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Evaluation and Implementation of the C-Pen on the Reading Level, Comprehension, and Oral Reading Fluency of Third-Grade Students With Learning Disabilities: An Action Research Study

Kawanna McKenzie

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EVALUATION AND IMPLEMENTATION OF THE C-PEN ON THE READING LEVEL,
COMPREHENSION, AND ORAL READING FLUENCY OF THIRD-GRADE STUDENTS
WITH LEARNING DISABILITIES: AN ACTION RESEARCH STUDY

by

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DEDICATION

This work is dedicated to my family and friends for their unconditional love, support, encouragement, and belief in me while I wrote these chapters. I look forward to closing this remarkable chapter of my life and departing from my office/dining room table, the place where they would see me most.

First, to my mother, who has always been there for me. Next, to my son, for his patience throughout this entire journey. It seems as though I have been in school for most of his life. And finally, to my nieces, nephews, and friends who inspired and motivated me to keep going and not give up.

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Thanks to my district and school administrators for allowing me to conduct my research in our district. In addition, a special thanks to the teacher, student participants, and their families for their participation in my research.

Last, I humbly acknowledge all the students who inspired my study. They may never get to read what I have written, but I am proud to bring awareness to technology that can help them overcome their struggles with literacy.

ABSTRACT

Third-grade students with learning disabilities struggle to meet reading proficiency levels at both the national and local levels. The appropriate support, services, and instruction of students with learning disabilities can help them achieve reading proficiency. Specific educational laws have been implemented to enable students with learning disabilities to use assistive technologies such as text-to-speech tools to support their reading. The purpose of this action research study was to evaluate the impact of a text-to-speech tool—the C-Pen—on the reading skills of third-grade students with learning disabilities at an elementary/middle school. The focus of this study was on three main research questions and three sub-questions. The first question was designed to explore how the use of the C-Pen affected the reading of students with learning disabilities, with sub-questions to explore how providing the C-Pen affected the students' reading level, comprehension, and oral reading fluency. The second question was used to explore the perceptions of third-grade students with learning disabilities toward the use of the C-Pen to support their reading, and the third question was used to explore the third-grade teacher's perception of the C-Pen in supporting the reading of students with learning disabilities.

This action research study involved an innovation in which the C-Pen was provided to third-grade students with learning disabilities for 6 weeks in their general education classroom to support their reading. Data collection consisted of a standardized

pretest and posttest using the Developmental Reading Assessment-2, classroom observations, a teacher interview, and student interviews. Data were analyzed using a convergent parallel mixed methods design. Quantitative data were analyzed using descriptive statistics and qualitative data were analyzed using inductive analysis. Two themes emerged from the student interview data: the C-Pen allowed the students to develop reading skills that they could not develop without the C-Pen, and students demonstrated mixed perceptions about using the C-Pen to read. The teacher interview revealed two themes: the C-Pen had a positive impact on students' reading, and the teacher expressed positive perceptions about the C-Pen. The findings of this study show the implementation of the C-Pen had a positive impact on student reading level, comprehension, and oral reading fluency.

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LIST OF ABBREVIATIONS

ADA.....	Americans with Disabilities Act
CDC	Centers for Disease Control
COVID-19.....	Coronavirus Disease 2019
CTML	Cognitive Theory of Multimedia Learning
DRA2	Developmental Reading Assessment 2
ELA.....	English Language Arts
ESEA.....	Elementary and Secondary Education Act
ESSA.....	Every Student Succeeds Act
FAPE.....	Free Appropriate Public Education
IDEA.....	Individuals with Disabilities Education Act
IEP.....	Individual Education Plan
NAEP	National Assessment of Educational Progress
NCLB	No Child Left Behind
SC READY.....	South Carolina College-and-Career Ready Assessments
SCDE	South Carolina Department of Education
SEED.....	The Standards for Evaluation and Eligibility Determination
SLD	Specific Learning Disability
SLP.....	Speech-Language Pathologist
TTS	Text-to-Speech
WPM.....	Words per Minute

CHAPTER 1

INTRODUCTION

National Context

Reading is a multifaceted process and all readers have varying levels of skills and knowledge proficiency (National Accessible Reading Assessment Projects, 2006).

Determining elementary students' reading proficiency is a priority in the standards-based educational climate of accountability (Missall, Hosp, Hosp, & Meisinger, 2019). The importance of student accountability in recent revisions of the Elementary and Secondary Education Act (ESEA, 1965), notably the No Child Left Behind Act (NCLB, 2002) and the current Every Student Succeeds Act (ESSA, 2015), has put an emphasis on educational outcomes in the area of student reading proficiency (Missall et al., 2019).

Reading proficiency among third-grade students is problematic across the nation, as 74% of students perform below the proficiency level at the end of the school year (Lesaux, 2021). Although the focus has been on reading proficiency for decades, reading proficiency levels have remained a challenge for students in the third grade, especially for students with learning disabilities.

Many third-grade students with learning disabilities are at a low reading proficiency level and often face challenges in developing essential reading skills. According to the Nation's Report Card, 93% of students in the nation with learning disabilities were below the proficient reading level at the end of the 2018–2019 school year (National Assessment of Educational Progress, 2019). The ESSA mandates that all

students, including those with learning disabilities, reach standards and reading proficiency by the end of their grade level (Rodriguez, Amado, & Tarango, 2016). Within the standards-based system, the requirements do not change when students or groups of students do not meet the expected academic achievement level (Kauffman, Hallahan, & Pullen, 2017). Alternatively, for students with learning disabilities, changes can be made to the supports, services, and specialized instruction to ensure they meet expectations (Kauffman et al., 2017). Accountability systems for students with learning disabilities are aggregated on an individual student basis and regulated by an individual education plan (IEP), which serves as the accountability system for the delivery of supports, services, and specialized instruction. The aim is to ensure students with disabilities benefit from standards-based reforms and achieve high educational standards (Li, 2014).

Over the years, there has been an accountability model shift from NCLB to ESSA. Within this accountability model shift, students with learning disabilities who participate in standardized assessments are allowed to use test accommodations such as extended time, having the test items read aloud, or taking the test in a separate setting (Cawthon, Kaye, Lockhart, & Beretvas, 2012). Specific learning disabilities often affect how students perform on school assessments. With the increased emphasis on assessment results as an indicator of educational quality, the question of how to appropriately assess the performance of students with learning disabilities takes on new significance (Cawthon et al., 2012). Regulations about which accommodations are allowed on an assessment can depend on the context of the assessment (Schulte, Villwock, Whichard, & Stallings, 2001). An assessment is high-stakes if it is used to make decisions about student progress, such as whether the score is to be used for high school graduation or

college admission or to evaluate school effectiveness under the NCLB accountability reform (Schulte et al., 2001). In a system where scores carry such weight, the effect of accommodations on the accuracy of test scores, including the potential to over- or underestimate student proficiency, requires special consideration (Cawthon et al., 2012). Students with learning disabilities overcome the barriers and challenges by having equal opportunity.

The ESSA represents the nation's commitment to educational opportunities that are equitable for all students (Young, Winn, & Reedy, 2017). With that, the ESSA enables students with learning disabilities to use accommodations as appropriate (Thurlow & Larson, 2011). Accommodations are adaptations made to instruction, testing materials, or procedures that decrease barriers to access students' abilities rather than focusing on their disabilities (National Center on Educational Outcomes, 2018). Without accommodations, student abilities and knowledge may not be accurately measured (National Center on Educational Outcomes, 2018). It is challenging for some students with learning disabilities to show their knowledge and abilities in reading fluently, accurately, and with comprehension, primarily when their disabilities affect reading (Thurlow et al., 2009). This challenge is addressed by providing such students with accommodations to ensure they have equal access to instruction or assessment.

Accommodations are grouped into the following categories: presentation, response, setting, timing, and scheduling (National Center on Educational Outcomes, 2018). The type of accommodation most often researched is the read-aloud accommodation, which is in the presentation category. Read-aloud can be delivered in

various modes, including prerecorded audio, a human reader in an individual or group setting, or computerized text-to-speech (TTS; Buzick & Stone, 2014).

Technology can be provided as an accommodation for students with disabilities as authorized by the Assistive Technology Act of 1988, reauthorized in 1994, 1998, and 2004. Presently, students with learning disabilities can use assistive technologies in their classrooms as accommodations. It is clear technology has affected the lives of individuals with learning disabilities in the United States (Stumbo, Martin, & Hedrick, 2009), though there is little research on the impact of using these technologies during instruction for students with learning disabilities.

Local Context

In 2014, the South Carolina legislature passed the Read to Succeed Act, which outlines that by the end of the third grade, students will be able to read proficiently (RMC Research Corporation, 2017). In response to this act, named Act 284, educators at all of South Carolina's public schools are required to increase the reading proficiency of all students by the end of the third grade which is measured by the South Carolina College- and Career Ready Assessment (SC READY; South Carolina Department of Education [SCDE], 2017). The names of the school and participants included in this study are pseudonyms.

The need to improve the reading proficiency of third-grade students with learning disabilities at Eastview Elementary/Middle School (a pseudonym) is evidenced by the English language arts assessment (ELA) results on the 2017–2018 SC READY. See Appendix A for the ELA SC READY score ranges for third-grade students. A total of 21 students at the selected school were assessed within the disabled category with the ELA

SC READY state assessment and 66.7% of the students assessed did not meet expectations, 23.8% approached expectations, 4.8% met expectations, and 4.8% exceeded expectations. Appendix B contains the definitions of not meeting expectations, approaching expectations, meeting expectations, and exceeding expectations. There were 75 nondisabled students assessed, and 26.7% did not meet expectations, 37.3% approached expectations, 24.0% met expectations, and 12.0% exceeded expectations (SCDE, 2018). Table 1.1 shows the results of the 2017–2018 ELA SC READY for third-grade disabled students and nondisabled students from the selected school.

Table 1.1 *Third-Grade 2017–2018 ELA SC READY Results*

Demographics	Number tested	Does not meet expectations	Approaches expectations	Meets expectations	Exceeds expectations
Disabled	21	66.7%	23.8%	4.8%	4.8%
Nondisabled	75	26.7%	37.3%	24.0%	12.0%

The SC READY assessment results are used for state and federal accountability purposes (SCDE, 2018). According to the ESSA,

at the beginning of the 2017–2018 school year, a student must be retained in the third grade if the student fails to demonstrate reading proficiency at the end of the third grade as indicated by scoring at the lowest achievement level on the state reading assessment. (SCDE, 2018, p. 1)

The lowest achievement level is “does not meet expectations,” demonstrating the student does not meet the criteria for reading proficiency in the third grade. All students in third through eighth grades, including students with disabilities, must be administered the assessment, except those who qualify for the alternate testing as documented in their IEP

(SCDE, 2018). The achievement gap between students who have learning disabilities and nondisabled students is considerable, and the goal to close the gap is a desirable one.

Statement of the Problem

Third-grade students with learning disabilities need to improve their reading proficiency. On the 2017–2018 ELA SC READY state summative assessment, 66.7% of students with disabilities achieved the lowest level of achievement (i.e., does not meet expectations) compared to 26.7% of their nondisabled peers.

The effectiveness of the use of accommodations and types of accommodations for students with disabilities has been widely researched (Fletcher et al., 2009; Fuchs, Fuchs, & Capizzi, 2005; Meyer & Bouck, 2017; Rieck & Wadsworth, 2005; Schmitt, McCallum, Eale, Obeldobel, & Dingus, 2009). All students with learning disabilities are eligible to receive accommodations as deemed necessary (Individuals with Disabilities Education Act [IDEA], 2004). Accommodations are intended to measure what students know (Rieck & Wadsworth, 2005), which is why it is essential to understand the effects and consequences of different types of accommodations (McKevitt & Elliott, 2003). However, the accommodations received by students do not necessarily ensure academic success (Rieck & Wadsworth, 2005).

A human reader has provided read-aloud accommodations in the general education classrooms at Eastview Elementary/Middle School over the past 15 years. The use of assistive technology, such as TTS tools, as accommodations has not yet been included as a part of instruction for third-grade students with learning disabilities. The addition of assistive technology such as the C-Pen can be used to lower barriers and help improve the capabilities of students with learning disabilities. The problem addressed in

this study was how the use of the C-Pen would affect the reading skills of third-grade students with learning disabilities.

Purpose Statement

The purpose of this action research was to evaluate the impact of the C-Pen on the reading skills of third-grade students with learning disabilities at Eastview Elementary/Middle School.

Research Questions

The following questions guided this study:

1. How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?
 - a. How does the use of the C-Pen affect the reading level of third-grade students with learning disabilities?
 - b. How does the use of the C-Pen affect the reading comprehension of third-grade students with learning disabilities?
 - c. How does the use of the C-Pen affect the oral reading fluency of third-grade students with learning disabilities?
2. What are the perceptions of third-grade students with learning disabilities of the use of the C-Pen to support their reading?
3. What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?

Research Subjectivities and Positionality

I am currently the assistant principal in a rural public school, Eastview Elementary/Middle School, in South Carolina. I previously held the position of lead

speech-language pathologist (SLP) in the same school. As the lead SLP, I collaborated and worked closely with other special education teachers. During many discussions about students, I began to think critically about why students were not progressing in meeting grade-level academic standards. The students I shared with the special education teachers had common goals we worked on concurrently in the areas of phonological awareness, phonics, language, reading comprehension, and fluency. Students with various difficulties first prompted my interest in the doctor of education program in curriculum and instruction with a concentration in educational technology.

I chose to pursue the degree with a concentration in educational technology because of my school's one-to-one technology initiatives in almost all grade levels and the high demand for teachers to effectively incorporate technology within the core curriculum on a daily basis. Teachers at my school use the technology provided for students, which is usually a Chromebook or iPad. Students in the general education setting do not have access to other assistive technology tools such as the C-Pen. With more struggling readers being integrated into the general education classrooms and the increasingly prevalent use of education technology (Cheung & Slavin, 2013), I felt a sense of urgency to research the impact of the applications that can effect change for that population of students. Technology innovations are available to help students with special learning needs gain access to the curriculum and information and report their findings so they can keep pace with their grade-age peers (White & Robertson, 2015). The problem is students with learning disabilities are not demonstrating they can keep pace with their peers, even with technology and additional specialized instruction.

My philosophy is that all students can learn when given instruction that addresses their specific needs. The problem with instruction seems to be with making the connections students need to make learning outcomes transferable. I now know and have confidence that research can be used effectively and transferred to the school's everyday practices. With applicable research, teachers should have the freedom to choose the best method of instruction and practice to help students achieve their goals. This philosophy is supported by my view that researchers should have the freedom to choose the procedures, methods, and techniques that best align with their research (Creswell & Creswell, 2018). These beliefs are consistent with pragmatism, a philosophy based on the idea that theories can be generalizable and contextual by examining them for transferability to another situation (Shannon-Baker, 2016). The pragmatic researcher can maintain both subjectivity in how they reflect on research and objectivity in data collection and analysis (Shannon-Baker, 2016). As the researcher of this study with control over the type of innovation used, I allowed the teacher of the study to choose the students' activities and assignments that accompanied the innovation of the C-Pen.

Even though my work role has changed from that of SLP, I continue to understand the various difficulties students with learning disabilities possess when learning and using skills to read. I conducted my research as an insider and evaluated the impact of a TTS tool, the C-Pen, within the students' accommodations. From a pragmatic stance, I am aware of my beliefs and the nature of human knowledge and how knowledge is gathered throughout one's own experiences. As a researcher, I recognize the existence and importance of the physical world and the developing social and psychological world

that includes culture, human institutions, language, and subjective thoughts (Johnson & Onwuegbuzie, 2004).

Definition of Terms

Assistive technology. Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability (IDEA, 2004).

C-Pen. A portable and lightweight reading pen that can define single words and read printed sentences aloud with a human-like digital voice (Scanning Pens, n.d.).

Developmental Reading Assessment-2 (DRA2). A benchmark assessment designed to assess the reading ability of individuals from kindergarten through eighth grade (McCarty & Christ, 2010).

Learning disability. A discrepancy between an individual's ability and their achievement or performance (Lovett & Lewandowski, 2006).

Multiple-choice questions. Questions in which students are asked to select one alternative from a given set of alternatives in response to a question stem (Torres, Lopes, Babo, & Azevedo, 2011).

Open-ended questions. Questions with responses that do not have predefined answers, leaving the participants free to respond however they see fit (Walsh & Brinker, 2016).

Oral reading fluency. The oral translation (making meaningful connections) of a text with speed and accuracy (Fuchs, Fuchs, Hosp, & Jenkins, 2001).

Reading accuracy. The ability to read words without making a mistake (McCarty & Christ, 2010).

Reading comprehension. A student's ability to retell and understand a text, including the main ideas, key facts, and characters, events, or topics (McCarty & Christ, 2010).

Reading level. A student's oral reading fluency and comprehension at independent performance levels (McCarty & Christ, 2010).

Reading rate: The number of words read per minute (WPM; McCarty & Christ, 2010).

Test accommodations. Changes in standardized assessment conditions introduced to give students with learning disabilities the same opportunities as those without learning disabilities by removing the construct-irrelevant variance created by their disabilities (Tindal & Fuchs, 2000). Test accommodations are also defined as changes in the way tests are given that differ from the conditions under which the tests were standardized (Fuchs et al., 2005).

Text-to-speech (TTS) software. Software that recognizes the symbols on the page followed by reading aloud the text through speakers and at the same time presenting the written text on a computer screen (Staels & Van den Broeck, 2015).

CHAPTER 2

LITERATURE REVIEW

The purpose of this action research was to evaluate the impact of the C-Pen, a TTS tool, on the reading skills of third-grade students with learning disabilities at Eastview Elementary/Middle School. The review of related literature is based on the three main research questions:

1. How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?
2. What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?
3. What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?

The search results were generated from a variety of electronic databases and websites, including Education Source, ERIC, PsycINFO, ProQuest, Ebscohost, and Google Scholar. My search included a combination of key terms: *text-to-speech*, *accommodations*, *learning disabilities*, *reading comprehension*, *oral reading fluency*, *reading accuracy*, *reading rate*, *literacy*, *perceptions*, *struggling readers*, *smartpen*, *C-Pen*, *standardized reading assessment*, and *assistive technology*. As I searched for articles, I limited the search parameters to include articles that were scholarly and peer-reviewed. In addition, I used qualifiers such as (OR), (AND), and (NOT) to narrow my searches for more specific and relevant results related to my topic. This literature review

includes historical and current literature related to the impact of TTS tools, such as reading pens, when provided to students with learning disabilities.

This literature review covers eight sections: (a) theoretical underpinnings, (b) learning disabilities, (c) accommodations, (d) assistive technology, (e) reading proficiency, (f) reading comprehension, (g) oral reading fluency and its importance, and (h) a chapter summary. The first section presents an overview of the theoretical underpinnings that address the cognitive theory of multimedia learning (CTML) in students with learning disabilities and provides a framework for using multimedia materials during instruction. The second section addresses learning disabilities, including the definition, nature, and laws regulating students with disabilities. The third section describes accommodations as they relate to students with learning disabilities and reading comprehension. The fourth section presents an overview of a type of assistive technology called TTS and outlines the benefits and challenges surrounding its use. The fifth section describes reading proficiency, comparing proficient readers to struggling readers. The sixth section covers what is meant by reading comprehension and the complex process. The seventh section addresses oral reading fluency and its importance. The final section is a review of the chapter.

Theoretical Underpinnings

The theoretical basis of this action research was Mayer's CTML (Mayer, 2014a). Mayer explored cognition, instruction, and technology, which led to the development of the CTML (Veronikas & Shaughnessy, 2005). A tenet within the CTML is that learners learn from pictures and words (Almasseri & AlHojailan, 2019) and is defined by three assumptions: limited capacity, dual-channel, and active processing. According to the

CTML, the limited capacity assumption is that learners can process a limited amount of information when presented. The dual-channel assumption indicates learners have two separate channels—the visual and auditory—that are used for processing information. The active processing assumption relates to how learners cognitively process information through the visual and auditory channels (Mayer, 2014a).

Students with learning disabilities process information uniquely, especially when information is presented in multimedia (i.e., audio, animations, images, text, video, and interactive content) forms (Mayer, 2005). Teachers should consider these differences when designing their lesson plans and teaching strategies to ensure the chosen instructional strategies do not create cognitive load or overwhelm the learners (Mayer, 2005). Teachers should also consider the roles of the visual and auditory channels and understand that learning is an active process involving the selection, organization, and integration of data based on existing knowledge (Mayer, 2005). According to Mayer (2005), a learner's mental capacity is designed to process limited amounts of information at a time in each channel of the brain, leading to the formation of mental representations. Students with disabilities may have mental limitations on information that is processed through either auditory or visual channels depending on the nature of their disability.

In any form of multimedia learning, teachers should consider the five CTML principles to reduce cognitive overload among learners. The first principle, coherence, indicates more memory is available for scheme construction when extraneous learning materials are reduced (Jiang, Renandya, & Zhang, 2017). TTS technologies and instructional strategies used alongside this form of technology should be reduced to ensure visual and verbal information are limited for learners to achieve instructional goals

(Mayer, 2014a). Second, the signaling principle indicates students learn better when cues are incorporated into the learning process (Mayer, 2014a). Depending on the learners' needs, the teacher can use visual signaling or verbal signaling. The type of signal used in TTS environments should be appropriate to the learners to help them select, organize, and actively integrate new concepts into the learning process (Mayer, 2005). Third, the redundancy principle indicates students learn better when on-screen texts are replaced with multimedia presentations consisting of narrations and graphics (Yue, Bjork, & Bjork, 2013). Therefore, teachers should minimize the use of on-screen texts in TTS-based instructions to reduce the possibility of students experiencing a visual working memory overload. The fourth principle, spatial contiguity, indicates learning occurs when text and pictures are introduced together (Jiang et al., 2017). When using TTS tools, the instruction should be designed so the text and pictures are presented correspondingly. Finally, the fifth principle is based on temporal contiguity, which indicates teachers should present corresponding words and pictures simultaneously (Jiang et al., 2017). Concurrent presentations of text and pictures enhance student retention and knowledge transfer. These five principles are guides to the way teachers should design instruction for learners, especially those with learning disabilities (Mayer, 2005). The focus in the current study was on the third principle—the redundancy principle—to determine whether it holds true for students with learning disabilities with the use of the C-Pen.

