect reading comprehension such as the readers' backgrounds, their ability to process information strategically, their meta-cognitive awareness of learning, and their knowledge of vocabulary (Gersten et al., 2001). The interaction of these components makes reading comprehension a complex process.

This complexity has resulted in a number of models and theories, which means there is no single theory for reading. For instance, Perfetti and Stafura (2014) suggested the reading systems framework, which offers three levels of theories necessary for reading comprehension.

First is that there are three sources of knowledge: linguistic (i.e., language), orthographic (i.e., print), and general knowledge about the text and world. Second is the process of reading, which includes decoding, word identification, meaning retrieval, constituent building, inferencing, and comprehension monitoring. (This could be cognitive and meta-cognitive strategies). Third is the cognitive system that runs and manages these processes.

This comprehensive reading model includes most reading components, but other researchers have suggested smaller groups of reading theories. Reading theories generally are presented in two types of models: bottom-up and top-down. These two main themes view reading from two different perspectives in two different directions. Bottom-up theories hypothesize that children learn sub-skills (letters and words) first then learn understanding (text meaning). Instructional approaches grounded in these theories teach decoding first then teach strategies to comprehend text (Reutzel & Cooter, 2013). Thus, this approach views cognitive processing as a secondary skill that needs to be considered once the decoding skill has been taught and mastered. Therefore, comprehension strategies and background knowledge are not considered in this approach. Examples of this type of theory are "one second of reading" by Gough (1972), and the theory of automatic information processing by LaBerge and Samuels (1974).

In the opposite direction, top-down theories argue that decoding should not be a primary focus when teaching reading. Instead, top-down theories hypothesize that reading is a cognitive process supported by memory (Alvermann, Unrau, & Ruddell, 2013), and background knowledge (Carrell & Eisterhold, 1983). Readers should connect the information they gain from the text with their knowledge. Thus, teaching comprehension strategies in this approach are more important than teaching letters and individual words. An example of this type is schema theory

(Anderson, 1977), which posits that reading is an interaction between the reader's knowledge and the text. Thus, readers should have prior knowledge to understand the written language. These two categories include most reading theories; however, other theories are comprehensive and might be considered as a combination of these two models. One such example is the simple view of reading.

Simple view of reading

The simple view of reading (Gough, 1996; Gough & Tunmer, 1986; Hoover & Gough, 1990) posits that reading comprehension is a product of both linguistic comprehension and word recognition. According to this theory, *linguistic comprehension* is the ability to derive interpreter information from spoken words. *Reading comprehension* is the same ability but through printed text (Hoover & Gough, 1990). Also, this theory defines *word recognition* as the ability to derive meaning from printed input (Hoover & Gough, 1990). In other words, word recognition is the ability to read printed words, while linguistic comprehension is the ability to understand language. Linguistic comprehension is typically measured by answering questions after listening to a passage, while reading comprehension requires reading a passage. This relation has been supported by research. For example, the measures of word recognition and listening comprehension account for 45–85% of the variance in reading comprehension (Adlof, Catts, & Little, 2006).

To assess reading skills, the components should be multiplied by each other (R = D * LC) with a value range from 0 to 1. According to this view, reading disabilities could be *dyslexia* in the case where readers have significant difficulties decoding (i.e., D is low or near 0), *hyperlexia* in the case they have significant difficulties comprehending (i.e., LC is low or near 0), or the readers have extreme difficulty because they have both dyslexia and Hyperlexia (Gough, 1996;

Gough & Tunmer, 1986; Hagtvet, 2003). However, poor readers may have different issues such as intellectual and linguistic problems (Hagtvet; Stanovich, 1988). All of these are represented in students with a SLD, which makes Gough and Tunmer's simple view of reading an applicable theoretical framework for this study.

Students with Specific Learning Disabilities

According to the Individuals with Disabilities Education Improvement Act IDEA (2009), a SLD can occur in one or more of the following domains: oral expression, listening comprehension, basic reading, reading comprehension, reading fluency, math calculations, math problem solving, and written expression (Fletcher, Stuebing, Morris, & Lyon, 2013). According to the Department of Education, a SLD is

> a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. (20 U.S.C Section 1401, p. 30)

The most common academic disability for this group is reading ("National Center for Learning Disabilities," 2014a).

Reasons why students with a SLD struggle with reading comprehension

Within a simple view framework, for students with a SLD to develop proficient reading comprehension, they must develop lower order reading skills. Reading comprehension has a strong relation with decoding (Herr & Bateman, 2013), fluency (Denckla et al., 2013), vocabulary (Flood, Lapp, & Fisher, 2002), prior knowledge (Swanson, Harris, & Graham, 2013), phonological and phonemic awareness (Lyon & Weiser, 2013), syntactic abilities (Mokhtari &

Thompson, 2006), and understanding text structures and task (Gersten et al., 2001). Besides limited reading skills, students with a SLD may have issues in their cognitive reading processes such as working memory and short-term memory (Paris & Hamilton, 2009; Swanson & Zheng, 2013). Also, students with a SLD often fail to improve their reading skills because they do not apply systematic strategies (Berkeley et al., 2010; Gersten et al., 2001; Scruggs, Bennion, & Lifson, 1985). They may have proficient cognitive abilities but not know how to use them (Gersten et al., 2001). The following sections will review the most important components that affect reading comprehension for students with a SLD explicitly.

Cognitive processing. One factor that affects reading comprehension for students with a SLD is cognitive processing, which includes working memory, short-term memory, and attention. *Working memory* refers to the ability to hold information in short-term storage while processing incoming information (Siegel & Mazabel, 2013, p. 189), while *short-term memory* is the ability to hold information for a short time to allow processing information in one's working memory (Swanson & Zheng, 2013). These two factors have a strong relationship to reading comprehension (Paris & Hamilton, 2009; Swanson & Zheng, 2013). The explanation is that reading comprehension requires students to make a combination of meaning among words and sentences and store information while reading, which requires a proficient level of working and short-term memory (Paris & Hamilton, 2009). The other explanation is that, when students' expend extra effort decoding, they cannot free cognitive resources for comprehension (Therrien, 2004). Fluent readers process decoding automatically, which helps them to have enough cognitive resources for comprehension (LaBerge & Samuels, 1974). Last, according to Swanson and Zheng, students with a SLD showed limited abilities in the mental allocation of attentional

resources and poor monitoring that impedes them from filtering out irrelevant information (2013).

Lower order reading skills. Another important factor that affects reading comprehension for students with a SLD is limitations of their lower-order reading skills (e.g., phonological and phonemic awareness, text structures, decoding, fluency, prior knowledge). For instance, phonological and phonemic awareness are important to develop reading comprehension (Hagtvet, 2003). Poor readers have limited abilities linking letters and words to their shapes and meaning, that is, to decode.

Decoding is the ability to pronounce written words correctly including knowledge of letter- sounds and patterns ("National Reading Panel," 2000) and is one of the most critical issues in developing reading comprehension. It is assessed by the ability to pronounce individual words (Hoover & Gough, 1990). This skill requires students to recognize the letters, associate the letters with their sounds, hold these sounds in memory, and combine letter sounds to produce word meaning in vocabulary. Thus, decoding requires more complex processes that include short-term memory, working memory, prior knowledge, and phonological awareness. Challenges in decoding mean less engagement with the text meaning (Hoffman, 2009). There is a strong relation between decoding and comprehension (Flood et al., 2002), around .70 in the early grades (Hulme & Snowling, 2011).

Besides decoding, knowledge of word meanings may limit reading comprehension skills for students with a SLD. While reading unknown words, students spend extra effort decoding, pronouncing, and understanding the words, which negatively impacts comprehension. Research has shown the relationship between vocabulary and comprehension (Aarnoutse & van Leeuwe,

1998; Flood et al., 2002) and among vocabulary, comprehension, and fluency (Denckla et al., 2013).

The other component that affects reading comprehension is reading fluency. *Reading fluency* is the ability to read words accurately at an appropriate level of speed ("National Reading Panel," 2000). Fluent reading requires accuracy in word decoding, automatic processing, and prosody, which results from appropriate syntactic and semantic understanding (Hosp & Suchey, 2014). Fluency issues affect reading comprehension. Mastropieri, Leinart, and Scruggs (1999), suggested that slower reading might occur because students may put most of the cognitive effort into decoding, which leaves fewer cognitive resources to process meaning. Also, they may fail to hold the words in their memories until the end of the sentences (Mastropieri et al., 1999). Thus, it is clear that limited decoding abilities and memory deficits result in poor fluency, which negatively affects reading comprehension. However, there is a conflict in research about this relation. For example, Paris and Hamilton (2009) found that poor fluency may not affect comprehension abilities. Other research indicated that intervention for fluency results in increases in reading comprehension, but intervention for reading comprehension did not result in fluency gains (Gersten et al., 2001).

Use of cognitive strategies. The other component that affects reading comprehension for students with a SLD is their limited use of cognitive strategies. Students with a SLD may have sufficient cognitive abilities, but they often do not know how to apply them (Berkeley et al., 2010; Gersten et al., 2001). They are often unaware of meta-cognitive processes needed to understand text. Good readers understand this process and think while reading. Also, students with a SLD may use cognitive strategy inefficiently (Gersten et al., 2001; Scruggs et al., 1985). For example, good readers process many thoughts while reading compared to poor readers (Lyon

& Weiser, 2013). Good readers use cognitive strategies that help them to make more connections between the reading ideas compared to poor readers. Thus, this highlights the importance of teaching cognitive and meta-cognitive strategies, which is described in the following sections. Teaching these strategies to students with SLD fosters reading comprehension (Gavelek & Bresnahan, 2009). Thus, students with a SLD are in need of effective reading instruction that helps them to overcome their cognitive processing limitations, improve their lower order reading skills, and learn comprehension strategies.

Effective Reading Instruction for Students with SLD

One of the most effective instructional approaches for students with a SLD is explicit instruction, which includes guided practice, feedback, corrections, and independent practice (Rupley, Blair, & Nichols, 2009). Also, explicit instruction practices divide lessons into small steps and emphasize modeling to enhance reading skills. These practices have been found to be effective for students with a SLD (Swanson, 1999). For instance, Foorman and Torgeson (2001) identified three critical instructional components important for reading intervention for students at risk for reading difficulties. First, intervention should be phonemically explicit, which includes comprehensive, direct, and systematic instruction for phonemic awareness. Second, programming should be intensified by increasing the time of reading classes or providing support in small groups. Intensive intervention is effective for these students (Felton, 1993; Jitendra, Edwards, Sacks, & Jacobson, 2004). Third, students are supported emotionally and cognitively, which includes providing positive reinforcement and feedback.

Explicit instruction has been used successfully to support lower order reading skills such as decoding (Felton, 1993), phonemic awareness (Torgesen et al., 2001), vocabulary (Jitendra et al., 2004), and fluency (Chard, Vaughn, & Tyler, 2002). Also, explicit instruction has been used

to support teaching reading comprehension cognitive strategies (Boulineau, Fore, Hagan-Burke, & Burke, 2004). For example, teachers could teach reading strategies by modeling them (Pearson & Dole, 1987). This process includes teachers' thinking aloud as they are reading.

Reading comprehension instructions for students with a SLD

Compared to other academic and reading skills, reading comprehension is not a distinctly-structured task, which means it cannot be broken into small pieces (Rosenshine, Meister, & Chapman, 1996). Thus, cognitive and meta-cognitive strategies are the most suitable strategies to improve this skill (Berkeley et al., 2010). *Cognitive strategies* are "procedures that guide students as they attempt to complete less-structured tasks such as reading comprehension and writing" (Rosenshine et al., 1996, p. 181). Even though the meta-cognitive and cognitive strategies indicate the same meaning in the research literature, they are slightly different. *Meta-cognitive strategies* are defined as thinking about thinking. For example, when students read a passage, they need to ask themselves frequently about what they are reading to make sense of it. Question generation, comprehension monitoring, and self-questioning are examples of these strategies. Cognitive strategies, meanwhile, "are the test-takers' ongoing mental activities to use their language and world knowledge to solve the given tasks" (Phakiti, 2003, p. 30). This type involves strategies such as summarization and prediction.

Many large literature reviews have investigated the most effective cognitive and meta-cognitive reading comprehension strategies for learners with different abilities. For example, the National Reading Panel (2000) conducted a large meta-analysis and found eight different reading comprehension strategies: comprehension monitoring, cooperative learning, graphic organizers, story structure, question answering, question generation, summarization, and the combination of multiple strategies. Most of these strategies have been found to be effective in improving reading

comprehension for students with a SLD such as comprehension monitoring (Chan, Cole, & Barfett, 1987), question generation (Rosenshine et al., 1996), graphic organizers (Stagliano & Boon, 2009), cooperative learning (Stevens & Slavin, 1995), and summarization (Malone & Mastropieri, 1992). Also, Swanson and Sachse-Lee(2000) conducted a large meta-analysis for single subject design for all academic skills and found that studies that used instructional strategies were effective compared to other studies that did not use strategies.

Other literature reviews focused on determining the most effective reading comprehension intervention for students with a SLD (Berkeley et al., 2010; Gersten et al., 2001; Jitendra et al., 2011). For instance, structured cognitive strategies were identified as the most effective strategies for students with a SLD (Berkeley et al., 2010). They found that reading comprehension could be improved when applying cognitive strategies, text enhancements, and behavioral treatments. In another literature review, Gersten et al. (2001) found that grammar stories where students are required to pay attention to the story elements were the most effective strategy for narrative texts. Also, it has been found that combining two strategies enhances reading comprehension. For example, combined cognitive/meta-cognitive strategy and direct instruction enhance reading comprehension (Swanson et al., 2013) as does combining two cognitive/meta-cognitive reading strategies (Vaughn et al., 2013). Technology such as computer use has also been shown to improve reading comprehension (Stetter & Hughes, 2010). The most effective computer uses were when the computer programs included different types of activities to support instructions.

Assistive Technology in Supporting Interventions for Students with Disabilities

Technology in supporting students with SLD in reading

Involving technology in teaching has increased dramatically since 1990 ("Institute of Education Sciences," 2009). Compared to traditional instructional methods, computers provide a variety of features that support the learning environment such as providing access to curriculum and learning control. Computer-assisted instruction "offers students with SLD self-paced, individualized instruction that includes immediate feedback and multiple opportunities for practice" (Kim et al., 2006, p. 236). Besides, motivation toward learning can be prompted via computers for those who have a lack of motivation (Haydon et al., 2012).

The most common educational use of computers has been to deliver instruction or provide access to curricula. Delivering instruction by using the computer includes strategies such as asking students to fill out electronic graphic organizers (Wade et al., 2010). Another way of delivering instruction is to provide instruction explicitly including modeling and practicing (C. H. Hitchcock et al., 2004; Jimenez et al., 2003). These instructional methods have been found to be effective for students with a SLD (Hall, Hughes, & Filbert, 2000). The other use of computers in teaching students with a SLD is providing access to curriculum, which is a method that helps struggling readers to gain information. For instance, reading text aloud to students who have difficulty decoding improves reading comprehension (Higgins & Raskind, 2000; Higgins & Raskind, 2004; Moorman et al., 2010). One explanation of this improvement is that when read to, students do not need to use visual decoding skills. Decoding processing may overtax the students' cognitive process in a way that prevents them from thinking about what they are reading (Higgins & Raskind, 2005). This approach aligns with the simple view of reading because, as this theory stated, decoding is a necessary component to comprehension. Also, a

student who struggles with vocabulary may use an electronic dictionary to look up word meanings and better comprehend the text (Higgins & Raskind, 2005).

These technological instructions have been found to effectively improve reading comprehension for students with a SLD (Jimenez et al., 2003; Kim et al., 2006; MacArthur & Haynes, 1995). Studies have used computers to support reading comprehension intervention in different approaches such as presenting graphic organizing (Wade et al., 2010), presenting and reading text (Moorman et al., 2010), and providing reading activities such as asking multiple option questions and matching games (Kim et al., 2006). Even though desktop computers have been used as essential tools to support reading intervention, a new type of technology has emerged with handheld devices.

Handheld devices. A handheld device is any kind of tablet computer that allow users to operate programs such as Apple devices (e.g., iPhone, iPod, iPad) and Android devices (e.g., Galaxy Phone and Galaxy Note). The uses of handheld devices have been increasing over the last few years. For example, according to the Pew Internet & American Life Project, 42% of Americans in 2014 had a tablet computer while 64% had smartphones ("Pew Research Center," 2014). These statistics are even higher in schools because 52% of students in grades six to eight have tablets ("Project Tomorrow," 2015). Also, 53% of surveyed students wanted their school to allow them to use their handheld devices to support their learning ("Project Tomorrow," 2015). Thus, it is important to investigate their usefulness to support instruction and to support students with disabilities.

Even though little research has been published investigating the use of tablet devices with students with disabilities, the results were promising. Handheld devices have been used successfully to improve a variety of skills for students with a variety of disabilities. To support

academic skills, tablets have been used to improve engagement (Larson, 2010), math, spelling, and learning independently (Cumming, Strnadova, & Singh, 2014). For instance, Haydon et al. (2012) compared math skills for high school students with emotional disturbances when using an iPad versus a worksheet. The researchers used an Apple app (iTouch MATH) and found that students increased their problem-solving skills and active engagement skills using the iPad over worksheets. Fernández-López et al. (2013) used an educational Apple app for children with autism, attention deficit hyperactivity disorder (ADHD), and intellectual disabilities (ID). The researchers used the Picaa app, which included activities such as exploration, association, puzzles, and sorting. The results indicated that the students showed improvement in language, math, environmental awareness, autonomy, and social skills. Kagohara et al. (2012) used iPad-based video modeling to teach a spell-check function on a computer. The students were asked to watch videos on an iPad and then apply what they watched on computers. The results indicated that students with Asperger syndrome and ADHD improved their performance.

Social and communication skills improved when using a tablet. To support social skills, Blood et al. (2011) adapted video modeling on the iPod touch. They recorded videos of the student and asked him to evaluate himself in a self-monitoring model. The results proved the effectiveness of this strategy when using an iPod touch. Also, a group of studies addressed communication skills, mostly for students with autism (Achmadi et al., 2012; Kagohara, van der Meer, et al., 2012; Kagohara et al., 2010; van der Meer, Didden, et al., 2012; van der Meer et al., 2011; van der Meer, Sutherland, O'Reilly, Lancioni, & Sigafoos, 2012). The majority of the studies used Proloquo2Go for the iPod and iPad, which is an app version of a speech-generating device (SGD). A SGD is an augmentative and alternative communication (AAC) device to request preferred stimuli. This app is designed primarily for people who have communication

difficulties. Users touch the preferred stimuli icon on the iPad screen to transfer the touched item to speech. All studies proved that Proloquo2Go is an effective app to enhance communication skills.

