UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

EFFECT OF TEXT-TO-SPEECH AND HUMAN READER ON LISTENING COMPREHENSION FOR STUDENTS WITH LEARNING DISABILITIES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

In partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

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Norman, Oklahoma

2018

EFFECT OF TEXT-TO-SPEECH AND HUMAN READER ON LISTENING COMPREHENSION FOR STUDENTS WITH LEARNING DISABILITIES

A DISSERTATION APPROVED FOR THE

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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Acknowledgements

I would like to thank Dr. Cullen for her support and guidance. She has been instrumental in maintaining the necessary forward momentum during the final stages of my dissertation process. I would also like to express my gratitude to my committee members members—Dr. Kendra Williams-Diehm, Maeghan Hennessey, Michael Crowson, and Hollie Mackey—for their helpful comments and feedback throughout the writing process and at my defense.

I am also grateful to Norman Public Schools for allowing me to work with students at Norman High School. Donna Tiemann, Mark Levy, and Kara Stoltenberg, who collected fidelity of implementation data and interobserver agreement data, deserve recognition for their assistance. I am also grateful to Jennifer Pautler for her flexibility and understanding during our co-taught English classes.

I would also like to thank Dr. Joyce Brandes for her support, patience, and guidance during my dissertation process as well as throughout my doctoral program. Her mentorship in scholarship and teaching has proven invaluable.

Finally, I am forever indebted and grateful to my family for their continued support, assistance, and understanding throughout my educational career. The work ethic I learned from them as well the importance of perseverance has served me well throughout this process.

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Abstract

Students with learning disabilities in reading often have difficulty with comprehension. In this study, four participants with learning disabilities, ages 16 and 17, were assessed in listening comprehension using an alternate treatment design to determine the effect of two treatments (a) text-to-speech, and (b) human reader on listening comprehension using text excerpts and multiple-choice listening comprehension quizzes from Harper Lee's novel *To Kill a Mockingbird*. Results, although mixed, found that mean scores for listening comprehension were greater during the human reader treatment. Implications and conclusions of this study revealed that text-to-speech may benefit students with learning disabilities who struggle with reading and comprehension when used as a supplement to explicit teacher instruction, however, the text-to-speech was not as effective as a human reader on listening comprehension for students with learning disabilities.

Keywords: learning disabilities, text-to-speech, assistive technology

Introduction

Technology (e.g., laptops, tablets, smartphones, etc.) is readily present in many classrooms because of its numerous capabilities and affordability, allowing teachers to deliver and enhance classroom instruction (Bonds-Raacke & Raacke, 2008; Dey, Burn, & Gerdes, 2009). Teachers face a variety of new challenges in many classrooms that were not present in earlier decades due to changing student demographics, ways in which information is gathered, technological refinement, and ways in which students communicate with others (Kuznekoff & Titsworth, 2013; Robb & Shellengarber, 2012). Given these challenges, it is paramount that new strategies are devised to meet students' changing classroom learning needs.

Concerns (e.g., engagement and satisfaction) persist about technology use in the classroom, especially with regard to laptops and smartphones despite the many potential uses and benefits that technology holds for our daily lives and in education settings. For example, laptops may increase student engagement and satisfaction, but may also cause unintended distraction. Impaired learning and distraction can occur not only for the user, but also for those sitting near an in-class laptop user (Fried, 2008; Sana, Weston, & Cepeda, 2013). The amount of time spent using technology can also be of concern, especially for adolescents as well (Ra et al., 2018; Walsh et al., 2018). Too much screen time can affect attention, sleep patterns, and cognition abilities of teenagers when not consumed in moderation (Ra et al., 2018; Walsh et al. 2018). Even though these challenges exist, many students find these devices engaging. In turn, this technology can increase the motivation to learn, and provide relevant skills for the future (Ciampa, 2012; Kim, Blair, & Lim, 2014; Lam, McNaught, Lee, & Chan, 2014). These technological

devices (e.g., laptops, tablets, smartphones, etc.) have allowed students to collect and synthesize information easily and classroom settings as technology has developed and its use increased in recent years (Herrera Díaz, Cruz Ramos, & Sandoval Sánchez, 2014; Ifenthaler & Schweinbenz, 2013; Kim et al., 2014; Moran, Hawkes, & El Gayar, 2010). With the increase in computer use in the classroom over the past couple decades, especially as schools move toward 1:1 initiatives, understanding ways in which technology can assist learning in the classroom has become more important.

Listening Comprehension

This increase in technology use in schools (Lindroth & Bergquist, 2010; Fried, 2008, Sana et al., 2013) does not change the necessary skills that students need to be successful. Skills, such as listening comprehension, are vital to student success in the classroom (Hogan, Adolf, & Alonzo, 2014). Listening comprehension is defined as the skill necessary for understanding language when it is heard as opposed to when it is read (Hogan et al., 2014). In the classroom, opportunities for listening comprehension, including following directions and retelling a story heard from the teacher or an audiobook (Ciampa, 2012), are often every day experiences for students. Skills, such as vocabulary enhancement and comprehension, can be improved through the use of technology (Ciampa, 2012; Korat & Shamir, 2012).

Takacs, Swart, and Bus (2014) completed a meta-analysis of 29 studies measuring listening comprehension with and without adults present. Results of the meta-analysis found that the presence of adults neither increased listening comprehension nor did comprehension improve whether using the scaffolds integrated into e-books or discussing the story with an adult. Additionally, Segers, Takke, and Verhoeven (2004) examined

story comprehension and native English and non-native English speaking kindergarten students using teacher-mediated and computer-mediated story reading. While Segers et al. (2004) found that non-native English-speaking students had improved story comprehension when the teacher read the story, the study also found that students made similar academic gains when a computer read the story. The computer allowed students to work at an independent pace, both with and without teacher support, through the scaffolding built into the computer software program. The use of computers allowed teachers to selectively and thoughtfully use instruction time to assist students who need individual attention while allowing other students to work independently in order to give every student the latitude to learn in an environment that suited them.