Redundancy Principle

Teachers have increasingly begun to provide lessons using pictures, graphical presentations, animations, and on-screen texts using multimedia devices (Mayer, 2014b). The redundancy principle indicates the presentation of the same information in different

modalities hinders the learning process instead of facilitating it as expected (Jiang et al., 2017). Additionally, the redundancy principle supports learners to understand more from multimedia presentations that feature graphics and narrations than from those with either narrations or graphics or on-screen text (Jiang et al., 2017). Presentation of the same information in multiple forms overloads the mind and hinders students from understanding essential information.

Researchers have analyzed several studies and situations to identify the best learning strategy that eliminates redundancy in the multimedia learning process. Knoop-van Campen, Segers, and Verhoeven (2019) argued that teaching through audio is more effective than teaching using graphics or narrations in multimedia learning. Audio contents have low redundancy compared to written texts, and students can understand better when taught verbally. Mayer and Moreno (2003) have implied written content overloads students' minds and challenges their memory to understand the content. Audio content is easily understood because it has fewer redundant effects than other forms of learning. Further, on-screen text and graphics pose a challenge to students as they must scan the materials in the written form. Thus, the current multimedia learning process features more audio content in the form of narrations to accompany the graphics and on-screen text and aid in student understanding.

CTML and Assistive Technology

CTML requires incorporating assistive technology tools to enhance the effectiveness in aiding the learning process. Assistive technology tools consist of any device, equipment, or software that can facilitate the learning process in the classroom (Ahmed, 2018). Mayer (2005) stated multimedia-based instruction can involve a

technology-centered approach or a learner-centered approach. The use of TTS tools can create a balance between the capabilities of the technology used and the nature of the learners' capabilities (Alnahdi, 2014). To enhance students' autonomous learning, teachers should perceive multimedia learning as both information acquisition and knowledge construction.

TTS tools represent a learning technology that can help students with learning disabilities achieve optimal performance in the classroom. Besides exploring the functional capabilities of students, teachers should focus on learner-centered strategies that can be used to enhance students' cognitive function (Alnahdi, 2014). The CTML indicates the brain does not interpret a multimedia presentation of auditory information, words, and pictures in an exclusive manner; instead, these components are chosen and organized systematically to produce logical mental constructs (Mayer, 2014b). Therefore, TTS technologies that are used as multimedia approaches are capable of enhancing students' cognition and, ultimately, their learning.

Learning Disabilities

With the increasingly diverse population of learners in today's classrooms, teachers should have an awareness of the abilities and disabilities of learners in order to maximize their success. Learners have diverse needs that are varied and complex as a result of differences in age, ethnicity, gender, education, language, culture, socioeconomic factors, geography, learning styles, and past experiences (Gadbow, 2001). Learners who have the same diversity elements may have different learning needs that may require substantial, limited, or no accommodations (Gadbow & Du Bois, 1998). Accommodating learner differences will ultimately enhance students' learning

experiences and learning outcomes (Sheard & Lynch, 2003). Researchers have studied and discussed the accountability of assessing students with learning disabilities in public education and the impact public schools have on their achievement (Fuchs et al., 2005; Schulte et al., 2001). The overall findings show standardized assessment procedures will likely be a prevalent practice in public education and should be reliable and valid, given the push for satisfactory outcomes for students with learning disabilities (Fuchs et al., 2005; Schulte et al., 2001). Literature related to students with learning disabilities is reviewed in this section. The section covers (a) definitions of learning disability, and (b) learning disabilities and federal laws.

Definitions of Learning Disabilities

The terms “specific learning disabilities” and “learning disabilities” have the same definition and are used interchangeably in this paper. The Learning Disabilities Association of America (2020) defines a learning disability as a neurologically-based processing problem that can interfere with learning necessary skills in the areas of reading, math, or writing. The IDEA (2004) defines a specific learning disability as a disorder in one or more of the fundamental processes of language—spoken or written—in areas such as reading, listening, thinking, writing, speaking, spelling, or doing mathematical calculations (IDEA, 2004). In their study, Cawthon et al. (2012) explained students with a learning disability achieve below average on reading, mathematics, or written expression. Learning disabilities can vary in type and severity and may interfere with the attainment of skills needed for classroom performance. Factors that determine performance levels include the student’s age, exposure to quality instruction, and level of intelligence (Cawthon et al., 2012). To be classified as having a learning disability,

students must be evaluated and qualify in one or more of the three academic areas through gathering assessment data about how and if the disability has an impact on their learning. Specific laws mandate the eligibility, instruction, and assessment of students with learning disabilities.

Learning Disabilities and Federal Laws

Federal laws dictate students with disabilities receive a fair opportunity to receive an education with equal access to the curriculum to that of nondisabled students. Two significant federal laws mandate the protection of the rights and services of students with learning disabilities in schools: IDEA and Section 504 of the Rehabilitation Act (Section 504; U.S. Department of Education, Office for Civil Rights, 2010),

The IDEA provides legal rights for people with disabilities in public schools. Students age 3 through 21 years within the public-school setting are eligible for an IEP, a plan that mandates special education and related services to meet students' educational needs. Under the IDEA, students qualify for free and appropriate education (FAPE). Federal laws assist students with disabilities in primary and secondary school. IDEA (IDEA, 2004) enables students to special education and other services to help them attain their highest potential (Weis, Dean, & Osborne, 2016).

According to Sulkowski and Kaczor (2014), Section 504 is a civil rights law that prohibits discrimination against those with disabilities who attend schools that receive federal funding. Schools are required to meet students' needs by removing barriers to their learning. Section 504 also offers accommodations, legal rights, FAPE, and freedom from discrimination at private schools (Sulkowski & Kaczor, 2014).

Accommodations

Literature related to accommodations of assessment for students with learning disabilities is reviewed in this section. The review focuses on the following areas: (a) definitions of accommodations, (b) test accommodations, (c) accommodations for students with learning disabilities, (d) read-aloud accommodations, and (e) technology-oriented accommodations.

Definitions of Accommodations

Diversity is present in today's classrooms not only in terms of social membership, racial background, and linguistic or language-learning backgrounds, but also in ability levels (Jozwik & Douglas, 2017). In a typical classroom, teachers must address the barriers and challenges of students with a wide range of ability levels and needs.

Accommodations are alterations presented to students with learning disabilities such that they can complete their assignments and tests with the same access as nondisabled students. The content of the assignment is not altered, and students are not provided with an unfair advantage. Within the classroom, some students with learning disabilities require specialized instruction—an appropriate education that addresses and meets their needs. Students with learning disabilities are offered accommodations in order to eliminate unnecessary barriers that prevent them from showing their underlying abilities (Jozwik & Douglas, 2017).

Accommodations are valid when they provide support to those students who need it and not to all students (Giusto & Ehri, 2019). If an accommodation increases the academic outcomes of all students, then it has not served its purpose because the gap

between those with and without learning disabilities remains, thus providing no differential benefit to students with disabilities (Giusto & Ehri, 2019).

Test Accommodations

Researchers have studied and discussed improving the validity and reliability of accommodations as related to test scores (Fletcher et al., 2009; Fuchs et al., 2005; Kettler, 2012). Fuchs et al. (2005) concluded that the same accommodation is not effective or valid for every student and may benefit some students while hindering others, Kettler (2012) concluded accommodations are not valid for every individual and no accommodation is valid for every test, and Fletcher et al. (2009) concluded there was not much evidence that the read-aloud and structured extended time accommodations added construct-irrelevant variance to an assessment.

Students with learning disabilities possess characteristics that make it difficult for them to access content (Bolt & Ysseldyke, 2008). In order to remove barriers for effective test administration, students with learning disabilities have changes made in the form of accommodations (Bolt & Ysseldyke, 2008). Such changes to the testing procedures used for the majority of individuals have been termed “testing accommodations” (Bolt & Ysseldyke, 2008). Accommodations do not change what the test measures; however, accommodations do enable students with learning disabilities to comprehend without being impeded by their disability.

Accommodations for Students with Learning Disabilities

When a student receives a diagnosis of a learning disability, the student or guardian must place a request according to the specific needs of the student (Condra et al., 2015). IDEA calls for the active participation of both the student and legal guardian,

who would have the responsibility of deciding appropriate accommodations for the student. The IDEA (2004) states the student's IEP team—composed of the teacher, the student, and the parents or guardians—must advocate for appropriate programs specific to the needs of the child. Several laws within the United States require leaders of districts and schools to provide test accommodations to students with disabilities. The IDEA (IDEA, 2004) makes it mandatory for states to have proper guidelines and regulations in place regarding the provision of accommodations in educational institutions (DeMatthews & Knight, 2019).

Read-Aloud Accommodations

Read-aloud accommodations are a way to help remove the barriers faced by students with disabilities in reading comprehension (Li, 2014). Many empirical studies have been conducted on the effects of read-aloud accommodations, though the results are mixed (Li, 2014). Li (2014) found the accommodation effect was significantly stronger when the subject was reading rather than math. The effect of read-aloud accommodations was also stronger when human proctors read the test than when read by video and audio players or computers (Li, 2014). Weston (2002) studied the positive effects of the read-aloud accommodation using a sample of a group of students from the fourth grade sitting for the mathematics test under conditions suitable for nondisabled students as well as those with learning disabilities. Though the study had many limitations, results indicated accommodations helped increase the scores of students with learning disabilities. These results are useful for assessing the importance of the read-aloud accommodation in general.

Technology-Oriented Accommodations

Schools are in a new era of technology and assessment is evolving as well (Gelbart, 2018). High-stakes tests based on state standards and summative assessments are increasingly being delivered via computer-based systems (Gelbart, 2018). Computer-based assessment delivery could have a significant effect on students with learning disabilities. Gelbart (2018) explored the benefits and challenges of testing students with learning disabilities via computer-based systems and examined accessing accommodations via computer-based systems, best practices in preparing students for computer-based tests, teacher training, and the partnering of educators and test designers in creating test platforms. The finding showed students are frequently years behind in the acquisition of academic skills, yet regarding high-stakes testing, students who have learning disabilities are expected to perform on grade level with their peers (Gelbart, 2018). Educators should also use technology in classrooms regularly; however, this should not occur by chance. Technology training for teachers must be purposeful and relevant in preparing students to succeed in this new frontier of high-stakes testing (Gelbart, 2018).

Assistive Technology

In educational settings, assistive technology refers to the services and devices used to increase the competencies of students with learning disabilities. Assistive technology is not merely computers and high-tech devices, it can also include middle tech or very low tech such as the pencil grip, slant boards, highlighter, and visual schedules (Adebisi, Liman, & Longpoe, 2015). Assistive technology includes tablet applications

and computer programs that support speech-to-text and TTS, graphic organizers, and word prediction (Adebisi et al., 2015).

Literature related to assistive technology is reviewed in this section. Several types of assistive technology solutions exist for those with learning disabilities. Products such as memory aids, audiobooks, note-taking systems, reminders, and TTS technology are used to improve students' communication and learning skills (Chiang, Liu, Lee, & Shih, 2012). Therefore, whether students have cognitive problems, dyslexia, or physical impairments, assistive technology helps in partially eliminating their problems and allowing them to function effectively as their nondisabled peers. The review focuses on the following: (a) definitions of assistive technology, (b) definitions of text-to-speech, (c) benefits of text-to-speech, (d) challenges of text-to-speech, (e) assistive technology and learning disabilities, (f) assistive technology and reading, and (g) the reading pen.

Definitions of Assistive Technology

The technology used by individuals with disabilities has historically been known as “assistive technology” (Edyburn, 2013). The term assistive technology refers to any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability (IDEA, 2004). The term assistive technology is defined in various ways in the literature. Okonji and Ogwezzy (2019) defined assistive technology as a special type of equipment that promotes digital access for anyone who has a disability. Lederer (2021) defined assistive technology as the use of technology designed for those with motor, visual, hearing, or speech limitations.

Definitions of Text-to-Speech

Innovations have been incorporated into TTS technology to help students read digital texts. Text readers can be integrated into learning devices. TTS is defined as the automatic conversion of text into speech (Tora, Uslu, & Karam Mehmet, 2017). TTS software recognizes the symbols on the page followed by reading aloud the text through speakers and at the same time presenting the written text on a computer screen (Staels & Van den Broeck, 2015). TTS devices convert written text into computer-generated synthesized speech that closely resembles natural speech (Berkeley & Lindstrom, 2011). TTS engines can help struggling readers improve reading comprehension, fluency, and accuracy (Berkeley & Lindstrom, 2011).

Benefits of Text-to-Speech

Adebisi et al. (2015) explored whether electronic TTS pens are linked to the enhanced literacy abilities of students. Students with learning disabilities were grouped into two categories, and one of the groups was given TTS assistive software in an attempt to improve their reading comprehension. Students in this group showed progress in their ability to spell without errors and understand the meanings of unfamiliar words (Adebisi et al., 2015). In contrast, students in the control group did not show any significant improvements. Wood, Moxley, Tighe, and Wager (2018) examined the impacts of TTS on disabled high school students. The study's findings revealed students who used TTS software consistently improved their reading comprehension skills (Wood et al., 2018). In both studies, TTS assistive technology enhanced students' abilities to hear texts as they were being read aloud, consequently improving their reading capabilities.

Beyond the benefits discussed above, other advantages of TTS technologies include saved time and money, improved listening, and enhanced student performance (Forgrave, 2002). Using TTS applications and extensions is one way to assist students with learning disabilities who struggle to complete reading assignments independently (Bone & Bouck, 2017). With advances of technology, practitioners and education researchers have begun to study TTS and related tools to understand how to help students with reading disabilities (Wood et al., 2018).

Challenges of Text-to-Speech

Alkahtani (2013) found a vast number of teachers had inadequate levels of knowledge and skills in the area of assistive technology. Additionally, Alkahtani's results revealed a need for teacher training and professional development to assist students in accessing the curriculum. Although teachers may not always have the knowledge and capability to use assistive technology, the problems can also arise from the device's mechanics.

TTS assistive technology is not perfect and there are some disadvantages. Among these challenges are misinterpretation and a lack of accuracy—TTS technology does not always read the texts displayed on the screens accurately and sometimes fails to understand the language context, consequently leading to errors (Berkeley & Lindstrom, 2011). Unlike real people, TTS software is sometimes unable to choose the most appropriate spelling of decoded words (Berkeley & Lindstrom, 2011). TTS also lacks the emotions and tones required in prosodic dependencies (Berkeley & Lindstrom, 2011). Over time, TTS technologies have improved in that they now sound more human-like and less robotic. However, this does not mean they always find the correct stress or intonation

of words. Intonation refers to essential changes in frequency made during speech that can sometimes be omitted (Berkeley & Lindstrom, 2011). Moreover, several studies have confirmed the lack of emotional expressivity in TTS technology (Chiang et al., 2012; Meyer & Bouck, 2014; Tora et al., 2017). An increasing number of assistive technology interventions exist for adolescents and adults with learning disabilities, but there has been no systematized review of their effectiveness (Perelmutter, Karla, McGregor, & Gordon, 2017).

Assistive Technology and Learning Disabilities

Assistive technology plays a critical role in leveling the field and equalizing learning for students with diverse needs (Berkeley & Lindstrom, 2011). Through its extensive use, teachers can personalize their teaching and enhance the skills of students with learning disabilities. Today, most school-age children with learning disabilities are familiar with technology. The use of assistive technology in the classroom requires an assessment of students' needs so teachers can determine the most appropriate assistive technology for specific students (Ackerman & Goldsmith, 2011). Assistive technology addresses an array of learning problems. For example, a student who struggles with math may need to use a calculator to help achieve excellent scores on an assignment.

Assistive Technology and Reading

A challenge facing teachers is the number of students coming to class without the required reading and comprehension skills. Studies indicate a large number of public-school students cannot efficiently read and complete grade-level work (Flanagan, Bouck, & Richardson, 2013). According to Park, Takahashi, Roberts, and Delise (2017), inadequate skills are caused by a lack of motivation, insufficient instruction, and

disabilities, among other factors. One of the strategies for addressing this problem is assistive technology, which helps in improved, increased, and maintained student functional capacities. Many students have reported positive outcomes after using assistive technology for reading differences (Satsangi, Miller, & Savage, 2019). These outcomes often result in improved comprehension, student attention, motivation, and attitude (Satsangi et al., 2019).

Reading Pen

The reading pen is a lightweight portable assistive technology tool that allows students with literacy problems to read printed texts. The reading pen is a standard assistive technology tool used by students with dyslexia, English as a second language learners, poor readers, and beginner readers (Patti & Garland, 2015). It also has a TTS feature of naturally speaking English, French, Australian, Spanish, and more (Patti & Garland, 2015). Depending on the feature options of the TTS tool, the spoken voices can be changed to accommodate the listeners' speaking styles, accents, preferences in volume, digital voice, or human-like voice (Patti & Garland, 2015). The differences in voices could plausibly assist in how the listener comprehends what is being spoken. Students with reading difficulties can use the reading pen to listen to their preferred pronunciations to improve their general understanding of what is read.

Reading pens can also be used during exams to enable students with learning disabilities to access questions without the need for special requirements (Patti & Garland, 2015). In schools, reading pens are used to access cognitively appropriate texts where students' decoding abilities and phonetic knowledge prevent them from reading by

themselves. The main ideas behind this use are to level the academic playing field and reduce the barriers and challenges faced by students with learning disabilities.

Ok and Rao (2107) explored the use of digital pens by teachers in supporting secondary students with learning disabilities. The researchers also analyzed the potential advantages and limitations associated with the use of digital pens. Ok and Rao reported students who continually use these pens display positive academic outcomes. However, it was apparent that further research on the methods of use of these pens is needed.

The reading pen is one such assistive technology that is used to bypass the vocabulary decoding skills of students who have learning disabilities. A few studies have been conducted on the effects of reading pens on the comprehensive abilities of students with learning disabilities (Berkeley & Lindstrom, 2011; Meyer & Bouck, 2014; Patti & Garland, 2015). These studies have primarily focused on secondary students, whereas no known studies have been published on the effect of reading pens on students in other grade levels (Berkeley & Lindstrom, 2011).

Reading Proficiency

This section of the review examines the literature on the subject of reading with a focus on two types of readers: proficient readers and struggling readers. Furthermore, the section includes a review of relevant literature regarding reading skills.

Reading is a fundamental and essential skill that every student needs to acquire within the early grades as it underpins their learning efficiency during higher academic levels. Reading involves decoding words, comprehending, understanding, and constructing meaning from text. Students' ability to read and understand texts defines their efficiency in gaining knowledge from academic content, with those having higher

capabilities referred to as proficient readers and those having difficulties referred to as struggling readers. Gaining proficient reading skills by the third grade is helpful to students because after the third grade, the academic content diversifies and requires students to be competent readers to gain knowledge proficiently.

Proficient Readers

Reading proficiency refers to a reader's ability to decode a written text and comprehend, understand, and extract meaning. Freed, Hamilton, and Long (2017) stated proficient readers have the following characteristics and abilities: they use existing knowledge to decode and interpret meaning from text by activating prior knowledge of the text style, structure, content, and learning process; they make connections between known information and new knowledge; and they take time to wonder about concepts, content, and outcomes, questioning the author's ideas and design of their texts (Freed et al., 2017). Therefore, a proficient reader makes connections, infers, questions, and comprehends written texts to extract meaning.

Paige, Smith, Rupley, and Wells (2021) found proficient readers use divergent strategies before, during, and after reading to comprehend text. Before reading, proficient readers activate and build upon their prior knowledge and establish a reading purpose before engaging any text. Freed et al. (2017) discussed similarly what happens during reading, indicating proficient readers connect new texts with prior experiences and knowledge to draw conclusions from the text. Wolter (2017) found proficient readers also take their time after reading texts to discuss the accuracy of their earlier predictions and summarize vital ideas reflected in the text. Therefore, proficient readers apply different

strategies during various reading stages, enabling them to comprehend, reflect, and question text to gain additional knowledge.

Struggling Readers

Proficient and struggling readers differ in many ways when they engage in reading and apply strategies during, before, and after reading that leverage their reading capabilities and comprehension of written text. Before reading text, struggling readers possess partial background knowledge on the subject and inconsistently evoke this background knowledge to infer meaning from a particular text (Paige et al., 2021; Stevens, Park, & Vaughn, 2019). During reading, struggling readers have limited reading attention span, often require assistance during reading tasks, inconsistently harness word attack strategies, and have dismal reading fluency (Paige et al., 2021). Struggling readers have difficulty monitoring their comprehension, exposing them to mistakes in the reading process (Cho, Toste, Lee, & Ju, 2019; Rasinski, 2017).

Developmental Reading by Third Grade

Reading in the third grade involves mastering literacy competencies to enable students to acquire knowledge in academic content as they progress to higher grade levels. Students primarily develop their reading skills at this stage and gain key reading competencies. Reading at a third-grade level entails students iteratively developing comprehension abilities such as fluent word decoding, making inferences, and applying background knowledge as dictated by the context (Stanley, Petscher, & Catts, 2018). By third grade, students should be able to efficiently read complex words; read grade-level text with correct accuracy, fluency, and understanding; and readily self-correct their mistakes and reread when text is unclear (Kusdemir & Bulut, 2018). Third-graders can

efficiently answer questions regarding the text, clearly draw specific examples, and read and differentiate between various academic genres (Stanley et al., 2018). Reading development is an iterative process in which learners develop alphabetic, phonics, word recognition, fluency, vocabulary, and comprehension skills that contribute to their reading and academic content understanding (Fraumeni-Mcbride, 2017). Therefore, reading development occurs iteratively among students, and by the third grade, the student has already acquired proficient reading skills.

Consequences for Students Who Are Not Proficient in Reading by Third Grade

Failure to acquire proficient reading skills by the end of the third grade may hinder students' learning progress because they have deficiencies in mastering academic content. Third-graders who struggle with reading proficiency are vulnerable to low motivation toward learning that may spark a negative attitude toward education, consequently leading to low academic performance and high vulnerability to school dropout (Fraumeni-Mcbride, 2017). Furthermore, reading deficiencies are difficult to alter in later academic stages due to the comprehension gaps that impede the efficiency of knowledge gain. Hock et al. (2009) concluded a lack of reading fluency and comprehension skills negatively affect student performance in reading. Therefore, failing to grasp essential reading skills by the end of the third grade is unfavorable to a student's later academic career.