To support transition programs designed to help students with intellectual disabilities to be independent on the job, studies have found the iPod and iPad to be supportive. Van Laarhoven et al. (2009) used an iPod to increase task completion. The participants were asked to watch videos before or during completing a task in employment settings. Burke, Andersen, Bowen, Howard, and Allen (2010) used an iPhone and iPod to teach appropriate responses in a fire safety education program. Both studies used video modeling to deliver instruction for students, and both studies were effective. Another group of studies used the same strategy to teach independent skills. Cihak et al. (2010) used video modeling on the iPod to teach students with Autism Spectrum Disorder (ASD) basic independent appropriate movement behaviors in school. Other researchers used the same technique to teach leisure skills such as playing music, watching movies, and looking at pictures (Hammond, Whatley, Ayres, & Gast, 2010; Kagohara, 2011; Kagohara et al., 2011). All studies support the use of an iPod in teaching independent skills via a video modeling strategy.

Besides using hand held devices in teaching, a few studies addressed the effect of social acceptance, motivation, and learning engagement when using handheld devices. For example, Haydon et al. (2012), after conducting a comparison study between math problems on paper or an iPad, asked the participants and their teacher what they preferred. The participants reported that both the students and the teachers preferred the iPad over worksheets. Also, they observed an increase in learning engagement when using iPads. In another study, Patten and Craig (2007) found that elementary and middle school students increased their engagement in learning

activities when using iPads. In the same context, Gulchak (2008) found that on-task behaviors were increased when using iPads for students with emotional and behavioral disorders. Also, in a literature review, Kagohara et al. (2013) found that using iPads in teaching is socially accepted by individuals with disabilities. The iPads were preferred compared to other assistive technological aids (e.g., SGDs) and paper sheets. When other students and faculty were surveyed, the iPad was preferred as well. Researchers compared Apple iPad tablets, Motorola Xoom tablets, Amazon Kindles, and Barnes and Noble Nooks. They found that the iPad was the most preferred device to use for personalized purposes such as reading and socializing (Le Ber, Lombardo, Honisett, Jones, & Weber, 2013). The popularity of this device according to the study was because of the tablets expanded functionality.

These studies suggested positive effects from the use of handheld devices on learning activities; however, there were no studies on other features of the iPad on students with disabilities such as motivation, compatibility, and ease of operation. Little research has investigated these features on the larger population. For example, the Technical Library at Sandia National Laboratories evaluated the compatibility in reading the library of electronic material in PDF files of five types of devices (Pollock, 2012). They found that the iPad was the only fully supportive device for reading PDF journals compared to Amazon's Kindle 2, Amazon' Kindle DX, Sony's Reader PRS300 Pocket, Sony's Reader PRS900 Daily Edition, and Barnes & Noble's Nook. These results were supported by Connell, Bayliss, and Farmer (2012), who found that iPads were easier to use compared to similar devices such as the Kindle reader or printed text.

Computers have been used successfully in supporting intervention for students with disabilities. Technology used to support delivering instructions or access to curriculum. Both

methods were effective in improving a variety of skills for students with a SLD, especially reading. Even though there is such a trend in using new technologies (e.g., tablet computers, little research has investigated their effectiveness. The majority of published studies focus on social and communication skills for students with disabilities, but there is no research investigating the efficacy of these devices in teaching reading to students with a SLD.

Essential Instruction Components in This Study

The reading intervention in the study has both code- and meaning-based components including questions generation and repeated reading. The following section is a description of each component and its research literature.

Question generation. One of the most effective strategies for reading comprehension is question generation ("National Reading Panel," 2000), a self-questioning, self-regulatory, comprehension-monitoring, and meta-cognitive strategy (Rosenshine et al., 1996). In this strategy, students are taught to ask themselves questions about the reading to enhance their awareness of the text information. The rationale for this strategy is that students become more involved in reading when they are asking questions and answering themselves (Rosenshine et al., 1996). The other rationale is that students with a SLD have limited knowledge about text structures, which affects their reading comprehension abilities (Cain, 1996; Gersten et al., 2001). Thus, when students know the story structure, they tend to understand more information.

Question generation has been effective in improving reading comprehension. For example, Rosenshine et al. (1996) reviewed 27 studies that used different approaches of question generation. The overall effect size was (d = 0.36) when compared to standardized tests and (d = 0.86) when using experimenter-developed tests. This strategy also has been effective when used with students with a SLD (Griffey, Zigmond, & Leinhardt, 1988; Wong & Jones, 1982; Wong,

Wong, Perry, & Sawatsky, 1986).

Repeated reading. *Repeated reading* is "any intervention procedure that requires students to read passages in connected text or word lists more than once" (Chard, Ketterlin-Geller, Baker, Doabler, & Apichatabutra, 2009, p. 266). Repeated reading is based on the theory of automatic word processing (LaBerge & Samuels, 1974). According to this theory, repeated reading gives students exposure to the same words many times, which results in improving fluency (Chard et al., 2002). Literature syntheses have found positive effects when using repeated reading on fluency (Chard et al., 2002; Meyer & Felton, 1999). Also, in a meta-analysis, Therrien (2004) found an effect size of (d = 0.75) for fluency when using repeated reading.

Even though repeated reading is effective for fluency, there is a conflict in perspectives on its effectiveness for reading comprehension. The supportive viewpoint hypothesizes that repeated reading improves reading comprehension based on the idea that rereading the same passage allows students to free up resources for comprehension (Therrien, 2004). In other words, when students reread the same passage, they reach the fluency stage, which helps them to pay attention to the text meaning. The other viewpoint argues that repeated reading has limited effect on reading comprehension. For example, Chard et al. (2009) argued that repeated reading is useful to support only students who are in the fluency development stage. Also, there was a limited effect on reading comprehension when the instruction used only repeated reading (Therrien & Hughes, 2008). For instance, researchers found that repeated readings have an effect on literal comprehension but not on inferential comprehension (Freeland, Skinner, Jackson, McDaniel, & Smith, 2000; Therrien & Hughes, 2008).

Current Research in Reading Comprehension for Elementary-Age Students with SLD

Even though the previous studies have shown different types of teaching strategies, most of them addressed a variety of students with different ages and disabilities. Thus, the following section will review and investigate only the most recent studies that focused on teaching reading comprehension for elementary-age students with a SLD. This analysis is important to provide a framework for this study.

The analysis resulted in 10 studies that primarily addressed reading comprehension for elementary-age students with a SLD since 2000. The studies fall into three categories. The first category is meaning based (see Table 1 for the details about the meaning-based studies). The studies in this category taught meta-cognitive strategies and vocabulary to improve reading comprehension. The second category is code based (see Table 2 for the details about the code-based studies). The studies in this category addressed the skills (e.g., decoding, fluency) needed to read words and connected text. These studies used different types of approaches to support printed codes in order to improve reading comprehension. The third category is a combination of both approaches (see Table 3 for the details about the combination approach studies). Studies in this category addressed meaning and code together to improve reading comprehension.

Meaning-based studies. These studies used meaning-based instruction (e.g., meta-cognitive strategies, vocabulary) to improve reading. Boulineau et al. (2004) investigated the effectiveness of using story mapping on reading comprehension skills for six third- and fourth-grade students who were identified as having a SLD. All participants were at least one grade behind their expected levels in reading comprehension based on the Kaufman Test of Educational Achievement (Kaufman & Kaufman, 1985) and had IQ scores from 90–98. The researchers used an ABA design to examine the effect of providing explicit instruction with story

grammar elements. Participants were asked to read a story and complete a story map per session for 13 sessions. The mean percentage of correct answers improved from 25–35% in the baseline to 76–96% in the intervention.

Table 1

Details of the Reviewed Meaning-Based Studies

Study	Participants	Study design	Instructional strategy	Intervention	Results
Boulineau et al. (2004)	Six third and fourth students with SLD	Single subject design ABA	Story map (targeted comprehension)	Participants were asked to read a story and complete a story map	All participants improved their reading comprehension
Stagliano and Boon (2009)	Three fourth students with SLD	Single-subject multiple-probe design across participants	Story map for expository text(targeted comprehension)	The participants read expository text passages, complete story map chart, and answer five comprehension questions	All participants improve their reading comprehension skills
Taylor, Alber, and Walker (2002)	Five third through sixth graders with SLD	Single subject, alternative treatments design without baseline	Story map and self-questioning (targeted comprehension)	The participants read stories and complete story map, while they had to read ten generic questions before reading the story in the self-questioning condition.	All students improve their reading comprehension skills but there was not significant different between the two treatments
Wade, Boon, and Spencer (2010)	Three elementary-age students with SLD		Graphic organizer (targeted comprehension)	The participants read stories from their books and then used the software program, Kidspiration© to complete a story map about what they had read.	All participants had improved their reading comprehension

Xin and Rieth (2001)	76 students grades 4 to 6 with a SLD	Pre-posttest control group design	Video-assisted anchored instruction (targeted vocabulary)	The students in the intervention group watched videos to learn word meanings and concepts while the control group learned from dictionary and printed texts in the traditional way.	Higher word acquisition scores no significant in reading comprehension

Stagliano and Boon (2009) studied the effects of using story maps on reading comprehension skills for three fourth-grade students with a SLD. The participants were identified as having a SLD by their school and performed two grade levels behind their expected level by using the Qualitative Reading Inventory-4 (QRI-IV). During intervention, the participants read expository text passages, completed story map charts, and answered five comprehension questions. The researchers used a single-subject multiple-probe design across participants. For 24 sessions in 2 months, the participants showed improvement in reading comprehension skills based on the percentage of correct comprehension questions. The mean percentages during baseline for the participant improved from 6.67%, 26.67%, and 11.43% to 92%, 85%, and 86.67%, respectively.

Taylor, Alber, and Walker (2002) compared the effect of using a story map and self-questioning strategies on the reading comprehension of five third through sixth graders with a SLD. The participants' performance ranged from 11 to 19 on the reading comprehension subtest of the Wechsler Individual Achievement Test (WIAT). In the first condition, participants read stories and completed a story map, while they had to read 10 generic questions before reading the story in the second condition. The third condition was "no intervention." The three conditions were introduced randomly. The authors used a single subject, alternating treatments design without a baseline to examine the effect of the three conditions. Using 10 comprehension

questions to assess the effect, both interventions were effective compared to the no intervention condition without a significant difference between the two interventions. A Mann Whitney U test indicated a significant effect for self-questioning ($p < .002$) and story mapping ($p < .005$).

Wade et al. (2010) studied the effectiveness of using an electronic graphic organizer on the reading comprehension of three third- and fourth-grade students who had been identified by their school as having a SLD. All were one grade below grade level in reading comprehension according to the K-TEA (Kaufman & Kaufman, 1985). The researchers used Kidspiration© software, which is an electronic graphic organizing program that uses the same story grammar components as the paper-and-pencil task. In the intervention phase, the participants read stories from their books and then used Kidspiration© to complete a story map about what they had read. The dependent measure was a number of questions answered on a paper version of story maps. In 6 days, 45 minutes per day using an ABC single-subject research design, all participants had improved their reading comprehension. The means the three students improved from 22%, 44%, and 33% to 85%, 89%, and 85%, respectively.

Xin and Rieth (2001) studied the effectiveness of using video-assisted anchored instruction in the vocabulary acquisition and reading comprehension skills of 76 fourth- through sixth-grade students with a SLD. All had been identified by their school district as having a SLD. The students' mean scores were 2.4 grade levels on vocabulary and 2.5 grade levels on reading comprehension below their grade placement as measured by the Stanford Achievement Test (SAT, 1989). The intervention group watched videos on computers to learn word meanings and concepts of the text while the control group learned from a dictionary and printed texts. Then, all participants read the same passages and took tests that had been developed by the researchers. The duration of the study was three times per week, 30 minutes per session for 6 weeks. Using a

pre/post-test control group design, the results indicated that the participants performed statistically higher on word acquisition compared to the control group (d = 0.58). However, there were no significant differences between the two groups in reading comprehension.

Code-based studies. Code-based reading skills (e.g., decoding, fluency) improve reading comprehension. O'Connor, White, and Swanson (2007) investigated the effectiveness of repeated reading and continuous reading on reading fluency and comprehension. Seventeen struggling readers and 20 students who were classified as having a SLD in second and fourth grade were randomly assigned to two treatment groups and one control group. The repeated reading group was asked to read each passage three times for 15 minutes, while the continuous group was asked to read passages only once for 15 minutes. The intervention was conducted for 14 weeks, 3 days a week. The results showed that repeated reading and continuous groups had significant improvement in reading comprehension and fluency on the Gray Oral Reading Tests, Fourth Edition (Wiederholt & Bryant, 2001), over control groups with large effect sizes (d = 1.034 and 1.006 respectively). However, there were no significant differences between the two treatment groups.

Table 2

Details of the Reviewed Code-Based Studies

Study	Participants	Study design	Instructional strategy	Intervention	Results
O'Connor, White, and Swanson (2007)	17 poor reader and 20 with a SLD, 2nd and 4th grade students.	Random assignment to one of two treatments and control group	Repeated or continuous reading (targeted fluency)	The participants in the repeated reading group were asked to read each passage three times for fifteen minutes, while continuous group were asked to read more passages in fifteen minutes.	Both treatments improved reading comprehension and fluency but there were no significant differences

					between the two treatments.
Sorrell, Bell, and McCallum (2007)	12 students from 2ed to 5th grades, 4 is a SLD	Randomized treatment design	Text-to-speech (targeted listing comprehension)	The intervention group listened to stories from computers while the control group read the same stories but in papers silently.	The results showed that, there is no significant different between the two groups.
Jimenez et al. (2003)	73 students ranging in age from 7-10 years old with a SLD. 14 with LD, 31 poor readers without a SLD, and 28 control group	Quasi-experimental		The participants used a program that includes steps, feedback, independent practice, and instruction. The computers presented words on a screen and pronounced them, segmented, to the participants. Then, the participants were asked to pronounce each segment or to click on the word to hear it again as a sub-word or as a whole word.	The participants showed improvement in all skills including reading comprehension.

Sorrell, Bell, and McCallum (2007) compared the effect of computerized reader and traditional reading on reading comprehension and fluency. Twelve students from second to fifth grade participated in the study. Four of them had been identified as having a SLD. The intervention group was asked to listen to stories (text-to-speech) through a computer program (Kurzweil 3000) and to answer questions while the control group read the same stories on paper silently. The intervention provided 45 minutes per session, 4 sessions per day for 4 weeks. Using a randomized treatment design, the participants were paired based on their reading skills, and the researchers used the comprehension quizzes to compare the two groups. The results showed that there were no significant differences between the two groups.

Jimenez et al. (2003) studied the effectiveness of using a software program to enhance the word identification and comprehension of 73 students ranging in age from 7–10 years with and without a SLD. The researcher used a discrepancy method to classify students with a SLD. The participants were randomly divided into three groups: the SLD group, poor reader group, and control group. The program was an experimental treatment of dyslexia (TEDIS), which is designed to teach words explicitly and independently. Using a quasi-experimental design, the researchers used The Odd Word Out (Bowey & Francis, 1991) to measure word identification and multiple-choice comprehension questions for reading comprehension. After 15 sessions, 40 minutes each, they found that the participants showed improvement in all skills including word identification (d = 0.33) and reading comprehension (d = 0.28) compared to the control group. The researchers found no evidence of a difference between the students with a SLD and without, even though the participants with a SLD faced more difficulties.

Meaning and code-based studies. Studies in this category both addressed reading skills and taught meta-cognitive strategies. Therrien and Hughes (2008) compared the effect of repeated reading and question generation on reading fluency and comprehension of fourth- through sixth-grade students with a SLD. Eighteen students with a SLD as identified by their school using a discrepancy model and 17 students who scored two grades or more below their placement level participated in the study. The participants were randomly assigned to the groups using their instructional reading levels. In the repeated reading group, the participants reread passages aloud until they met the researcher criteria (the 50th percentile at subjects' instructional reading level). For the second group, the participants were asked to read five generic story questions before reading the passage and after reading the passage, followed by answering these generic story questions. In 2 weeks, using a single-factor design to examine the dependent

variables (eight comprehension questions for each passage and Correct Word Per Minute, CWPM), the results showed that repeated reading was effective at increasing fluency compared to question generation (d = 0.94). Also, repeated reading was significantly effective compared to question generation on factual comprehension questions (d = 0.85), but there were no differences between the two groups for inferential questions.

Hitchcock et al.(2004) used a multi-component intervention for four first-grade students with reading difficulties. Two students had been identified as having a SLD according to their school. In the first condition, the participants were asked to read stories with tutors who provided different types of explicit instruction such as modeling. In the second condition, the students were asked to view reading fluency self-modeling videos. In the third condition, the tutors used explicit instruction with a story map. For 8 weeks and using single subject design, multiple baselines across reading fluency and comprehension, the results showed that all students improved reading fluency and comprehension based on CWPM and correctly answered questions. Video self-modeling had the greater effect on fluency. However, using Woodcock Reading Mastery Tests (WRMT-R), the pre/post test results showed that there were no significant differences.

Table 3

Details of the Reviewed Meaning and Code-Based Studies

Study	Participants	Study design	Instructional strategy	Intervention	Results
Therrien and Hughes (2008)	32 fourth- through sixth-grade students. (18 with a SLD and 17 poor	Random assignment	Repeated reading and question generation (targeted fluency and comprehension)	Repeated reading group reread passages while questions generation group read genetic questions before and after reading.	Repeated reading improves reading fluency and comprehension more than question

	readers)				generation.
Hitchcock, Prater, and Dowrick (2004)	4 first grade students. 2 with a SLD	Single subject design, multiple baseline across behaviors	Tutors, self-modeling video, and story map (fluency and comprehension)	The participants were asked to read stories with tutors who provide different types of explicit instruction such as modeling and repeating reading. Also, the students viewed reading fluency self-modeling videos and used story map.	All participants improved their reading flouncy and comprehension. Self-modeling videos was the most effective for flouncy

Summary. Reviewing the studies that investigated reading comprehension skills for elementary-age students with a SLD resulted in two main approaches. The first approach is teaching meta-cognitive strategies or vocabulary to improve reading comprehension. This approach focuses on meaning, which pays less consideration to coding skills. All studies that taught meta-cognitive strategies used graphic organizers, which is a simple figure that shows stories' elements (e.g., characters, events, settings) to enhance students' understanding of text constructions and directs their attention to what they are reading. This approach was effective for students with a SLD. The second approach was addressing coding skills (i.e., word identification and fluency) or listening instead of decoding in order to improve reading comprehension. To some extent, this approach was effective. Other researchers combined or compared these two approaches; the results were promising.