Students with Disabilities

Students with disabilities have difficulty accessing curriculum due to the wide gap between themselves and their grade-level peers who are meeting state standards in reading (Anderson-Inman & Horney, 2009; Kennedy & Deshler, 2010; Reshly, 2010; Roberts, Torgesen, Boardmen, & Scammacca, 2008). For these individuals, having disabilities often presents barriers that impact not only the ability to learn new skills and recall information in the school setting, but also presents barriers that reach beyond this academic realm into life after high school graduation, including future educational choices such as entering the workforce and functioning in society (Fälth & Svensson, 2015; Isaila & Nicolau, 2010; Lewis, 1998; Meyer & Bouck, 2014; Vaughn et al., 2015). The issue of assistive settings, especially text-to-speech, would benefit these individuals (Fälth & Svensson, 2015; Meyer & Bouck, 2014; Silver-Pacuilla & Fleishman, 2006).

Assistive Technology and Individuals with Disabilities

Technology, including the use of computers and cell phones, has become part of everyday life in the academic, personal, and professional settings (Blackhurst, Lahm, Harrison, & Chandler, 1999; Bouck et al., 2012; Kaye, Yeager, & Reed, 2008). While not a guarantee of improved quality of life (Scherer, 1994), for individuals with disabilities, a specialized form of technology – known as assistive technology (AT) – can augment and assist the functioning of individuals with disabilities in these settings to increase independence and learning (Blackhurst et al., 1999; Bouck et al., 2012; Shinohara & Wobbrock, 2016). The Individuals with Disabilities Education Improvement Act (IDEA), defines AT as "any item, piece of equipment or product system, whether acquired commercially of the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of children with disabilities" (U.S.C. §1401 (1)). AT, then, may be a myriad of devices ranging from minimal technology, such as a pencil grip to high levels of technology, such as a computer (CAST, 2011). However, personal preference is an important factor in how assistive technology (AT) is used (Martin, Martin, Stumbo, & Morrill, 2011). Individual use of AT should lead to improved quality of life, be helpful, and not create more work for the user (Blackhurst et al., 1999; Mull & Sitlington, 2003). AT design must take into account not only the environment where it will be used (Blackhurst et al., 1999) but also the skills of the user or else the AT will likely be abandoned (Scherer, 1994; Shinohara & Wobbrock, 2016).

Assistive technology plays an important part for individuals with disabilities, especially in academic and professional settings by providing access to curriculum, such as the use of word processing software and audiobooks (Day & Edwards, 1996), and

facilitating access to performance tasks in the professional setting, such as the use of chat and email programs (Fichten, Barile, & Asuncion, 2003). For example, a teacher may use technology in a high school classroom (such as an audiobook) to replace reading aloud. In high schools, teachers often teach the same material repeatedly to different classes throughout the day. When reading a novel in English class, the teacher, who often reads the novel aloud to each class, may occasionally use an audiobook instead of reading the same passages to different classes multiple times per day.

Universal Design for Learning

Universal design for learning (UDL) considers the diverse nature of students' by focusing on how they learn so that they can reach their fullest academic potential by reducing or eliminating academic difficulties (Lieberman, Lytle, & Clarq, 2008; Lopes-Murphy, 2012; Meyer & Rose, 2000; Rao & Torres, 2017; Rose & Meyer, 2002). Universal design for learning consists of three areas that must be addressed: (a) repetition – multiple access points to curriculum so that students understand what they are supposed to learn, (b) expression – multiple ways of approaching curriculum so that students understand how learning can occur, and (c) engagement – multiple ways for students to participate in the learning process to understand why the information is important (Dolmage, 2015; King-Sears, 2014; Messinger-Willman & Marino, 2010; Wilson, 2017). Each of these three areas is divided into subsections. Under representation: (a) perception or providing information through our venues besides print (e.g., the use of color or sound; (b) language (e.g., the use of text-to-speech) or the use of symbols to convey meaning, and (c) comprehension (e.g., the use of concept maps or visual organizers) (CAST, 2011).

The subsections under expression include: (a) physicality (e.g., the use of manipulatives or using the joystick); (b) expression (e.g., the use of media and/or materials necessary to express oneself – multimedia or text-to-speech (TTS), and (c) executive functioning (the use of checklists or the use of peer feedback) (CAST, 2011). Engagement holds three subsections as well: (a) interest (e.g., personalized assignments or changes in work sessions); (b) effort (e.g., the use of group work or providing feedback that focuses on the learning process); and (c) self-regulation (e.g., the use of rubrics or the use of work samples to explain expectations) (CAST, 2011).

There is legal backing for the implementation of UDL (Edyburn, 2010; King-Sears, 2014; Lieberman et al., 2008). Aside from the Individuals with Disabilities Education Act, which (a) mandates access to the general education curriculum for students with disabilities, and (b) encourages the inclusion of students with disabilities in the general education classroom (Edyburn, 2010; Individuals with Disabilities Education Improvement Act, 2004), UDL is also addressed in other legislation. Because many students, including those with disabilities, will pursue postsecondary education, the Higher Education Act of 2008 addresses UDL, defining it as:

> A scientifically valid framework for guiding educational practice that: (a) provides flexibility in the ways information is presented; in the ways students respond or demonstrate knowledge and skills; and in the ways students are engaged, and (b) reduces barriers and instruction; provides appropriate accommodations, supports, and challenges; and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient (20 U.S.C. §1003 (24)).

With this definition in mind, it is possible to use the UDL framework to explore how students with reading disabilities may benefit from using assistive technology in a high school classroom setting. Accessibility features were not implemented from the beginning when the curriculum was built. However, the use of these features does constitute accommodations that provide flexibility and reduce barriers in instruction and student achievement, pursuant to federal legislation.

Universal Design for Learning and Assistive Technology

Much of the assistive technology (AT) affordances of technology (such as computers, tablets, and smartphones) were designed with a UDL framework; understanding UDL can help to also understand the value of assistive technology. In the past, assistive technology, (AT) has served in primary application to help individuals with impairment, (e.g., physical, visual, or hearing) with daily functioning and/or communication (Edyburn, 2004). Therefore, it makes sense to explore the use of MacBooks®, within a UDL framework, as assistive technology for students with disabilities.

The use of technology can give students the opportunity to learn and to be expressive in multiple ways while learning to practice digital citizenship today (McMahon & Walker, 2014), and preparing for necessary job skills tomorrow (Wehmeyer, Palmer, Smith, Parent, Davies, & Stock, 2006). Just as UDL is used to overcome barriers in academic curricula, assistive settings are designed to overcome barriers and build upon users' strengths by mitigating deficits in an ability to perform a task (Fälth & Svensson, 2015; Isaila & Nicolau, 2010; Lewis, 1998). In the same way that UDL is not specifically intended for individuals with disabilities, assistive settings

are intended for everyone (Lewis, 1998). However, the use of assistive settings and technology by people with disabilities is common (Engstrom, 2005; Lewis, 1998). This technology, much like UDL, allows instruction to be individualized to meet the level and need of the student (Kennedy & Deshler, 2010; Kennedy, Deshler, & Lloyd, 2015; Engstrom, 2005).