Reading Comprehension

Reading is a foundational skill for interpreting and comprehending written text. Students with learning disabilities sometimes struggle with reading comprehension. Reading comprehension plays a significant role in the academic as well as the

professional success of students at all levels. Consequently, reading comprehension requires the synchronization of various skills (Harley, 2014).

Leaders within educational settings have started adopting differentiated teaching, wherein different teachings method are adopted for the students as per the differences in their reading and comprehension abilities (Torgesen, 2006). Such differentiated teaching methods are experimental methods of customized learning and are aimed at compensating for such students with learning difficulties in their process of receiving a quality education. Furthermore, accommodations such as extended time to complete examinations and the use of technological aids are offered as a way to bring the education of students with learning disabilities up to the level provided to nondisabled peers. The provision of accommodations considers the characteristics of the students with learning disabilities and helps them use their full potential during their studies as well as during exams (Bone & Bouck, 2017). The review in this section covers (a) definitions of reading comprehension, (b) reading and learning disabilities, and, (c) reading comprehension as a process.

Definitions of Reading Comprehension

Snow (2002) defined reading comprehension as the ability to construct meaning from interacting with a text, which is critical for students to succeed in today's educational settings. Giusto and Ehri (2019) defined reading comprehension as a product of two component skills: the ability to decode written words and linguistic comprehension, which involves using lexical, syntactic, semantic, and pragmatic knowledge of spoken language to achieve sentence and discourse interpretations of a text. This distinction yields four categories of readers: one category of good readers who

possess skill in both word recognition and linguistic comprehension and three categories of poor readers (i.e., those with weak word reading skill but adequate linguistic comprehension, those with adequate word reading but poor linguistic comprehension, and those who lack both skills; Giusto & Ehri, 2019). Reading comprehension tests have classified items by type for scoring and item analysis and such tests are skill views and skill definitions of reading comprehension (Dagostino, Carifio, Bauer, Zhao, & Hashim, 2014). Reading comprehension is defined as a set of particular skills—such as decoding, letter knowledge, and phoneme awareness—that must be mastered and applied in order for the reader to understand a text (Dagostino et al., 2014).

Reading and Learning Disabilities

Reading and understanding what is read are central in ensuring academic achievement and social integration. Reading, therefore, appears to be one of the most crucial abilities children must acquire during the elementary school years (Potocki, Magnan, & Ecalle, 2015). Weak reading comprehension skills will affect the academic success of students. Students may then acquire these reading skills and knowledge gains when reading independently (i.e., without TTS software use), resulting in more fluent reading, increased vocabulary, and improved comprehension (Park et al., 2017). Students with learning disabilities in reading have difficulties with reading and understanding grade-level academic material (Meyer & Bouck, 2017). One frequently used method of support is using read-aloud accommodations, which can be live or via TTS (Meyer & Bouck, 2017).

Reading Comprehension as a Process

For students who have challenges with decoding text, their word-reading accuracy interferes with measuring their abilities to comprehend and understand a text (Gandhi, Ogut, Stein, Bzura, & Daniela, 2018). The development of reading comprehension skills is a multifaceted process because the construct of reading comprehension is inherently multidimensional (Rupp & Lesaux, 2006). As students respond to test items, they actively construct meaning by processing input and extracting relevant information in accordance with the predetermined purposes (Kahraman, 2019).

Researchers have sought to understand reading comprehension from the development and specification of various models and frameworks that account for the numerous processes of reading (Butterfuss & Kendeou, 2018). When teaching students with learning disabilities, teachers must consider evidence-based practices that can be used to develop reading comprehension skills that encourage school and transition success (Kim, McKenna, & Park, 2017).

For adolescent students who readily understand written information in textbooks, novels, newspapers, or the Internet, learning new content through reading is an automatic process (Anderson, 2009). Thus, for proficient readers, reading becomes an ongoing cumulative process that meets their daily needs while increasing their knowledge (Anderson, 2009). When faced with a difficult text, these readers can absorb the information by rereading, looking up unknown words, or thinking through the context. In these cases, the act of reading produces minimal stress (Anderson, 2009). This is not the case for students considered at-risk readers, including those identified as having reading disabilities or those who have cognitive challenges (Anderson, 2009). For struggling

readers, reading becomes overwhelming as they attempt to learn required content in school, deal with daily living challenges, and prepare for successful careers (Anderson, 2009).

Oral Reading Fluency and its Importance

Fluency plays a vital role in reading by bridging the gap between word recognition and the development of meaning. Fluency is an essential component of reading that enables readers to decode words in a written text with appropriate speed, automaticity, accuracy, and comprehension (Fernandes, Querido, Verhaeghe, Marques, & Araujo, 2017). Oral reading fluency is assessed based on accuracy, reading rate, and expression. Regarding accuracy, proficient oral readers have high competency in identifying unfamiliar and familiar words correctly (Hudson, Shamblaw, Harkness, & Sabbagh, 2020). Competent oral readers have a fast, steady reading rate and effortlessly and automatically identify conversant and nonfamiliar words (Paige et al., 2021). Competent oral reading also entails a reader connecting with the text, developing expressions related to its context, and conveying meaning from the text during verbal reading. Proficient oral readers explicitly read using suitable expressions, apply punctuation signals, and constantly vary their voice, tone, stress, pitch, and required phrasing during oral presentations (Fernandes et al., 2017). When students apply fluency competencies, oral readers can efficiently and accurately construct meaning and understanding from written texts and orally communicate. Therefore, oral reading fluency is a notable skill a reader may demonstrate when engaging in reading text.

Chapter Summary

This literature review served to synthesize the literature related to the effect of the C-Pen as an accommodation for students with learning disabilities. This review presented information that shows the impact of federal laws, accommodations, and assistive technologies on the learning experiences of students with learning disabilities. Evidence from the reviewed literature indicates innovative technologies, such as TTS tools, can be used to improve students' outcomes and abilities in reading while removing barriers and challenges. This literature review also established that TTS assistive technologies used as accommodations can result in improved reading skills. The gap in the research points to a lack of studies of the effectiveness of a reading pen called the C-Pen as a TTS accommodation for students with learning disabilities. An evaluation of the impact of the C-Pen, when provided to students with learning disabilities, was the focus of the current study. Improving students' outcomes should be a priority for educators of students with learning disabilities.

CHAPTER 3

METHOD

The focus in this action research was on a local school problem at Eastview Elementary/Middle School (the school and students listed in this study were given pseudonyms to protect the confidentiality of all participants). Third-grade students who have learning disabilities in the area of reading struggle with meeting reading proficiency standards set by the SCDE by the end of the school year. Problems that occur across a school and have a wide impact are appropriate for using action research methods (Lari, Rose, Ernst, Kelly, & DeLuca, 2019). The research questions for my study were as follows:

1. How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?
 - a. How does the use of the C-Pen affect the reading level of third-grade students with learning disabilities?
 - b. How does the use of the C-Pen affect the reading comprehension of third-grade students with learning disabilities?
 - c. How does the use of the C-Pen affect the oral reading fluency of third-grade students with learning disabilities?
2. What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?

3. What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?

This chapter contains details of the methods I used to conduct this action research study with a focus on the research design, setting and participants involved in the study, innovation, data collection methods, procedures and timeline, and data analysis. The end of the chapter includes the rigor and trustworthiness, and the plan for sharing and communicating results.

Research Design

Through this action research, I sought to evaluate the impact of the C-Pen as an innovation on the reading skills of third-grade students who have learning disabilities. A greater understanding of the impact of using TTS tools—such as the C-Pen—to support reading will help teachers become more informed about best practices for students with learning disabilities. In this case, the use of the C-Pen as an accommodation to support reading in schools is part of the technological disruptions in the education field; therefore, it is valuable to evaluate the impact of this new phenomenon with third-grade students who have learning disabilities.

Action research is one of the research designs used in the education field (Ferrance, 2000) and has many benefits. First, action research is used to address a local problem; the problem in this study was relevant to my school and not another one. The C-Pen was provided to third-grade students with reading disabilities to use in their classrooms, which is appropriate for students in this population, to evaluate how the C-Pen affected their reading. Second, action research can help teachers identify problem areas that require immediate attention. Many teachers desire to know more about helping

their students reach learning goals while expanding upon their knowledge about their students. Third, action research promotes collaboration among colleagues to improve educational practices. Finally, action research provides benefits for teachers, students, and anyone else vested in the teaching and learning process (Mertler, 2017).

In contrast, traditional research in education is typically conducted by researchers who have no connections to the environment they are studying (Mertler, 2017). In action research, subjects demonstrate initiative and do not merely conform to prearranged ideas of research outcomes (Rogers, 2014). Action research involves cyclical and iterative (Mertler, 2017) processes and not linear ones. Action research also does not involve implementing predetermined answers; it is used to find creative solutions to educational problems (Mertler, 2017).

Action research involves the implementation of actions for the improvement of a particular practice and the identification of more opportunities for intervention improvement. In seeking to evaluate the impact of using the C-Pen with third-grade students with learning disabilities, I incorporated a mixed methods design for my action research. A mixed methods design can provide the best understanding of a research problem by using quantitative and qualitative data together within a study (Creswell & Creswell, 2018). A quantitative method only study would have yielded information about students' pretest and posttest data, whereas a qualitative method study would have provided information on the students' and teacher's perceptions. Therefore, the overall goal of mixed methods research is to strengthen a study's conclusions by aligning and expanding quantitative and qualitative data sources (Schoonenboom & Johnson, 2017).

In this study, I employed a convergent parallel mixed methods design as I collected all quantitative and qualitative data simultaneously but separately, analyzed the two data sets independently, and then merged the results during data analysis to develop an understanding of the overall results (Creswell & Plano Clark, 2018). I used this convergent design approach to understand and corroborate the quantitative and qualitative results by bringing together the strengths and weaknesses of quantitative and qualitative data sets (Creswell & Plano Clark, 2018). Last, the convergent design suited my desire to find a reliable solution for the problem statement that facilitated perspectives and knowledge that may otherwise not be studied.

Setting

I conducted this action research in a rural area in an elementary/middle school located in southeastern South Carolina that serves approximately 780 students in pre-kindergarten through eighth grade. This section presents the (a) demographics of the school, (b) third-grade general education classes, (c) third-grade academic support classes, and (d) student use of technology.

Demographics of the School

The school's demographic composition is as follows: 37% African American, 56% Caucasian, 1% Asian, 5% Hispanic, and 1% two or more race categories. The poverty level for the school is 69.9% and 481 students receive subsidized meals (26 reduced, 455 free). The elementary/middle school is a Title I school, in which at least 40% of students qualify for free or reduced lunch. A total of 135 students qualify as students with disabilities (65 learning disabilities; 32 Academic Support II; 79 speech and language disabilities). The staff is composed of 86 members (56 certified, 30 classified),

with six members teaching special education. The average general education classroom has a ratio of 22 students to one teacher. There are 49 teachers in the school and 100% are highly certified in their content areas according to SCDE requirements.

Third-Grade General Education Classes

The COVID-19 pandemic has affected classrooms across the nation, as well as in my school. In response to the Centers for Disease Control and Prevention's (CDC, 2019) strategies for preventing the transmission of the virus, specific safety protocols were implemented that affected how students and teachers interacted during the study. The participants were required to wear face masks and adhere to physical distancing requirements. If students' desks could not be distanced 6 feet apart, plexiglass partitions were placed on tables to keep physical distance (see Figure 3.1). The third-grade classroom had both small and large tables. Before the COVID-19 pandemic, the tables held six students; now, there were no more than four students per table. The environment in the study was different than the pre-COVID-19 environment. Pre-pandemic participants would have been encouraged to collaborate with close distancing in small groups; however, COVID-19 disrupted the interactions among the teacher, students, and myself.



Figure 3.1. Picture of third-grade classroom.

One third-grade general education class was involved in this study. Students with learning disabilities are exposed to the same curriculum in the third-grade classroom as their nondisabled peers. The curriculum was the workshop model (Calkins, 2001), a comprehensive instructional curriculum that supports students' independent reading and writing with guided and explicit systems of instruction. The classes had a mixture of students with disabilities and students without disabilities. All students received Tier I instruction, which meant the instruction was provided to all students. Within the Tier I instruction, students with learning disabilities received the same reading instruction, assessments, assignments, and homework as their nondisabled peers. Reading was supported in multiple ways, including whole group, small group, and independent reading instruction. A typical class period incorporated many reading strategies during an

uninterrupted 90-minute time frame (see Appendix C for an example of the reading block).

Whole group. Whole group was when the teacher taught a lesson to all students. The components of reading integrated during this instruction were word study, read-aloud, mini-lesson, and reading workshop closure activities. Whole group instruction began with word study, which builds on students' oral and academic vocabulary. The teacher preselected vocabulary from texts read during the week or preselected words based on students' needs. Students practiced high-frequency words, fluency skills, vocabulary, word learning, word-learning strategies, definitions, words in context, phonics, and high-frequency words. Read-aloud was when the teacher supported reading and writing instruction and content-area integration. Students built on background knowledge vocabulary, model fluency reading, model think aloud, and discussions about texts during this instruction. Mini-lessons provided explicit, direct instruction through modeling and guided practice. Mini-lesson instruction was built on students' academic vocabulary, content vocabulary, fluency, and comprehension during activities. The reading workshop closure activities provided opportunities to check students' understanding using formative assessments, progress monitoring tools, exit slips, retelling, and journaling.

Small group. Small groups were when the students collaborated or worked together to help remediate the skills students lacked. The teacher determined the small groups according to students' academic ability. Due to COVID-19, small group activities were limited to pairs of students. During small group instruction, students participated with a student who was sitting at the same table. The teacher facilitated lessons and

monitored while students worked together. Small group instruction was student-centered and instruction was centered around literature and incorporated literary and informational texts to guide students to a deeper understanding of what they read. Activities included reading comprehension strategies and skills, story events, characters, personal experiences related to a text, critical thinking, problem solving, reflections, responding to books, and constructing meaning with peers.

Independent practice. Independent practice was when the students worked independently to build on the enjoyment of reading. Students worked in workstations during this instruction. The teacher worked with students who needed remediation and other students worked independently in skills-based workstations. Activities included word study, writing, comprehension, fluency, and independent reading practice.

Third-Grade Academic Support Classes

The Academic Support I setting followed the same safety protocols as the general education classes. Students practiced physical distancing and wore masks during any interactions. The classroom setting also used plexiglass when students could not physically distance by 6 feet (see Figure 3.2). Academic support classes were where students received additional academic support for their learning disabilities. Students received various methods of specialized instruction based on their IEPs.



Figure 3.2. Academic support room.

Students worked with special education teachers on specific predetermined goals outlined in their IEPs individually or in small groups. Instruction was given to directly focus on reading skills such as alphabetic knowledge, phonics, phonological awareness, reading fluency, reading accuracy, reading rate, and comprehension. The delivery of specialized instruction was based on student reading levels by using visuals, lessons using Chromebooks, compensatory learning strategies, and commercial and teacher-made reading materials. When there were assignments where there was much reading, students received support such as oral administration provided by the teacher and extended time for assignments, quizzes, and tests. There was not a specific curriculum used for specialized instruction.

Student Use of Technology

A variety of technologies were used in the classroom. Each student in Grades 3–8 had access to a Chromebook. Students do not use Chromebooks daily; however, teachers incorporate other technology into lessons using a smart board (see Figure 3.3) daily to help students with disabilities access several teaching presentations. Technology was used for instruction in a variety of ways. Students completed reading and math instruction using the iReady curriculum from Curriculum Associates on the Internet for at least 45 minutes per week. The iReady curriculum is an online platform where students take a diagnostic three times per year to determine their ability levels based on the SC READY standards. After each diagnostic, the students are provided with targeted individualized instruction based on the diagnostic results. Students with disabilities are supported in their reading through individualized instruction using the iReady curriculum and small group sessions with the teacher. The individualized instruction provided to students includes the computer reading the material to students.

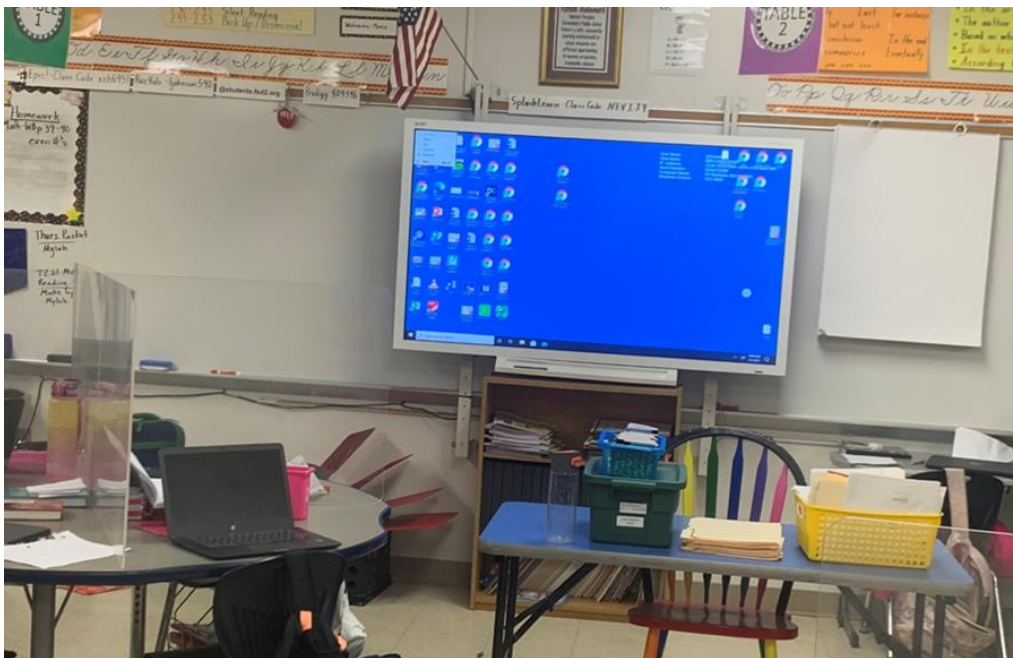


Figure 3.3. Smart board in the third-grade classroom.

Participants

This action research study included four third-grade students who had a learning disability in the area of reading and one third-grade teacher. This class was chosen because there was only one third-grade class at our school and it had four students with learning disabilities. Participation in the research study was voluntary, with no consequences for nonparticipation. I obtained verbal consent for participation in this research study during a phone call with the students' parents. There were no rewards or privileges for participation in the study.

The student participants in this study were four third-grade students with a common specific learning disability in the area of reading. Other learning characteristics of the disabilities varied for each participant. The students' names are pseudonyms used to protect the confidentiality of the participants. All participants received academic support services for their disability in reading and remained in the general education classroom for 80% of the day. Carter, a 9-year-old male, only had a diagnosis of specific learning disabilities in reading. Shon, a 10-year-old male, had a diagnosis of specific learning disabilities in reading and writing. Lee, an 8-year-old female, had a diagnosis of specific learning disabilities in reading and hearing. Chris, an 8-year-old male, had a diagnosis of specific learning disabilities in reading and speech-language impairment. The student participants' characteristics can be found in Table 3.1.

Table 3.1 *Student Participant Characteristics*

Name	Gender	Age	Ethnicity	Initial eligibility; primary and secondary characteristics	Used C- Pen previously	Percentage of time in general education per day
Carter	Male	9	Caucasian	4/2019 SLD in reading	No	80%
Shon	Male	10	Caucasian	4/2019 SLD in reading; math	No	80%
Lee	Female	8	Caucasian	6/2019 SLD in reading; hearing impairment	No	80%
Chris	Male	8	Caucasian	3/2019 SLD in reading; speech-language impairment	No	80%

Note. SLD = specific learning disability.

All students met the eligibility criterion of having a specific learning disability in the area of reading as outlined by the Standards for Evaluation and Eligibility Determination (Zais, 2011). All four students had an IEP predetermined by psychological assessment data, IEP team meeting decision, and state and federal regulations. An IEP is a plan that includes specialized instruction to help students with the skills they need to work in the general education classroom.

Students' pre-innovation reading levels were one to two grade levels below, according to their IEPs. The four student participants received special education services that addressed their learning disabilities in the Academic Support I room. The student participants, on average, spent a minimum of 80% of their day in the general education

classroom and 20% of their day in the Academic Support I room. All student participants had an IEP in place; however, the study did not affect any of their specialized services.

There was one teacher participant in this study. The teacher had been an educator for 31 years and had taught third-grade students for 22 of those years. The teacher administered the pretest and posttest to students. The teacher participant was employed full-time by the school district and was certified in elementary education and highly qualified in their content areas. The teacher taught all content areas, including English language arts, math, science, social studies, and writing. The criterion for the teacher was based on the teacher teaching third grade. The teacher in the study worked directly with the students in assessment, preparing and conducting lessons, innovation, and opportunities for students to use the C-Pen during a 6-week time frame.

Innovation

The innovation for this action research study was the implementation of the C-Pen, a TTS device that has the capability to read text out loud in many languages that was initially developed as a type of speech synthesis that simulated human speech. The students in the study did not have experience using TTS tools in the classroom before the study. The TTS application provided a synchronized visual and auditory presentation of the text (Bone & Bouck, 2017). I designed this study to evaluate the impact of the C-Pen on the reading ability of third-grade students with learning disabilities. During the study, students used the C-Pen for 6 weeks to assist with reading texts within their classrooms. This section addresses the (a) description of the C-Pen, (b) training phase, and (c) innovation phase.

Description of the C-Pen

The C-Pen is a portable and lightweight reading pen that can define single words and read printed sentences aloud with a “human-like digital voice” (Scanning Pens, n.d., para. 1; see Figure 3.4). The C-Pen can be a valuable tool to assist people who have dyslexia, reading or vision difficulties, or need assistance with reading. The C-Pen is used by scanning one or two lines of text at a time. The C-Pen can recognize and read American and British English, French, and Spanish (Scanning Pens, n.d.). The audio can be played through built-in speakers or headphones. The C-Pen can store scanned text files and hold up to one gigabyte of data. The C-Pen has a rechargeable battery that can last for several hours.