The results of this analysis highlight two important considerations beneficial to support this study's approach. First, the most common and effective strategy for elementary-age students with a SLD includes strategies that direct students' attention to the reading elements to enhance their understanding. These strategies require students to pay attention to the reading (i.e., story)

elements such as events, characters, and actions. There are different types of strategies that could be used interchangeably such as story mapping, question generation, and graphic organizer. Thus, question generation will be used as a meta-cognitive strategy in this study.

The second beneficial point from this analysis is that addressing meaning and coding results in effective comprehension outcomes. This approach is aligned with the framework of this study. The simple view of reading theory hypothesized that reading comprehension is combination of linguistic comprehension and decoding. Thus, the two conditions in this study address this approach. In the first intervention uses repeated reading, while the second intervention uses text-to-speech to address code based. Repeated reading help students overcome the decoding issue, while text-to-speech offer the students' opportunity to access the text. However, both interventions will use question generation to address meaning-based.

CHAPTER THREE

METHOD

The purpose of this study is to compare two reading interventions (repeated reading and tablet text-to-speech). Both interventions aim to improve reading comprehension for students with specific learning disabilities (SLD). This study will answer the following question: What are the effects of tablet text-to-speech combined with question generation strategies relative to the repeated reading combined with question generation strategies on reading comprehension for elementary-age learners with a SLD?

Participants

The participants in the study were enrolled in the third and fourth grades at an elementary school in a Midwestern state. The selection process was based on the following criteria. First, the students had to be classified as having reading difficulties by their school and enrolled in a special education program. Second, students were not diagnosed with any other disabilities (e.g., autism or physical impairments). Third, the students had to demonstrate that they perform below their expected levels in reading comprehension (i.e., at least one grade level). However, students had to read below the 50th percentile fall norm for their grade levels (Hasbrouck & Tindal, 2006). Last, they had to be elementary age students.

Table 4

Participants' Information

Student	Gender	Age	Grade	Race	Reading comprehension score (MAP)	Reading Fluency Score (Fasting* & Halaas Lyster)	Current reading level	Eligibility for the study
Jay	Male	9	4th	White	166	47	2 years behind	YES
Amy	Female	8	3rd	African American	168	21	1.5 years behind	YES
Pam	Female	10	4th	White	172	50	2 years behind	YES
Sam	Male	7	2nd	White	151	7	2 years behind	NO
Danny	Male	9	4th	White	164	62	0.5 year behind	NO

Note. MAP = Measures of Academic Progress; FAST = Formative Assessment System for Teachers

Five participants met the criteria (see Table 4 for demographic information). This information was obtained from the school records based on the results of the beginning of the Fall 2015 semester. After the researcher obtained consent, further assessment was administered to ensure that the participants were eligible for the research and to determine the instructional reading levels. The instructional reading level, as defined by Hasbrouck and Tindal, is "text that is challenging but manageable for the reader" (2006, p. 614). Curriculum-based measurement (CBM) passages from the Formative Assessment System for Teachers were used to assess students' oral passage reading (OPR) skills. Students read passages at their grade levels, followed by passages one grade and two grades below their grade levels. The instructional reading level for students was defined as occurring when the student's (a) correct words per minute (CWPM) were above the benchmark for that grade level, and (b) accuracy was greater

than 90%. Reading accuracy was calculated by dividing the total number of correct words the student read by the total number of words they attempted to read. Instructional levels were determined as the lowest level that students had not mastered via the two criteria. After the assessment, three participants were eligible for the study: Jay, Amy, and Pam. See Table 5 for assessment and instructional reading levels. Sam was excluded because his assessment scores showed that his reading fluency was below two years and did not have sufficient decoding skills. Danny was excluded because his assessment scores showed that he was only less a half year behind his expected reading levels.

Table 5

Participants' Assessment Scores

Participants	FAST reading fluency score at the student current grade	FAST reading fluency score at the student reading level	Accuracy	Instructional reading level
Jay	35	58	.97	2nd
Amy	15	26	.90	1st
Pam	41	53	.90	2nd

A special education teacher with three years' experience working with elementary age students who was working with students with special education needs implemented the study. The teacher is a white male and holds a bachelor's degree in elementary education and is pursuing a master's degree in special education currently. Before starting the intervention, the teacher attended a three-part training session. In the first part of the training, the researcher described the rationale of the intervention and the research design. In the second part, the researcher explained the research procedures and modeled the baseline condition and how to deliver the two types of the intervention. The teacher was then asked to practice the procedures with the researcher. Feedback was provided in this stage. In the third part, the teacher was

asked to apply one session of the baseline and the two interventions to the researcher to ensure that the teacher had mastered the procedures. Using a procedural checklist (appendix D, E, and F), the teacher could apply the procedures with an accuracy of 92% for the baseline condition, 92% for the rereading condition, and 97% for the tablet condition. After starting the study, weekly meetings were held to answer questions, provide feedback for the teacher, and pre-correct for potential drift.

Materials

The materials for this study were selected from a reading database created by Therrien et al. (2006). Therrien and his colleagues wrote 50 passages per grade from first through sixth grade to be used for a series of Reread-Adapt and Answer-Comprehend (RAAC) studies. Table 6 includes an example of these passages and Table 7 includes an example of the eight comprehensive questions. All passages are narrative, nonfiction, and story based. The passages were leveled using the Flesch–Kincaid Grade Level Method (Flesch, 1948). The length of each passage is limited to ensure that an average student can finish reading it in 1 to 1.25 minutes (Hua et al., 2012; Therrien et al., 2006). In addition, eight comprehension questions were designed for each passage. They include four factual and four inferential questions. The authors used Davey and McBride (1986) operationalized definitions to write the questions (Therrien et al., 2006). The factual questions can be underlined in the text, while inferential require integration of information (Davey & McBride, 1986).

The passages were presented on paper for the RAAC condition and in an electronic version on an iPad 2 with a 9.7-inch screen for the second condition. In both conditions, the teacher had a paper copy of the passages to mark the decoding errors and record the finish time. The teacher was also provided with an iPad2, timer, and voice recorder.

Table 6

Example of a Passage

The yellow bus pulled up. It was Becca's first day of school. She was very happy. Becca wanted to go to school like her older brother Robby. He had been going to school for years. Robby was in fourth grade. The ride to school was exciting. Becca looked out the window and thought about the day. When they got to school, Becca met her teacher. Mr. Kule was very nice. He welcomed the students to his room. Becca had fun on her first day. They played games to get to know each other. They even made a picture for their mom. They toured the school, too. Becca knew she was going to love school.

Table 7

Example of the Eight Comprehensive Questions

1. What color was Becca's bus?
2. Was Becca afraid to go to school?
3. What was Becca's brother's name?
4. What did the students do on the first day?
5. Did Becca get to talk to any of the other students in her room?
6. What do you think Becca saw on her tour?
7. Did Becca want to go to school the next day?
8. What was Mr. Kule like?

Procedures

The study took place at the school in the resource room and was conducted in one-on-one sessions. The intervention was conducted three times per week for two months during the students' special education reading class. Each session was approximately 20 minutes. The resource room was approximately 8 feet by 15 feet. The room has a large U-shaped table and four chairs.

Baseline. The special education teacher pulled out one student to sit at the face-to-face set-up table where there were two chairs facing each other. The teacher gave the student a paper copy of a passage and asked the student to read the passage aloud. The instructions for baseline did not include any prompts and were provided as the following: "Read this story the best you

can. Pay attention to what you are reading, as you will need to answer some questions. If you get stuck, I will tell you the word so you can keep reading." Once the student started reading, the teacher started the timer. During reading, the teacher marked the student's errors (Appendix A includes details of error scoring procedures). If the student did not read a word and paused for three seconds, the teacher read the word and marked it as an error. Once the student finished reading, the teacher took the passage away and asked him or her to retell everything he or she could remember. The teacher then asked the student the eight comprehension questions and wrote down the student's answers. The student was asked to walk back to his or her class, and the same process was repeated with the rest of the students. This process took about five minutes for each student. The teacher was asked to follow instructions as provided in Appendix A.

RAAC condition. The student was moved to the face-to-face setting as described in the baseline phase. When the participant was ready, the teacher gave the participant to read out loud the five generic questions from a cue card as shown in Table 8. The same questions were used in each intervention session. The student read the cue card for less than one minute. The teacher then took the cue card away and gave a paper copy of a passage to the student to read.

Table 8

Generic Questions (Cue Card)

(a) Who is the main character?
(b) Where and when did the story take place?
(c) What did the main character do?
(d) How did the story end?
(e) How did the main character feel?

The teacher gave the following instructions: "Read this story the best you can. Pay attention to what you are reading, as you will need to answer these questions. If you get stuck, I will tell you the word so you can keep reading." As the student started reading, the teacher

started the timer and marked the errors. After finishing reading, the teacher recorded the finishing time, reviewed the student's errors, and corrected them by using a model-prompt-check procedure. According to the procedure, the teacher directed the student's attention to the incorrectly read word, read the word, and asked the student to read it. After correcting all errors, the teacher asked the student to read the passage two more times following the same procedures without question prompting.

After the student read the passage three times, with the teacher recording the student's reading time, errors, and providing feedback each time, the teacher asked the student to read the five generic questions (cue card) again and answer them one by one. While answering, the teacher provided prompts to encourage the student to provide more information about the story.

The teacher then took the cue card and the passage from the student, asked the student to retell and answer the eight specific comprehension questions about the passage, and wrote down the student's answers, as described in the baseline. The researcher used a timer to record the duration of the interventions. The intervention was timed once the teacher started giving the instructions "you will need to read...." It ended once the teacher thanked the student for answering the 8 comprehensive questions. The length of this intervention will be reported in the results section. The teacher was asked to follow the instructions as provided in Appendix B.

Tablet condition. All procedures in the RAAC condition were implemented, except that instead of reading three times, the students listened to the passages once from an iPad2. The differences between the two intervention conditions are highlighted in Figure 1. During this condition, the teacher started each session by having the participant read the five generic questions presented on the iPad. After the student read the generic questions, the teacher swiped on the iPad to the next page where the passage was presented. The iPad presented the passage in

16-point black font. The reading speed was set at 120 words per minute and read in a female voice for all students. The teacher asked the student to listen to the iPad and provided the following instructions: "You will be listening to a passage from this iPad. Listen to this story and follow along the best you can. Pay attention to what you are listening, as you will need to answer these questions." After the iPad read the whole story, the teacher swiped the screen back to the generic questions and asked the student to read and answer them. After the student finished answering the questions, the teacher asked him or her to retell the story and asked the specific comprehension questions as described in the baseline. The teacher was asked to follow the instructions in Appendix C.

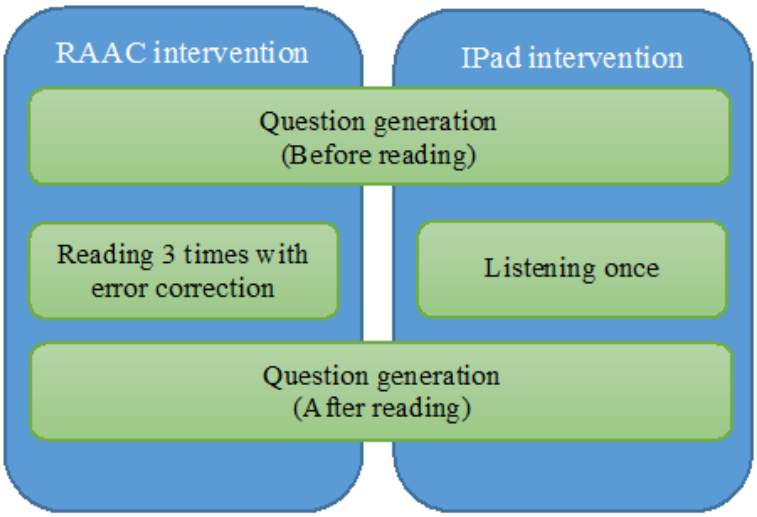

Figure 1. Differences between tablet condition and RAAC condition

Dependent Variables

This study examines the effect of the independent variable on reading comprehension skill; thus, the primary dependent variable to measure the changes in reading comprehension was

the Index of Narrative Complexity (INC). Labov (1973) developed INC primarily to monitor students' progress in reading. Later, Petersen et al. (2008) validated the tool to evaluate narrative texts. The reliability of the INC ranged from 0.604 to 0.898, and its validity ranged from 0.602 to 0.828. This tool includes rubrics of 13 elements that evaluate students' retells and gives a score from 0 to 2 or 3 for each element. Table 9 provides details about the INC elements and possible points for each element. Table 10 includes an example of one element for INC.

Table 9

INC Elements and Possible Points for Each Element

Elements	Possible points
1. Character	3
2. Setting	2
3. Initiating Event	3
4. Internal Response	2
5. Plan	3
6. Action	2
7. Complication	2
8. Consequence	3
9. Formulaic Markers	2
10. Temporal Markers	2
11. Causal Adverbial Clauses	2
12. Knowledge of Dialogue	2
13. Narrator Evaluations	2
Maximum Possible Points	30

Table 10

Example of Index of Narrative Complexity

Narrative element	0 Point	1 Point	2 Point	3 Point
Character A character is any reference to the subject of a clause in a narrative.	No main character is included, or only ambiguous pronouns are used Example: a) They were walking. b) He was walking.	Includes a least one main character with non-specific labels only. Example: a) Once there was a boy. b) The boy was walking.	Includes one main character with a specific name for the character. Example: a) Once there was a boy named Charles.	Includes more than one main character with specific names. Examples: a) Once there was a boy named Charles and a girl named Mary.

To score the students' retells, the retells of each session were transcribed to text format by the researcher and evaluated using INC. One issue regarding this measure is that it requires passages that have very similar details (Petersen et al., 2008). However, because the materials that are used in this study do not contain similar details, an alternative procedure was used. The original passages were scored to determine the maximum score based on INC. The students' retells were scored and compared to the original passages. The proportions of the students' retells were then reported. To calculate the proportion, the student's retell scores were divided by the original passages scores, multiplied by 100. For example, if a student retell score was 20 and the original passage score was 25, the proportion of the student retell for that passage would be 80%.

In addition to this measure, other groups of measures were used to support the results and data analysis. First, the number of correct answers to the eight comprehension questions (information about the comprehension questions is described in the materials section). Second,

the CWPM of the final reading was collected after each session and used to measure fluency. In term of reliability, CWPM have a moderate high correlation (r = .67) with other standardized tests of reading achievement (Reschly, Busch, Betts, Deno, & Long, 2009). In term of validity, CWPM is predictive of reading comprehension measures with a correlation of (r = .69-.49) (Hintze & Silberglitt, 2005). CWPM was collected by multiplying the number of seconds taken to read the passage by 60, then dividing that number by the number of words in the passage. In addition, the number of decoding errors and the duration of the two interventions were collected.

Experimental Design

A single-subject multiple baseline across participants with alternating treatment design was used for this study. Figure 2 shows an example of this design. The combination of these two designs increases the strength of the experimental demonstration (Kazdin, 2011), which improves internal validity. First, this design can demonstrate the effects of the two reading interventions relative to baseline following the logic of multiple-baseline designs. Second, this design compares the relative effects of the two types of interventions on the dependent measures in the context of an alternative treatment design. Meeting the requirements of both designs demonstrated the interventions' impact persuasively. This design served to examine the effects on reading comprehension skills of the two interventions across participants and between the two conditions. This combination allows the participants to serve as a control for their own performance and for one another's. It also enables the participants to respond differently to the treatments. Thus, three points of functional relation were demonstrated: differences between baseline and intervention phases, differences across participants, and differences between the two interventions.

This design is appropriate to use for academic skills. Reading is one of the academic skills that cannot be reversed by a return to baseline. Once students learn academic skills, they cannot unlearn them; thus, there is no withdrawal phase in this design. On the other hand, withholding the intervention from participants might raise ethical concerns (Kazdin, 2011; Kennedy, 2005). Thus, the interventions were provided as soon as a stable trend was established in order to minimize the baseline lengths.

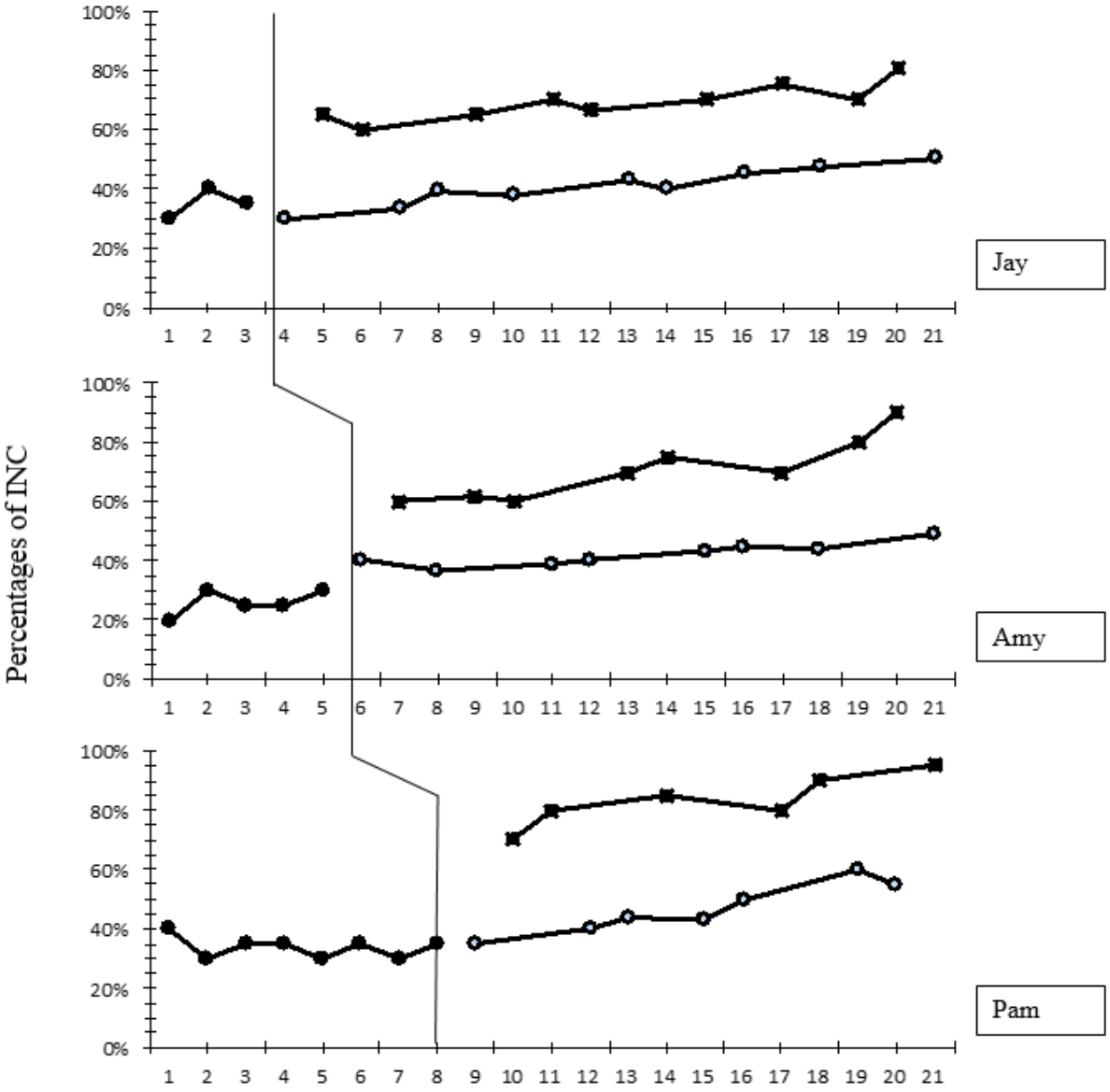

Figure 2. Example of the experimental design

Another potential issue is multiple treatment interference (Barlow & Hayes, 1979). This issue presents when the effect of one treatment is being influenced by the effect of the other (Kazdin, 2011). For example, the participants' data may show higher points followed by lower points or vice versa. However, this will not be an issue in this study because each intervention will use a different method. RAAC intervention will use repeated reading while tablet intervention will use a text-to-speech.