Given that the presence of this technology in classrooms has increased (Lindroth & Bergquist, 2010; Fried, 2008, Sana et al., 2013), and more students are using these devices for notetaking during class (Fried, 2008; Muller & Oppenheimer, 2014), at question is whether the use of laptops in class help or hinder student learning (Fried, 2008; Muller & Oppenheimer, 2014; Sana et al., 2013). Studies (e.g., Fried, 2008; Sana et al., 2013) have found that using the laptop in class can increase student engagement and satisfaction, but in-class use of these devices actually result in an overload and a distraction which, in turn, leads to lower test scores. Additionally, in-class use of these devices results not only in impaired learning and distraction for the user, but it also distracts those sitting near an in-class laptop user (Fried, 2008; Sana et al., 2013).

When used appropriately in academic settings, modern technology has educational benefit. Assistive settings available on today's computers include (a) zoom, (b) voiceover, (c) text-to-speech, (d) speech-to-text, and (e) display alterations to mitigate vision issues. Hearing issues can be mitigated by (a) audio, and (b) captions. Additionally, speech-to-text and (potential) keyboard alterations mitigated for physical disabilities that impair typing ability (Burgstahler, 2002; Izzo, 2012; Koch, 2017). Given these settings, many of them complement UDL and can be implemented to include multiple means of (a) representation, (b) expression, and (c) engagement to give students

he will access to curriculum. With this in mind, Apple® products are often chosen by teachers and schools to bring technology into the classroom and create digital learners for the world tomorrow (McMahon & Walker, 2014). Additionally, Apple® Inc. has built-in accessibility features that integrate well with the UDL framework (Izzo, 2012; McMahon & Walker, 2014).

Stigmatization and Assistive Technology

AT use is complicated by factors such as whether the user's disability is acquired or congenital, cultural beliefs, and coping skills (American Speech-Language Hearing Association, 2017; Luborsky, 1993). Despite the access it provides in personal, professional, and academic settings, social stigmatization of AT users exists, but is experienced differently by different populations. Shinohara and Wobbrock (2011) found two misperceptions about AT exist (a) AT will functionally eliminate the user's disability, and (b) AT users are more helpless without their device. These misperceptions mean that any access that could be provided to the AT user is already limited, as stigmatization is already present. Using AT can result in loss of social credibility (Shinohara & Wobbrock, 2011) in that the use of AT shows others, in a visible way, that AT is necessary. This can cause the user to become self-conscious about using AT. Such negative social interactions can lead to feelings of decreased self-worth and cause the individual to isolate himself or herself in order to avoid feelings of shame, resulting in discontinuation of use of the AT (Bispo & Branco, 2009; Bouck et al., 2012; Kaye et al., 2008; Parette & Scherer, 2004). For example, someone who was unfamiliar with AT devices may ask personal questions of the AT user or comment on the device. The AT user may then feel obligated to explain the need for the device and how it works to

someone who has very limited knowledge and minimal exposure to how AT devices can be used (Shinohara & Wobbrock, 2011). For the AT user, this causes feelings of isolation and social stigma (Shinohara &Wobbrock, 2011, 2016).

Numerous aspects can lead to stigmatization for the AT user including (a) aesthetics, (b) age, and (c) personal preferences surrounding AT (Blackhurst et al., 1999; Pape, Kim, & Weiner, 2002; Parette & Scherer, 2004; Shinohara & Wobbrock, 2011). Because AT has historically been dominated by a clinical model grounded in functionality (Ravneberg, 2012), aesthetics and social acceptability of AT have not been considered to the extent they have been in mainstream devices (Christiansen, 1999; Parette & Scherer, 2004; Shinohara & Wobbrock, 2011) such as it has with Apple® products (Shinohara & Wobbrock, 2016). For example, GoTalk 9+, created by the Attainment Company, has nine icons that can store up to 45 messages (Attainment Company, Inc., 2018). While functional and affordable (under $300), being able to use 45 phrases in conversation substantially limits conversation topics, flexibility, and opportunity. This device comes with the stand and the shoulder strap to increase portability. By design, this device is 22.86 x 30.45 x 2.8575 cm and weighs 652.05 g (Attainment Company, Inc., 2018). However, the user of this device faces social stigmatization and isolation even though the device, ironically, creates accessibility for the user.

However, mainstream devices – with not only aesthetic appeal, but also technological capabilities of apps and integrated software – provide opportunities to reduce social stigmatization and encourage continued use of AT devices if teachers include all students in a technologically integrated environment (Blackhurst et al., 1999; Day & Edwards,

1996; Mull & Sitlington, 2003). For this reason, using a MacBook® may not be as stigmatizing for users who may have encountered stigma during previous experiences. As mobile technology is now everywhere (Higginbotham & Jacobs, 2011; McNaughton & Light, 2013), iPads, iPods, and smartphones – including numerous apps for Apple and Android (McNaughton & Light, 2013) provide access and include all the mainstream applications such as texting and Internet capabilities as well as built in AT (Higginbotham & Jacobs, 2011; McNaughton & Light, 2013). Users of these mainstream devices are subject to less social stigmatization and feelings of isolation (Shinohara & Wobbrock, 2011, 2016). Additionally, age is a factor in social acceptance of AT. Teenagers expect more from their AT in terms of aesthetics and less in terms of function, as compared to older adults (Hemmingsson, Lidström, & Nygård, 2009; Parette & Scherer, 2004; Shinohara & Wobbrock, 2011). Personal preference is an important factor in how AT is perceived by the user (Martin et al., 2011).

Text-to-Speech

Text-to-speech (TTS) software reads words that appear on the computer screen aloud (Berkeley & Lindstrom, 2001; Meyer & Bouck, 2014), and has become an accepted accommodation for students with reading difficulties and those with disabilities (Fälth & Svensson, 2015; Meyer & Bouck, 2014; Silver-Pacuilla & Fleishman, 2006; Stodden, Roberts, Takahashi, Park, & Stodden, 2012).