During the innovation phase of the study, students learned the voice speed, volume, and text reader features of the C-Pen. The voice speed feature allowed students to set the speed they preferred the text to be read aloud to further optimize understanding. The volume feature allowed students listen to words read aloud or sentences or paragraphs. The text reader feature allowed students to scan printed text and hear the text being read aloud by highlighting the words with the device.



Figure 3.4. C-Pen.

Training Phase

The C-Pen was used in two phases in this study. Students' first introduction to the C-Pen occurred in the training phase of the study (see Appendix D). The student participants received training and practice using the C-Pen in a conference room to enable the students to physically distance 6 feet due to the COVID-19 pandemic. Participants were trained in a group session over 5 days for 30 minutes per day, during which they practiced using the C-Pen. Five lessons presented students with skills that assisted with the implementation of the innovation.

During the first lesson, participants learned how to hold the C-Pen and turn it on and off, and pretended to draw a straight line across a piece of paper. This lesson helped them with learning how to scan texts during day two. In the last part of the first lesson, participants received training on charging and storing the C-Pen. In lesson two, participants scanned words, phrases, and sentences to hear how words were read aloud. Also during lesson two, the participants learned how to select the reading speed and volume that was most comfortable for them. In lesson three, participants learned how to use the headphones and where to plug in the earbuds. Also during lesson three, students were provided with a variety of leveled texts, including kindergarten, first-, second-, and third-grade texts, to practice using the features (i.e., speed, volume, and text reader features). In lesson four, participants practiced scanning individual words, whole sentences, and one entire paragraph of text. The training followed the repetition of lesson three during lessons four and five. At the end of the fifth lesson, I used the training protocol to assess students' ability to use the C-Pen (i.e., turn it on and off, charge it, use the volume, use headphones, scan, and listen to text read). The participants were able to

stop the training because all four students could complete all tasks with 100% accuracy. No participants needed to continue the training after the 5 days.

Innovation Phase

The students used the C-Pen in the classroom during the innovation condition phase of the study. The students kept the C-Pen in the classroom during the 6 weeks of the innovation and C-Pens were charged at the end of the school day and left at the charging station in the classroom. The participants retrieved their C-Pens at the beginning of each school day and returned them at the end of the day to be charged. The participants were allowed to use the C-Pen in the classroom with any written text the classroom teacher provided. The students used the C-Pen throughout the school day to assist with all activities presented in text form, including all activities, assignments, quizzes, and tests. The students could use the C-Pen during reading, math, writing, social studies, science, or any other subject of their choice. The teacher did not guide the students to use the C-Pen. The students used the C-Pen when they wanted to use it for any of the assignments.

Data Collection

I used both quantitative and qualitative data sources to evaluate the impact of the use of the C-Pen on the reading ability of students with learning disabilities at Eastview Elementary/Middle School. Appendix H is the approval letter from the Internal Review Board from the University of South Carolina to conduct this research study. The data collection plan for this study is outlined in Table 3.2, which provides an alignment of the research questions and data sources. The quantitative data collection instruments included a pretest and posttest and the qualitative methods included observations, individual

teacher interview, and student interviews. This section details the (a) quantitative data sources, and (b) qualitative data sources.

Table 3.2 *Research Questions and Data Sources*

Research questions	Data sources
RQ1: How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?	Pretest and posttest (DRA2)
(a) How does the use of the C-Pen affect the reading level of third-grade students with learning disabilities?	Observations
(b) How does the use of the C-Pen affect the reading comprehension of third-grade students?	Student interviews
(c) How does the use of the C-Pen affect the oral reading fluency of third-grade students with learning disabilities?	Teacher interview
RQ2: What are the perceptions of third-grade students with learning disabilities about the C-Pen to support their reading?	Student interviews
RQ3: What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?	Teacher interviews

Quantitative Data Sources

This study involved the use of a pretest and posttest to determine the impact of the C-Pen by comparing the scores of the Developmental Reading Assessment-2 (DRA2) given prior to the innovation and after the innovation. The DRA2 was used as the pretest and posttest to evaluate the impact of participants' reading level, comprehension, accuracy, and rate before and after the use of the C-Pen (Pearson Education, 2011). The DRA2 is a benchmark assessment designed to assess the reading ability of individuals from kindergarten through eighth grade. The DRA2 has a range of stories leveled from one to eight, which are measured by text difficulty. The DRA2 reading assessments were different for each student participant because all four participants read on different reading levels. The DRA2 involved four administering steps: (a) the teacher assessed the

participants' reading engagement, (b) the teacher assessed the participants' oral reading, (c) the teacher assessed the participants' comprehension and printed language scores, and (d) the teacher analyzed the participants' reading level (Pearson Education, 2011). Even though the DRA2 focused on the previous four steps, this study focused on the findings from three of those steps, including findings of oral reading fluency, comprehension, and reading level.

The DRA2 is given by the classroom teacher three times per year to measure student achievement in reading, focusing on reading level, engagement, reading comprehension, and oral reading fluency. Engagement was a part of the DRA2 administration; however, the results of student engagement were not included in this study. The participants read a passage aloud and retold the story with minimal prompting. The DRA2 provided a measure of accuracy by dividing the number of words read correctly by the total number of words in the story. The teacher recorded the errors using the guidelines provided in the testing manual. Comprehension was assessed by asking participants to retell the story and answer open-ended questions. If a participant could not comprehend what was read, they moved down one oral reading fluency level. The DRA2 tests and rubric could not be disclosed in this study due to copyright issues.

The DRA2 performance levels were determined by the following scoring categories: Emerging (Levels A–12), Developing (Levels A–12), Intervention (Levels 14–40), Instructional (Levels 14–40), Independent (Levels A–40), and Advanced (Levels 4–40; Pearson Education, 2011). The minimum score reported for individuals can be a level A and the maximum score reported for individuals can be a level 80. A score of a

reading level of 30 indicates an independent reading level that is on-level for the third grade.

The reliability of the DRA2 has been examined for internal consistency, passage reliability, test–retest reliability, and inter-rater and rater expert reliability (Pearson Education, 2011). The internal consistency reliability provides information on how well the test items measure the same variable and behavioral trait (Pearson Education, 2011). Cronbach’s alpha is an indicator of internal consistency that is based on inter-item correlations, in which the higher the alpha the higher the reliability of the measure (Pearson Education, 2011). The internal consistency was reported with Cronbach’s alpha at 0.762 for oral fluency and 0.722 for reading comprehension (Pearson Education, 2011). Each reading level has two to four reading passages that are a combination of fiction and nonfiction. Overall, the DRA2 shows high-moderate to high reliability and was determined to be a reliable instrument because it produces stable, consistent results over time from different raters, samples of work, and content (Pearson Education, 2011).

The validity of the DRA2 was examined for content-related, criterion, and construct validity (Pearson Education, 2011). The findings showed the DRA2 is a valid assessment for measuring oral reading fluency and reading comprehension. More specifically, the findings showed the subtests measure the constructs they were designed to measure, including oral fluency and reading comprehension. The results also showed the constructs correlate with one another at a moderate level (Pearson Education, 2011). There is a strong correlation between age and the accuracy of reading more challenging texts (Pearson Education, 2011).

Qualitative Data Sources

Observations. Observations are a central and fundamental method used to discover and explain complex interactions in natural social settings (Bloomberg & Volpe, 2016). The purpose of the observations in this study was to observe participants using the C-Pen in their natural setting. During the observations, I recorded students' use of the C-Pen and also the number of opportunities for them to use the pens. I observed the student participants six times during their reading block and collected data as the students used the C-Pen in the classroom. I gathered information firsthand as it was happening rather than only relying the classroom teacher's perspective.

During the time of the observations, I had to have minimal proximal interactions due to the COVID-19 safety precautions. As an adult outside of the class cohort, I had to remain at least 6 feet from the students. I observed students from a distance as they completed activities using the C-Pen.

I visited at the beginning of the reading block to allow time to view the entire class period. I visited each class once a week during the 6 weeks of the study. I attended classes from the beginning of the reading period to the end. The reading block usually lasts 90 minutes per day and took place in the morning from 7:50 a.m.–9:20 a.m. I used an Observation Protocol (see Appendix E) to document field notes on the frequency of use of the C-Pen and other behaviors. While taking notes, I used thick and rich descriptions of details of events happening in the classroom. Vivid details of events allow readers to be able to envision the experience of the research. The purpose of thick descriptions was to create credible statements that produced the feelings the readers

would have experienced, or could have experienced, during the events described in the study (Creswell & Miller, 2000).

Student interviews. It was my goal to provide a detailed description of student perceptions about the use of the C-Pen. I conducted semi-structured, open-ended student interviews after the innovation phase of the study (see Appendix F). I conducted an individual interview with each of the four students in my office and recorded each using a voice recorder app with permission from the students and their parents. See Table 3.3 for the alignment of the research questions and interview questions. Student interviews provided detailed and firsthand perceptions of the students' experiences. Another advantage was that the interviews permitted me as the researcher to investigate further and ask for clarification of a participant's response to given questions (Mertler, 2017). I contacted the teacher to schedule a time for the student interviews. The interviews lasted approximately 10 minutes for the students. An example question was: How did you feel about reading before using the C-Pen? I transcribed each interview within 48 hours of completion.

Table 3.3 *Research Question and Student Interview Question Alignment*

Research question	Interview questions
RQ2: What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?	<ol style="list-style-type: none"> 1. Tell me about your experience with using the C-Pen. 2. How did you feel about reading right now? <ol style="list-style-type: none"> a. Can you give me an example? 3. How does using the C-Pen change your feelings about reading? <ol style="list-style-type: none"> a. Can you give me some examples? 4. How have you used the C-Pen in your classroom? <ol style="list-style-type: none"> a. Can you give me some examples?

Research question	Interview questions
	<ol style="list-style-type: none"> 5. How does using the C-Pen change your reading in the classroom? <ol style="list-style-type: none"> a. Can you give me some examples? 6. How does using the C-Pen change your reading fluency? <ol style="list-style-type: none"> a. How fast or slow you read? 7. How does using the C-Pen change your comprehension, which is how you understand what you read? <ol style="list-style-type: none"> a. Can you give me some details? 8. Which features of the C-Pen did you use the most and which did you use the least in class? 9. Is there anything else you would like to share with me?

Teacher interview. I conducted the teacher interview in my office after the 6 weeks of the innovation phase of the study. The interview lasted 20 minutes and was recorded using a voice recorder app. I used the teacher interview to gather information about the teacher’s perception of the C-Pen and the support of students with learning disabilities. The interview was semi-structured with open-ended questions; however, I occasionally asked the teacher to explain answers in more detail to capture a clearer understanding. A sample question was. How have your students used the C-Pen during class? (see Appendix G). See Table 3.4 for the alignment of the research questions and interview questions.

Table 3.4 *Research Questions and Teacher Interview Question Alignment*

Research question	Interview questions
RQ3: What are the third-grade teacher’s perceptions of the use of the C-Pen	<ol style="list-style-type: none"> 1. How have your students used the C-Pen during class? <ol style="list-style-type: none"> a. Please give examples. 2. What do you think about the effects of the C-Pen?

Research question	Interview questions
to support the reading of students with learning disabilities?	<ul style="list-style-type: none"> a. Please give examples. 3. Tell me about your students' reading comprehension before and after using the C-Pen. 4. Tell me about your students' reading accuracy before and after using the C-Pen. 5. Tell me about your students' oral reading fluency before and after using the C-Pen. 6. How often did your student use the C-Pen during the 6-week period? <ul style="list-style-type: none"> a. Can you give me some examples? 7. How do you feel about the use of the C-Pen? <ul style="list-style-type: none"> a. Can you give me some examples? 8. What were your views on using the C-Pen prior to this study? <ul style="list-style-type: none"> a. Have your views changed? 9. Based on your observations, would you recommend the C-Pen to other students who are having reading difficulty? <ul style="list-style-type: none"> a. Why or why not? 10. What recommendations do you have to improve this type of accommodation for students using the C-Pen? 11. Is there anything else you would like to share that I did not ask?

Data Analysis

I used descriptive statistics and inductive analysis to analyze the data in this action research study. Table 3.5 shows the alignment of the research questions, data sources, and analysis methods (Creswell & Creswell, 2018). This section covers the quantitative analysis, qualitative analysis, integration of data analysis, and representation of findings.

Table 3.5 *Research Questions, Data Sources, and Analysis Methods*

Research questions	Data sources	Analysis methods
RQ1: How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?	Pretest and posttest	Descriptive statistics
(a) How does the use of the C-Pen affect the reading level of third-grade students with learning disabilities?	Interviews	Inductive analysis
(b) How does the use of the C-Pen affect the reading comprehension of third-grade students with learning disabilities?	Observations	Inductive analysis
(c) How does the use of the C-Pen affect the oral reading fluency of third-grade students with learning disabilities?		
RQ2: What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?	Student interview	Inductive analysis
RQ3: What are the third-grade teacher's perceptions of the use of the C-Pen to support the reading of students with learning disabilities?	Teacher interview	Inductive analysis

Quantitative Analysis

I analyzed the quantitative data from the DRA2 pretest and posttest using descriptive statistics to identify changes in the participants' reading skills. I compared the pretest and posttest scores for each student participant in the areas of reading level, reading comprehension, and oral reading fluency to determine the impact of the C-Pen on their reading. Scores for each student's DRA2 assessment are detailed in the next chapter.

Qualitative Analysis

I analyzed the qualitative data using inductive analysis (Mertler, 2017). In order to reduce the number of data, I organized data into important patterns and themes, and then followed a three-step process that included organization, description, and interpretation of

data. I began the process by recording and transcribing the student and teacher interviews. I typed the transcriptions and then uploaded them to Delve, an online qualitative data analysis software that stores and organizes information such as qualitative data in research. After uploading the transcripts to Delve, I examined each through in vivo coding, structural coding, and initial coding. Following the initial coding process, I examined the data and began organizing.

The organization step involved first cycle coding, during which I retrieved data from the interview transcriptions to develop a coding scheme by determining which data had similar types of information. The second step of the first cycle coding involved naming the main features of the categories from the coding of data. In this step, I made connections between the data and the research questions. From these data, I developed categories, themes, and assertions. I discovered several themes through the first cycle coding process. I refined each theme that emerged and combined and noted the occurrences of patterns. Those themes led to the interpretation of data to answer the research questions. The final step was to interpret all data. I searched for behaviors and aspects of the data that answered questions and provided challenges to current or future practice. The inductive analysis emerged from direct observations and interviews with participants (Patton, 2002). I counted how many students discussed each statement of each code and examined the codes that occurred the most often. The themes are discussed in the next chapter. The qualitative analysis uncovered categories, patterns, and themes.

Observations. In the analysis of the classroom observations, I examined the narratives for patterns that occurred from each observation. I recorded observational data using the Observation Protocol (see Appendix E). I identified narrative descriptions that

were specific to each observation day. I began the process by transferring information from the observation protocols into a Microsoft Word document. I then documented the common findings from the observations.

Interviews. The analysis of qualitative data requires sequential steps to be followed, from the specific to the general, and involves multiple levels of analysis (Creswell & Creswell, 2018). I transcribed, coded, and analyzed the interviews using a qualitative software program, Delve. The process began with the organization step of the inductive analysis. I gathered data from face-to-face individual interviews with students and the teacher and transcribed each interview verbatim from an audio recording. Transcribing the interview word-for-word helped in producing more accurate and reliable results. In the second step of this inductive data analysis, I described the main categories identified through the coding process. Last, I interpreted themes to answer the research questions.

Integration of Data Analysis

I combined the quantitative and qualitative data analyses for interpretation and merged the results of both analyses. By merging the qualitative and quantitative data, analysis was complete. Finally, I interpreted the information in search of challenges to current and future practice (Mertler, 2017).

Representation of Findings

The findings are displayed through figures, narratives, and tables. I represent my findings using narratives and themes with thick, rich descriptions. Tables are used to display themes collected from observations, a teacher interview, and student interviews.

Procedures and Timeline

I conducted this study beginning in August 2020 and ending in November 2020. The procedures of this research were as follows: pre-innovation phase, baseline phase, training, innovation condition, post innovation phase, interviews, and data analysis. Each of the parts is described with a timeframe in Table 3.6.

Table 3.6 *Procedures and Timeline*

Phase	Expectations	Timeframe
Pre-innovation phase	Identify participants Explain confidentiality	Two weeks
Baseline phase	Teacher administered the DRA2 (pretest)	Two weeks
Training	Train all participants on using the C-Pen	One week
Innovation condition	Introduce the C-Pen for classroom use during classroom activities, quizzes, and tests	Six weeks
	Classroom observations	Four times
Post innovation phase	Teacher administered the DRA2 (posttest)	Two weeks
Interviews	Complete individual interviews with the students and teacher	Two weeks
Data analysis	Analysis of pretest and posttest, transcribe interviews, analysis of interviews and observations	Ten weeks

Baseline Phase

The teacher administered the DRA2 to all students to determine their current reading level, reading comprehension, reading accuracy, and reading rate. The study included four student participants and one teacher participant.

Training

Before the innovation condition began, participants were engaged in a week-long training session on the use of the C-Pen. The participants were instructed on how to turn

on the C-Pen, highlight text, and other useful features. Participants practiced with texts that were below, on, and above grade level. The training ended after the 5-day period and all participants were able to turn on the C-Pen and use basic features with 100% accuracy.

Innovation Condition

Immediately after the participants completed the baseline phase, they began using the C-Pen within the classroom during all classroom activities for a total of 6 weeks. Student participants used the C-Pen during class for all activities, assignments, quizzes, and tests that required reading in the classroom. I completed observations during the all 6 weeks of the innovation phase.

Post Innovation

The classroom teacher administered the DRA2 posttest. The teacher assessed the students' reading level, reading comprehension, reading accuracy, and reading rate.

Interviews

Following the post innovation phase, the participants engaged in individual interviews to describe their experience with using the C-Pen. I designed the interview questions to explore the participants' perceptions of using the C-Pen. I recorded all interviews and transcribed them within 48 hours. After the transcription of the data, I ensured trustworthiness through member checking to ensure the accuracy of the notes.

Data Analysis

Once all data were collected from the pretest, innovation, posttest, and interviews, I analyzed them using triangulation (Mertler, 2017). First, I obtained and analyzed the quantitative data from the DRA2 pretest and posttest. Second, I obtained qualitative data

from the observations and interviews. I transcribed the observations and interviews verbatim. Third, I reduced the number of narrative data by finding themes or patterns and similarities or differences within the data (Mertler, 2017). Finally, after all themes were found, I brought all data together to interpret the results to look for commonalities between the quantitative and qualitative data. This data analysis phase took 10 weeks to complete.

Rigor and Trustworthiness

Rigor and trustworthiness refer to how valid and dependable the data that have been collected are and whether they measure what they purport to measure (Mertler, 2017). I used various methods to ensure rigor and trustworthiness, including (a) triangulation; (b) member checking; (c) peer debriefing; and (d) thick, rich descriptions.

Triangulation

In triangulating data, research findings are supported by using multiple methods and sources of data to enhance the rigor and trustworthiness of those findings (Mertler, 2017). Triangulation is defined as a technique that facilitates the validation of data through cross verification from two or more sources (Honorene, 2017). I used triangulation of both quantitative and qualitative data to add strength to this study. I collected and analyzed quantitative assessment data, and then interviewed third-grade students and their teacher as qualitative measures. I triangulated the data using a convergent method by bringing together and analyzing the DRA2 pretest and posttest and the inductive analysis from the student and teacher interviews.

Member Checking

Member checking is the process of asking participants who were involved in the study to review the accuracy of the research report (Mertler, 2017). The benefits of member checking include determining the accuracy of the qualitative findings by taking the final report and determining whether the participants feel it is accurate (Creswell & Creswell, 2018). To accomplish this, I was in close communication with the teacher participant of the study by asking her to verify that I documented information correctly. I first asked her to read the DRA2 test descriptions and testing results to make sure they were correct. After I transcribed the teacher interview, I asked the teacher to verify that the transcription was documented in the correct context. After the second coding of the data, I asked the teacher in the study to review the codes and themes to make sure my interpretations of interview data were correct. Because the participants are the ones studied in the experience, they would have specific information about the context in which the experiences occurred, their reasons for the occurrence, and their responses (Loh, 2013). I asked the student participants to verify the transcriptions of their interviews. I shared a copy of the transcriptions with the student participants and read the transcriptions to them. Because of their difficulties with reading, I wanted to make sure that they understood all of the information that was transcribed. I will give their parents a copy of the final report.

Peer Debriefing

Peer debriefing requires the researcher to work with others to help reflect on and critique the research (Mertler, 2017). Peers in a similar field, or working within a similar area of research, would have some familiarity with the relevant research literature and

research methods and would have engaged in similar research work, so they would be able to provide some corroboration concerning the interpretation of the data (Loh, 2013). In this study, I held peer debriefings with my dissertation chair. After the first cycle coding and during the second cycle coding, my dissertation chair reviewed and asked questions about the research, which strengthened my research practice and helped me grow as a professional (Hail, Hurst, & Camp, 2011).

Thick, Rich Descriptions

Thick, rich descriptions are included in the setting and participants section of this chapter. Vivid details of the setting, participants, and events enable readers to be able to envision the experience of the research. The purpose of a thick description is to create credible statements that produce for the readers the feeling that they have experienced or could have experienced the events being described in the study (Creswell & Miller, 2000).

Plan for Sharing and Communicating Research Findings

I will share the findings of this research with stakeholders of varying levels of involvement in the local, regional, and national contexts. Before the beginning of the 2021–2022 school year, I will conduct a formal meeting with the study participants, including the teacher, students, and students’ parents. During the meeting, I will present information from all phases of the research using visual aids. The meeting will be held in the school’s cafeteria to allow for physical distancing due to COVID-19. A protocol for sharing the information will be explained to the participants. It is essential that a protocol including specific information about sharing results be adequately reviewed and

considered (Ferris & Sass-Kortsak, 2011). I will allot a few minutes for questions and answers at the end of the meeting, as discussed by Mertler (2017).