Repeated measurements of the same performance (i.e., reading skills, details are provided in the next section) were conducted (J. Hitchcock et al., 2010). The data points were collected for each session and for each participant during baseline and interventions. The interventions were also introduced separately, sequentially, randomly, and in spaced times after a stable baseline on INC was established for each participant, as suggested by Kazdin (2011). The stable baseline is met when there is a lack of trend (i.e., slope) with little variability. However, because the study was conducted at the end of the semester, the baseline sessions had to be shortened, which affected the stability criteria. The interventions lasted for approximately two months.

Beside the baseline and intervention phases, the study included a follow up phase (post intervention session). The data collection for this phase took place one week after the intervention was withdrawn because of the end of the semester. This phase was similar to the baseline phase. The participants were asked to read passages once, retell, and answer the comprehensive questions for the passage. The follow-up phase includes three data points.

Data Analyses

The data were analyzed using visual analysis to determine the changes in reading comprehension (Kazdin, 2011) including level, variability, trend, and stability. Also, a descriptive statistics including mean and standard deviation were examined. In addition, a mean

effect size procedure was used. Effect size estimates the changes on the dependent variable as a result of the interventions (Kazdin, 2011). This procedure is used to support the visual analysis and provide meaningful values that show the strength of the treatments (Beeson & Robey, 2006). Also, when there is variability in the data, using an effect size becomes necessary to observe the precision of the measurement (Rakap, 2015). To calculate the mean effect size, the mean of the treatments was subtracted from the baseline mean and then the differences were divided by the pooled standard deviation (see Figures 3 and 4). The pooled standard deviation is used for accuracy of estimation (Kratochwill & Levin, 1992), and it is appropriate when there is low variance in baseline compared to using only baseline to calculate standard deviation. This method of calculation is similar to the procedures used by (Beeson & Robey, 2006; Swanson & Sachse-Lee, 2000).

$$d = \frac{M_1 - M_2}{SD_{pooled}}$$

Figure 3. Formula to calculate effect size for mean differences between conditions

$$Sp = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Figure 4. Formula to calculate the pooled standard deviation

Pre- and Posttest

Before starting and after completing the intervention, pre and posttest were implemented. The measure was reading comprehension assessment at the participants' current grade level from EasyCBM. EasyCBM is an assessment system developed at the University of Oregon. It is used to assess K through eighth grade students in reading and math skills. The reading comprehension component includes a narrative passage of approximately 1500 words with 20 multiple-choice questions (Nese, Anderson, Hoelscher, Tindal, & Alonzo, 2011). In one study, the reliability for passage reading fluency and multiple-choice reading comprehension ranged from 0.45 to 0.97 for test-retest and 0.76 to 0.97 for the alternate form (Alonzo & Tindal, 2009). In another study, the criterion-related validity ranged from 0.39 to 0.76 for vocabulary and comprehension when compared to the Gates-MacGinitie Reading Tests and the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Lai, Alonzo, & Tindal, 2013).

EasyCBM measures students' reading comprehension and listening comprehension skills. In two different sessions, all participants read one passage to measure reading comprehension and one for listening comprehension. Students read the passages from papers and listened to the passages from an iPad. The comprehension questions about the CBM passages were used as standard test. The scores are reported in the results section.

Reliability and Procedural Integrity

Inter-observer reliability. Inter-observer reliability data were collected across all conditions for all sessions using a point-by-point agreement formula. The point-by-point reliability was calculated by counting the number of agreements between the first scorer and the second scorer. Next, this number was divided by the total number of agreements and disagreements and multiplied by 100. To score INC, the researcher scored all original passages

and retells. Another PhD student with research experience served as the second scorer, independently scoring 33% of the original passages and 33% of the retells (8 out of 24). The average inter-observer reliability for the original passages was 91% (range = 77%-100) while it was 87% (range = 75% - 100) for student retells.

The teacher also scored all participants' eight comprehension questions, while the researcher served as the second scorer and scored 100% of all sessions. Using point-by-point agreement, the average inter-observer reliability for comprehension questions was 95% (range = 67% -100) across all conditions for all participants. Reliability for decoding errors and reading times were calculated by dividing the smaller number by the large number and multiplying by 100. The average reliability for decoding and reading times was 98% (98% -100%) for both across all conditions for all students.

Procedural integrity. During all sessions, the special education teacher implemented the intervention, and the researcher served as observer. The researcher used a procedural checklist to ensure that the teacher followed the procedures accurately during the intervention. The teacher was also told not to provide the intervention outside the intervention time or to provide the intervention to other participants who were still on hold. The researcher conducted random observations during students' typical school days to observe any teaching practices that were similar to the intervention components. Appendixes D, E, and F include procedural checklists for the baseline and the two interventions. Dividing the number of teacher completed steps by the total number of steps on the procedural checklist was used to calculate the procedural integrity.

The researcher collected the procedural integrity data during 100% of all sessions across all conditions for all participants. The average procedural integrity for Jay was 100% in baseline,

99% for the tablet condition, and 100% for the rereading condition. For Amy, the average procedural integrity was 98% in baseline condition and 100% for both interventions. For Pam, the procedural integrity in the baseline condition was 99% and 100% for the both interventions.

Social Validity

Social validity data were collected on the study procedures. Personal interviews were conducted with participants in order to obtain information about their preferences. The teacher interviewed each participant individually for approximately three minutes at the end of the study. The teacher asked the following questions: (a) Do you like to read from an iPad or papers? Why? (b) Do you like to listen to the story from the iPad or read it? Why? (c) Do you like to read three times or not? Why? (d) Do the generic questions help you to focus on the story? (e) Do you think you understand how to read a story?

CHAPTER FOUR

RESULTS

Overview

The purpose of this study is to compare two reading interventions, repeated reading and tablet text-to-speech. Both interventions aim to improve reading comprehension for students with Specific Learning Disabilities (SLD). All participants have reading difficulties and read below their expected reading levels. The study used a single-subject, multiple-baseline design across participants with alternating treatments. This chapter provides the results of the interventions for the participants.

Results

Each participant had a baseline, two interventions, and a follow-up phase for a total of 8 weeks, three sessions per week. The intervention phase was introduced once a stable baseline had been established. Jay had three, Amy had six, and Pam had nine baseline data points. Jay had nine tablet sessions and nine rereading sessions by the end of the study. Amy had seven tablet sessions and seven rereading sessions. Pam had six tablet sessions and six rereading sessions. After withdrawing the intervention for a week, the teacher conducted a follow-up phase (post intervention session) for all participants that included three data points for each participant.

The data were analyzed (the reading comprehension measure; INC) mainly using visual analysis including level, trend, and variability. The trend of data was examined using the spilt-middle line of progress (Cooper, Heron, & Heward, 2007). Also, the mean, standard deviations, and range were used to support the visual analysis. In addition to this analysis, the mean effect sizes and pre and post results were reported.

Jay.

INC. The index of narrative complexity (INC) was used to measure reading comprehension skills. The scores reported represent the proportion of information that the participant retold from the passages. The trend in data was evaluated using split-middle line of progress. During baseline, Jay's INC score was 58.43% (range = 52.94%–65.22%; see Figure 5 and Table 11). He had only three data points during baseline; however, there was an immediate change in level followed by an increase in trend with slight variability after both interventions were implemented. His retell for the 18 sessions increased by 28.53%.

During the tablet condition alone, he had a gradual and consistent ascending trend with less variability relative to baseline. During this condition he had an average of 79.65% (range = 63.16%–90.00%). During the rereading condition alone, he had similar trend and variability as in the tablet condition; however, the rereading condition level was higher than that of the tablet condition. He had an average of 90.25% (range = 79.17%–100.00%), 10.60% higher than the tablet intervention. During the post-intervention phase, Jay's mean INC score was 86.97% (range = 80.95%- 90.48%).

Table 11

Jay's Mean and SD for all Dependent Variables

Jay	Baseline M (SD)	Tablet M (SD)	Rereading M (SD)	Both interventions M (SD)	Follow-up M (SD)
INC	58.43	79.65	90.25	84.95	86.97
	(5.09)	(8.34)	(6.48)	(9.16)	(4.27)
Questions	6.33	7.11	7.44	7.28	7.67
	(0.47)	(0.87)	(0.68)	(0.80)	(0.47)
Fluency	49.85	-	82.95	-	70.17
	(9.90)	-	(5.76)	-	(9.71)
Errors	10.33	-	1.00	-	3.67

	(4.99)	-	(1.15)	-	(1.25)

Note. Tablet condition does not include oral reading.

Comprehension questions. During baseline, Jay had a relatively stable baseline, however, when both interventions were implemented there was not an immediate change nor an increase in trend. Also, there was a moderate level of variability in both conditions. Jay answered an average of 6.33 comprehension questions for each passage during baseline (range = 6–7). However, when the tablet condition was implemented, this average was 7.11 (range = 6–8). For the rereading condition, the average was 7.44 (range = 7–8). However, during the post-intervention phase, Jay answered an average of 7.67 questions correctly.

Correct words per minute. During three sessions in the baseline phase, Jay read an average of 49.85 correct words per minute (CWPM, range = 35.86–57.37; see and figure 6). When the interventions were implemented, Jay's performance increased on the final reading to an average of 82.95 CWPM (range = 71.75–90.43) during the rereading condition. (There was no reading in the tablet condition.) Jay also maintained this high performance during the follow-up phase. His average reading during this phase was 70.17 CWPM, 20.32 higher than baseline.

Errors. During baseline, the average number of errors was 10.33 (range = 5–17). However, when the intervention was implemented, the number of errors decreased by 6.67 errors compared to the follow-up phase. The average number of errors in the rereading condition was 1 (range = 0–3). However, Jay had an average of 3.67 errors during the follow-up phase, a result slightly higher than during the intervention phase but still lower than the baseline.

Duration. *Duration* is the time it took the teacher to apply the intervention. The average duration in the rereading condition for Jay was 10.59 minutes (range = 9–13) but was much shorter for the tablet condition, which had an average duration of 4.48 minutes (range = 4–5.30), a difference of 5.41 minutes (see Figure 7).

Amy

INC. The two interventions were implemented for Amy after six baseline sessions. See Table 12. During baseline, she had great variability with a slightly ascending trend based on split-middle line of progress. She had an average INC of 36.46% (range = 23.53%–55.56 %). When both interventions had been implemented, her retell performance increased dramatically by 34.06%. She showed an immediate change in level with slightly ascending data paths during the both interventions. During the tablet condition alone, she showed an immediate change in level with slightly ascending data paths and moderate variability. The average for the tablet condition alone was 64.83% (range = 47.37% –76.47%). During the rereading condition, she also showed an ascending trend relative to baseline but with greater variability comparing to the tablet condition. However, the level was slightly higher than the tablet condition. The average INC for the rereading condition alone was 76.21% (range = 45.00% –93.75%). After withdrawing both interventions and implementing the post-intervention phase, Amy's retell increased to 87.36% (range = 85.71%-86.36%).

Table 12

Amy's Mean and SD for all Dependent Variables

Amy	Baseline M (SD)	Tablet M (SD)	Rereading M (SD)	Both interventions M (SD)	Follow-up M (SD)
INC	36.46	64.83	76.21	70.52	87.36
	(10.33)	(9.13)	(15.83)	(14.11)	(1.89)
Questions	5.83	6.86	6.71	6.79	6.67
	(1.57)	(0.83)	(1.16)	(1.01)	(0.47)
Fluency	16.32	-	39.98	-	23.51
	(2.02)	-	(8.43)	-	(0.61)
Errors	21.00	-	5.29	-	15.67
	(4.08)	-	(5.20)	-	(2.05)

Note. Tablet condition does not include oral reading.

Comprehension questions. During baseline, Amy showed a great level of variability with a descending trend. However, when both interventions were implemented, there was not an immediate change in level. Amy answered an average of 5.83 questions (range = 3–8) out of eight comprehension questions for each passage. However, this number increased slightly when the interventions were introduced and then withdrawn. During both interventions, Amy demonstrated less variability compared to baseline, however, there was not a trend for any conditions. Amy answered correctly an average of 6.86 questions (range = 6–8) during the tablet condition and an average of 6.71 (range = 4–8) questions during the rereading condition. When both interventions were withdrawn, Amy maintained her performance with an average of 6.67 questions.

Correct words per minute. Amy started with a slow reading rate. Her average during baseline was 16.32 CWPM (range = 13.68–19.70). However, when the interventions were implemented, her reading rate increased by 23.66 for an average rate on the final reading of 39.98 CWPM (range = 25.33–51.00). When the interventions were withdrawn, however, her performance decreased slightly. Her average rate during the follow-up phase was 23.51 CWPM, still 7.19 higher than baseline.

Errors. The number of errors during baseline was high for Amy. This number decreased by 15.71 when the interventions were implemented, but increased again when the interventions were withdrawn. The average number of errors during baseline was 21.00 (range = 17.00–28.00). During the intervention phase, the average number of errors on the final reading decreased to 5.29 (range = 1.00 –17.00). When the interventions were withdrawn, she had an average of 15.57 errors, 5.33 lower than baseline.

Duration. The average time it took the teacher to apply the rereading intervention for Amy was 16.46 minutes (range = 15.00–20.00). However, the time to apply the tablet intervention was 6.14 minutes (range = 5.00–8.00), 10.41 minutes shorter.

Pam

INC. Pam was the last one to receive the interventions. She had nine baseline sessions before the interventions were provided. See Table 13. During the baseline, she had an ascending trend with great variability. Her average INC was 54.37% (range =23.81%–70.59%). However, when both interventions were implemented, there was not an immediate change in level.

During the tablet condition, she did not show an immediate change in level. She had less variability compared to baseline but there was not a clear trend. Pam retold an average of 80.35% (range = 76.19% –87.50%) during the tablet intervention. During the rereading condition she had a stable and consistent ascending trend with less variability relative to baseline. Her average INC score during this condition was 80.27% (range = 68.18% – 87.50%) which is similar to the tablet condition. During the post-intervention phase, Pam's mean INC score was 80.45% (range = 71.43%-85.71%).

Table 13

Pam's Mean and SD for all Dependent Variables

Pam	Baseline M (SD)	Tablet M (SD)	Rereading M (SD)	Both interventions M (SD)	Follow-up M (SD)
INC	54.73 (13.83)	80.35 (3.95)	80.27 (6.63)	80.31 (5.45)	80.45 (6.41)
Questions	5.56 (1.07)	7.50 (0.76)	7.50 (0.76)	7.50 (0.76)	6.67 (0.47)
Fluency	54.30 (12.00)	- -	75.48 (17.30)	- -	67.72 (9.64)
Errors	13.89 (4.33)	- -	3.17 (1.95)	- -	5.33 (1.70)

Note. Tablet condition does not include oral reading.

***Comprehension questions*.** During baseline, Pam showed a great level of variability with no trend of data. The average number of answered questions correctly was 5.56 for Pam (range = 4–7). However, this number increased slightly when both interventions were implemented. There was not an immediate change in level. Also, there was not a trend in the data for any condition. For the tablet intervention alone, she had an average of 7.50 answered questions (range = 6–8). She also had an average of 7.50 answered questions (range = 6–8) during the rereading intervention. She maintained this performance during the follow-up phase, with an average of 7.50 answered questions.

Correct words per minute. During baseline, Pam's average reading rate was 54.30 CWPM (range = 41.18–81.43). Her average CWPM was 75.48 (range = 57.57–109.35) on the final reading during the rereading intervention. Her CWPM decreased slightly to 67.72 during the follow-up phase but still represented an increase of 13.41 over baseline.

***Errors*.** Pam had an average of 13.89 errors during baseline (range = 4.00–19.00). However, this average fell during the rereading intervention to 3.17 errors (range = 1.00–6.00), 10.72 lower than baseline. Pam had only 5.33 errors during the follow-up phase; furthermore, she showed a decrease of 8.56 compared to baseline.

Duration. The average time it took the teacher to apply the rereading intervention was 10.45 minutes (range = 9.00–12.00) for Pam. The average time to apply the tablet intervention was 5.33 minutes (range =5.00–6.00), 5.42 minutes shorter.

Summary of results

In comparison to the baseline condition, the effects of both reading interventions on comprehension were clear for two of the participants. However, the effects were less clear for the

last participant. The visual analysis did not identify a functional relation between any intervention and reading comprehension on the 8 comprehensive questions measured.

With regard to the relative effects of the two interventions on reading comprehension, one student (Jay) had a higher INC score during the RAAC condition. However, the relative effects of the two reading interventions were less clear with the other two students. Therefore, the data did not confirm a functional relation between INC and the two types of reading interventions.

Pre/Post Tests

Before the interventions, each participant had to read an easyCBM passage once and listen to another passage once as a standardized test. The number of correctly answered questions was then calculated. Table 14 details the participants' results and provides a comparison by percentile to easyCBM norms in the fall. All participants improved their reading comprehension skills slightly at the end of the study. However, all participants had higher scores in listening comprehension than reading comprehension.