Although academic research for the efficacy of TTS as an accommodation that improves student learning is limited (Edyburn, 2007; Meyer & Bouck, 2014), for students with disabilities, the assistive settings of TTS can be critical to mitigating reading challenges and allow increased access to curriculum (Berekley & Lindstrom, 2011;

Meyer & Bouck, 2014). It is important to use adaptations that will increase learning and begin to close the achievement gap for the students. Learning to use the accessibility features, such as text-to-speech, will give students with learning disabilities more tools to help them be successful in the classroom. The use of technology in the field of special education has made positive changes in the past two decades (Edyburn, 2000; Isaila & Nicolau, 2010; Wood, Moxley, Tighe, & Wagner, 2017). For students with learning disabilities, AT has the potential to positively affect access to academic curriculum and address their specific learning needs (Engstrom, 2005; Kennedy et al., 2015). Modern technology (e.g., laptops, tablets, smartphones, etc.) have text-to-speech built into the device, or specialty software can be installed on devices to make AT, such as text-to-speech, available to students with disabilities.

Problem Statement

Students in special education need instructional adaptations pertaining to the general education curriculum to help achieve academic success. It is important to use instructional adaptations that will increase learning and begin to close the achievement gap for the students, as they often have academic deficits that amount to being multiple grade levels behind their same-age peers. As technological devices have become an ever-present part of today's society (Maldonado & Morgan, 2010; Tessier, 2013), the use of this technology can be invaluable as a pedagogical tool in the classroom. Using this technology not only allows students to access information and increases the quality of student learning and motivation, but it also gives teachers flexibility and carries the potential to make teaching less cumbersome, warranting further exploration into

pedagogically stimulating and meaningful use in the classroom (Acheson, Barratt, & Balthazor, 2013; Enriquez, 2010; Maldonado & Morgan, 2010).

Reading is often a challenging task for students with disabilities. Much academic literature about the use of technology, (electronic books, and reading and listening comprehension) for students in general education exists (e.g., Doty, Popplewell, & Byers, 2001; Pearman, 2008; Segers et al., 2004). Even though 1:1 technology initiatives (Bebell & O'Dwyer, 2010) in schools as well as the omnipresence of technology in daily life holds potential for greater access and quality of life for individuals with disabilities, there is a gap in academic literature concerning the use of technology and listening comprehension for students with disabilities – specifically students with learning disabilities (LD).

Purpose and Objectives

The purpose of this research was to examine the effect of two conditions (a) text-to-speech (TTS) and (b) human reader on listening comprehension for students with learning disabilities (LD). The objectives included:

1. The measurement of listening comprehension scores of students with LD using the text-to-speech (TTS) function to read an excerpt of *To Kill a Mockingbird*.
2. The measurement of listening comprehension scores of students with LD using a human reader to read an excerpt of *To Kill a Mockingbird*.
3. The comparison of both conditions on listening comprehension scores of students with LD.

4. The identification of the condition yielding the highest listening comprehension scores for students with LD.
5. The social validation provided by using technology in the classroom in the same way as peers.
6. Social validation provided by teachers and using technology to gain access to the general education curriculum.

Method

Setting

The high school, where this study took place, had a population of 2,169 students with 1,002 students eligible for free and reduced lunch. Eighteen percent of the students were served on IEPs. Student population by race and ethnicity were as follows: 55% White, 16% Hispanic/Latino, 12% two or more races, 8% Black, 2% Asian, and less than 1% Pacific Islander. This study took place during a daily 50-min high school instructional support English class. This class had a maximum of 15 students, all on Individualized Education Programs (IEPs) for reading and writing difficulties, who attended this English class daily for English services as outlined on their IEPs. However, not every student was classified with the primary disability of learning disability in reading. Numerous other disabilities (e.g., intellectual disability, other health impairment, etc.) were enrolled in this English class. This English class in this instructional support classroom was taught by a teacher with 19 total years teaching experience. Twelve years in general education and seven additional years in the special education setting. During her teaching career, in addition to English, she also taught drama, speech and debate, the

Bible as literature, personal financial literacy, and African American literature. She was certified in special education as well as in English. Academic content taught in this classroom was the same as the content for students without IEPs in the general education setting except for the implementation of instructional adaptations to make the content more accessible to the students. These instructional adaptations included (a) shortened assignments, (b) extended time to complete assignments, (c) extended time given to students for oral and written responses, and (d) the use of graphic organizers. Additionally, the overall instructional pace in this classroom was slower to accommodate the learning difficulties of the students. This classroom was one of nine classrooms on either side of the hallway. Fifteen student desks were spread in five rows of three desks. Each study participant sat in one desk in each row. The English classroom also contained a teacher's desk in the back of the room.

Participants

The researcher recruited four high school students, all who had junior class standing, from a southern central high school in the United States to participate in this study. The study participants all had reading disabilities. Students with learning disabilities and reading often have difficulty with word recognition and when reading orally (Smith, 2004). For these individuals, comprehension and reading orally lead to numerous difficulties including (a) omitting word(s), (b) replacing the printed word with another word, (c) mispronouncing the printed word so incorrectly that it is not understandable in context, (d) pausing for multiple seconds before pronouncing a word, and (c) changing the word order of the sentence (Smith, 2004). In addition to having reading difficulties as explained above, each study participant met the following inclusion

criteria (a) had a current diagnosis of learning disability, (b) had a current (valid for the 2018 – 2019 academic year) Individualized Education Program (IEP) for specific learning disability in reading, (c) enrolled in an instructional support English class, and (d) had regular school attendance. Participants were assigned a pseudonym. The researcher taught most of the study participants in English class during a previous high school grade. Demographic information included age, race, and socioeconomic status, if available. All study participants (a) agreed to participate in the study, (b) gave their assent, and (c) had parental consent to participate in accordance with Institutional Review Board procedures. Because data collection occurred during the course of daily teacher practice, it was necessary to protect the identity of study participants. Therefore, data was collected from all students in the instructional English support class. All students, including the study participants, received a $20 Visa® gift card, but only data from the study participants was kept and recorded.