Second, I will share the research with other stakeholders, including the school board, superintendent, director of student services, and school building administrators, at the first board meeting of the 2021–2022 school year. This meeting will be held at the district office. During this meeting, the participants' confidentiality will be protected. This meeting will be a formal meeting in which I will share the research, results, and action plan. The action plan is described in Chapter 5 under my personal implications of this study. According to Mertler (2017), "The results of action research can be used as an effective means of enabling your school or district to make educational decisions that are better informed" (p. 261). Any recommendations within the action plan will need to be approved by the administrative staff and the school board before any change can happen within the school as opportunities present themselves.

Finally, I will share my findings at the Association for Educational Communications and Technology (AECT) in November 2021. At the conference, I will share my findings with professionals who are interested in this type of research regarding TTS technology tools and may want to build on the topic of my study.

CHAPTER 4

ANALYSIS AND FINDINGS

The purpose of this action research was to evaluate the impact of the C-Pen on the reading skills of third-grade students with learning disabilities at Eastview Elementary/Middle School. Three research questions and three sub-questions guided the collection of data for this study:

1. How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?
 - a. How does the use of the C-Pen affect the reading level of third-grade students with learning disabilities?
 - b. How does the use of the C-Pen affect the reading comprehension of third-grade students with learning disabilities?
 - c. How does the use of the C-Pen affect the oral reading fluency of third-grade students with learning disabilities?
2. What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?
3. What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?

This chapter presents an analysis and findings of the quantitative and qualitative data collected during this action research. The chapter includes (a) quantitative findings and analysis, (b) qualitative findings and interpretations, and (c) a chapter summary.

Quantitative Findings and Analysis

This section presents the analysis method and results for the quantitative data collected on four third-grade student participants with learning disabilities. The quantitative data source was a pretest and posttest using the DRA2. The following is a description of the methods used during the quantitative analysis of this action research and concludes with a summary of each student participant's findings. Due to the small number of participants, the internal reliability of the pretest and posttest was not calculated.

Developmental Reading Assessment 2

The DRA2 is a standardized assessment designed to assess the reading proficiency of students in kindergarten through eighth grade. The kindergarten through third grade (K-3) version of the DRA2 was used as the quantitative pretest and posttest to measure participants' reading level, reading comprehension, and oral reading fluency. The DRA2 was given twice during the study, including at the beginning of the school year and then again after 12 weeks of instruction, of which 6 weeks were the actual innovation. After each administration, I organized the DRA2 data and prepared them for analysis. All identifying information was removed from protocols and pseudonyms were assigned.

The DRA2 requires students to read a selected story aloud while the teacher documents their reading behaviors. This measure consists of fiction and nonfiction leveled texts with multiple story titles, reading levels, and genres. The DRA2 consists of three subcategories that help develop the student's independent reading level: reading engagement, reading comprehension, and oral reading fluency. The DRA2 reading levels

are determined by multiple scoring categories that correlate with specific grade levels (see Table 4.1). For example, a reading level of 30 indicates an independent reading level on-level for the third grade.

Table 4.1 *Grade Levels to Developmental Reading Assessment-2 Levels*

Grade level	DRA2 level
Kindergarten	A-3
First grade	4-16
Second grade	18-28
Third grade	30-38

For this research study, the teacher administered the DRA2 to the four third-grade students with learning disabilities as a pretest before and then as a posttest after the C-Pen innovation. The teacher administered the DRA2 in the classroom individually with each student participant. The teacher chose a book from the DRA2 series for students to read during the pretest based on the information she gathered about their interests from individual student reading conferences or that were similar to the students' previous year's reading level by using a list of comparable titles. During the individual conference with each student, the teacher asked questions to determine their reading interests and ability. For the posttest, the teacher chose the book title based on the level the student scored on during the pretest. Given instruction on what and where to read, the student read a specific section of the book aloud. If students could not read the chosen book with fluency, another book was chosen one level below the previous.

The DRA2 Teacher Observation Guide was used to record scores and other reading behaviors. Included in the Teacher Observation Guide was the DRA2 Continuum, which was used to score students' reading behaviors based on specific areas

of reading. The DRA2 Continuum scores were analyzed separately for reading engagement, comprehension, and oral reading fluency to identify the students' reading level (Pearson Education, 2011). The DRA2 Continuum rated student performance from four levels, including 1 = Intervention, 2 = Instructional, 3 = Independent, and 4 = Advanced.

The teacher followed a script outlined on the DRA2 Teacher Observation Guide to give students instructions on completing the assessment. The teacher also recorded the time it took for students to read the texts. The teacher then asked a series of questions about the text and calculated scores using a scoring rubric on the pretest and posttest. Example questions from the DRA2 were: What do you think the author is trying to tell you in the story, and why do you think that was important (Pearson Education, 2011)? The number of questions and types of questions varied depending on the students' reading level. All four student participants' tests were different because they all were on different reading levels.

Reading level. Independent reading levels measured how well the students could read independently without others' assistance. The total reading level scores were obtained from three sections: engagement, comprehension, and oral reading fluency. The DRA2 independent reading level scores were established from scores calculated from the DRA2 Observation Teacher Guide. The results demonstrated all four students' reading levels increased after the innovation. Table 4.2 shows students' DRA2 reading level pretest and posttest scores.

Table 4.2 *Developmental Reading Assessment-2 Reading Level Scores*

Student	Pretest	Posttest
Carter	24	28
Shon	20	24
Lee	16	18
Chris	4	6

Table 4.2 shows Carter achieved a reading level score of 24 at the beginning of the semester and scored 28 on the posttest. Shon's reading level increased from 20 on the pretest to 24 on the posttest. Lee's pretest reading level score was 16, which improved by 2 points to 18 on the posttest. Christ had the lowest reading level compared to the other students, but his reading level increased from 4 to 6 after the 6-week innovation.

Reading comprehension. The DRA2 measures reading comprehension, or students' ability to understand what they read, focused on seven key areas. Each student's areas of focus were different according to their reading level. Carter's pretest, Lee's posttest, and Shon's pretest and posttest focused on the areas of prediction; retelling: sequence of events; retelling: characters and details; retelling: vocabulary; retelling: teacher support; interpretation; and reflection (Pearson Education, 2011). Carter's posttest focused on the features of prediction; nonfiction text features; scaffolded summary; scaffolded summary: vocabulary; literal comprehension; interpretation; and reflection (Pearson Education, 2011). Lee's pretest and Chris' pretest and posttest focused on five out of seven of the same areas except their test focused on previewing instead of prediction and making connections instead of interpretations (Pearson Education, 2011). The previewing subsection is assessed before the DRA2 leveled book is read. The teacher cued students through prompts such as, "Tell me three things that

might happen in the story” (McCarty & Christ, 2010). Students could not look at the book after the initial reading. The teacher used the DRA2 Continuum to score this section of the test. To calculate reading comprehension scores, the teacher summed all seven of the previous features using point values. The point values range from 1 to 4 and were assigned to each question to obtain a total reading comprehension score with a possible total of 28 points. Table 4.3 shows findings for each student.

Table 4.3 *Developmental Reading Assessment-2 Comprehension Scores*

		Retelling						
		Prediction; Previewing	Sequence of events	Characters and details	Vocabulary	Teacher support	Interpretation; Connections	Reflection
Carter	Pretest	4	3	2	2	3	2	3
	Posttest	4	3	3	3	3	2	3
Shon	Pretest	3	2	3	3	2	3	3
	Posttest	3	3	3	3	3	2	2
Lee	Pretest	4	3	3	3	2	3	2
	Posttest	4	3	3	3	3	2	2
Chris	Pretest	3	3	2	3	3	3	3
	Posttest	2	3	3	3	3	3	2

Carter had an overall score of 19 on the pretest and increased to 20 on the posttest. Shon’s scores remained the same at 19 on the pretest and posttest. Lee’s reading comprehension scores also did not change from the pretest to the posttest, in which she achieved 20 points. Chris scored 19 points on the pretest and 19 points on the posttest.

Oral reading fluency. This section of the DRA2 required students to read aloud to the teacher and the teacher recorded specific details related to their reading behaviors

and performance. The teacher used a record of the oral reading guide to track six types of errors, including substitutions, omissions, insertions, reversals, incorrectly sounded out words, and words spoken by the teacher. The DRA2 measure of oral reading fluency score was calculated based on words read per minute (WPM), accuracy, expression, and phrasing.

To establish the students' reading rate, the WPM was calculated. The teacher timed the student reading a specific part of the text. The number of seconds it took for each student to read the text was divided by the number of words, multiplied by 60 seconds. This calculation provided the WPM (see Table 4.4). Carter read 71 WPM on the pretest and improved to 75 on the posttest. Shon had a significant gain from the pretest to the posttest, improving by 38 WPM. Lee's pretest score was 47 and the posttest score improved to 69 WPM. Chris could not receive a WPM score based on his reading levels of 4 and 6 because reading levels A–12 were not timed and WPM scores were not calculated.

Table 4.4 *DRA2 Words per Minute, Miscues, and Word Count*

		WPM	Miscues	Word count
Carter	Pretest	71	5	170
	Posttest	75	2	168
Shon	Pretest	46	4	153
	Posttest	84	3	172
Lee	Pretest	47	10	258
	Posttest	69	2	141
Chris	Pretest	Not calculated	3	54
	Posttest	Not calculated	2	72

Note. WPM = words per minute.

Student oral reading fluency was rated individually using the DRA2 Continuum. The DRA2 Continuum provided the four areas of oral reading behaviors. Carter's, Shon's and Lee's pretest and posttest scores were calculated in the areas of expression, phrasing, rate, and accuracy, whereas Chris's pretest and posttest areas of focus were phrasing, monitoring/self-corrections, problem-solving unknown words, and accuracy (Pearson Education, 2011). Each reading behavior recorded was given a point value of 1–4, summing to a possible total of 16 points. Carter scored 11 on the pretest and 13 at the end of the innovation. Shon achieved 9 points on the pretest and improved to 12 on the posttest. Lee improved her score by 2 points from the pretest to posttest, scoring 11 and increasing to 13 points on the posttest. Chris's scores remained the same on the pretest and posttest at 11 points.

Qualitative Findings and Interpretations

The following section presents the results of the three sources of qualitative data: observations, student interviews, and a teacher interview. All students in this section are referred to using pseudonyms. This section includes descriptions of (a) qualitative data sources, (b) analysis of qualitative data, and (c) presentation of findings.

Qualitative Data Sources

The following section provides an overview of the three methods of qualitative data for this study: (a) observations and (b) interviews.

Observations. I conducted a total of six classroom observations of the four student participants and used the Observation Protocol Checklist (see Appendix E) to document how students used the C-Pen during their reading block. Observations began 1 week after the students received training on how to use the C-Pen and were conducted

over a 6-week period. Observations gave a firsthand account of the students' use of the C-Pen that the students would not have been able to report during interviews (Bloomberg & Volpe, 2016). I also used the observations to validate and interpret the research findings.

COVID-19 protocols mandated changes to how our classrooms operated and how observations had to be conducted due to physical distancing and mask-wearing. Because of COVID-19 protocols, interactions were limited. Before COVID-19, our instructional curriculum promoted student engagement, interactions, and movement around the classroom. Typically, students and teachers were able to move around the room freely. During observations, there was limited movement among the teacher, students, and myself.

Due to COVID-19, I had to follow established safety protocols and steps before observing and during each observation:

- I received permission from the other administrative staff to conduct observations over 6 weeks.
- I discussed safety measures with the school nurse because our school followed guidelines set by the CDC (2019) to wear masks and social distancing of 6 feet.
- I verified each date and time I would observe with the classroom teacher so she could sanitize the area where I would sit and make sure necessary personal protective equipment was available.

Interviews. I conducted four student interviews and one teacher interview for this study. Interviews were semi-structured and provided an opportunity for each participant

to express their perception of the impact of using the C-Pen on reading skills. Student interviews consisted of nine questions (see Appendix F) and the teacher interview consisted of 11 questions (see Appendix G). The student interviews took about 10 minutes to complete and the teacher interview took about 20 minutes to complete. The duration of the student interviews was short due to the students' grade level and experiences in answering questions formally about their use of the C-Pen. All interviews took place on separate days, in the morning in my office. I conducted the student interviews during their special area time and the teacher interview during her planning block. After all interviews were complete, I transcribed each verbatim into a Microsoft Word document. After the interview transcriptions were verified, I analyzed the responses from each interview using a multiple-step process.

Analysis of Qualitative Data

This section details the data analysis from (a) observations, and (b) student interviews and teacher interview.

Observations. The observations were useful in generating a description of the students' use of the C-Pen during the innovation phase. I conducted observations of the four students of the study during their reading instruction in their classroom. Pseudonyms were used for each participant while reporting the observations. Students on the form are referred to as Participant 1 (Carter), Participant 2 (Shon), Participant 3 (Lee), and Participant 4 (Chris). The observation notes were handwritten, summarized, and presented through detailed narratives. An example of a completed observation is represented in Figure 4.1.

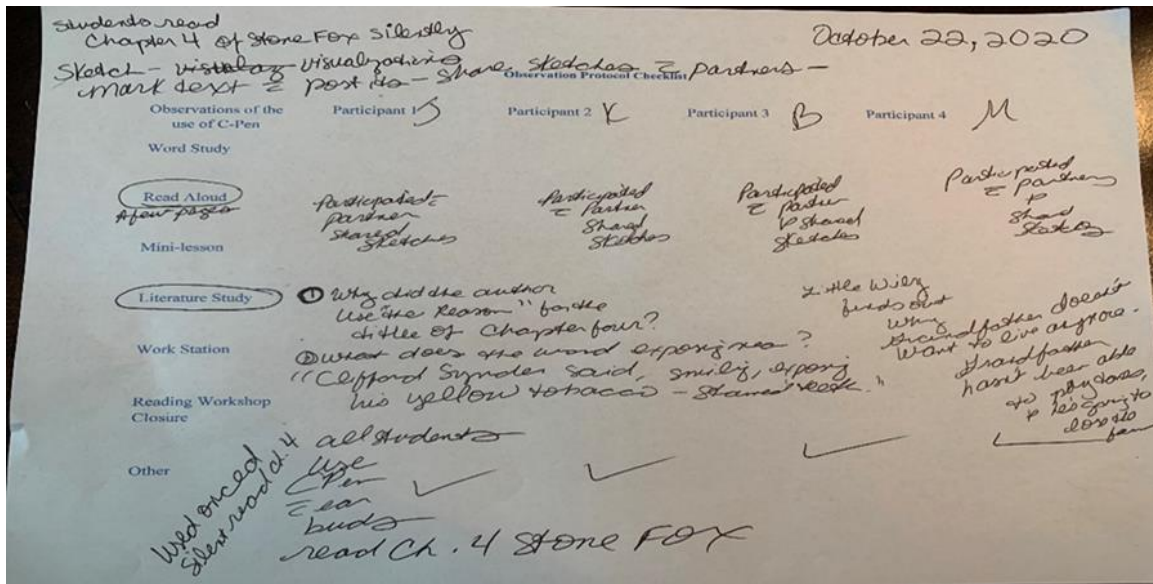


Figure 4.1. Example of completed observation protocol.

The activities used during the six classroom observations are described in Table 4.5.

Table 4.5 Activities Students Completed with the Help of the C-Pen

Observation	Activity
1	Completed genres test with 10 multiple-choice questions.
2	Read a passage using context clues to answer open-ended questions.
3	Read Chapter 4 of <i>Stone Fox</i> by John Reynolds Gardiner.
4	Read Chapter 10 of <i>Stone Fox</i> by John Reynolds Gardiner and summarized.
5	Read poem <i>Twas the Night Before Thanksgiving</i> by Dav Pilkey and answered open-ended questions.
6	Read <i>We Gather Together...Now Please Get Lost</i> by Diane de Groat, then completed either a crossword puzzle or answered multiple-choice questions.

Week one observation. The first observation included all four students. I observed students for 90 minutes of the reading block. The instruction was about historical fiction and part of a unit on genres. First, the teacher presented a PowerPoint on historical fiction and asked questions during the PowerPoint presentation. The teacher used the smart board to project the book *Pink and Say* by Patricia Polacco from YouTube. Carter

participated by answering a question the teacher asked aloud. Shon, Lee, and Chris did not answer any of the teacher's questions. All students sat and listened during this time. In a formative assessment of what was taught on historical fiction, the teacher instructed students to reflect on events from the story and write an explanation of Pink's causes and the effects of Say surviving. Students wrote an explanation in their journals that were stored under their desks. All of the previous activities took approximately 60 minutes.

The teacher then distributed a 10-question multiple-choice test on genres. Only the four student participants had the opportunity to use the C-Pen during this test because it was paper based. All four students took out the C-Pen without the teacher instructing them to do so. All four students turned on the C-Pen, connected earbuds, and used the pen to help read the questions and answer choices on the genre test. The teacher walked around the room as students completed the test. The teacher assisted Chris with vocabulary and context clues. The teacher did not assist the three other participants. The teacher used the smart board with Kahoot to review the answers. Students checked their answers using Kahoot. The four students completed the assignment at the same time as their peers independently. All four students scored 100% on the test.

Week two observation. The second week's observation took place during the last hour of the reading block. I was not able to observe during the entire 90-minute block due to an unforeseen circumstance. Carter, Shon, and Chris were present during this observation, and Lee was absent. The teacher reviewed the concept of suffixes using examples on the smart board. All students sat and listened. Carter and Shon participated by answering questions the teacher asked aloud. Chris did not answer any of the questions. The teacher then told students they would read a passage called "The Science

Project” and answer questions. The activity was a paper assignment in which the students had an opportunity to use the C-Pen. Carter, Shon, and Chris used the C-Pen to read the passage and questions. The questions consisted of skills introduced previously, including suffixes, genres, and vocabulary. The passage and questions were retrieved from the teacher as students completed the assignment. Carter was the first to complete the assignment, followed by Shon. Chris was the last of the three to finish among the students in the study; however, he was not the last to complete from the entire class. The students’ grades were not recorded during the observation.

Week three observation. During this third observation, I observed students for the entire 90-minute reading block. All four students were present during the observation. The teacher introduced the lesson on visualization. The teacher explained what visualizations were, then read aloud a few pages of Chapter 4 from the book *Stone Fox* by John Reynolds Gardiner. Each student had their own copy of the novel and followed along. The student participants did not use the C-Pen while the teacher read the text. This lesson on visualization was intended to help students with reading comprehension as they read the book. The teacher modeled the strategy of visualizing and then asked students to use sticky notes to sketch what they visualized during her reading. The students were then asked to share sticky notes with their side-by-side partners. The partners were predetermined and consisted of students who sat nearest to them. Students participated with partners in handing the sticky notes around the plexiglass and were masked due to COVID-19 guidelines for physical distancing. Students discussed their sketches with one another. There was a time for the student pairs to share what the pair had discussed. Shon, Lee, and their partners shared the sketches. Carter and Chris did not have an

opportunity to share during this time because the teacher only called on a few pairs of students to share. The teacher then instructed students to read Chapter 4 silently. All four students in the study used the C-Pen to read the chapter. All four students had earbuds attached so they would not distract the other students.

After reading Chapter 4 and at the end of the class period, the teacher asked the following questions, “Why did the author use ‘The Reason’ for the title of Chapter 4?” and “What does the word ‘exposing’ mean?” None of the students in the study answered the questions. The other students in the class were quicker at answering the questions that day. The questions asked by the teacher were the conclusion to the lesson.

Week four observation. In week four, I observed during the entire reading block, which lasted for 90 minutes. Three of the four student participants were present. Shon was absent during the observation. The teacher began the lesson by introducing the skill of summarizing. The teacher showed a YouTube video that discussed and gave examples of summarizing. The teacher used an anchor chart with examples of summarization. The teacher read the first page from Chapter 10 of *Stone Fox* by John Reynolds Gardiner. Students read along using their books. The C-Pen was used by the student participants when given the assignment of continuing to read the rest of the chapter. The student participants used earbuds while listening to the story being read. There were no issues with students turning on the device or reading the text. The students had an assignment to write a summary of the chapter in their journals once they finished reading the chapter. Carter and Lee completed reading before Chris. Chris did not completely read the chapter before the reading block period ended. Chris needed more time as it takes Chris longer to read. According to his IEP, one of Chris’s accommodations is that he requires extended

time to read. The teacher said the students would continue the assignment the next day. None of the students in the class completed the assignment by the end of the period.

Week five observation. I was able to observe during the 90-minute reading block. Shon was the only student present during this observation. The other three student participants were absent because they were all quarantined due to the COVID-19 pandemic. The students who were quarantined were able to return to school for the sixth week of the study after being quarantined away from school.

The lesson for the day was on synonyms. The teacher introduced a poem along with the following vocabulary words: “aloft,” “terrains,” “embraces,” “clamored,” and “fledged.” The teacher explained the assignment in that students would read “Twas the Night Before Thanksgiving” and answer the open-ended questions that followed. An example of a question was, “What happened to the character at the end of the poem?” The poem was a paper-based assignment. Because Shon was the only student not absent, he was the only one who used the C-Pen during this observation. Shon did not initially take the C-Pen out to use. He tried to read the poem and questions on his own initially. Shon then took the C-Pen out on his own to help him read after looking at the poem and questions for a few minutes. The assignment was not graded during the lesson. The teacher collected papers to grade at a different time.

Week six observation. In week six, I observed three of the four students (Carter, Shon, and Lee) during the entire 90-minute reading block. Chris was absent during this observation. The teacher introduced the lesson with a review of drawing conclusions using a PowerPoint. The teacher explained the concept of drawing conclusions and asked questions about her examples from the PowerPoint. None of the three student participants

engaged in the questioning or raised their hand to answer the teacher's questions about drawing conclusions. Next, the teacher introduced the story *We Gather Together... Now Please Get Lost* by Diane de Groat. The story was read on YouTube for the students and all students listened to it. The teacher gave students a choice of activities to complete after reading that were related to the story. Students had a choice of completing a crossword puzzle, answering four open-ended questions, comparing and contrasting using a Venn diagram, or writing a prompt. Carter and Shon chose the crossword puzzle, and Lee chose the open-ended questions about the book. Carter and Shon completed the assignment using the C-Pen to read the words in the word bank, and Lee used the C-Pen to read the four open-ended questions presented about the story. All three students got the C-Pen out on their own to use with the chosen assignment. All three students appeared comfortable using the C-Pen. The students had fluid use of the C-Pen without pausing to look around for cues from the teacher or classmates. The students did not have any issues using the C-Pen for the different assignments. The students completed the assignments and turned in their work before the 90-minute reading block ended. Lee completed her assignment first, followed by Shon and then Carter.