Table 14

Participants' Pre/Post Test Results on EasyCBM

	Reading				Listening			
Participants	Pre-Test scores	Compared to EasyCBM norms Percentile	Post-Test scores	Compared to EasyCBM norms in Fall	Pre-Test scores	Compared to EasyCBM norms Percentile	Post-Test scours	Compared to EasyCBM norms in Fall
Jay	5	5th	7	14th	5	5th	11	44th
Amy	6	11th	7	17th	8	25th	11	50th
Pam	4	3rd	7	14th	8	19th	12	50th

Statistical Analysis

Effect size (d). The effect size between means was estimated. Table 15 includes all details of participants' effect sizes for both interventions together and for each intervention alone. All participants had high effect sizes compared to baseline. Jay demonstrated large effect sizes for all conditions with significant differences for rereading over tablet condition. He has observed effects of $d = 2.72$ for the tablet condition and 5.11 for rereading condition. Amy and Pam demonstrated large effect sizes with almost no differences between them. Amy's effect size for the tablet condition was 2.93 and 2.92 for the rereading condition. Pam had 2.59 for tablet condition and 2.20 for rereading condition.

Table 15

Effect Size (d) for Mean Differences in INC between Phases

Participants	Both interventions *d*	tablet *d*	Rereading *d*
Jay	3.01	2.72	5.11
Amy	2.59	2.93	2.92
Pam	2.59	2.30	2.20

Social Validity

When the teacher asked the participants about the interventions, all preferred to listen to the tablet compared to rereading. However, each one had a different explanation. Jay preferred to listen to the tablet over rereading because that way he did not feel overwhelmed by reading. Amy liked to listen to the tablet, but she reported that rereading three times helped her better understand the material. Pam thought that listening to the tablet was better because "It helps me picture what is happening." When the participants were asked whether they liked to reread passages three times, Jay said that it helped him understand the story better, while Pam thought it only helped if she did not really understand the story. Amy did not like rereading the passages

three times. When the participants were asked if the generic questions helped them understand the stories, all of them agreed that it did. Pam in particular thought that reading the generic questions helped her take extra time thinking about the main details in the story.

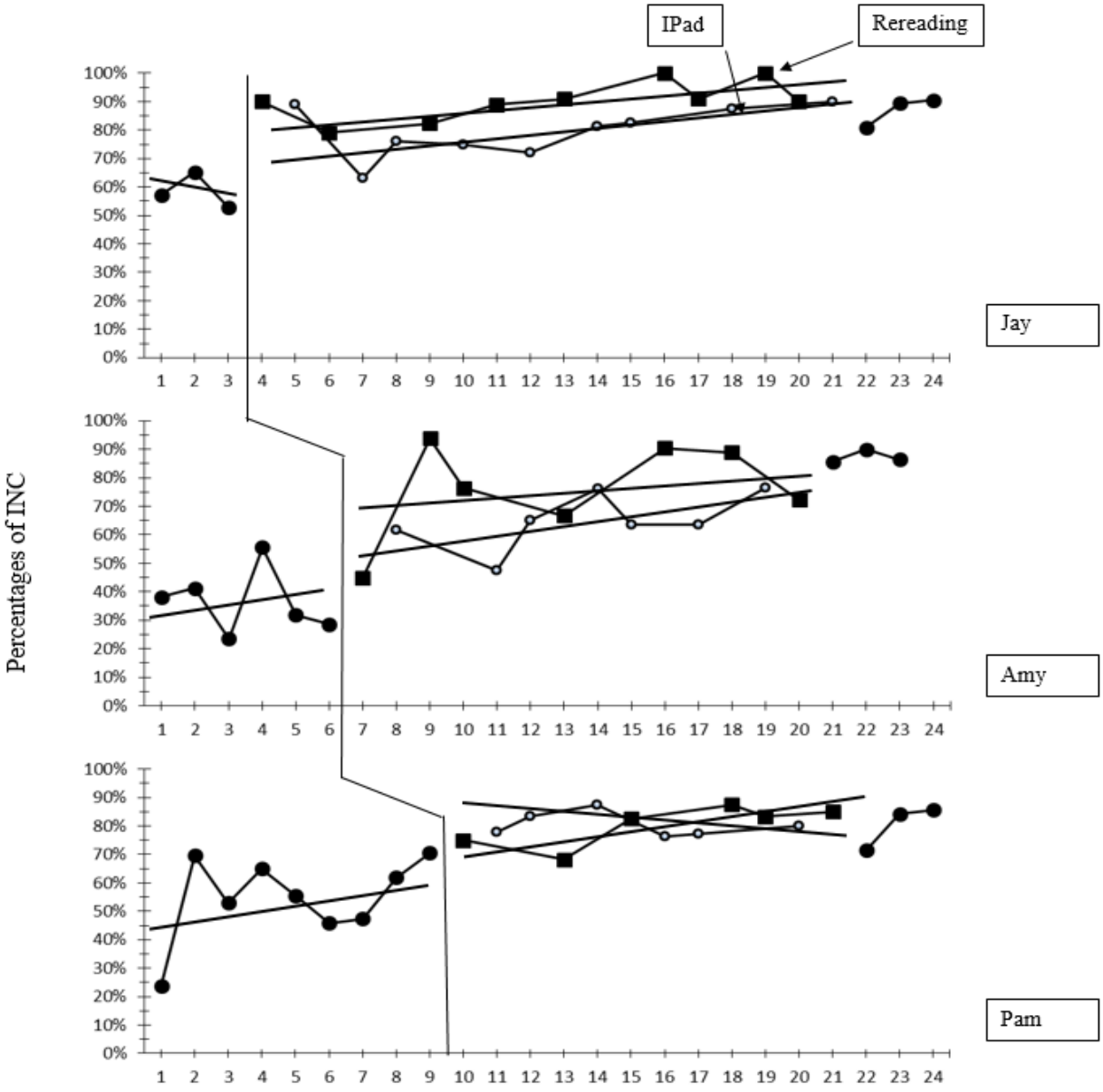

Figure 5. The participants' results based on inc measure.

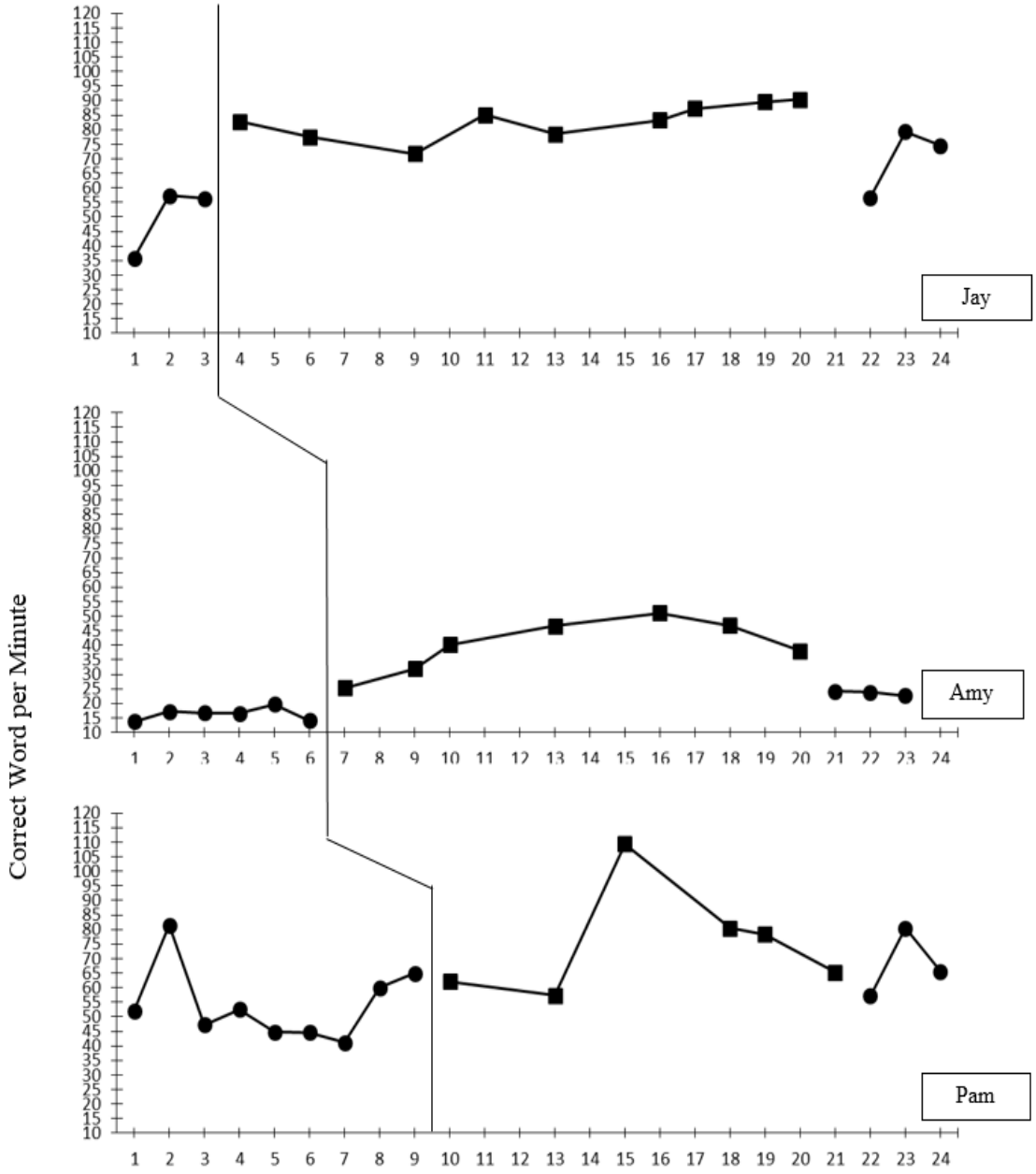

Figure 6. The participants' correct word per minute results

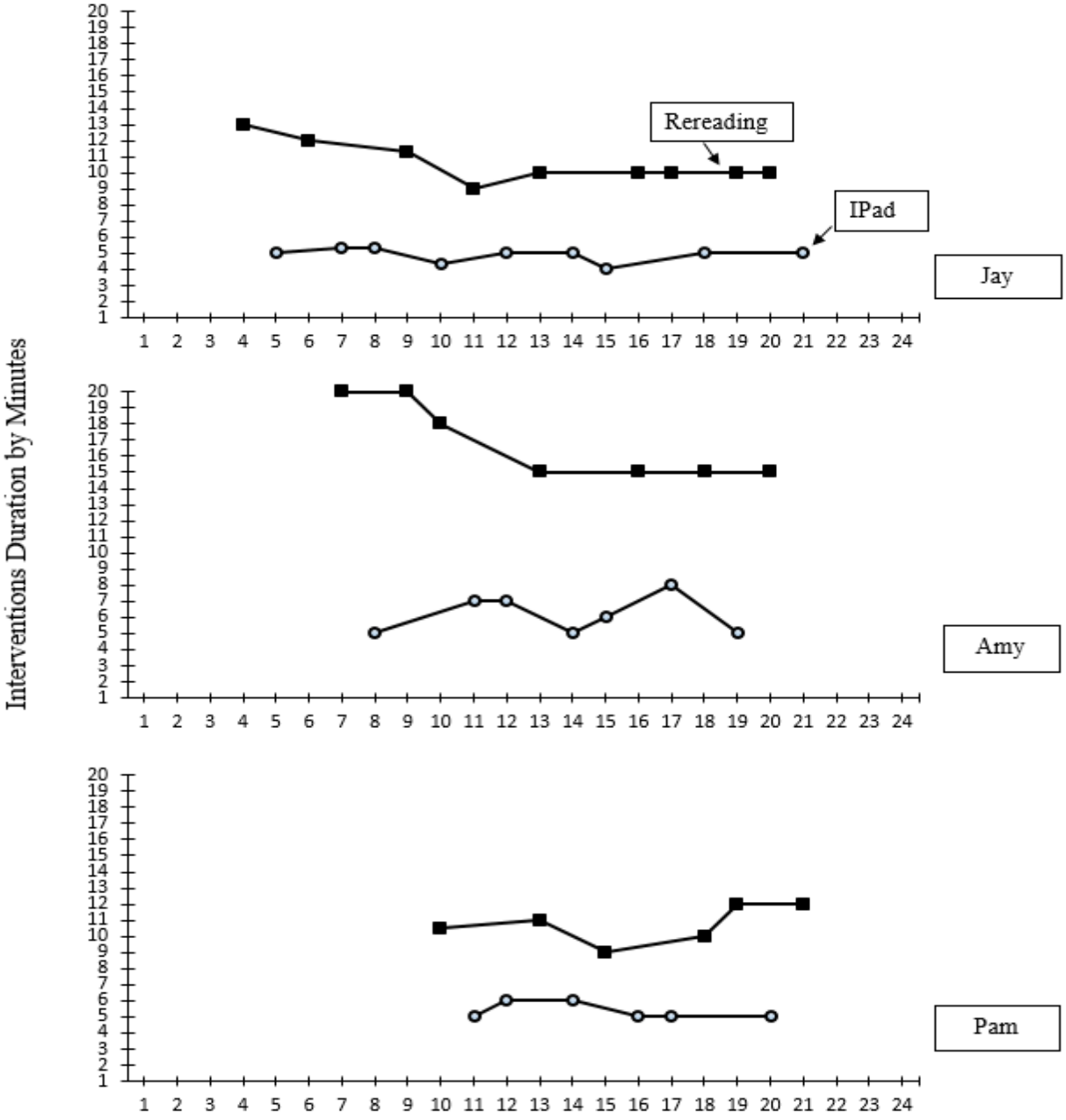

Figure 7. The results of intervention duration by minutes between the two conditions

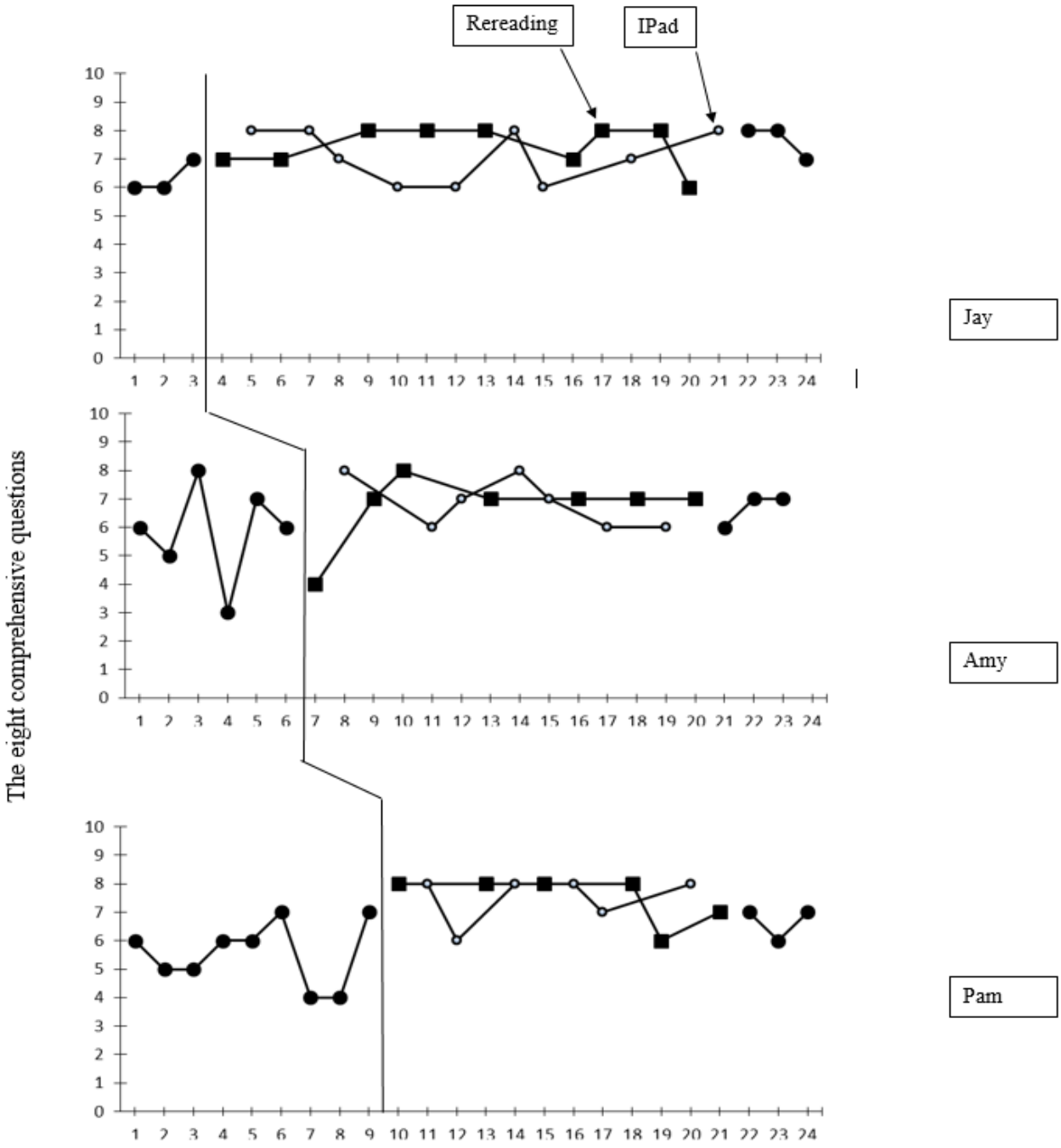

Figure 8. The results of the eight comprehensive questions

CHAPTER FIVE

DISCUSSION

This study compares two reading interventions, repeated reading and tablet text-to-speech, combined with the question generation meta-cognitive strategy. These interventions aim to improve reading comprehension in elementary-age students with specific learning disabilities (SLD). This study was designed to answer the following question: What are the effects of tablet text-to-speech combined with question generation strategies relative to the repeated reading combined with question generation strategies on reading comprehension for elementary-age learners with a SLD?

Each intervention was introduced separately, sequentially, and randomly. This study used a single-subject, alternating-treatment design across participants. Participants were assessed mainly using two measures: the Index of Narrative Complexity (INC) and 8 comprehensive questions. Results indicated that, throughout the data analysis, two participants (Jay and Amy) improved in reading comprehension relative to baseline on the INC measure. However, according to the visual analysis, Pam's performance did not improve after the interventions were provided. On the 8 comprehensive questions, no participant showed improvement.

The following sections include a detailed discussion of the results for each intervention. I will start with a discussion of the tablet condition followed by the RAAC condition. Then, I will discuss the comparison between both conditions followed by discussing this study approach. Then, I will conclude with the study's implications, limitations, and suggestions for future research.

Tablet intervention

The tablet intervention used in this study included two components: listening comprehension (listening to text read aloud on the iPad) and a meta-cognitive strategy (i.e., question generation). Both components together in this condition resulted in reading comprehension improvement for two participants. Jay's average retells of passage information changed from 58.43% during baseline to 79.65% during tablet condition, Amy's performance changed from 36.46% to 64.83%, and Pam's changed from 54.73% to 80.35%. In term of visual analysis, only Jay and Amy showed a change in level and ascending data paths when the tablet condition was implemented. However, Pam, did not show change in level nor an increasing trend when the tablet condition was implemented.