The school district where this study took place used numerous assessments to determine eligibility for special education services. Not every study participant received the exact same standardized assessments as part of their special education eligibility battery of assessments. For three-year re-evaluation purposes, this school district normally used the Kaufman Test of Academic Achievement (KTEA). Therefore, if a student was receiving special education services in this district for at least six years, KTEA scores were available in their academic records from their three-year re-evaluation. However, other assessments were also used by the district to build a portfolio of academic performance for students in special education. To help describe the study participants, the researcher included all achievement test scores available in recent their

recent (within the last four years) academic records. The Oklahoma Core Curriculum Test (OCCT), while no longer administered by the state, reported scores in four levels: (1) advanced, (2) proficient, (3) limited knowledge, and (4) unsatisfactory. The Wechsler Individual Achievement Test (WIAT-III), the Woodcock Johnson (WJ-III), and the Kaufman Test of Academic Achievement (KTEA-II) all assessments, except the OCCT, reported scores using a standard score. Standard scores are scaled so that the mean score is 100. One standard deviation (15 points) above and below the mean score of 100 determines the average range of performance. Therefore, standard scores between 85 and 115 were considered average scores. While all students were reading below grade level, using *To Kill a Mockingbird* for the text excerpts was appropriate, as it facilitated least restrictive environment (LRE) for students with disabilities.

Chad. Chad was a 16-year old Black male with a disability in reading. He attended instructional support classes, taught by a special education teacher with a maximum of 15 students in the classroom at one time, for history, English, transition skills, and Tech Now. While standard score on the KTEA reading comprehension subtest was 72, his academic records showed a WIAT reading comprehension standard score of 52, and a score of unsatisfactory on the OCCT reading test.

Ivan. Ivan was a 16-year old Hispanic/Latino male with a disability in reading. He attended instructional support classes, taught by a special education teacher with a maximum of 15 students in the classroom at one time, for math and English. Although his standard score on the KTEA-II reading comprehension subtest was 94, which is in the average range, he scored unsatisfactory on the OCCT reading test.

Nancy. Nancy was a 17-year-old White female with a disability in reading. She attended instructional support classes, taught by a special education teacher with a maximum of 15 students in the classroom at one time, for history, English, and math. Her standard score on the KTEA-II reading comprehension subtest was 101 and her WJ-III passage comprehension standard score was 84, both in the average range, she scored limited knowledge on the OCCT reading test.

Priscilla. Priscilla was a 16-year old Black female with a disability in reading. She attended instructional support classes, taught by a special education teacher with a maximum of 15 students in the classroom at one time, for history, science and English. Her standard score on the KTEA-II reading comprehension subtest was 81, and her WIAT-III reading comprehension standard score was 76, in addition to an unsatisfactory score on the OCCT reading test.

(See Table 1).

District 1 to 1 Initiative

The researcher does not specifically endorse MacBook® or Apple® products. One year before this study took place, this school was part of a district-wide iTech initiative. There were numerous goals associated with the iTech initiative: (a) closing the digital divide between students of different socioeconomic status, (b) expanding educational opportunities, (c) enhancing project-based learning and learning beyond the classroom, and (d) improving opportunities to collaborate. In this particular school, students were expected to use the device daily and bring the device with them to every class. This initiative provided MacBook® laptops to all secondary (middle school and high school) students and provided elementary schools with Apple® iPads. While

elementary students did not receive their own personal device, all secondary students received a MacBook® to be used for academics as long as they were enrolled in the district, including summer months. Each computer had (a) Microsoft® Office (including Word, PowerPoint, Excel, Outlook, and OneNote), (b) Internet, and (c) Apple® apps, such as iCalendar, iTunes, iMovie, Keynote, and Photo Booth. Additionally, these devices also included all the accessibility settings built into the Mac OS High Sierra. These included: (a) zoom (the ability to make on-screen text larger or smaller); (b) voiceover (text-to-speech function); (c) sticky keys (activates a key (e.g., alt key), to eliminate the need to press multiple keys simultaneously; (d) slow keys (ability to change how long a key is held before the system recognizes the keystroke; (e) mouse keys (uses keyboard to replace the mouse for cursor movement; and (f) inverted color display (transposes screen color to make it easier for individuals with visual limitations to see the screen) No additional assistive technology was installed widely on the computers. However, additional assistive technology programs (such as Natural Reader or Dragon Naturally Speaking) could be added to the computer if such software were deemed necessary by the IEP team. None of the students in this study had additional assistive technologies installed on their computers. While text-to-speech (TTS) was available through software and other devices, TTS is built into MacBook®. Since students had, and were familiar with the MacBook®, it was used to deliver the TTS intervention. Samantha was chosen for the voice because it was void of identifiable and potentially confusing language accents (e.g., British, German, etc.) and it was a female voice that was akin to what many students may be accustomed to hearing in a classroom. The reading speed was set to the default of normal.

Table 1

Participant Information

Name	Age	Disability	KTEA-II RC SS	WJ-III RC SS	WIAT-III RC SS	OCCT R	Race
Chad	16	SLD-R	72	--	52	U	BL
Ivan	16	SLD-R	94	--	--	U	H/L
Nancy	17	SLD-R	101	84	--	LK	WH
Priscilla	16	SLD-R	81	--	76	U	BL

Note. SLD-R = specific learning disability in reading; KTEA = Kaufman Test of Educational Achievement; RC = reading comprehension; SS = standard score; WJ = Woodcock Johnson; WIAT = Wechsler Individual Achievement Test; OCCT = Oklahoma Core Curriculum Test; R = reading; U = unsatisfactory; LK = limited knowledge; BL = Black; H/L = Hispanic/Latino; WH = White.

Materials

Text excerpts. Text excerpts from *To Kill a Mockingbird*, by Harper Lee were used as listening comprehension passages. This novel was chosen because it (a) was on the required reading list for the district curriculum, (b) was a regular classroom activity, and (c) was appropriate for this grade level. Each text excerpt consisted of approximately 1,500 words from chapters 22 – 31. If a text excerpt reached the 1,500-word limit in the middle of a sentence, that sentence was removed from the text excerpt in order to avoid a surfeit of words. All excerpts began at the beginning of each chapter.

Multiple-choice questions. A combination of prefabricated (BookRags, 2015) and researcher-created multiple choice questions were used to assess listening

comprehension. Prefabricated questions, which correlated with the text excerpts, were chosen. The researcher then created additional multiple-choice questions for each text excerpt used.