Summary of observations. Observations enabled me to document how the students used the C-Pen in the classroom. I gained insights into what activities students could use it for and how many opportunities they had to use the C-Pen based on the type of instruction and activities they were provided. The six observations also gave me an understanding of how the teacher could plan instruction for students to use the C-Pen. The C-Pen was used only during paper-based activities in the classroom. The teacher planned activities suitable for students to use the C-Pen to assist with their reading.

The findings from my observation notes show there were consistent opportunities for students to use the C-Pen. There were no instances when students had difficulty using the C-Pen. I observed all four students being able to use the C-Pen independently with paper-based assignments in the classroom. I observed students use the C-Pen to read words from various assignments such as books, quizzes, and daily activities. Due to COVID-19, I observed students from a distance with very little close contact due to physical distancing guidelines. There were two occasions when I asked the students how they felt after using the C-Pen. During the first observation, which was the first week of using the C-Pen, all four students reported they “liked using” the C-Pen. During the fourth week observation, I asked students if reading was easy or hard using the C-Pen. Carter, Lee, and Chris were present during the reading block and reported reading was “easier.” Also due to COVID-19, there were times when students were absent from school due to being quarantined. All students were present during the first week of my observations and the third week of my observations.

Student and teacher interviews. I analyzed the student interviews and teacher interview separately. I considered combining the interview data, but I did not want to lose the teacher’s voice because she was a key participant in the study. While analyzing the data, I described and reported emerging behaviors, categories, patterns, and themes through an inductive analysis process. Interviews were recorded using a voice recorder app and then transcribed verbatim. When all of the data were collected, summarized, and transcribed, I began analytic memoing by reflecting on each data source to understand what was being said (Saldaña, 2016; see Figure 4.2). This first step gave me an overall view of the information I had and an opportunity to reflect on its overall meaning

(Creswell & Creswell, 2018). Second, I reread all information and divided the information into chunks, sentence by sentence. Third, I uploaded all the transcribed data into Delve, an online qualitative analysis software. This process helped find relevant information and repetitions, leading to the coding of all the data as described in the next sections, which include (a) first cycle coding, (b) code mapping, and (c) second cycle coding. In an inductive analysis process, I described emerging behaviors, categories, patterns, and themes.

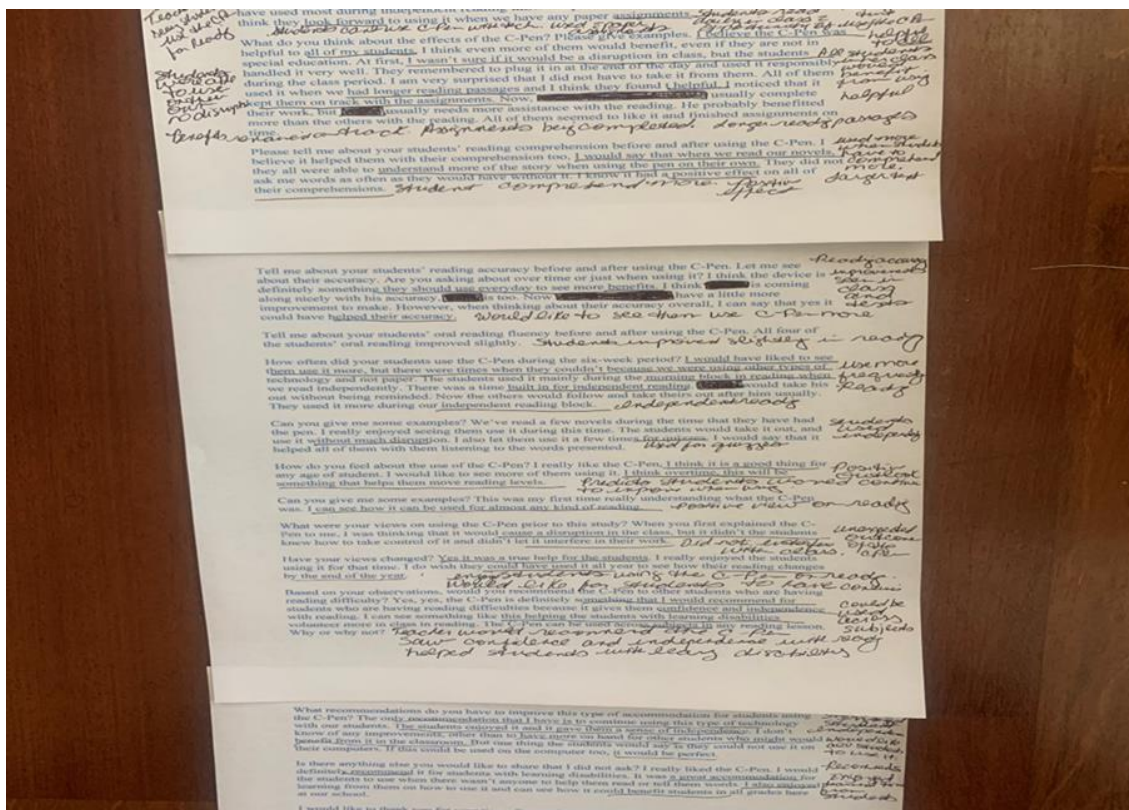


Figure 4.2. Analytic memo.

First cycle coding. As part of the first cycle coding process, I used three coding methods to look at the information sentence by sentence through in vivo coding, structural coding, and initial coding. I began with in vivo coding (Saldaña, 2016), in which I used the participants' words verbatim to label the codes. In vivo coding allowed me to capture the words of the participants (Saldaña, 2016). Examples of in vivo codes

included “helps me read words,” “understand more words,” and “use it to read.” Next, I used structural coding, where I assigned codes from segments of my research questions (Saldaña, 2016). Using structural coding, I assigned codes related to my first research question, which was: How does the use of the C-Pen affect the reading of third-grade students with learning disabilities? Using structural coding confirmed that the interview questions aligned with the research questions. See Figure 4.3 for an example of structural coding in Delve. Examples of structural coding included “confidence,” “independence,” and “beneficial.”

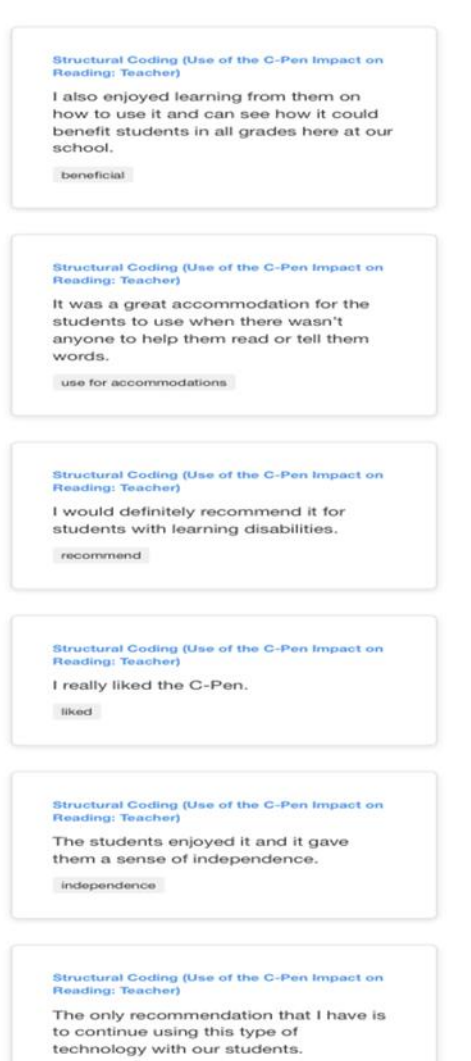


Figure 4.3. Structural coding in Delve.

Finally, I used initial coding to break down the data into discrete parts (Saldaña, 2016). I viewed the data sentence by sentence during this process and was able to find similarities and differences within the data. See Table 4.6 for a summary of the qualitative data sources used and codes applied, and Figure 4.4 for an example of initial coding in Delve.

Table 4.6 *Summary of Quantity of Qualitative Data by Source*

Qualitative interviews	Number of participants	Total number of codes applied
Student interviews	4	121
Teacher interview	1	76

	Initial codes	
Couldn't always understand words	after using the C-Pen	good at using the C-Pen
not sure if comprehension improved	feel better about reading	liked using with headphones
I like reading with it	it was fun	helped read words
does not help reading speed	read by myself	heled read faster
I like it	cannot think of anything else	read more words
unsure about comprehension	understanding improved	helps complete tests
read long books	not that I know of	good at using the C-Pen
reading is hard	cool	liked using with headphones
did not use it all the time	liked to hear other languages	helped read words
read words to me	liked them all	read unknown words
use it to read	did not affect reading speed	helps me
read unknown words	I do not know	helps read faster
did work	read words I did not know	liked using it
standard features	helps me	like the c-pen
tells the words	helps read faster	listen by yourself
understanding improved	liked using it	read words
understand words better	like the C-Pen	want it back
understand more words	listen by yourself	liked them all
words I did not know	read words	no thoughts on oral reading fluency
the thing that reads words	read books	helped read words
reading is easier	read chapters	reading is easier
little bit easier	no thoughts on oral reading fluency	little bit easier
Unsure	read words I did not know	helps me

Figure 4.4. Initial coding in Delve.

Code mapping. After the first cycle coding and before the second cycle coding, I used code mapping (Saldaña, 2016) to clarify the data and determine what information fit together. I exported all codes from Delve to a Microsoft Word document to view all codes by cycle. I created a Microsoft Excel spreadsheet and organized codes by similarities and differences to discover categories. I arrived at a total of seven categories for the student interviews and eight for the teacher interview. A peer review and feedback from emails with Dr. Arslan-Ari guided me to change broad codes by thinking more specifically about the codes I chose. I created a Microsoft Excel document with three sections of codes, categories, and themes to separate them into more specific categories.

Second cycle coding. In the second coding cycle, I used pattern coding to summarize segments of data into smaller categories (Saldaña, 2016). As described by Saldaña (2016), pattern coding is used to determine the patterns or contradictions that emerge from the data. I created codes for patterns and then developed themes. I originally planned to use sticky notes to categorize the findings; however, following a peer debriefing with Dr. Arslan-Ari, I chose to continue to use the Microsoft Excel spreadsheet instead to keep all information digital and in one file. Dr. Arslan-Ari encouraged me to look for commonalities in participant responses and determine which were significant to what the participants said. I then reexamined the codes to look for similarities in the responses. Some examples of codes found were *complete tests*, *read more words*, *understanding improved*, and *read unknown words* and combined them into category of *improved skills*. The codes were combined because they all described the improved skills the students reported from using the C-Pen. From the categories that were

derived, coding revealed keywords and phrases that I developed into themes. I used the same method to find themes.

Once the specific themes were established, as a part of member checking, I discussed the themes with the teacher participant to ensure accuracy. The Microsoft Excel file made it easier for the students and teacher to review the chosen themes. The themes for the student interviews had two or more responses in common. I then finalized themes for the interviews and began to organize and analyze the data. From the analysis, two themes emerged from the student interviews and two from the teacher interview (see Tables 4.8 and 4.9).

Presentation of Findings from Student Interviews

This section presents the findings of the student interviews. The presentation of results that follows includes a narrative description of each theme and a discussion of how the data connect to the themes presented. Verbatim quotes are also included to support the authenticity of the findings. Two themes emerged as a result of the coding analysis for the student interviews: (a) impact on reading, and (b) student perceptions. Table 4.7 presents a list of themes, categories, and evidence from the student interviews.

Table 4.7 *Themes, Categories, and Evidence from Student Interviews*

Themes	Categories	Evidence
Theme 1: C-Pen allowed the students to develop reading skills they could not develop without the C-Pen.	• Improved skills	Lee stated, “It helped me read a little faster.”
	• Independence	Carter stated, “Yes I would want it back because I can read by myself.”
	• Motivated	Shon stated, “I feel better.”
	• Assistance with reading	Chris stated, “It helps me read words.”
	• Completed assignments	Shon stated, “It helps me read more words and do my tests.”
Theme 2: Students demonstrated mixed perceptions about using the C-Pen to read.	• Positive perceptions	Carter stated, “It was fun.”
	• Neutral perceptions	Shon stated, “Not that I know of.”
	• Negative perceptions	Lee stated, “Sometimes when I rolled it over a word, um, it would say different things and not the word.”

C-Pen allowed the students to develop reading skills they could not develop without the C-Pen. In this study, this theme reflected the skills the students gained from using the C-Pen. The skills gained had a positive impact on their reading, particularly their reading skills, comprehension, and oral reading fluency. This theme generally reflects the impact the C-Pen has made on students’ reading. This theme is distinguishable from Theme 2 in representing students’ views on how the C-Pen assisted their capabilities in the classroom, as opposed to how the functions of the C-Pen helped them in the classroom with their reading. Five categories developed this theme: (a) improved skills, (b) independence, (c) motivated, (d) assistance with reading, and (e) completed assignments.

Improved skills. Improved skills were found particularly in reading. Improved skills in this study meant students gained abilities in reading. When asked how the C-Pen changed their reading in the classroom, students responded as follows: “I used it to read a lot when reading books” (Carter), “I used it to read books with . . . I used it to read words I didn’t know” (Shon), “It helped me read a little faster” (Lee), and “It helps me read words” (Chris). All four students reported an improvement with reading words when using the C-Pen.

Independence. Independence in this study meant students were able to complete reading tasks without asking for help. All four students stated the C-Pen helped them read words. When asked if the C-Pen was taken away would he want it back, Carter stated, “Yes, I would want it back because I can read by myself.” When asked which feature she liked best, Lee responded, “headphones, that you can plug up the headphones and listen to it by yourself.” When asked how he used the C-Pen in the classroom, Chris replied, “I use it to read long books.” When asked how the C-Pen changed his reading in the classroom, Shon stated, “It helps me read more words and do my tests.”

Motivated. This theme, motivation, meant students showed an interest in completing assignments. Asked how they felt about reading right now, Shon stated, “I feel better.” Carter stated, “It is hard. It makes it a little bit easier.” Chris responded, “I like using it. It helped me read words.” Lee expressed her feeling about using the C-Pen by stating, “I liked using it to read.”

Assistance with reading. All four students consistently reported the C-Pen assisted them with reading. The definition for assistance with reading explains that the C-Pen helped students read text. Similarly, Camardese, Morelli, Peled, and Kirkpatrick

(2014) concluded specific features of assistive technologies enhance the reading styles of students. Several student participants believed the C-Pen helped them read words they did not know. Asked about using the C-Pen, Shon responded, “It helped me with words I don’t understand. Words I didn’t know.” Carter stated, “Use it for words I don’t know.” Lee stated, “That it could tell words to you that you didn’t know.” Chris reported, “It helps me read words.”

Completed assignments. Defining completed assignments in this study meant the C-Pen helped students participate in the general education curriculum to complete their assignments. Similarly, Bone and Bouck (2017) studied how TTS enhanced student performance and found benefits for those who struggled to complete reading assignments to complete them independently. All four students explained their experience with how the C-Pen helped them complete assignments: “I used it that day to read in the chapters book” (Carter), “It helps me read more words and do my tests” (Shon), “I used it to read books” (Lee), and “I used it to read some long books” (Chris).

Students demonstrated mixed perceptions about using the C-Pen to read. The second theme that emerged from student interviews was student perceptions. This theme meant students reported mixed experiences of using the C-Pen. The three categories in this theme revealed students displayed various perspectives of the C-Pen, including (a) positive perceptions, (b) neutral perceptions, and (c) negative perceptions.

Positive perceptions. In this study, positive perceptions related to the attributes the students liked about the C-Pen. Some of the positive perceptions reported by students included the following: felt better about reading, reading was easier, understood more words, and enjoyed reading books. Students expressed positive perceptions of the C-Pen

by indicating their overall interpretations of the C-Pen and their favorite features. In a study by Wood et al. (2018), the authors reported reading was enhanced by the ability to hear texts as they were being read to, consequently improving reading capabilities. The following quotes are verbatim as students expressed their experiences using the C-Pen: “It was fun” (Carter), “It has been pretty good . . . I like using it” (Shon), “I think it’s really cool” (Lee), and “I like it” (Chris).

Neutral perceptions. Neutral perceptions were the reports from students that were neither positive nor negative. In a previous study by Perelmutter et al. (2017), the students had mixed effects from using the C-Pen. Within those mixed effects there were students who had positive, neutral, and negative responses. The following responses were neutral during the interview: “I can’t think of anything else” (Carter), and “Not that I know of” (Shon).

Negative perceptions. Negative perceptions in this study meant students reported a negative quality about the C-Pen. Negative perceptions from students included the C-Pen could not be used with all assignments and it did not always read words accurately. Among some of the challenges in a study by Berkeley and Lindstrom (2011) was the lack of accuracy text readers may have that means they do not always read screens accurately. A similar challenge was found when Lee reported during her interview, “Sometimes when I rolled it over a word, um, it would say different things and not the word.” In another challenge, Carter stated, “We couldn’t use it for Prodigy.” Prodigy is an online math education game; the C-Pen can only be used with paper-based materials.

Presentation of Findings from Teacher Interviews

I interviewed the third-grade teacher to identify her perceptions of using the C-Pen to support the reading ability of students with learning disabilities. The presentation of results includes a description and definition of each theme and the categories that developed each theme. Two themes were identified in the teacher interview data: (a) impact on students' reading, and (b) teacher perceptions. The categories that fell under these two themes were the following: helped students, confidence, independence, responsibility, beneficial, helpful for teacher, and versatility. Table 4.8 includes a list of themes, categories, and evidence from the teacher interview.

Table 4.8 *Themes, Categories, and Evidence from Teacher Interview*

Themes	Categories	Evidence
Theme 1: C-Pen had a positive impact on students' reading.	• Helped students read	"I think over time, this will be something that helps move reading levels."
	• Confidence	"Yes, yes, the C-Pen is definitely something that I would recommend for students who are having reading difficulties because it gives them confidence and independence with reading."
	• Independence	"It [the C-Pen] was a great accommodation for the students to use when there wasn't anyone to help them read or tell the words."
	• Responsibility	"They remembered to plug it in at the end of the day and used it responsibly during the class period."
Theme 2: Teacher expressed positive perceptions about the C-Pen.	• Beneficial for students	"I think it a good thing for any age of the student."
	• Helpful for teacher	"They [students] did not ask me words as often as they would have without it [C-Pen]."
	• Versatility	"The C-Pen can be used across subjects in any reading lesson."

C-Pen had a positive impact on students' reading. In this study, C-Pen had a positive impact on students meant the teacher reported the C-Pen had a positive effect on

students' reading. The categories that follow developed this theme: (a) helped students read, (b) confidence, (c) independence, and (d) responsibility.

Helped students read. In this study, helped students read meant the C-Pen made tasks easier for students. The teacher said of her expectations for the benefits for students' long-term C-Pen use, "I think over time, this will be something that helps them move reading level." The teacher also described students' reading skills, comprehension, and oral reading fluency as improving. Similarly, results of a study by Patti and Garland (2015) showed assistive technology—such as the C-Pen—improved general reading skills. When the teacher was interviewed about the effects of the C-Pen, she stated:

I believe the C-Pen was helpful to all of my students. I think even more of them would benefit, even if they are not in special education. At first, I wasn't sure if it would be a disruption in class, but the students handled it very well. They remembered to plug it in at the end of the day and used it responsibly during the class period. I am very surprised that I did not have to take it from them. All of them used it when we had longer reading passages and I think they found it helpful. I noticed that it kept them on track with the assignments. Now, Carter and Shon usually complete their work, but Chris usually needs more assistance with the reading. He probably benefited more than the others with the reading. All of them seemed to like it and finished assignments on time.

Confidence. The teacher reported the C-Pen gave students confidence with reading. When asked during the interview if she would recommend the C-Pen to other students who are having reading difficulty, the teacher responded, "Yes, yes, the C-Pen is

definitely something that I would recommend for students who are having reading difficulties because it gives them confidence and independence with reading.”

Independence. In elaborating on her perception that the C-Pen contributed to independent learning, the teacher reported her observations, “It [the C-Pen] was a great accommodation for the students to use when there wasn’t anyone to help them read or tell the words.” In this study, the theme independence meant the students completed some reading tasks on their own.

Responsibility. Students demonstrated responsibility by managing the C-Pen without having to be told by the teacher. During the interview, the teacher referenced her initial apprehension about implementing the C-Pen but stated she was relieved that her students adapted appropriately. In the interview, she stated:

At first, I wasn’t sure if it would be a disruption in class, but students handled it well. They remembered to plug it in at the end of the day and used it responsibly during the class period. I am very surprised that I did not have to take it from them.

Teacher expressed positive perceptions about the C-Pen. For this study, this theme reflected the teacher’s positive interpretations of the C-Pen after her students used it in the classroom over 6 weeks. The teacher’s perceptions of the C-Pen were overall positive. Flanagan et al. (2013) studied teachers’ perceptions of students’ use of assistive technology during literacy instruction and found positive results. The following categories developed this theme: (a) beneficial for students, (b) helpful for teacher, and (c) versatility.

Beneficial for students. The teacher felt as though the C-Pen did produce good results for students who used it during the study and possibly others if allowed to use it. The teacher expressed her perceptions of the C-Pen, stating she liked the device, felt it benefited students, and recommended its use for other students with learning disabilities. Notably, she found the C-Pen to be highly beneficial to students. She stated, “I think it is a good thing for any age of the student,” and “I can see how it can be used for almost any kind of reading.” The teacher further indicated that because of the benefits she observed her students deriving from the C-Pen, she would recommend that other students with learning disabilities be allowed to use one. The teacher stated, “The C-Pen is definitely something that I would recommend for students who have reading difficulties,” and added more specifically of students with learning disabilities, “I would definitely recommend it for students with learning disabilities.”