In general, these results are consistent with previous research that used assistive technology to support reading comprehension instruction (Hall et al., 2000; Higgins & Raskind, 2000; Higgins & Raskind, 2004; C. H. Hitchcock et al., 2004; Jimenez et al., 2003; Kim et al., 2006; Moorman et al., 2010). Adding to this significant body of research, this study confirms that the tablet may be a useful assistive technology for students with SLD, helping to support their academic skills (Cumming et al., 2014; Fernandez-Lopez et al., 2013; Haydon et al., 2012; Kagohara, Sigafoos, et al., 2012; Kagohara, van der Meer, et al., 2012; Larson, 2010).

Combining text-to-speech and question generation in this condition resulted in reading comprehension improvement for two students. The results correspond with previous studies that combined text-to-speech and meta-cognitive strategies to improve reading comprehension skills for students with SLD (Kim et al., 2006). One explanation of this improvement is that when read to, students do not need to use visual decoding skills. Decoding processing may overtax the students' cognitive processes in a way that prevents them from thinking about what they are

reading (Higgins & Raskind, 2005). The same conclusion was found when using text-to-speech to help students access curriculum and gain knowledge from texts (Higgins & Raskind, 2005; Moorman et al., 2010). Also, it is likely that the question generation strategy enhanced students' reading comprehension. Question generation directs students' attention to the text's contents to become more involved in reading (Rosenshine et al., 1996). Also, as in other studies (Griffey et al., 1988; Wong & Jones, 1982; Wong et al., 1986), this strategy improved reading comprehension for students with SLD. It is likely that this strategy helps these students because students with a SLD have limited knowledge about text structures (Cain, 1996; Gersten et al., 2001).

Pam did not demonstrate a functional relationship between both interventions and reading comprehension. Even though there was a difference in baseline and interventions means (54.73% to 80.35%), there was a trend (increase) at the end of the baseline sessions, which may limit the conclusion that the interventions are responsible for improvement in reading comprehension skills. This trend may result from practicing skills (Kazdin, 2011). Longer baseline (Pam had 9 baseline sessions) requires students to practice the targeted skill, which may result in improvement even without providing an intervention. The second explanation is that, Pam had shorter intervention sessions relative to baseline. Students with SLD benefit from longer interventions sessions (Therrien et al., 2006). In the Therrien study, they provided a total of 50 session's interventions, while Pam only received 6 sessions for each condition.

RAAC intervention

The average reading comprehension measured by INC changed from 58.43 % to 90.25% for Jay, from 36.46% to 76.21% for Amy, and from 54.73% to 80.27% for Pam. However, using visual analysis two participants (Jay and Amy) performed higher compared to his or her baseline

performance after taking part in the RAAC intervention. In this condition, participants read the same passage three times while also using the question generation strategy and answering the generated questions. This differs from the tablet condition in that, although both used question generation, participants read the same passage three times; in the tablet condition, they listened to it aloud on the tablet a single time.

The results correspond with previous studies that also used repeated reading and question generation strategies to improve reading skills in students with disabilities. Previous studies have shown that combining repeated reading with question generation is effective at helping young adults with autism or intellectual disabilities (Hua et al., 2012), and students with SLD (Therrien & Hughes, 2008; Therrien, Kirk, & Woods-Groves, 2012; Therrien et al., 2006). Those results are echoed in the results of the present study.

In other studies that used repeated reading to improve reading fluency (Chard et al., 2002; Meyer & Felton, 1999; Therrien, 2004), the reading rate of all participants increased when the interventions were implemented. In this case, the same is true: Jay's average reading fluency improved from a baseline of 49.85 correct words per minute (CWPM) to 82.95 during intervention; Amy's from 16.32 to 39.98; and Pam's from 54.30 to 75.48 CWPM. The fluency result is unique for this condition because there was not a reading component in the tablet condition. However, the comprehension findings in this condition were similar to the findings for the tablet condition. Thus, close comparison should be made in order to exam the effect of each intervention.

Comparing Conditions

Using the INC results, two participants demonstrated an increase in reading comprehension skills regardless of which intervention was used. In term of visual analysis, there

was not an important difference between the conditions on the INC measure for Amy and Pam. However, when inspecting the trend lines, the RAAC condition was slightly higher compared to the tablet condition for Jay only. Amy showed a change in level relative to baseline for both conditions, however, the great level of variability in both interventions limit the judgment of which intervention is better. Pam did not show a noteworthy improvement relative to baseline, nor showed differences between conditions. The raw scores and the mean effect sizes support the visual analysis results.

According to the INC mean effect size, conditions for Amy and Pam were similar regardless of intervention type—no detectable differences exist between the RAAC and tablet conditions. The mean effect size for Amy was d = 2.93 on the tablet and 2.92 for the RAAC condition. For Pam, it was 2.30 on the tablet and 2.20 for repeated reading. In contrast, Jay scored notably higher for the RAAC condition as compared to the tablet condition. For Jay, the mean effect size for the tablet intervention was 2.72, compared to 5.11 for repeated reading. The INC raw means support this result. He could retell an average of 79.65% during the tablet condition and 90.25% during the RAAC condition. One explanation is that reading the same passage three times resulted in better understanding (Therrien, 2004). The results might have changed if participants had listened to the same passage aloud three times in the tablet condition. However, this study did not account for the difference in number of exposures to passages (three for repeated reading, one for tablet), so this remains undetermined.

The same explanation could be used for Amy. Even though she had almost the same INC mean effect sizes, her raw score on the INC was higher for the RAAC condition. The average for the tablet condition was 64.83% and the average for the rereading condition was 76.21%. The differences between the INC mean effect sizes and the INC raw means for Amy may refer to

the use of pooled standard deviation to calculate the effect size. The mean effect size for Amy was d = 2.93 on the tablet and 2.92 for the RAAC condition when using the pooled standard deviation. The effect size for Amy is d = 2.75 for the tablet condition and 3.85 for the RAAC condition if we only use the baseline standard deviation to calculate the mean effect size. The pooled standard deviation requires calculating the baseline and the conditions standard deviations as shown in Figure 4. The second explanation for the differences between the raw means and effect size for Amy is the variability in her data. Figure 5 showed that there is high variability between conditions for Amy compared to Jay and Pam. Jay had the most stable data path followed by Pam. Despite the differences in the two conditions, both interventions are built on the same approach that addressed both higher and lower order reading skills.

Study Approach

This study used an intervention approach that included both code-based and meaning-based methods to improve reading comprehension. The study used question generation, a meta-cognitive strategy, to target reading comprehension, the meaning-based component. The study used text-to-speech and repeated reading strategies to address the code-based components (i.e., decoding and fluency). This methodology is based on a simple view of reading outlined by Gough (1986), which theorizes that reading comprehension constitutes a combination of linguistic comprehension and decoding.

The results of this study confirm and extend those of similar studies that also used this approach (C. H. Hitchcock et al., 2004; Kim et al., 2006). Participants improved their reading comprehension in either condition, with little discrepancy between RAAC and tablet text-to-speech interventions. Such improvements may be especially accessible to younger students with SLD.

Other studies that used only text-to-speech did not demonstrate improvement in participants' reading comprehension (Sorrell et al., 2007; Stodden, Roberts, Takahashi, Park, & Stodden, 2012). Similarly, studies that used the repeated reading intervention in isolation did not produce a significant improvement in reading comprehension (Chard et al., 2009; Freeland et al., 2000; Therrien & Hughes, 2008). Thus, it is important to address both parts of the equation (code-based and meaning-based) effectively. Although both interventions are built on the same approach, they differ in implementation times.

Duration

Determining the effectiveness of the interventions was the main purpose of the study; however, the length of each intervention's implementation was collected in order to investigate and support the comparison of the interventions' efficacy. All the participants had an equal number of intervention sessions for each condition; however, the researcher recorded the duration of each intervention session. The results indicate that the tablet intervention required an average of 5.45 minutes to deliver and the RAAC intervention required an average of 12.73 minutes. The tablet condition was shorter compared to the RAAC condition for Jay by approximately 46%, for Amy by 37%, and for Pam by 50%.

Implications

Students with SLD perform poorly in reading activities ("National Center for Learning Disabilities," 2014a), especially in reading comprehension (Kameenui & Carnine, 2002; Vaughn et al., 2002). Thus, intervention at earlier ages is critical for academic success (Scruggs, 2013). In general, the results of the present study confirm that combining meta-cognitive and code-based strategies leads to an improvement in reading comprehension for elementary-age students with SLD.

Considering the rising enrollment in special education programs nationwide ("National Center for Education Statistics," 2014; "National Center for Learning Disabilities," 2014a), efficient intervention could maximize positive results and minimize the duration of intervention. To this end, the reading comprehension improvements encompassed by this study indicate that, while both interventions offer benefits to those struggling with reading comprehension, using text-to-speech equipment may save teachers time and maximize intervention efficiency. The instructional time it takes to provide the repeated intervention to one student may be used to provide text-to-speech intervention to two students. This implication is important to consider when the number of students in the special education program is large and the goal is to provide sufficient instruction time for each student.

This study also indicates that schools may improve reading comprehension by implementing meaning-based and code-based interventions at the same time. Addressing meaning-based concerns requires the use of a meta-cognitive strategy, which directs students' attention to main details in the stories. This study suggests the effectiveness of question generation, which represents one such strategy. In contrast, institutions must also address code-based concerns, using techniques to enhance students' ability to move from identifying letters to understanding them. In this study, text-to-speech and repeated reading techniques helped students overcome decoding issues and improved their understanding of the text.

This study also suggests that even students who have difficulties in lower-order reading skills (decoding) may benefit from practicing higher-order reading skills (reading comprehension). Students with SLD may have sufficient cognitive abilities, but they often do not know how to apply them (Berkeley et al., 2010; Gersten et al., 2001), or use them inefficiently (Gersten et al., 2001; Scruggs et al., 1985). Thus, teaching these strategies to students with SLD

fosters reading comprehension (Gavelek & Bresnahan, 2009) even if they are still at development decoding stages. Therefore, educators should not wait until a student has mastered decoding skills before addressing reading comprehension.

However, for assistive technology to be useful, its users must be familiar with its operation. Multiple studies suggest that the use of technologies—including text presenters and readers—is not effective if used in isolation (Sorrell et al., 2007; Stodden et al., 2012). Technology only works when based on useful evidence that is grounded in practice or tested theory. This study indicates that the combination of meta-cognitive strategies with tablet text-to-speech features may represent one useful practice to improve reading comprehension. These suggestions are promising but more research is needed to maximize the effectiveness of these strategies and strengthen its limitations.

Limitations and Future Research

There are several limitations to the study. First, even though there were not big differences between the interventions, the participants were exposed to the text in the RAAC intervention three times versus one time in the tablet intervention. The result might be different if the participants were exposed to the text three times in each intervention. Thus, considering the reading comprehension improvement in the context of the number of exposures to the text may limit the conclusion that an intervention is better than the other. Thus, addressing this comparison in future research is needed.

Second, the researcher decided to provide the interventions for the participants even though there was variability in baseline data for two participants (Amy and Pam). As stated rules in the method section, the interventions should be provided once a stable baseline has been established (Kazdin, 2011). However, because the study took place in the second half of the

academic semester, the baseline session numbers had to be shortened in order to provide enough intervention sessions for each participant.

The third limitation is that the comparison in the study was to compare intervention package to another intervention package. The findings cannot tell which component in each intervention package is responsible for reading comprehension improvements. Thus, interpreting these findings should be limited to the package level comparison. Investigating each component or comparing between these components in future research may provide a considerable implication for students with SLD.

The fourth limitation is measurement error in dependent variables. The researcher conducted inter-observer reliability for the INC measures; nonetheless, measurement errors could affect the validity of the results. Replicating the same study using different measures would enhance the validity of this study's procedures and results (Rosenthal, 1990). Also, the 8 comprehension questions were not used explicitly in the data analysis due to its limited effects. Even though all participants answered more correct questions compared to the baseline phase, this measure did not reflect the changes in the dependent variable as INC did. The INC measure was used in this study because of its sensitivity to changes compared to the 8 comprehension questions. INC could capture changes on the students' performances (Petersen et al., 2008).

Furthermore, the pre- and post- results of the study are questionable and may not have used the most suitable measures. The easyCBM uses long passages that require participants to complete tests in several sessions and then answer questions. This may contribute to students' higher performance on listening comprehension tests, as compared to reading comprehension tests. Thus, based on the pre-post results, it cannot be determined if an actual performance

improvement occurred. Also, because there was not a control group, a causal relation cannot be determined.

The fifth limitation is social validity questions. Although this study does not explicitly address participant motivation, interviews with the students indicate a universal preference for the tablet. However, these results should be interpreted with caution because social validity questions were not worded equally for each intervention. Also, the social validity part was not the primary goal of this study. Thus, more research is needed in this area.

Last, this study used narrative text, which differs from expository text. Expository texts include different structure, vocabulary, and require reading strategies (Gajria, Jitendra, Sood, & Sacks, 2007). Students at higher-grade levels need to use more expository text (Paris & Hamilton, 2009), which allows them to acquire academic skills as their learning careers advance. Thus, more studies are needed that may use the same procedure in this study but with expository text. Some studies have investigated the effect of using reading comprehension strategies to enhance expository understanding (Gajria et al., 2007), however, using an approach that addresses both meaning and code base in such investigation may have promising results.

External validity in single-subject research is enhanced through systematic replication across studies (Horner et al., 2005). Also, replicating studies overcomes the error of measurement (Rosenthal, 1990) and is necessary to control for extraneous variables (Gross, 1997). Thus, each condition must undergo further research in isolation as applied to this population—particularly the tablet condition. Much research exists in the field of repeated reading interventions; in contrast, no previous research has used an identical tablet intervention procedure. Isolating the tablet condition in a separate study would distinguish the effect exerted by the repeated reading condition; furthermore, researchers would have the opportunity to study

the tablet in combination with meta-cognition strategies in more detail. Replicating only the tablet condition in this study may support this finding. Moreover, this study combined only one meta-cognition reading comprehension strategy (i.e., question generation) with the use of the tablet. The examination of different meta-cognition strategies used in combination with text-to-speech may further support the results of this study.

As a tablet, this study used iPads to support reading comprehension intervention. Thus, other devices and tools may show similar effects when applied in a systematic way as in this study. More research is needed to investigate other tools that are available in schools and may be less costly compared to iPads.

Conclusion

The academic area in which students with SLD have the most difficulty is reading comprehension (Hulme & Snowling, 2011). Improving reading comprehension requires efficient interventions that address meaning- and code-based skills at the same time. This approach to interventions has not been addressed extensively in the literature. Thus, this study adapted this approach to compare two reading interventions (repeated reading vs. tablet text-to-speech) combined with a meta-cognitive strategy (question generation). Regardless of the approach, new technologies such as the iPad have shown promising results when they are used for instruction of students with disabilities (Blood et al., 2011; Haydon et al., 2012; Kagohara et al., 2013).

The participants in this study were taught using two interventions that applied the same reading comprehension strategy, but each intervention used a different approach to address the code-based skills (decoding and fluency). Participants in the RAAC intervention were asked to reread the same passage three times in addition to reading and answering the comprehension questions, whereas participants in the tablet intervention were required to listen to the passage

from a tablet only once. Two participants showed improvement in their reading comprehension skills with significant effect sizes for both conditions. These findings support the literature on instruction that addresses meaning- and code-based skills in order to improve reading comprehension.

REFERENCES

Aarnoutse, C., & van Leeuwe, J. (1998). Relation between reading comprehension, vocabulary, reading pleasure, and reading frequency. *Educational Research and Evaluation, 4*(2), 143-166.

Achmadi, D., Kagohara, D. M., van der Meer, L., O'Reilly, M. F., Lancioni, G. E., Sutherland, D., . . . Sigafoos, J. (2012). Teaching advanced operation of an iPod-based speech-generating device to two students with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*, 1258-1264. doi:10.1016/j.rasd.2012.05.005

Adlof, S. M., Catts, H. W., & Little, T. D. (2006). Should the simple view of reading include a fluency component? *Reading and Writing, 19*(9), 933-958. doi:10.1007/s11145-006-9024-z

Alonzo, J., & Tindal, G. (2009). Alternate form and test-retest reliability of easyCBM reading measures. Technical Report # 0906: *Behavioral Research and Teaching*, University of Oregon.

Alvermann, D. E., Unrau, N. J., & Ruddell, R. B. (2013). *Theoretical models and processes of reading* (Vol. 978): International Reading Assoc.

Anderson, R. C. (1977). The notion of schemata and the educational enterprise: General discussion of the conference *Schooling and the Acquisition of Knowledge*: Lawrence Erlbaum.

Barlow, D. H., & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis, 12*(2), 199-210.

Beeson, P. M., & Robey, R. R. (2006). Evaluating single-subject treatment research: Lessons learned from the aphasia literature. *Neuropsychology Review, 16*(4), 161-169. doi:10.1007/s11065-006-9013-7

Berkeley, S., Scruggs, T. E., & Mastropieri, M. A. (2010). Reading Comprehension Instruction for Students With Learning Disabilities, 1995-2006: A Meta-Analysis. *Remedial and Special Education, 31*(6), 423-436. doi:10.1177/0741932509355988

Blood, E., Johnson, J. W., Ridenour, L., Simmons, K., & Crouch, S. (2011). Using an iPod touch to teach social and self-management skills to an elementary student with emotional/behavioral disorders. *Education and Treatment of Children, 34*(3), 299-321.

Boulineau, T., Fore, C., Hagan-Burke, S., & Burke, M. D. (2004). Use of story-mapping to increase the story-grammar text comprehension of elementary students with learning disabilities. *Learning Disability Quarterly, 27*(2), 105-121. doi:10.2307/1593645

Bowey, J. A., & Francis, J. (1991). Phonolog- ical analysis as a function of age and ex- posure to reading instruction. *Applied Psycholinguistics, 12*, 91-121.

Brenner, J. (2013). Pew Internet: Mobile. Retrieved from http://pewinternet.org/Commentary/2012/February/Pew-Internet-Mobile.aspx

Burke, R. V., Andersen, M. N., Bowen, S. L., Howard, M. R., & Allen, K. D. (2010). Evaluation of two instruction methods to increase employment options for young adults with autism spectrum disorders. *Research in Developmental Disabilities, 31*(6), 1223-1233. doi:10.1016/j.ridd.2010.07.023

Cain, K. (1996). Story knowledge and comprehension skill. In C. Cornoldi & J. V. Oakhill (Eds.), *Reading Comprehension Difficulties: Processes and Intervention* (pp. 167-192). Mahwah, NJ: Lawrence Erlbaum Associates.