Experimental Design

Alternating treatment design (Gast & Ledford, 2014; Martella, Nelson, Morgan, & Marchand-Martella, 2013) was implemented to compare the effect of two conditions: (a) text-to-speech functionality, and (b) human reader. These conditions were randomly generated using an online randomizer (random.org) to determine the condition to be used. If the condition was randomly selected more than two consecutive days, the alternate condition would have been automatically used to help guard against sequencing effect (Martella et al., 2013). Each daily session consisted of a 15-min segment wherein students listened to a passage and answered multiple-choice listening comprehension questions (Appendix A). The passage was read using text-to-speech functionality or by a human reader. To control for internal validity threats (a) condition length of at least three data points for both conditions were collected, and (b) conditions were determined using a randomized process (Martella et al., 2013).

Dependent Variable

The researcher used a combination of prefabricated multiple-choice questions (BookRags, 2015) and researcher-created multiple-choice questions to create daily 10 multiple-choice-question quizzes that assessed listening comprehension with four discriminators per question. The dependent measure was the percentage of correct listening comprehension questions on daily quizzes. The independent measure in each condition was the 1,500-word text excerpt. To keep the difficulty of the listening

comprehension quizzes at a consistent Lexile level, each quiz was measured using a free online Lexile measurement tool, and was entered into the measurement tool by the researcher, who was not trained by MetaMetrics®. As the novel *To Kill a Mockingbird* was scored at a Lexile level of 870 (MetaMetrics®, 2018), all the listening comprehension quizzes had a Lexile level no higher than 870. (See Table 2). Lexile levels were within the reading levels in accordance with the study participants' Individualized Education Programs (IEPs). *To Kill a Mockingbird* was chosen because it was part of the required reading list for the district curriculum.

Table 2

Comparison of Lexile Levels for Excerpts and Comprehension Questions

Ch Excerpt	Lexile Level	Grade Level	CQ Lexile Level	Grade Level
22	690	3 – 4	630	3 – 4
23	890	5 – 6	560	3
24	850	5 – 6	590	3
25	800	4 – 5	640	3 – 4
26	930	6 – 7	670	3 – 4
27	1010	7 – 8	660	3 – 4
28	800	4 – 5	600	3
29	660	3 – 4	530	2 – 3
30	730	3 – 4	590	3
31	600	3 – 4	530	2 – 3

Note. Ch = chapter; CQ = comprehension questions.

Conditions (Independent Variables)

Human reader. The teacher read aloud the excerpts of *To Kill a Mockingbird* to the students as well as the multiple-choice questions with discriminators. Each excerpt, each question, and each discriminator was read only one time.

Assistive technology (text-to-speech). Using the TTS functionality, the MacBook® was used to read the excerpt of *To Kill a Mockingbird* to students as well as the multiple-choice listening comprehension questions and coordinating discriminators to students. Each excerpt, each question, and each discriminator was read only one time.

Interobserver agreement. Two additional high school English teachers, one with more than 24 years teaching experience and another teacher with five years teaching

experience, graded independently the listening comprehension quizzes. These teachers were given the listening comprehension quizzes with an answer key. Each teacher scored the quizzes, giving one point for each correct answer. The scores were compared with those graded by the researcher. The agreements for each set of daily listening comprehension questions for each study participant were scored using an answer key. The number of correct multiple-choice questions for each student was added together and multiplied by 100 to determine the interobserver agreement percentage (Hartman, 1977; Martella et al., 2013). Interobserver agreement was 99.5% for this study.

Social Validity

Semi-structured interview questions were used to ascertain student perceptions of AT and its use in the classroom setting (Appendix B). All study participants discussed that they did not previously know how to access TTS on the MacBook®. Surveys, adapted form the work by Flanagan, Bauck, and Richardson (2013), were used to ascertain teacher technology use and knowledge regarding AT and whether they will continue to use AT in the classroom (Appendix C).

Data Collection

In this study, participants were given 10 multiple-choice listening comprehension questions over daily excerpts of *To Kill a Mockingbird* by Harper Lee. Each student received a paper copy of the questions in order to facilitate easy grading that is often too cumbersome to provide using Google Classroom. Ten school days of data collection occurred during 17 calendar days. Participants were subjected to the TTS treatment (Treatment A) on days 1, 3, 4, 6, 8, and 10. Participants were subjected to the human reader treatment (Treatment B) on days 2, 5, 7, and 9. These conditions were randomly

generated using an online randomizer (random.org) to determine the condition to be used. If the condition was randomly selected more than two consecutive days, the alternate condition would have been automatically used to help guard against sequencing effect (Martella et al., 2013). No study participants were absent during data collection days.

Procedures

Human reader. The teacher read an excerpt of *To Kill a Mockingbird* to students. Variance in excerpt lengths occurred because (a) excerpts were concluded with the last complete sentence before 1,500 words were reached. After reading the excerpt, the teacher gave study participants a 10-question multiple-choice listening comprehension quiz. The teacher read the multiple-choice questions and the corresponding discriminators to the students only one time. Study participants recorded their answers using paper and pencil. The quizzes were collected from all participants at the end of each session. This randomized condition was determined by an online random list generator. If this randomized list led to a condition being used more than two consecutive days, the alternate condition was chosen automatically to reduce sequencing effect (Martella et al., 2013). Data were measured over a 10-day period of time.

Assistive technology (text-to-speech). The MacBook® TTS functionality was enacted by highlighting the text and holding the Option key while pressing the Esc key to read the 1,500-word excerpt of *To Kill a Mockingbird* to the study participants. To ensure only that portion of the original text was read, the researcher created a portable document format (PDF) of the excerpt so the TTS functionality stopped reading automatically at the end of the excerpt. Study participants were given a 10-question multiple-choice listening comprehension quiz. The MacBook® read the multiple-choice questions and

corresponding discriminators to the participants. The text excerpt, multiple-choice questions, and corresponding discriminators were read only one time. Study participants recorded their answers using paper and pencil. The quizzes were collected from all participants at the end of each session. This randomized condition was determined by an online random number generator. If the online generator led to a condition being used more than two consecutive days, the alternate condition was chosen automatically to reduce sequencing effect. Data were measured over 10-day period of time.

Teacher surveys and study participant interviews. Surveys, given to nine English teachers, were collected. These teachers (a) taught grades 9-12 instructional support classes, college preparatory and/or advanced placement English classes, (b) had at least one year of teaching experience in the school district, and (c) had students IEPs in their classes. Four student participant interviews were conducted at the conclusion of the data collection. English teachers received paper copies of surveys to complete and return to the researcher. Study participant interviews were conducted individually in the classroom where the treatments were administered to students during data collection. The researcher asked students questions, noted their responses, and asked for clarification of their responses as needed.