Helpful for teacher. In this study, this theme meant the C-Pen was useful. The teacher found the C-Pen useful for her in that she did not have to read words to the students as often, which led to students becoming more self-reliant when completing their assignments. She stated, “They [students] did not ask me words as often as they would have without it [C-Pen].” Ok and Rao (2017) found a similar benefit in using assistive technologies to support content and skill acquisition for students where students became more independent.

Versatility. Versatility in this study meant how the C-Pen could be used for a variety of subjects and student groupings. The teacher said of the potential benefits of the broader implementation of C-Pen use, “I can see something like this helping the students with learning disabilities volunteer more in class.” When asked if she would recommend

the C-Pen to other students with reading difficulties, the teacher said, “The C-Pen can be used across subjects in any reading lesson.” The mention of versatility also meant the C-Pen could also be used with students who do not have learning disabilities.

Chapter Summary

This chapter presented the analysis and findings of data collected from quantitative and qualitative data sources. I collected quantitative data from the DRA2 pretest and posttest and collected qualitative data from classroom observations, student interviews, and the teacher interview. A total of six classroom observations detailed the activities students completed using the C-Pen. Two themes emerged from the student interview data: (a) C-Pen allowed the students to develop reading skills they could not develop without the C-Pen, and (b) students demonstrated mixed perceptions about using the C-Pen to read. Two themes emerged from the teacher interview data: (a) C-Pen had a positive impact on students’ reading, and (b) teacher expressed positive perceptions about the C-Pen. Analyzing both the quantitative and the qualitative data provided an increased understanding of the impact of implementing the C-Pen with students in the classroom over the 6-week innovation period.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND LIMITATIONS

The purpose of this action research was to evaluate the impact of the C-Pen on the reading skills of third-grade students with learning disabilities at Eastview Elementary/Middle School. In this chapter, I position the findings with the literature on the impact of the assistive technology tool—the C-Pen—on reading level, comprehension, oral reading fluency, classroom observations, student perceptions, and teacher perceptions. Reported findings from the quantitative and qualitative data through a discussion of the major research questions are given. Following the discussion, I present personal implications, implications for teachers who work with students with learning disabilities, and implications for future research. Finally, I discuss the limitations of the study.

Discussion

I used the quantitative and qualitative data collected in this study to answer three major research questions. This discussion is organized into three sections, including a discussion of results for each research question: (a) Research Question 1: How does the use of the C-Pen affect the reading of third-grade students with learning disabilities? (b) Research Question 2: What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading? (c) Research Question 3: What is the third-grade teacher's perception of the use of the C-Pen to support the

reading of students with learning disabilities? I connect the study's findings to the literature on assistive technology tools, reading, and the study's theoretical framework.

Research Question 1

How does the use of the C-Pen affect the reading of third-grade students with learning disabilities?

This study's findings showed the C-Pen affected the student participants' reading in a positive way. This first research question was answered through the analysis and findings of the pretest, posttest, observations, student interviews, and the teacher interview. These findings support the implementation of the C-Pen by third-grade students with learning disabilities. The analysis provided insight for the following: (a) impact of the C-Pen on reading level, (b) impact of the C-Pen on reading comprehension, and (c) the impact of the C-Pen on oral reading fluency. Both quantitative and qualitative findings are presented to answer this question.

Impact of C-Pen on reading level. The four student participants were given a pretest and posttest to determine the impact on their reading after using the C-Pen. According to Chiang et al. (2012), assistive technologies help partially eliminate reading problems, allowing students to function effectively as their nondisabled peers. Similarly, in this study, all four students' reading level scores improved by the end of the innovation. All four students' reading levels improved by 2 points from the pretest to the posttest. These findings are consistent with those of Ok and Rao (2017) in that reading pens support student content knowledge and skill acquisition and can lead to growth in reading performance levels. For struggling readers, reading can become overwhelming as they attempt to learn the required content (Anderson, 2009). I conducted this study to

help students overcome these struggles. One frequently used method of supporting reading is read-aloud accommodations, which can be live or using TTS (Meyer & Bouck, 2017), such as the C-Pen used in this study.

The theme “C-Pen allowed the students to develop reading skills they could not develop without the C-Pen” from the student interviews answered this research question. When asked how they felt after using the C-Pen, students indicated it had a positive impact. Carter said of the effect of the C-Pen on his feelings about reading, “It [the C-Pen] makes it [reading] a little bit easier.” Shon stated, “I feel better,” when asked how he felt about reading after using the C-Pen. When asked if the C-Pen changed her feelings about reading, Lee responded, “Yes, I like it.” Chris provided a partly discrepant response to whether the C-Pen affected his feelings about reading, “I don’t know,” but then added of the C-Pen, “I just like to use it to read.” Patti and Garland (2015) found student skills can be improved in the areas of reading, writing, and math when using assistive technology. Patti and Garland evaluated student use of reading pens in their classroom and found the students improved in their study skills, ability to complete independent work, and assessments. Similarly, the findings of this study showed students’ use of the C-Pen in their classroom led to improved skills in reading.

Findings from the teacher interview were consistent with the students’ interview responses, indicating the C-Pen was effective in improving students’ reading skills. The teacher confirmed student responses indicating the overall effect of using the C-Pen on all four students’ reading was positive, saying, “I believe the C-Pen was helpful to all of my students.”

Accommodating learner differences with TTS tools enhances learning outcomes and experiences (Sheard & Lynch, 2003). Other findings from the student interviews also addressed this research question. Students reported positive experiences of using the C-Pen. These findings are distinct to Research Question 1 because findings referred to the students' views of their reading performance with the C-Pen. The students' descriptions of their experiences using the C-Pen were associated with the satisfaction in understanding more of what they read. According to Meyer and Bouck (2017), students with learning disabilities in reading have difficulties reading and understanding grade-level curricular material.

Observations of the students using the C-Pen in the classroom revealed students were able to complete reading assignments independently. During the first observation, all four students were able to use the C-Pen without the help of the teacher or peers. In this study, students used the C-Pen to alleviate barriers, which improved reading levels. According to the CTML, learning occurs when pictures and narrations are presented (Mayer, 2014a). The redundancy principle of the CTML supports that eliminating extraneous information allows more information to be processed in working memory (Mayer, 2014a). In this study, students were able to understand information presented with text and narrations alone, and without pictures. Therefore, TTS tools, such as the C-Pen, help students focus on text and auditory information to understand more of what they read.

Impact of C-Pen on comprehension. This study's findings on the impact of the C-Pen on reading comprehension were inconsistent. The DRA2 scores showed three of the four students did not improve in the area of reading comprehension as a result of the

C-Pen innovation. Satsangi et al. (2019) reported positive outcomes after using assistive technology for reading, resulting in improved comprehension, attention, motivation, and attitude. In the current study, one student improved in comprehension and three of the four students' scores remained the same. These findings, although mixed and inconsistent, are consistent with an earlier study by Perelmutter et al. (2017), who found students achieved some positive effects from assistive technologies, but not others. In another study by Meyer and Bouck (2017), TTS had no effect on students' reading comprehension. Adebisi et al. (2015) explored the impact of an electronic reading pen on reading comprehension. Adebisi et al. examined a group of students who received the reading pen in which they improved their reading comprehension, whereas the control group did not show improvements. Another study by Wood et al. (2018) revealed an improvement in reading comprehension skills after using assistive technology. Results coincide with results from this study with students improving their abilities to hear texts being read aloud (Wood et al., 2018).

When Shon was asked in the student interview whether the C-Pen changed how well he understood what was read (reading comprehension), Shon stated, "Not that I know of," but in another response, Shon indicated the C-Pen improved his reading comprehension: "I understand the words better [after] I used it when I did not understand a word. It helps me read more words and do my tests." Shon's vocabulary improved, which could affect reading comprehension, but future studies could research the improvement of vocabulary acquisition and retention. Carter provided a corroborating response, "I understand more words." Lee answered "Yes" when asked if the C-Pen helped improve reading comprehension, and Chris also answered "Yes" when asked if

the C-Pen improved reading comprehension by helping him understand more words. Also, within this study, the findings were inconsistent with the teacher who reported that students' comprehension improved.

During the teacher interview, she stated, "I know it had a positive effect on all of their comprehensions." In expressing how the teacher perceived the C-Pen as enhancing students' reading comprehension, she provided a response that corroborated students' perceptions that their reading comprehension was improved through the C-Pen, stating, "When we read our novels, they all were able to understand more of the story when using the pen on their own. They did not ask me words as often as they would have without it." My observations corroborated with the teacher's report that the C-Pen had a positive effect on students' comprehension. During the observations, I observed students complete assignments with the C-Pen. Therefore, the effect of the C-Pen on the students' comprehension was inconsistent in that not all students improved as a result of the quantitative results, but did report improvements in the qualitative results.

Impact of C-Pen on oral reading fluency. Finally, in this discussion of the first research question, this study's findings on the impact of the C-Pen on oral reading fluency showed the C-Pen helped students increase their oral reading fluency. The results were similar to those of Chiang et al. (2012), who reported TTS tools can be effective for students with learning disabilities in terms of academic performance and oral reading fluency. Students perceived the C-Pen as having a positive impact on their reading, particularly for their reading level and oral reading fluency. The students' interview responses indicated that, overall, they found the TTS feature of the C-Pen to be a significant learning tool.

Scores from the DRA2 showed an increase in oral reading fluency scores. Carter read 71 WPM on the pretest and improved to 75 on the posttest. Shon had a significant gain from the pretest to the posttest, improving by 38 WPM on the posttest. Lee's pretest score was 47 and her posttest score improved to 69 WPM. The scores associated with the students' performances also indicated an improvement. Three students' scores improved, and one remained the same. Carter scored 11 on the pretest and 13 at the end of the innovation. Shon achieved 9 points on the pretest and improved to 12 on the posttest. Lee improved her score by 2 points from the pretest to posttest, scoring 11 and then increasing to 13 points on the posttest. Chris's scores remained the same on the pretest and posttest at 11 points.

Three of the four students stated the C-Pen had a positive impact on their oral reading fluency. Carter stated, "It helped me read faster," indicating a positive effect on reading fluency. Lee provided a response similar to Carter's in saying, "It helped me read a little faster." Even though Chris did not receive a score for oral reading fluency due to it not being timed because of his reading level, when asked whether the C-Pen helped him read faster or slower, Chris stated, "faster." Shon provided the only discrepant response, stating, "No, it didn't affect how fast I read." However, his score on the posttest indicated his reading speed had improved. Therefore, all four students felt as if their oral reading fluency had improved. During the teacher interview regarding oral reading fluency, she indicated the impact of using the C-Pen on the students' oral reading fluency was noticeable, stating, "All four of the students' oral reading improved slightly."

Research Question 2

What are the perceptions of third-grade students with learning disabilities on the use of the C-Pen to support their reading?

The second research question was answered through the analysis and findings of the observations, student interviews, and the teacher interview. The perceptions of the third-grade students with learning disabilities were mainly gathered through the student interviews. In this study, the finding that the students reported positive perceptions of the C-Pen is consistent with research indicating students with disabilities reported positive experiences with TTS technology because it enabled them to complete assignments with less difficulty (Bone & Bouck, 2017).

The features the students were trained to use were the speech, volume, and text reading features. Students found other features on their own, such as the feature to change languages and the highlight feature, which highlights words on the C-Pen screen. Students expressed positive perceptions of the C-Pen by indicating their overall perceptions and their favorite and least favorite features. Shon said of his overall experience of using the C-Pen, “It been pretty good” and “I like using it.” Of whether he would want the C-Pen back if it were taken away, Shon said, “I would want it back.” Carter said of his overall experience of using the C-Pen, “It was fun,” and answered the question of whether he would want the C-Pen back if were taken away, “Yes, I would want it back because I can read by myself.” After reporting mixed feelings about some of the C-Pen’s features, Lee said of her overall experience of using it, “I think it’s really cool,” and “I just like to use it to read.” Chris said of the C-Pen, “I like using it.” Lee and Chris were not asked if they would want the C-Pen back if it were taken away.

Of the features used on the C-Pen, Carter said, “The language was used to scan the words, like in Spanish” was his favorite. When asked whether there were any features of the C-Pen he did not like, Carter answered, “I like them all.” Shon said of the C-Pen features he used, “I just used it to say the words to me.” Carter did not indicate a favorite or least favorite feature, but expressed, “I like using it.” Lee stated her favorite features were, “That you can plug up the headphones and listen to it by yourself” and “That it could tell words to you that you didn’t know.” Of her least favorite features, Lee said, “Sometimes it talked and I couldn’t understand. Sometimes when I rolled it over a word it would say different things and not the word.” Chris provided a discrepant response with regard to the C-Pen features he used most and least, “Can’t think of anything.” The text reading feature was used most and by all four students; on the other hand, Lee did not like the text reading feature because the C-Pen did not always read words correctly.

The students’ perceptions of the C-Pen’s ability to read words they did not know were positive. TTS tools convert written text into computer-generated synthesized speech that closely resembles natural speech (Berkeley & Lindstrom, 2011). TTS tools can help struggling readers improve comprehension, fluency, and accuracy; hearing a word spoken within the need for decoding skills and improves the student’s ability to comprehend (Berkeley & Lindstrom, 2011). The findings are consistent with those of previous researchers who found TTS consistently improves students’ reading (Meyer & Bouck, 2014; Wood et al., 2018).

Research Question 2 focused on students’ perceptions of the C-Pen. Although the teacher could not provide firsthand reports of student perceptions, she was able to corroborate students’ interview responses by reporting that her observations were

consistent with student reports of positive experiences. The teacher corroborated all four students' responses by indicating her observations were consistent with the students' reports that they had positive perceptions and experiences of the C-Pen. In the teacher interview, she explained:

They have all loved using the C-Pen in class, especially during our reading block, first thing in the morning. [Carter] is always the first one to take his out, then the other students will remember to use theirs. They have used them most during independent reading time. They are able to listen to our stories daily. I think they look forward to using it when we have any paper assignments.

Notable in the teacher's response was her observation of the students' reactions to the C-Pen. She said, "They have all loved using the C-Pen." Also, it is noteworthy to stress that the teacher observed that students looked forward to using the C-Pen.

Research Question 3

What is the third-grade teacher's perception of the use of the C-Pen to support the reading of students with learning disabilities?

The third research question was answered through the analysis and findings of the teacher interview. The teacher expressed positive perceptions of the C-Pen in stating she liked the device, felt it benefitted students, and would recommend its use for other students with learning disabilities.

Of her positive perceptions of the C-Pen, the teacher said, "I enjoyed learning from them [students] on how to use it and can see how it could benefit students in all grades here at our school." Regarding any perceived disadvantages of the C-Pen, the teacher expressed the perception that the device would be ideal if it could assist students

with reading electronic media: “If this could be used on computers too, it would be perfect.” The teacher added that she initially had some apprehensiveness about implementing the C-Pen, but was relieved to see her students adapted to it appropriately:

At first, I wasn’t sure if it would be a disruption in class, but the students handled it well. They remembered to plug it in at the end of the day and used it responsibly during the class period. I am very surprised that I did not have to take it from them.

The teacher also perceived the C-Pen as highly beneficial to students. She stated, “I think it is a good thing for any age of student” and “I can see how it can be used for almost any kind of reading.” The teacher added of the C-Pen’s effects on students, “It gives them confidence and independence with reading.” In elaborating on her perception that the C-Pen contributed to independent learning, the teacher reported her observations, “It [the C-Pen] was a great accommodation for the students to use when there wasn’t anyone to help them read or tell them words.”

The teacher further indicated that because of the benefits she observed her students deriving from the C-Pen, she would recommend that other students with learning disabilities be allowed to use one. The teacher stated, “The C-Pen is something that I would recommend for students who are having reading difficulties,” and added more specifically of students with learning disabilities, “I would recommend it for students with learning disabilities.” The teacher said of the potential benefits of the broader implementation of C-Pen use, “I can see something like this helping the students with learning disabilities. The C-Pen can be used across subjects in any reading lesson.” Ok and Rao (2017) discussed benefits from using assistive technologies. In their study, they

found reading pens supported academic content acquisition along with students' skills. Another benefit found by Ok and Rao was reading pens can assist students with tests and formative assessments, which was similar to the findings of this study.

The teacher perceived the C-Pen implementation as improving the reading of the student participants, a finding that confirmed those of previous researchers. Ok and Rao (2017) indicated students who continually use reading pens display positive academic outcomes. Many students have reported positive outcomes after using assistive technology for reading differences that are often related to improved comprehension (Satsangi et al., 2019). Assistive technology tools encourage learning to take forms that accommodate various readers (Camardese et al., 2014). Patti and Garland (2015) found reading pens enabled students with learning disabilities to access assignments without the need for help and to read by themselves, similar to what was reported by the teacher in the current study.

Implications

This section details three types of implications for this study: (a) personal implications, (b) implications for teachers who work with students with disabilities, and (c) implications for future research.

Personal Implications

As a result of this study, there are two implications that will continue to inform my practice as an administrator and future research: (a) best practices in considering assistive technology, and (b) sharing information with an action plan.

Best practices in considering assistive technology. As I reflected on how to continue to help students with reading using assistive technology tools, four things came

to mind regarding what I have learned from how the C-Pen influenced the study's participants and the benefits of this type of technology. First, this study of assistive technology tools increased my understanding of how these tools can help students access classroom activities and materials they would otherwise not been able to do independently. Second, assistive technology tools can be life-changing for students who have difficulties reading at any given grade level. Third, assistive technologies are incorporated into devices used by people who have disabilities and those without. Fourth, assistive technologies have many built-in accessibility options today on current computers, phones, tablets, and computer programs, such as Google Suite.

Reflecting on how those options can assist a variety of learners led me to determine how I will continue to advocate for students. I see the need to remain abreast of the most recent best practices in assistive technology research. As mentioned previously in Chapter 2, two laws allow educators to consider assistive technologies as accommodations for their students with an IEP or 504 plans. My knowledge of this type of technology will assist with meeting my responsibilities at work. As an administrator, I participate in IEP meetings and serve as the local education agency (LEA), which is a person who oversees and is responsible for plans. As the LEA, I will make sure considerations for accommodations are discussed thoughtfully and carefully. A question in completing either plan asks specifically if the student requires assistive technology or services. As I prepare these meetings, I will collaborate with special education teachers to make sure a specialist trained in assistive technology is invited to the meeting.

I will also increase my knowledge of assistive technology tools for students to use for services and resources. The text reading feature was a frequently used feature by the

students in the study. With that, I will investigate tools that allow students to customize the read-aloud options just as the C-Pen did. As reported by the teacher in the study, a disadvantage of using the C-Pen is that it can only be used with paper-based assignments. I will seek other options that allow students to use technologies during digital reading assignments and presentations. Last, I will attend online trainings offered from the South Carolina Assistive Technology Program to enhance my knowledge of assistive technology tools, such as the C-Pen.

Action plan for professional development. Although the results of this study are not generalizable, I am still passionate about how assistive technology tools can help the students at my school. As part of my duties at work, I seek and plan professional development for staff. According to Mertler (2017), “Action plans may consist of brief statements or simple descriptions about the implementation of a new educational practice” (p. 219). I developed an action plan to carry out during the next school year at my school. Gelbart (2018) reported technology training must be purposeful and relevant in preparing students to succeed. This action plan will help teachers plan instruction and examine their practices surrounding assistive technologies. Although the findings regarding reading comprehension were inconsistent, the results did show the C-Pen can positively affect reading. I will share my action plan for professional development with stakeholders. The action plan involving the implementation of research-based technologies should be planned for teachers, paraprofessionals, administrators, and parents. All stakeholders should be trained and involved in the process to improve student achievement. The intent of the action plan is to provide teachers with the knowledge of technology tools they need to empower them in choosing assistive technology for their

students and increase their effectiveness in planning and meeting instructional goals for students. In order to accomplish a professional development with all stakeholders, I will contact the South Carolina Assistive Technology Program or the South Carolina Assistive Technology Specialist to seek on-site professional development. Using this resource from our state is cost-effective and will benefit student achievement. Forgrave (2002) reported an advantage of using TTS is that it saves time and money, improves listening, and enhances student academic performance. Table 5.1 outlines the beginning stages of my action plan for professional development.

Table 5.1 *Action Plan for Professional Development*

Who will conduct the PD?	Who will attend the PD?	What type of PD?	When will the PD be held?	Where will the PD be held?	Why will the PD be held?
The South Carolina Assistive Technology Program or South Carolina Assistive Technology Specialist	Teachers Paraprofessionals Administrators Parents Therapists	The type will be assistive technology. The staff will be surveyed to determine their specific needs in assistive technology before planning the date of the professional development.	The PD will be held during the 2021–2022 school year.	The PD will be held in the school’s cafeteria. If physical distancing and safety rules need to be followed, the PD can be held online.	The PD will be held to assist teachers with improving student achievement.

Note. PD = professional development.

Implications for Teachers Who Work with Students with Learning Disabilities

Though the study has personal implications that consider educators, there are also several implications for teachers who work with students with learning disabilities. This

section includes a discussion of (a) theoretical framework to influence instruction, (b) understanding the diverse learners, and (c) using technology with instruction.

Theoretical framework to influence instruction. The literature review of the CTML and the theoretical underpinnings of this study provided three instructional strategies teachers should consider when planning instruction. First, teachers should consider the differences in text, audio, images, animations, video, and interactive content (Mayer, 2005). Second, teachers should consider the roles of the visual and auditory channels when selecting and organizing data. Third, teachers should consider students' ability to process information through the visual and auditory channels (Mayer, 2005). Accommodating learner differences with TTS tools enhances learning outcomes and experiences (Sheard & Lynch, 2003).

Understanding the diverse learner. Ackerman and Goldsmith (2011) reported teachers can use technology as a way to personalize their teaching to enhance the skills of students with learning disabilities because it addresses a variety of problems students have academically. Third-grade students with learning disabilities have reading proficiency difficulties. One of the purposes in the design of this study was to contribute to the existing research and knowledge about using TTS to enhance the reading ability of students among my colleagues and other educators. By using TTS tools such as the C-Pen, teachers can provide students with learning disabilities opportunities to engage with assignments. Technology tools can offer learning experiences for students that can afford them new interests in learning and capacities to learn the material to understand content in various ways. To accomplish this, administrators should ensure teachers know how to choose appropriate technology tools that will facilitate student learning. As a school

leader, I will provide professional development and train teachers to make selections appropriate for students with learning disabilities. As an administrator, I will need to collaborate with and supply teachers with training. With our school being a one-to-one school, technology is a significant support to meeting students' needs for continuous educational improvements. Learning about assistive technologies and tools can help teachers with increasing student motivation and independence. One of the themes found within the qualitative data was "helped teachers." In this theme, the teacher reported students were able to read words independently and did not ask for words to be read as often. As students use technologies such as the C-Pen, teachers can continue to monitor students by assessing skills within the classroom setting. Therefore, the impact of this study could result in increased reading proficiency on state tests that are individually administered.