Carrell, P. L., & Eisterhold, J. C. (1983). Schema Theory And Esl Reading Pedagogy. *Tesol Quarterly, 17*(4), 553-573. doi:10.2307/3586613

Cartwright, K. (2009). The role of cognitive flexibility in reading comprehension: Past, present, and future. In S. E. Israel & G. G. Duffy (Eds.), *Handbook of research on reading comprehension* (pp. 115-139). New York, NY: Routledge.

Chan, L. K., Cole, P. G., & Barfett, S. (1987). Comprehension monitoring: Detection and identification of text inconsistencies by LD and normal students. *Learning Disability Quarterly, 10*(2), 114-124.

Chard, D. J., Ketterlin-Geller, L. R., Baker, S. K., Doabler, C., & Apichatabutra, C. (2009). Repeated Reading Interventions for Students With Learning Disabilities: Status of the Evidence. *Exceptional Children, 75*(3), 263-281.

Chard, D. J., Vaughn, S., & Tyler, B. J. (2002). A synthesis of research on effective interventions for building reading fluency with elementary students with learning disabilities. *Journal of Learning Disabilities, 35*(5), 386-406. doi:10.1177/00222194020350050101

Cihak, D., Fahrenkrog, C., Ayres, K. M., & Smith, C. (2010). The Use of Video Modeling via a Video iPod and a System of Least Prompts to Improve Transitional Behaviors for Students with Autism Spectrum Disorders in the General Education Classroom. *Journal of Positive Behavior Interventions, 12*(2), 103-115. doi:10.1177/1098300709332346

Connell, C., Bayliss, L., & Farmer, W. (2012). Effects of eBook Readers and Tablet Computers on Reading Comprehension. *International Journal of Instructional Media, 39*(2), 131-140.

Cooper, J., Heron, T., & Heward, W. (2007). Applied Behavior Analysis. Upper Saddle River, NJ: Pearson.

Cumming, T. M., Strnadova, I., & Singh, S. (2014). iPads as instructional tools to enhance learning opportunities for students with developmental disabilities: An action research project. *Action Research, 12*(2), 151-176. doi:10.1177/1476750314525480

Cunningham, P. M., & Allington, R. L. (2007). *Classrooms that Work: They Can All Read and Write*. Boston, MA: Pearson/Allyn and Bacon.

Davey, B., & McBride, S. (1986). Effects of question-generation training on reading comprehension. *Journal of Educational Psychology, 78*(4), 256-262. doi:10.1037/0022-0663.78.4.256

Denckla, M. B., Barouero, L. A., Linosrrom, E. R., Benedict, S. l., Wilson, L. M., & Cutting, L. E. (2013). Attention-deficit/hyperactivity disorder, executive function, and reading comprehension. In H. L. Swanson, H. K. R., & S. Graham (Eds.), *Handbook of Learning Disabilities* (pp. 155-168). New York, NY: Guilford Press.

Fasting*, R. B., & Halaas Lyster, S. A. (2005). The effects of computer technology in assisting the development of literacy in young struggling readers and spellers. *European Journal of Special Needs Education, 20*(1), 21-40.

Felton, R. H. (1993). Effects of instruction on the decoding skills of children with phonological-processing problems. *Journal of Learning Disabilities, 26*(9), 583-589.

Fernandez-Lopez, A., Jose Rodriguez-Fortiz, M., Luisa Rodriguez-Almendros, M., & Jose Martinez-Segura, M. (2013). Mobile learning technology based on iOS devices to support students with special education needs. *Computers & Education, 61*, 77-90. doi:10.1016/j.compedu.2012.09.014

Flesch, R. (1948). A new readability yardstick. *Journal of applied psychology, 32*(3), 221.

Fletcher, J. M., Stuebing, K. K., Morris, R. D., & Lyon, G. R. (2013). Classification and definition of learning disabilities: A hybrid model. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 33-50). New York, NY: Guilford Press.

Flood, J., Lapp, D., & Fisher, D. (2002). Parsing, Question, and Rephrasing (PQR) Building Syntactic Knowledge to Improve Reading Comprehension. In C. C. Block, Gambrell, L. B., & Pressley, M. (Ed.), *improving comprehension instruction: Rethinking research, theory, and classroom practice.* (1st ed., pp. 181-198). San Francisco, CA: Jossey-Bass.

Foorman, B. R., & Torgesen, J. (2001). Critical elements of classroom and small‐group instruction promote reading success in all children. *Learning Disabilities Research & Practice, 16*(4), 203-212.

Freeland, J. T., Skinner, C. H., Jackson, B., McDaniel, C. E., & Smith, S. (2000). Measuring and increasing silent reading comprehension rates: Empirically validating a repeated readings intervention. *Psychology in the Schools, 37*(5), 415-429. doi:10.1002/1520-6807(200009)37:5<415::aid-pits2>3.0.co;2-l

Fuchs, D., Fuchs, L. S., Mathes, P. G., Lipsey, M. W., & Roberts, P. H. (2001). *Is" Learning Disabilities" Just a Fancy Term for Low Achievement? A Meta-Analysis of Reading Differences between Low Achievers with and without the Label. Executive summary*. Paper presented at the Learning Disabilities Summit: Building a Foundation for the Future, Washington, DC.

Gajria, M., Jitendra, A. K., Sood, S., & Sacks, G. (2007). Improving comprehension of expository text in students with LD: A research synthesis. *Journal of Learning Disabilities, 40*(3), 210-225. doi:10.1177/00222194070400030301

Gavelek, J., & Bresnahan, P. (2009). Ways of meaning making: Sociocultural perspectives on reading comprehension. In S. E. Israel, & Duffy, G. G. (Ed.), *Handbook of research on reading comprehension* (pp. 140-176). New York, NY: Routledge.

Gersten, R., Fuchs, L. S., Williams, J. P., & Baker, S. (2001). Teaching Reading Comprehension Strategies to Students with Learning Disabilities: A Review of Research. *Review of Educational Research, 71*(2), 279-320.

Gough, P. B. (1972). One second of reading. *Visible Language, 6*(4), 291-320.

Gough, P. B. (1996). How children learn to read and why they fail. *Annals of Dyslexia, 46*(1), 1-20.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6-10.

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*(3), 445-476.

Griffey, Q. L., Zigmond, N., & Leinhardt, G. (1988). The effects of self-questioning and story structure training on the reading comprehension of poor readers. *Learning Disabilities Research, 4*, 45-15.

Gross, M. T. (1997). The Need for Replication Studies—Is It Really a Done Deal? *Journal of Orthopaedic & Sports Physical Therapy, 25*(3), 161-162.

Gulchak, D. J. (2008). Using a mobile handheld computer to teach a student with an emotional and behavioral disorder to self-monitor attention. *Education and Treatment of Children, 31*(4), 567-581.

Hagtvet, B. E. (2003). Listening comprehension and reading comprehension in poor decoders: Evidence for the importance of syntactic and semantic skills as well as phonological skills. *Reading and Writing, 16*(6), 505-539.

Hall, T. E., Hughes, C. A., & Filbert, M. (2000). Computer assisted instruction in reading for students with learning disabilities: A research synthesis. *Education and Treatment of Children, 23*, 173-193.

Hammond, D. L., Whatley, A. D., Ayres, K. M., & Gast, D. L. (2010). Effectiveness of video modeling to teach iPod use to students with moderate intellectual disabilities. *Education and Training in Autism and Developmental Disabilities, 45*, 525-538.

Hasbrouck, J., & Tindal, G. A. (2006). Oral reading fluency norms: A valuable assessment tool for reading teachers. *Reading Teacher, 59*(7), 636-644. doi:10.1598/RT.59.7.3

Haydon, T., Hawkins, R., Denune, H., Kimener, L., McCoy, D., & Basham, J. (2012). A Comparison of iPads and Worksheets on Math Skills of High School Students with Emotional Disturbance. *Behavioral Disorders, 37*(4), 232-243.

Hernandez, D. J. (2011). *Double Jeopardy: How Third-Grade Reading Skills and Poverty Influence High School Graduation*. Retrieved from New York, NY:

Herr, C. M., & Bateman, B. D. (2013). Learning disabilities and the law. In H. L. Swanson, H. K. R., & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 51-68). York, NY: Guilford Press.

Higgins, E. L., & Raskind, M. H. (2000). Speaking to read: The effects of continuous vs. discrete speech recognition systems on the reading and spelling of children with learning disabilities. *Journal of Special Education Technology, 15*(1), 19.

Higgins, E. L., & Raskind, M. H. (2004). Speech Recognition-based and Automaticity Programs to help students with severe reading and spelling problems. *Annals of Dyslexia, 54*(2), 365-392. doi:10.1007/s11881-004-0017-9

Higgins, E. L., & Raskind, M. H. (2005). The compensatory effectiveness of the Quicktionary Reading Pen II on the reading comprehension of students with learning disabilities. *Journal of Special Education Technology, 20*(1), 31.

Hitchcock, C. H., Prater, M. A., & Dowrick, P. W. (2004). Reading comprehension and fluency: Examining the effects of tutoring and video self-modeling on first-grade students with reading difficulties. *Learning Disability Quarterly, 27*(2), 89-103. doi:10.2307/1593644

Hitchcock, J., author, Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *SINGLE ‐ CASE DESIGN TECHNICAL DOCUMENTATION*. Retrieved from

Hoffman, J. V. (2009). In search of the "simple view" of reading comprehension. In S. E. Israel, & Duffy, G. G. (Ed.), *Handbook of research on reading comprehension* (pp. 54-66). New Youk, NY: Routledge.

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing, 2*(2), 127-160.

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165-179.

Hosp, J. L., & Suchey, N. (2014). Reading assessment: reading fluency, reading fluently, and comprehension--commentary on the special topic. *School Psychology Review, 43*(1), 59-69.

Hua, Y., Hendrickson, J. M., Therrien, W. J., Woods-Groves, S., Ries, P. S., & Shaw, J. J. (2012). Effects of combined reading and question generation on reading fluency and comprehension of three young adults with autism and intellectual disability. *Focus on Autism and Other Developmental Disabilities, 27*(3), 135-146. doi:10.1177/1088357612448421

Hulme, C., & Snowling, M. J. (2011). Children's reading comprehension difficulties nature, causes, and treatments. *Current Directions in Psychological Science, 20*(3), 139-142.

Institute of Education Sciences. (2009). *Educational technology.* Retrieved from http://nces.ed.gov/fastfacts/display.asp?id=46

Jimenez, J. E., Ortiz, M. D., Rodrigo, M., Hernandez-Valle, I., Ramirez, G., Estevez, A., . . . Trabaue, M. D. (2003). Do the effects of computer-assisted practice differ for children with reading disabilities with and without IQ-achievement discrepancy? *Journal of Learning Disabilities, 36*(1), 34-47. doi:10.1177/00222194030360010501

Jitendra, A. K., Burgess, C., & Gajria, M. (2011). Cognitive strategy instruction for improving expository text comprehension of students with learning disabilities: The quality of evidence. *Exceptional Children, 77*(2), 135-159.

Jitendra, A. K., Edwards, L. L., Sacks, G., & Jacobson, L. A. (2004). What research says about vocabulary instruction for students with learning disabilities. *Exceptional Children, 70*(3), 299-322.

Kagohara, D. M. (2011). Three students with developmental disabilities learn to operate an iPod to access age-appropriate entertainment videos. *Journal of Behavioral Education, 20*(1), 33-43.

Kagohara, D. M., Sigafoos, J., Achmadi, D., O'Reilly, M., & Lancioni, G. (2012). Teaching children with autism spectrum disorders to check the spelling of words. *Research in Autism Spectrum Disorders, 6*(1), 304-310. doi:10.1016/j.rasd.2011.05.012

Kagohara, D. M., Sigafoos, J., Achmadi, D., van der Meer, L., O'Reilly, M. F., & Lancioni, G. E. (2011). Teaching students with developmental disabilities to operate an iPod Touch® to listen to music. *Research in Developmental Disabilities, 32*(6), 2987-2992.

Kagohara, D. M., van der Meer, L., Achmadi, D., Green, V. A., O'Reilly, M. F., Lancioni, G. E., . . . Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech-generating devices. *Research in Autism Spectrum Disorders, 6*(3), 1224-1233. doi:10.1016/j.rasd.2012.04.001

Kagohara, D. M., van der Meer, L., Achmadi, D., Green, V. A., O'Reilly, M. F., Mulloy, A., . . . Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. *Clinical Case Studies, 9*(5), 328-338.

Kagohara, D. M., van der Meer, L., Ramdoss, S., O'Reilly, M. F., Lancioni, G. E., Davis, T. N., . . . Sigafoos, J. (2013). Using iPods (R) and iPads (R) in teaching programs for individuals with developmental disabilities: A systematic review. *Research in Developmental Disabilities, 34*(1), 147-156. doi:10.1016/j.ridd.2012.07.027

Kameenui, E. J., & Carnine, D. W. (2002). *Effective teaching strategies that accommodate diverse learners* (2nd ed.). Des Moines, IA: Prentice-Hall Inc.

Kaufman, A. S., & Kaufman, N. L. (1985). *Kaufman test for Educational achievement.* Circle Pines, MN: American Guidance Service.

Kavale, K. A., & Reese, J. H. (1992). The character of learning disabilities: An Iowa profile. *Learning Disability Quarterly, 15*(2), 74-94.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings*: Oxford University Press.

Kennedy, C. H. (2005). *Single-case designs for educational research*. Boston, MA: Pearson/A & B.

Kim, A.-H., Vaughn, S., Klingner, J. K., Woodruff, A. L., Reutebuch, C. K., & Kouzekanani, K. (2006). Improving the reading comprehension of middle school students with disabilities through Computer-Assisted Collaborative Strategic Reading. *Remedial and Special Education, 27*(4), 235-249. doi:10.1177/07419325060270040401

Klingner, J. K., Vaughn, S., Hughes, M. T., Schumm, J. S., & Elbaum, B. (1998). Outcomes for students with and without learning disabilities in inclusive classrooms. *Learning Disabilities Research & Practice, 13*(3), 153-161.

Kratochwill, T. R., & Levin, J. R. (1992). *Single-case research design and analysis : new directions for psychology and education*. Hillsdale, NJ: Lawrence Erlbaum Associates.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive psychology, 6*(2), 293-323.

Labov, W. (1973). *Sociolinguistic patterns*. Philadelphia, PN: University of Pennsylvania Press.

Larson, L. C. (2010). Digital Readers: The Next Chapter in E-Book Reading and Response. *Reading Teacher, 64*(1), 15-22. doi:10.1598/rt.64.1.2

Le Ber, J. M., Lombardo, N. T., Honisett, A., Jones, P. S., & Weber, A. (2013). Assessing user preferences for e-readers and tablets. *Medical reference services quarterly, 32*(1), 1-11.

Lyon, G. R., & Weiser, B. (2013). The State of the Science in Learning Disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 118-154). New York, NY: Guilford press.

MacArthur, C. A., & Haynes, J. B. (1995). Student Assistant for Learning from Text (SALT) A Hypermedia Reading Aid. *Journal of Learning Disabilities, 28*(3), 150-159.

Malone, L. D., & Mastropieri, M. A. (1992). Reading comprehension instruction: Summarization and self-monitoring training for students with learning disabilities. *Exceptional Children, 58*(3), 270-279.

Mastropieri, M. A., Leinart, A., & Scruggs, T. E. (1999). Strategies to increase reading fluency. *Intervention in school and clinic, 34*(5), 278-283.

Meyer, M. S., & Felton, R. H. (1999). Repeated reading to enhance fluency: Old approaches and new directions. *Annals of Dyslexia, 49*, 283-306. doi:10.1007/s11881-999-0027-8

Mokhtari, K., & Thompson, H. B. (2006). How problems of reading fluency and comprehension are related to difficulties in syntactic awareness skills among fifth graders. *Literacy Research and Instruction, 46*(1), 73-94.

Moorman, A., Boon, R. T., Keller-Bell, Y., Stagliano, C., & Jeffs, T. (2010). Effects of Text-to-Speech Software on the Reading Rate and Comprehension Skills of High School Students with Specific Learning Disabilities. *Learning Disabilities: A Multidisciplinary Journal, 16*(1), 41-49.

National Center for Education Statistics. (2014). *Children and Youth with Disabilities.* Retrieved from http://nces.ed.gov/programs/coe/indicator_cgg.asp

National Center for Learning Disabilities. (2014a). *Learning Disability Fast Facts.* Retrieved from http://www.ncld.org/types-learning-disabilities/what-is-ld/learning-disability-fast-facts

National Center for Learning Disabilities. (2014b). *Learning Disability Fast Facts.* Retrieved from http://www.ncld.org/types-learning-disabilities/what-is-ld/learning-disability-fast-facts

National Center for Learning Disabilities. (2014c). *A High School Diploma Matters for Students with LD.* Retrieved from http://ncld.org/ld-insights/blogs/a-high-school-diploma-matters-for-students-with-ld

National Reading Panel. (2000). *Report of the national reading panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups.*

O'Connor, R. E., White, A., & Swanson, H. L. (2007). Repeated reading versus continuous reading: Influences on reading fluency and comprehension. *Exceptional Children, 74*(1), 31-46.

Okolo, M. C., & Ferretti, P. R. (2013). History instruction for students with learning disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 448-462). New York, NY: The Guilford Press.

Paris, S. G., & Hamilton, E. E. (2009). The development of children's reading comprehension. In S. E. Israel & G. G. Duffy (Eds.), *Handbook of research on reading comprehension* (pp. 32-53). New York, NY: Routledge.

Patten, K. B., & Craig, D. V. (2007). e-Literacy and Literacy: iPods, Popular Culture, and Language Learning. *International journal of the Book, 4*, 69-74.

Pearson, P. D., & Dole, J. A. (1987). Explicit comprehension instruction: A review of research and a new conceptualization of instruction. *The Elementary School Journal, 88,* 151-165.

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22-37.

Petersen, D. B., Gillam, S. L., & Gillam, R. B. (2008). Emerging procedures in narrative assessment: The Index of Narrative Complexity. *Topics in Language Disorders, 28*(2), 115-130.

Pew Research Center. (2014). *Mobile Technology Fact Sheet.* Retrieved from http://pewinternet.org/Commentary/2012/February/Pew-Internet-Mobile.aspx

Phakiti, A. (2003). A closer look at the relationship of cognitive and metacognitive strategy use to EFL reading achievement test performance. *Language testing, 20*(1), 26-56.

Pollock, D. E. (2012). e-Readers, Our Readers, and Electronic Collections: A Pilot Study at a National Laboratory Library. *Serials Review, 38*(3), 188-193.