Procedural reliability. The researcher taught an independent observer the condition procedures, and then the researcher and the independent observer practiced using the fidelity checklist. Items on the fidelity checklist included the following:

1. Teacher gained participants' attention.

2. Teacher said “Today, I am going to read a passage to you,” or “Today, the MacBook® will read a passage to you” (as appropriate) at the beginning of the session.
3. Teacher read (or started the MacBook® to read) excerpt to participants.
4. Teacher provided comprehension quiz to participants.
5. Teacher (or computer) read listening comprehension quiz questions to participants.
6. Teacher collected listening comprehension quizzes at the end of the session.

To train the independent observer, the researcher discussed the intervention and steps necessary to complete the intervention successfully. The researcher and independent observer rehearsed the intervention procedures and discussed what the intervention procedures should look like. The independent observer noted the steps completed and assigned a score from 0 (not implemented) to 5 (fully implemented) on a Likert scale to rate how well the intervention was delivered to the study participants. When at least 80% agreement was reached during practice sessions, the independent observer watched and scored the researcher delivering intervention procedures. Fidelity checks occurred in 30% of the sessions at a minimum of one time per condition during days 1, 3, and 9. Independent observer agreement was 100% for this study.

Results

Data were graphed and visually inspected and analyzed by the researcher. During the 10 days of data collection, study participants received the TTS treatment (Treatment A) six times during sessions 1, 3, 4, 6, 8, and 10. Study participants received the human

reader treatment (Treatment B) four times during sessions 2, 5, 7, and 9. Overall, the instructional intervention of human reader (Treatment B) yielded higher mean scores for all participants when compared with mean scores for text-to-speech (TTS) (Treatment A). Results for each participant are described below.

Chad

Figure 1 shows data for Chad. Treatment A utilized TTS to read a text excerpt of *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators. Treatment B utilized a human reader to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators.

Text-to-speech. TTS comprised six sessions. Chad's mean score was 40.67 (rounded to the nearest hundredth) with the range of 40. The standard deviation was 14.91 (rounded to the nearest hundredth). (See Table 3). Using the median score of 45, the researcher used a stability envelope of 25% above and 25% below the mean score to determine level and trend. For level and trend to be stable, 80% of the data points must fall on or within this envelope (Gast & Ledford, 2014). The level was variable and the level change deteriorated from moderate to low-to-moderate levels. To assess trend, the split-middle method (White & Haring 1980), wherein data sets for each treatment were divided into two groups and the intersection of session and scores were used to create a trendline, were used. This method was chosen over a freehand method of determining a trendline because the split-middle yields more accurate results with variable data sets (Gast & Ledford, 2014). The trend direction was decelerating and variable.

Human reader. Human reader comprised four sessions. Chad's mean score was 80 with a range of 30. The standard deviation was 12.25 (rounded to the nearest hundredth). (See Table 3). Using the median score of 75, the researcher created a stability envelope (Gast & Ledford, 2014) to assess level and trend. The level was variable in the level change deteriorated from high to moderately-high levels. The split-middle method (White & Haring, 1980) of trend analysis revealed the trend direction decelerated and was variable.

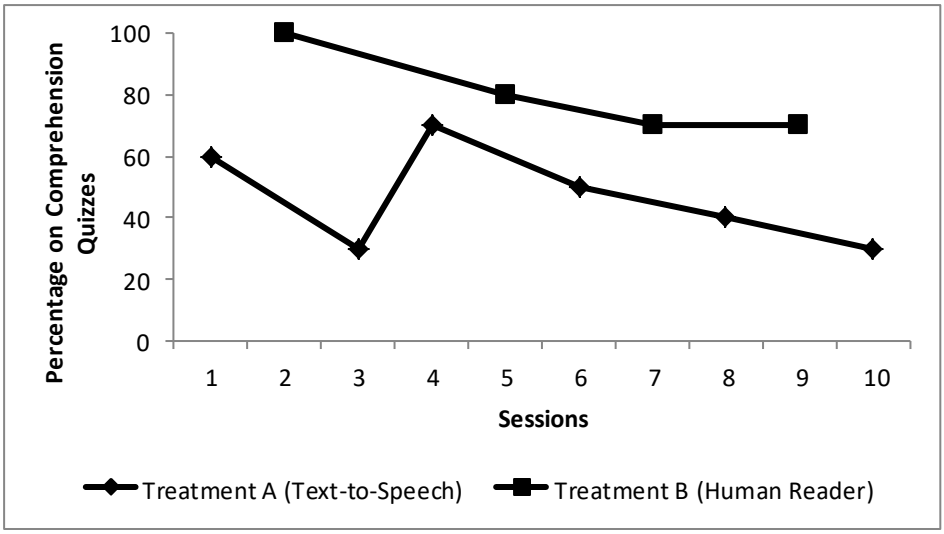

Figure 1. Percentage of correctly answered listening comprehension questions by Chad.

Table 3

Comprehension Score Analysis for Both Treatments

	TTS				Human Reader			
Participant	M	R	PSD	Mdn	M	R	PSD	Mdn
Chad	40.67*	40	14.91*	45	80	30	12.25*	75
Ivan	55	40	12.58*	60	67.5	20	12.99*	60
Nancy	70	70	28.28*	75	75	10	5	75
Priscilla	41.67*	40	15.72*	40	62.5	50	17.85*	60

Note. M = mean; R = range; PSD = population standard deviation; Mdn = median; * denotes value rounded to nearest hundredth.

Ivan

Figure 2 shows data for Ivan. Treatment A utilized TTS to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators. Treatment B utilized a human reader to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators.

Text-to-speech. TTS comprised six sessions. Ivan's mean score was 55 with a range of 40. The standard deviation was 12.58 (rounded to the nearest hundredth). (See Table 3). Using the median score of 60, the researcher created a stability envelope of 25% above and 25% below the mean score to determine level and trend. For level and trend to be stable, 80% of the data points must fall on or within this envelope (Gast & Ledford, 2014). The level was stable and the level change deteriorated from moderate to low-to-moderate levels. To assess trend, the split-middle method (White & Haring, 1980), wherein data sets for each treatment were divided into two groups in the

intersection of session and scores were used to create a trendline, were used. This method was chosen over a freehand method of determining a trendline because the split-middle method yields more accurate results with variable data sets (Gast & Ledford, 2014). The trend direction was decelerating and stable.