Using technology with instruction. Last, I will make sure the teachers are trained in assistive technology tools and have the ability to handle any technical assistance issues that may occur with students. For example, when Lee had difficulty with the C-Pen reading words aloud correctly, either the teacher or I could have provided assistance. Unfortunately, Lee did not report the difficulties she was having until the student interview. A challenge found by Berkeley and Lindstrom (2011) was the same as reported in the findings. Berkeley and Lindstrom discussed the text reading feature of TTS tools as being inaccurate at times.

Implications for Future Research

Educational practices in the future will evolve in response to changes in the world. Future educational practices may continue to be digital and facilitate the learning

process anywhere and at any time. I designed the current study to examine the impact of the C-Pen when used as an innovation with students with learning disabilities. Though the results did not reveal a significant difference in reading comprehension, the students made notable improvements in reading and oral reading fluency. More research is still needed on the implementation of the C-Pen to validate results. Implications for future research are summarized as follows.

First, the innovation in the study was conducted over a 6-week time frame. Future research may yield different results if conducted over a longer period in which learners can use the innovation tool for an extended length of time to become more familiar with the tool. Ok and Rao (2017) studied the advantages and limitations of using a reading pen and results indicated students who continually used reading pens displayed positive outcomes. As with this study, further research on the methods of the use of the pen should continue to be researched (Ok & Rao, 2017).

Second, this study included a small sample size of four students and one teacher. This sample of participants does not represent the larger population, which limits the generalizability of the finding. All student participants had learning disabilities and were members of the same third-grade classroom. Future researchers may consider replicating this study with a larger sample from various contexts, a more diverse population, or an older group of students to examine the outcomes and determine whether the same or similar findings are obtained. A larger sample could increase the generalizability of the results.

Third, due to the COVID-19 restrictions, I did not have control over the interactions with the participants. Valuable information may have been missed during

observations that I could have caught with the use of voice recordings. Therefore, future researchers may consider using a recording device to record the interactions between the students and the teacher within the classroom. Using voice recording would capture the teacher questions, student responses, and other details that could be missed.

Fourth, a classroom teacher should implement and evaluate the impact of the C-Pen on students' reading. Although as the researcher I gained valuable information to answer the research questions, I was not the teacher. A teacher could provide more information via observations. I was only able to observe students six times during the study. The teacher would also be able to report on students' reading behaviors when using the DRA2 assessment. I did not observe the teacher administering the assessment; had that been the case, more information could have been gathered.

Finally, as the present study was an action research study, a future researcher may consider using the design to investigate whether there is a difference in findings at another school or a sample from different schools. This would enable the researcher to investigate differences beyond a single school with third-grade students. There is little research in the area of assistive technology using the C-Pen, which calls for future studies in this area. There are benefits to conducting this type of study in a school; however, the setting limits the generalization of the findings to other contexts and populations. In this study, the design allowed the teacher and myself to follow up with students; however, in a future study, the researcher could use other schools.

Limitations

Action research can provide possible solutions to bridging gaps in educational practices; however, the results are neither right nor wrong, so identifying the limitations,

along with the strengths, is necessary (Mertler, 2017). Limitations are those characteristics of the study that affect the interpretation of the findings for transferability and application to practice (Bloomberg & Volpe, 2016). This study had two areas of limitations: (a) limitations of methodology, and (b) limitations of findings.

Limitations of Methodology

A significant limitation of this study was the use of a small sample ($N = 4$) of students from one third-grade class in an elementary/middle school. Additionally, the students were a young sample of students between 8 and 10 years old who had learning disabilities. With this small sample of students with learning disabilities, the students did not have prior experience discussing their perceptions of the C-Pen, which could have contributed to the short interview time. Even though this was a limitation, it helped me detail what the students were able to express about their use of the C-Pen.

A second limitation of the methodology related to the observations. Observations were described in as much detail as possible, but due to the circumstances of COVID-19, the descriptions were limited. Even though I had limited interactions with the students, my observations may have resulted in their limited classroom participation due to their feelings of being watched. Overall, the whole class participation and the environment were not typical due to the safety guidelines due to COVID-19. Other constraints related to observations included frequent student absences and quarantines due to COVID-19.

A third limitation of the methodology was the lack of an observation checklist. An observation checklist would have provided specific details about the classroom observations. The observation checklist protocol seen in Appendix E was developed as an open-ended document to record the number of opportunities students had to use the C-

Pen. An observation checklist that included specific questions outlined could have been useful in gathering more specific information about the classroom, students, and teacher.

Limitations of Findings

A limitation of the findings included the novelty effect, which can affect how students and teachers engage in new technology (Chwo, Marek, & Wu, 2018). According to Kamper (1991), the novelty effect is often an uncontrolled variable because improvements in students' learning are usually a result of changes made to the curriculum and not the technology used. The design of this study called for students to use the C-Pen for 6 weeks. Chwo et al. (2018) found novelty may serve as a confounding variable for studies lasting less than 8 weeks. Only one student was able to use the C-Pen for all 6 weeks; due to absences and quarantines from the COVID-19, three of the students used the C-Pen for 4 weeks. Overall, students and the teacher in the study had positive perceptions of the C-Pen; if the novelty effect is sound, it will result in skewed results of the positive outcomes.

The findings of this study do not apply to contexts or populations other than the one I studied (Mertler, 2017). Action research has many benefits; however, results cannot be generalized outside of the study conducted by the researcher. This limitation affects the generalization of the study because the sample of this study is not generalizable to the larger population. In this type of action research study, generalizations are impossible to other schools, districts, and populations.

Concluding Thoughts

Reading proficiency is essential for acquiring knowledge that will contribute to future success (Camardese et al., 2014). Nationally, students with learning disabilities

struggle to meet reading proficiency levels by the end of the third grade (Lesaux, 2021; National Accessible Reading Assessment Projects, 2006). Locally, third-grade students with learning disabilities struggle to meet reading proficiency standards outlined by the State of South Carolina, as evidenced by their reading performance on the SC READY (SCDE, 2018).

Students with learning disabilities are entitled to receive accommodations if their disability affects their ability to participate in the academic environment (Condra et al., 2015). Changes to the supports, services, and specialized instruction (Kauffman et al., 2017) through assistive technology tools, such as the C-Pen, can help students reach their academic potential.

The CTML (Mayer, 2005) served as the theoretical underpinnings of this study. The CTML indicates learners learn best when presented with pictures and narrations. The redundancy principle of the CTML was concluded to be false. The CTML could be applied in some cases. The learners in this study did not depend on pictures and narrations to learn but could read with texts and narrations. In other cases, students who struggle with reading, though more proficient readers, may not benefit from this theory.

The findings of this study indicated the C-Pen had a positive outcome on the third-grade students' reading and their teacher's perception of its effect on reading. Converged findings showed a commonality in that the students and teacher viewed the C-Pen as having a positive impact on reading. As a result, implementing the C-Pen in this study, within the third-grade classroom, was found to motivate and elicit independence in students with learning disabilities. As shown in previous studies, students with learning disabilities increased reading skills when using TTS (Meyer & Bouck, 2014).

Additionally, like this study's findings, previous studies reported increased reading among students with learning disabilities when using TTS (Ok & Rao, 2017).

This study contributes to an existing body of research and calls for further research on implementing and evaluating the impact of the C-Pen on students' reading. In addition to reading level, comprehension, and oral reading fluency, future researchers can study vocabulary acquisition as suggested in this study's findings. Overall findings indicated the C-Pen had a positive impact on the reading of third-grade students with learning disabilities. These results served as the basis for developing an action plan for professional development for stakeholders in research-based technologies.

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APPENDIX A

SOUTH CAROLINA READY PERFORMANCE LEVELS DEFINITIONS

Test Results

SC READY test results are reported in terms of overall performance levels, scale scores, performance by reporting categories*, and state percentile ranks.

*See the “Performance by Reporting Category” description on page 17 of this guide.

OVERALL PERFORMANCE LEVELS

For the South Carolina READY assessment (SC READY), educators have developed four performance levels to describe student mastery and command of the knowledge and skills outlined in the South Carolina College- and Career Ready Standards (SCCCRS). Most students have at least some knowledge of the information described in the content standards; however, performance levels concisely describe the extent to which students have demonstrated mastery of the knowledge and skills expressed in the SCCCRCRS. Performance levels give meaning and context to scale scores by describing the knowledge and skills students must demonstrate to achieve each level.

The four performance levels for SC READY are *Does Not Meet Expectations*, *Approaches Expectations*, *Meets Expectations*, and *Exceeds Expectations*. The general meaning of each level is provided below.

Does Not Meet Expectations – The student does not meet expectations as defined by the grade-level content standards.

Approaches Expectations – The student approaches expectations as defined by the grade-level content standards.

Meets Expectations – The student meets expectations as defined by the grade-level content standards.

Exceeds Expectations – The student exceeds expectations as defined by the grade-level content standards.

A student who does not meet expectations in the knowledge and skills necessary at this grade level of learning, as defined by the grade-level content standards, ***needs substantial academic support*** to be prepared for the next grade level and to be on track for college and career readiness.

A student who approaches expectations in the knowledge and skills necessary at this grade level of learning, as defined by the grade-level content standards, ***needs additional academic support*** to be prepared for the next grade level and to be on track for college and career readiness.

A student who meets expectations in the knowledge and skills necessary at this grade level of learning, as defined by the grade-level content standards, ***is prepared*** for the next grade level and is on track for college and career readiness.

A student who exceeds expectations in the knowledge and skills necessary at this grade level of learning, as defined by the grade-level content standards, ***is well prepared*** for the next grade level and is well prepared for college and career readiness.

Performance Level Descriptors (PLDs) show a *progression of knowledge and skills* that students are expected to have mastered across the performance levels. It is important to understand that a student should demonstrate knowledge and skills within his/her performance level *as well as all content and skills in any performance levels that precede his/her own, if any*. For example, a student who Meets Expectations should also possess the knowledge and skills described at the Approaches Expectations and Does Not Meet Expectations performance levels.

APPENDIX B

SOUTH CAROLINA READY SCORING GUIDE

VERTICAL SCALE SCORES

SC READY assessment scores moved to a new vertical scale in 2016–17. The tests continue to report scale scores; the scores are reported on the new vertically scaled metric. The four performance levels (Does Not Meet Expectations, Approaches Expectations, Meets Expectations, Exceeds Expectations) are unchanged (that is, the same degree of achievement is required to be placed in each performance level as was required in 2015–16). However, as grades three through eight have been placed on a common vertical scale, the values of the reported scores are different from 2015–16.

A vertical scale is one in which a given scale score value shows the same amount of achievement, regardless of the grade level in which the student is tested. However, that scale score must be interpreted in light of the cut scores for a particular grade. For example, students in grades three, five, and seven could all receive a math scale score of 550. That would indicate that the three students had about the same degree of achievement in math. However, that score would be classified as ‘Exceeds Expectations’ for a third-grade student, ‘Meets Expectations’ for a fifth-grade student, and ‘Approaches Expectations’ for a seventh-grade student.

A separate reading subscore is reported for ELA. The reading subscore is reported on the same scale, with the same performance levels, as the total ELA score. Other ELA and all math subscores are reported as one of three categories (Low, Middle, High), as they were in 2015–16.

Tables of the scale-score cuts for each subject, grade, and performance level, along with their associated lowest obtainable scale score (LOSS) and highest obtainable scale score (HOSS), are given below. The LOSS and HOSS are the theoretical minimum and maximum scale scores on each SC READY test. However, these theoretical minimum and maximum scores are not always obtainable in practice. For any particular grade, for example, the obtainable maximum scale score can be, and often is, less than the HOSS. Regardless of the obtainable minimum and maximum scale scores, the LOSS and HOSS will be the lowest and highest points on the Individual Student Report (ISR).

ELA Vertical Scale Score Ranges by Grade

Grade	LOSS	Does Not Meet	Approaches Expectations	Meets Expectations	Exceeds Expectations	HOSS
3	100	100–358	359–451	452–539	540–825	825
4	100	100–418	419–508	509–592	593–850	850
5	100	100–449	450–557	558–652	653–875	875
6	100	100–454	455–575	576–667	668–900	900
7	100	100–511	512–614	615–704	705–925	925
8	100	100–537	538–642	643–737	738–950	950

APPENDIX C

EXAMPLE OF THE READING BLOCK

Daily Reading Components	Instructional Format	Instructional Minutes	Activities
Word Study: Builds oral and academic vocabulary	Whole Group	10 minutes	Preselected words engage students in effective research-based fluency and vocabulary instruction using: Frye phrases, fluency practice, vocabulary, word learning strategies, word definitions, word context study, phonics, high-frequency words
Read Aloud: Supports reading and writing instruction and content-area integration	Whole Group	10 minutes	Select various genres to: Build oral vocabulary and background knowledge, model fluency reading, model think aloud, facilitate discussion
Mini-lesson: Provides explicit, direct instruction, modeling, and guided practice	Whole Group	10 minutes	Provide effective research-based reading instruction using: Academic vocabulary, content vocabulary, fluency, comprehension
Literature Study: Incorporates literary text and	Small Group	25 minutes	Collaborative and student-centered reading, reading comprehension

informational text to guide students to a deeper understanding of what they read			strategies and skills, Story events, characters, personal experiences related to text, engage in critical thinking, problem solving, reflection, and respond to books, construct meaning with other readers
<p>Work Stations:</p> <p>While the teacher works with a small group, the remaining students participate in focused workstation activities</p>	Independent Practice	30 minutes	Skills-based workstations, word study, comprehension, fluency, independent reading practice, writing
Reading Workshop Closure	Whole Group	5 minutes	Provides opportunities to check students' understanding with the use of formative assessments, progress monitoring tools, exit slips, retelling, and journaling

APPENDIX D

TRAINING ON THE USE OF THE C-PEN

Tasks	Participant 1	Participant 2	Participant 3	Participant 4
Participant will learn how to power the C-Pen on and off				
Participant will learn how to hold the C-Pen like a pencil or highlighter				
Participant will pretend to draw a straight line across a piece of paper				
Participant will scan words, phrases, and sentences				
Participants will select their reading speed				
Participants will practice using the headphones				
Participants will scan words properly				
Participants will practice reading texts that are below				

grade level, on grade level, and below grade level				
Participants will replay text				
Participants will practice adjusting the volume				
Participants will practice scanning paragraphs				
Participants will learn how to charge and store the C-Pen				
Participants will stop the training when they are able to complete all tasks with 100% accuracy				

APPENDIX E

OBSERVATION PROTOCOL CHECKLIST

Observation Protocol Checklist

Teacher_____

Students_____

Time/Subject_____

Observations of the use of C-Pen	Participant 1	Participant 2	Participant 3	Participant 4
Word Study				
Read Aloud				
Mini-lesson				
Literature Study				
Work Station				
Reading Workshop Closure				
Other				

APPENDIX F

STUDENT INTERVIEW PROTOCOL AND SCRIPT

Student Interview Protocol and Script

Student Name_____

Date_____

Time_____

Good morning, thank you for your participation in this interview. Thank you for helping me complete my dissertation. As you know, I am in school as a graduate student at the University of South Carolina and I am asking for your participation with this interview as a part of my research study. The purpose of my research study is to evaluate the impact of the C-Pen provided to third-grade students with learning disabilities here at our school. This interview will take about 30 minutes and will include questions centered around my purpose statement. I would like to ask for your permission to record this interview to make sure that I document all of your answers correctly. I will have to go back and listen to the recording and write down your answers again to make sure I wrote down everything you said. I will give your parent a copy of my report. Your identity will remain confidential, which means, I will not discuss your answers with anyone. I have three key research questions that I am wanting to find out the answers to. Your participation in this interview will help me determine your experiences using the C-Pen. I will ask you a total of 9 questions. Do you have any questions before we begin? OK! As I stated previously, your identity will remain confidential.

Let's begin.

Ok, the first question of the interview will begin now.

1. Tell me about your experience with using the C-Pen.
2. How did you feel about reading right now?
 - a. Can you give me an example?
3. How does using the C-Pen change your feelings about reading?
 - a. Can you give me some examples?
4. How have you used the C-Pen in your classroom?
 - a. Can you give me some examples?
5. How does using the C-Pen change your reading in the classroom?
 - a. Can you give me some examples?
6. How does using the C-Pen change your reading fluency?
 - a. How fast or slow you read?
7. How does using the C-Pen change your comprehension, which is how you understand what you read?

- a. Can you give me some details?
- 8. Which features of the C-Pen did you use the most and which did you use the least in class?
- 9. Is there anything else you would like to share with me?

Thank you again for this opportunity to ask you these questions about your feelings of the C-Pen.

APPENDIX G

TEACHER INTERVIEW PROTOCOL AND SCRIPT

Teacher Interview Protocol and Script

Teacher name_____

Date_____

Time_____

Good morning, thank you for your participation in this interview. I do value your time. As you know, I am a graduate student at the University of South Carolina and I am conducting this interview as a part of my research study. The purpose of my research study is to evaluate the impact of the C-Pen provided to third-grade students with learning disabilities here at this school. This interview will take about 30 minutes and will include questions centered around my purpose statement. I would like to ask for your permission to tape this interview to ensure that I document all of your answers correctly. Audio files will be retrieved and transcribed within 48 hours. Your participation and identity will remain confidential. I have three key research questions that I am wanting to find out the answers to. Your participation in this interview will help me determine your perceptions about the impact of the C-Pen. I will ask you a total of 11 questions. Do you have any questions before we begin? OK! As I stated previously, your identity will remain confidential.

Let's begin.

Ok, the first question of the interview will begin now.

1. How have your students used the C-Pen during class?
 - a. Please give examples.
2. What do you think about the effects of the C-Pen?
 - a. Please give examples.
3. Tell me about your students' reading comprehension before and after using the C-Pen.
4. Tell me about your students' reading accuracy before and after using the C-Pen.
5. Tell me about your students' oral reading fluency before and after using the C-Pen.
6. How often did your student use the C-Pen during the 6-week period?
 - a. Can you give me some examples?
7. How do you feel about the use of the C-Pen?
 - a. Can you give me some examples?
8. What were your views on using the C-Pen prior to this study?

- a. Have your views changed?
- 9. Based on your observations, would you recommend the C-Pen to other students who are having reading difficulty?
 - a. Why or why not?
- 10. What recommendations do you have to improve this type of accommodation for students using the C-Pen?
- 11. Is there anything else you would like to share that I did not ask?

I would like to thank you for your time. Do you have any additional questions for me at this time? May I follow-up with you to clarify any points I find that I did not understand? Once everything is finalized, I will send you a copy of the transcriptions and results from my study. Thank you again.

APPENDIX H

INTERNAL REVIEW BOARD APPROVAL LETTER



OFFICE OF RESEARCH COMPLIANCE

INSTITUTIONAL REVIEW BOARD FOR HUMAN RESEARCH DECLARATION of NOT RESEARCH

Kawanna McKenzie
College of Education
Department of Education Administration
Wardlaw
Columbia, SC 29208

Re: **Pro00100116**

Dear Ms. Kawanna McKenzie:

This is to certify that research study entitled ***Evaluation and Implementation of the C-Pen on the Reading Level, Comprehension, and Oral Reading Fluency of Fourth-grade Students with Learning Disabilities: An Action Research Study*** was reviewed on 5/28/2020 by the Office of Research Compliance, which is an administrative office that supports the University of South Carolina Institutional Review Board (USC IRB). The Office of Research Compliance, on behalf of the Institutional Review Board, has determined that the referenced research study is not subject to the Protection of Human Subject Regulations in accordance with the Code of Federal Regulations 45 CFR 46 et. seq.

No further oversight by the USC IRB is required. However, the investigator should inform the Office of Research Compliance prior to making any substantive changes in the research methods, as this may alter the status of the project and require another review.

If you have questions, contact Lisa M. Johnson at lisaj@mailbox.sc.edu or (803) 777-6670.

Sincerely,

A handwritten signature in blue ink, appearing to read "Lisa M. Johnson".

Lisa M. Johnson
ORC Assistant Director and IRB Manager

APPENDIX I
SCHOOL DISTRICT APPROVAL



March 30, 2020

University of South Carolina
Office of Research Compliance (ORC)
1600 Hampton Street, Suite 414
Columbia, SC 29208

RE: LETTER OF ACKNOWLEDGEMENT OF A RESEARCH PROJECT IN [REDACTED]

To Whom It May Concern:

This letter is to acknowledge that we have reviewed a request by Kawanna McKenzie to conduct an action research project entitled Evaluation and Implementation of the C-Pen on the Reading level, Comprehension, and Oral-Fluency of Fourth-Grade Students with Learning Disabilities: An Action Research Study with fourth-grade students at [REDACTED]

We confirm that the school district grants permission for the proposed action research to be conducted once full IRB approval or your approval has been granted.

Sincerely,

A black rectangular box redacting the signature of the Superintendent.

Superintendent

APPENDIX J

SCHOOL SITE APPROVAL



March 30, 2020

University of South Carolina
Office of Research Compliance (ORC)
1600 Hampton Street, Suite 414
Columbia, SC 29208

RE: LETTER OF ACKNOWLEDGEMENT OF A RESEARCH PROJECT IN [REDACTED]

To Whom It May Concern:

This letter is to acknowledge that I have reviewed a request by Kawanna McKenzie to conduct an action research project entitled Evaluation and Implementation of the C-Pen on the Reading level, Comprehension, and Oral-Fluency of Fourth-Grade Students with Learning Disabilities: An Action Research Study with fourth-grade students at [REDACTED]

I confirm that the school district grants permission for the proposed action research to be conducted once full IRB approval or your approval has been granted.

Sincerely,

[REDACTED]

Principal