Project Tomorrow. (2015). *From chalkboards to tablets: The digital conversion of the K-12 classroom.* Retrieved from http://www.tomorrow.org/speakup/2014_OnlineLearningReport.html

Rakap, S. (2015). Effect sizes as result interpretation aids in single-subject experimental research: description and application of four nonoverlap methods. *British Journal of Special Education, 42*(1), 11-33. doi:10.1111/1467-8578.12091

Reutzel, D., & Cooter, R. (2013). Bottom-Up Theories of the Reading Process. Retrieved from http://www.education.com/reference/article/bottom-up-theories-reading-process/

Rivera, D. P. E. (1997). Mathematics education and students with learning disabilities: Introduction to the special series. *Journal of Learning Disabilities, 30,* 2-19.

Rosenshine, B. (1995). Advances in research on instruction. *The Journal of educational research, 88*(5), 262-268.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of the intervention studies. *Review of Educational Research, 66*(2), 181-221.

Rosenthal, R. (1990). Replication in Behavioral Research. *Journal of Social Behavior and Personality, 5*(4), 1-30.

Rupley, W. H., Blair, T. R., & Nichols, W. D. (2009). Effective reading instruction for struggling readers: The role of direct/explicit teaching. *Reading & Writing Quarterly, 25*(2-3), 125-138.

Schirmer, B. R., Schaffer, L., Therrien, W. J., & Schirmer, T. N. (2012). REREAD-ADAPT AND ANSWER-COMPREHEND INTERVENTION WITH DEAF AND HARD OF HEARING READERS: EFFECT ON FLUENCY AND READING ACHIEVEMENT. *American Annals of the Deaf, 156*(5), 469-475.

Scruggs, T. E. (2013). Science and social studies education for students with learning disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 448-462). New York, NY: The Guilford Press.

Scruggs, T. E., Bennion, K., & Lifson, S. (1985). Learning disabled students' spontaneous use of test-taking skills on reading achievement tests. *Learning Disability Quarterly, 8*(3), 205-210.

Siegel, L. S., & Mazabel, S. (2013). Basic cognitive processes and reading disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 158-181).

Solis, M., Ciullo, S., Vaughn, S., Pyle, N., Hassaram, B., & Leroux, A. (2011). Reading comprehension interventions for middle school students with learning disabilities: A synthesis of 30 years of research. *Journal of Learning Disabilities, 45*, 1-15.

Sorrell, C. A., Bell, S. M., & McCallum, R. S. (2007). Reading rate and comprehension as a function of computerized versus traditional presentation mode: A preliminary study. *Journal of Special Education Technology, 22*(1), 1-12.

Stagliano, C., & Boon, R. T. (2009). The Effects of a Story-Mapping Procedure to Improve the Comprehension Skills of Expository Text Passages for Elementary Students with Learning Disabilities. *Learning Disabilities: A Contemporary Journal, 7*(2), 35-58.

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader The phonological-core variable-difference model. *Journal of Learning Disabilities, 21*(10), 590-604.

Stetter, M. E., & Hughes, M. T. (2010). Computer-assisted instruction to enhance the reading comprehension of struggling readers: A review of the literature. *Journal of Special Education Technology, 25*(4), 1-16.

Stevens, R. J., & Slavin, R. E. (1995). Effects of a cooperative learning approach in reading and writing on academically handicapped and nonhandicapped students. *The Elementary School Journal, 95*, 241-262.

Stodden, R. A., Roberts, K. D., Takahashi, K., Park, H. J., & Stodden, N. J. (2012). Use of text-to-speech software to improve reading skills of high school struggling readers. *Procedia Computer Science, 14*, 359-362. doi:10.1016/j.procs.2012.10.041

Swanson, H. L. (1999). *Interventions for students with learning disabilities: A meta-analysis of treatment outcomes*. New York, NY: Guilford Press.

Swanson, H. L., Harris, K. R., & Graham, S. (2013). Overview of foundations, causes, instruction, and methodology in the field of learning disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities,* (pp. 3-14). New York, NY: Guilford Press.

Swanson, H. L., & Sachse-Lee, C. (2000). A meta-analysis of single-subject-design intervention research for students with LD. *Journal of Learning Disabilities, 33*(2), 114-136.

Swanson, H. L., & Zheng, X. (2013). Memory difficulties in children and adults with learning disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 214-238). New York, NY: Guilford Press.

Taylor, L. K., Alber, S. R., & Walker, D. W. (2002). The comparative effects of a modified self-questioning strategy and story mapping on the reading comprehension of elementary students with learning disabilities. *Journal of Behavioral Education, 11*(2), 69-87.

Therrien, W. J. (2004). Fluency and comprehension gains as a result of repeated reading - A meta-analysis. *Remedial and Special Education, 25*(4), 252-261. doi:10.1177/07419325040250040801

Therrien, W. J., & Budin, S. G. (2008). Effects of the Reread-Adapt and Answer-Comprehend (RAAC) Intervention on the Reading Achievement of Students with Reading and Behavioral Difficulties. *Learning Disabilities: A Multidisciplinary Journal, 15*(1), 33-38.

Therrien, W. J., & Hughes, C. (2008). Comparison of Repeated Reading and Question Generation on Students' Reading Fluency and Comprehension. *Learning Disabilities: A Contemporary Journal, 6*(1), 1-16.

Therrien, W. J., Kirk, J. F., & Woods-Groves, S. (2012). Comparison of a Reading Fluency Intervention With and Without Passage Repetition on Reading Achievement. *Remedial and Special Education, 33*(5), 309-319. doi:10.1177/0741932511410360

Therrien, W. J., Wickstrom, K., & Jones, K. (2006). Effect of a Combined Repeated Reading and Question Generation Intervention on Reading Achievement. *Learning Disabilities Research & Practice, 21*(2), 89-97. doi:10.1111/j.1540-5826.2006.00209.x

Torgesen, J. K., Alexander, A. W., Wagner, R. K., Rashotte, C. A., Voeller, K. K., & Conway, T. (2001). Intensive remedial instruction for children with severe reading disabilities immediate and long-term outcomes from two instructional approaches. *Journal of Learning Disabilities, 34*(1), 33-58.

van der Meer, L., Didden, R., Sutherland, D., O'Reilly, M. F., Lancioni, G. E., & Sigafoos, J. (2012). Comparing three augmentative and alternative communication modes for children with developmental disabilities. *Journal of Developmental and Physical Disabilities, 24*(5), 451-468.

van der Meer, L., Kagohara, D. M., Achmadi, D., Green, V. A., Herrington, C., Sigafoos, J., . . . Rispoli, M. (2011). Teaching functional use of an iPod-based speech-generating device to individuals with developmental disabilities. *Journal of Special Education Technology, 26*(3), 1-11.

van der Meer, L., Sutherland, D., O'Reilly, M. F., Lancioni, G. E., & Sigafoos, J. (2012). A further comparison of manual signing, picture exchange, and speech-generating devices as communication modes for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*(4), 1247-1257.

Van Laarhoven, T., Johnson, J. W., Van Laarhoven-Myers, T., Grider, K. L., & Grider, K. M. (2009). The effectiveness of using a video iPod as a prompting device in employment settings. *Journal of Behavioral Education, 18*(2), 119-141.

Vaughn, S., Levy, S., Coleman, M., & Bos, C. S. (2002). Reading instruction for students with LD and EBD: A synthesis of observation studies. *Journal of Special Education, 36*(1), 2-13. doi:10.1177/00224669020360010101

Vaughn, S., Swanson, E., & Solis, M. (2013). Reading comprehension for adolescents with significant reading problems. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 375-387). New Youk, NY: Guilford press.

Wade, E., Boon, R. T., & Spencer, V. G. (2010). Use of Kidspiration [C] Software to Enhance the Reading Comprehension of Story Grammar Components for Elementary-Age Students with Specific Learning Disabilities. *Learning Disabilities: A Contemporary Journal, 8*(2), 31-41.

Wiederholt, J. L., & Bryant, B. R. (2001). *Gray oral reading test 4th edition (GORT-4)*. Austin, TX: Pro-Ed.

Wong, B. Y., & Jones, W. (1982). Increasing metacomprehension in learning disabled and normally achieving students through self-questioning training. *Learning Disability Quarterly, 5*(3), 228-240.

Wong, B. Y., Wong, R., Perry, N., & Sawatsky, D. (1986). The efficacy of a self-questioning summarization strategy for use by underachievers and learning disabled adolescents in social studies. *Learning Disabilities Focus, 2*, 20–35.

Xin, J. F., & Rieth, H. (2001). Video-assisted vocabulary instruction for elementary school students with learning disabilities. *Information Technology in Childhood Education Annual*, *1*, 87-104.

APPENDIX A BASELINE (NO INTERVENTION)

1. **Reading**
    a. Give a passage to the student.
    b. Tutor: "*Read this story the best you can. Pay attention to what you are reading, as you will need to answer some questions. If you get stuck, I will tell you the word so you can keep reading. Start here.* [Point to the first word of the passage]. *Begin."*
    c. Start your timer when the student says the first word of the passage.
    d. As the student reads along in the text, the tutor records any errors by making a slash (/) through the incorrectly read word. (In the tutor copy)
    e. After the student finishes the last word of the passage, stop the timer.
    f. Write down the finish time. (You only ask the student to read the passage ONCE**.**
    g. If the student does not say the initial word within 3 seconds, the tutor says the word and starts the timer.
    h. If the student hesitates for 3 seconds on any word, the tutor says the word and marks it as an error.
2. **Asking**
    a. Take away the passage from the student.
    b. Ask the student to retell. "*Tell me everything you can remember about what you just read. Before you start I want you to say your name."* (Record)
    c. The first time the student does not say anything for 3 seconds, say, "try to tell me everything you can." This prompt can be used only ONCE.
    d. If the student does not say anything or gets off track for 5 seconds, say, "STOP".
    e. Turn the page and ask the comprehension questions. *"Based on what the story said, what do you think the answer might be?"*
    f. Read the questions and write down the answers.
    g. If the student does not say anything or gets off track for 5 seconds, mark it as an error. And ask the next question.
    h. If the student asks the tutor to repeat the question, the tutor may repeat the question once.
    i. After the last question, tutor gives general praise and thanks the student. *"You did a good job! Thank you for working so hard!"*
3. **Scoring:**
    a. Words read correctly are scored as correct:
        - Self-corrected with in 3 seconds words are counted as correct
        - Repetitions are counted as correct.
        - Examples of dialectical speech are counted as correct
        - Inserted words are ignored
    - Words read correctly are scored as correct:
        - Mispronunciations are counted as errors. (small vs. *smill*)
        - Substitutions are counted as errors (returned to the house vs. *returned to the home*)
        - Omissions are counted as errors (compete in the last race vs. *compete the last race*).

- Transpositions of word-pairs are counted as 1 error. (Shining bright face vs. *bright shining face*)
- Words read to the student by the tutor after 3 seconds have gone by are counted as error.

APPENDIX B RAAC INTERVENTION

1. **Prompting**
    a. Give student the cue card and have him/her read cue card questions aloud. *"Before you read the story, I want you to read these questions."*
    b. After the student finish reading, take the cue card questions away.
2. **Reading for the first time**
    a. Give a passage to the student
    b. Tutor "*Read this story the best you can. Pay attention to what you are reading, as you will need to answer these questions. If you get stuck, I will tell you the word so you can keep reading. Start here.* [Point to the first word of the passage]. *Begin."*
    c. Start your timer when the student says the first word of the passage.
    d. As the student reads along in the text, the tutor records any errors by making a slash (/) through the incorrectly read word. (in the tutor copy)
    e. After the student finishes the last word of the passage, stop the timer.
    f. Write down the finish time.
    g. If the student does not say the initial word within 3 seconds, the tutor says the word and starts the timer.
    h. During reading, if the student hesitates for 3 seconds on any word, the tutor says the word and marks it as an error.
    i. Use this model: Tutor: "This word is _____", Tutor: "What word?"
3. **Reading for the second time**
    a. Ask the student to read the same passage again for the second time "
    b. Follow the same steps above from b – i
4. **Reading for the third time**
    a. Ask the student to read the same passage again for the third time "
    b. Follow the same steps above from b – i
5. **Adapt and Answer**
    a. Give the cue card questions to the students again
    b. Ask the student to read the questions and answer them
        i. No answer / incorrect answer **1st** time: Prompt student to look for information in the passage. "*See if you can find the answer in the passage."*
        ii. No answer / incorrect answer **2nd** time: "*See if you can find the answer in this sentence."*
        iii. No answer / incorrect answer **3rd** time: Provide answer and point to where you found the answer.
    c. Take away the passage and the cur card from the student.
6. **Passage retell**
    a. Ask the student to retell. "*Tell me everything you can remember about what you just read. Make sure you include this information when you tell me the story. Before you start I want you to say your name."* (Record)
    b. The first time the student does not say anything for 3 seconds, say, "try to tell me everything you can." This prompt can be used only ONCE.
    c. If the student does not say anything or gets off track for 5 seconds, say, "STOP".

7. **Ask comprehension questions and record answers.**
    a. Ask the comprehension questions. *"Based on what the story said, what do you think the answer might be?"*
    b. Read the questions and write down the answers.
    c. If the student does not say anything or gets off track for 5 seconds, mark it as an error. And ask the next question.
    d. If the student asks the tutor to repeat the question, the tutor may repeat the question once.
    e. After the last question, tutor gives general praise and thanks the student. *"You did a good job! Thank you for working so hard!"*
8. **Scoring:**
    b. Words read correctly are scored as correct:
        - Self-corrected with in 3 seconds words are counted as correct
        - Repetitions are counted as correct.
        - Examples of dialectical speech are counted as correct
        - Inserted words are ignored
    - Words read correctly are scored as correct:
        - Mispronunciations are counted as errors. (small vs. *smill*)
        - Substitutions are counted as errors (returned to the house vs. *returned to the home*)
        - Omissions are counted as errors (compete in the last race vs. *compete the last race*).
        - Transpositions of word-pairs are counted as 1 error. (Shining bright face vs. *bright shining face*)
        - Words read to the student by the tutor after 3 seconds have gone by are counted as error.

APPENDIX C TABLET INTERVENTION

1. **Prompting**
    a. Give the student the iPad with the five generic questions (cue card) presented on the screen. Have him/her read the questions aloud. *Before you listen to the story from this iPad, I want you to read these questions".*
    b. After the student read the questions, swipe the screen to the passage.
2. **Listening**
    a. Once the passage is presented on the screen, ask the student listen to the passage and follow along
    b. Tutor "*You will be listening to a passage from this iPad. Listen to this story and follow along the best you can. Pay attention to what you are listening, as you will need to answer these questions."* Click the reading bottom.
3. **Adapt and Answer**
    a. Swipe the screen again to the generic questions
    b. Ask the student to read the questions and answer them
        i. No answer / incorrect answer **1st** time: Prompt student to look for information in the passage. "*See if you can find the answer in the passage."*
        ii. No answer / incorrect answer **2nd** time: "*See if you can find the answer in this sentence."*
        iii. No answer / incorrect answer **3rd** time: Provide answer and point to where you found the answer.
    c. Take away the iPad from the student.
4. **Passage retell**
    a. Ask the student to retell. "*Tell me everything you can remember about what you just listen. Make sure you include this information when you tell me the story. Before you start I want you to say your name."* (Record)
    b. The first time the student does not say anything for 3 seconds, say, "try to tell me everything you can." This prompt can be used only ONCE.
    c. If the student does not say anything or gets off track for 5 seconds, say, "STOP".
5. **Ask comprehension questions and record answers.**
    a. Ask the comprehension questions. *"Based on what the story said, what do you think the answer might be?"*
    b. Read the questions and write down the answers.
    c. If the student does not say anything or gets off track for 5 seconds, mark it as an error. And ask the next question.
    d. If the student asks the tutor to repeat the question, the tutor may repeat the question once.
    e. After the last question, tutor gives general praise and thanks the student. *"You did a good job! Thank you for working so hard!"*

APPENDIX D INTEGRITY PROCEDURAL CHECKLIST (BASELINE)

	Student Name:	Date:	Session:	
1	Read the direction			
2	Student is ready.			
3	Start the stopwatch as soon as the student reads.			
4	Appropriate promoting/correction during reading.			
5	Stop the stopwatch as soon as the student finishes reading.			
6	Write down the finish time			
7	Take away the passage from the student			
8	Read the direction for passage retell			
9	Turn on the recorder			
10	Appropriate promoting during retell			
11	Read the direction for comprehension questions.			
12	Ask the comprehension questions.			
13	Write down student answers.			
14	Generic praise and thank the student.			

APPENDIX E INTEGRITY PROCEDURAL CHECKLIST (RAAC CONDITION)

	Student Name:	Date:	Session:	
1	Student is ready.			
2	Ask the student to read the question prompts.			
3	Student reads the question prompts.			
4	Read the direction			
5	Student is ready.			
6	Start the stopwatch as soon as the student reads.			
7	Appropriate promoting/correction during reading.			
8	Stop the stopwatch as soon as the student finishes reading.			
9	Write down the finish time			
10	Appropriate error correction.			
12	Have the student read the 2nd time.			
13	Student is ready.			
14	Start the stopwatch as soon as the student reads.			
15	Appropriate promoting/correction during reading.			
16	Stop the stopwatch as soon as the student finishes reading.			
17	Write down the finish time			
18	Appropriate error correction.			
20	Have the student read the 3rd time.			
21	Student is ready.			
22	Start the stopwatch as soon as the student reads.			
23	Appropriate promoting/correction during reading.			
24	Stop the stopwatch as soon as the student finishes reading.			
25	Write down the finish time			
26	Appropriate error correction.			
28	Ask the generic story grammar questions.			
29	Provide appropriate feedback/prompts.			
30	Take away the passage from the student			
31	Read the direction for passage retell			
32	Turn on the recorder			
33	Appropriate promoting during retell			
34	Read the direction for comprehension questions.			
35	Ask the comprehension questions.			
36	Write down student answers.			
37	Generic praise and thank the student.			

APPENDIX F INTEGRITY PROCEDURAL CHECKLIST (TABLET CONDITION)

	Student Name:	Date:	Session:	
1	Student is ready.			
2	The teacher gives an iPad to the student			
3	Ask the student to read the question prompts on the iPad			
4	Student reads the question prompts			
5	Swipe the screen to the passage			
6	Student listens to the iPad reading.			
7	Swipe the screen back to the grammar questions.			
8	Ask the student to read the question on the iPad and answer them			
9	Provide appropriate feedback/prompts.			
10	Take away the iPad from the student			
11	Read the direction for passage retell			
12	Turn on the recorder			
13	Appropriate promoting during retell			
14	Read the direction for comprehension questions.			
15	Ask the comprehension questions.			
16	Write down student answers.			
17	Generic praise and thank the student.			