Human reader. Human reader comprised four sessions. Ivan's mean score was 67.5 with a range of 30. The standard deviation was 12.99 (rounded to the nearest hundredth). (See Table 3). Using the median score of 60, the researcher created a stability envelope (Gast & Ledford, 2014) to assess level and trend. The level was variable, but the level change deteriorated from high to moderate levels. The split-middle method (White & Haring, 1980) of trend analysis revealed the trend direction decelerated and was stable.

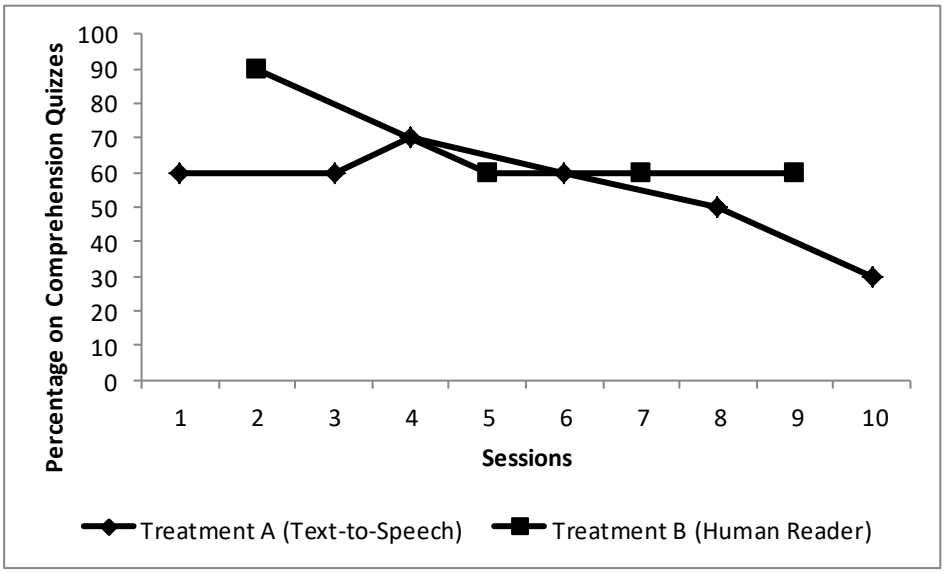

Figure 2. Percentage of correctly answered listening comprehension questions by Ivan.

Nancy

Figure 3 shows data for Nancy. Treatment A utilized TTS to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators. Treatment B utilized a human reader to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators.

Text-to-speech. TTS comprised six sessions. Nancy's mean score was 70 with the range of 70. The standard deviation was 28.28 (rounded to the nearest hundredth). (See Table 3). Using the median score of 75, the researcher created a stability envelope of 25% above and 25% below the mean score to determine level and trend. For level and trend to be stable, 80% of the data points must fall on or within this envelope (Gast & Ledford, 2014). The level was variable and the level change deteriorated from high to low-to-moderate levels. To assess trend, the split-middle method (White & Haring, 1980), wherein data sets for each treatment were divided into two groups and the intersection of session and scores were used to create a trendline, were used. This method was chosen over a freehand method of determining a trendline because the split-middle method yields more accurate results with variable data sets (Gast & Ledford, 2014). The trend direction was zero-celerating and stable.

Human reader. Human reader comprised four sessions. Nancy's mean score was 75 with a range of 10. The standard deviation was 5. (See Table 3). Using the median score of 75, the researcher created a stability envelope (Gast & Ledford, 2014) to assess level and trend. The level was stable and the change was nearly flat in the high to

moderately-high levels. The split-middle method (White & Haring, 1980) of trend analysis revealed the trend direction accelerated and was stable.

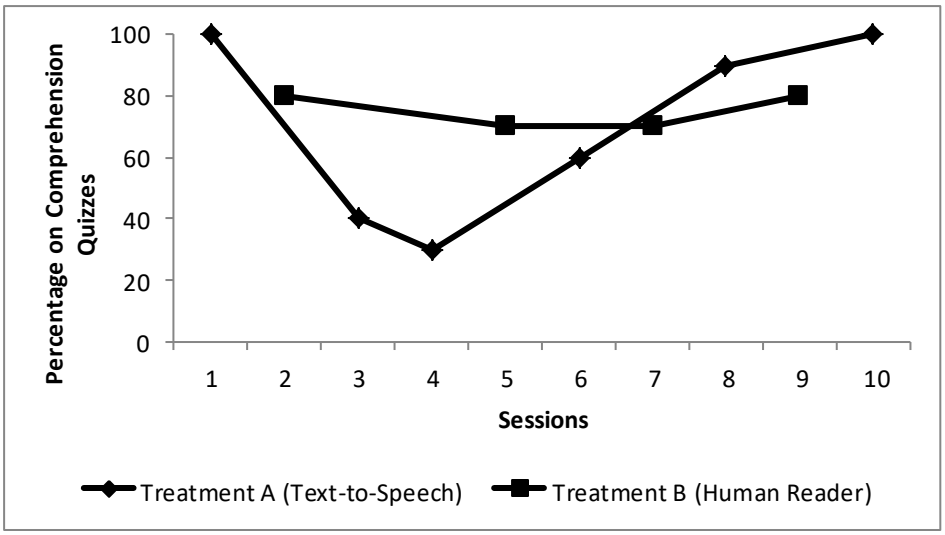

Figure 3. Percentage of correctly answered listening comprehension questions by Nancy.

Priscilla

Figure 4 shows data for Priscilla. Treatment A utilized TTS to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators. Treatment B utilized a human reader to read a text excerpt from *To Kill a Mockingbird* as well as listening comprehension questions and correlating multiple-choice discriminators.

Text-to-speech. TTS comprised six sessions. Priscilla's mean score was 41.67 (rounded to the nearest hundredth) with the range of 40. The standard deviation was 15.72 (rounded to the nearest hundredth). (See Table 3). Using the median score of 40, the researcher created a stability envelope of 25% above and 25% below the mean score to determine level and trend. For level and trend to be stable, 80% of the data points must fall on or within this envelope (Gast & Ledford, 2014). The level stability was variable,

but the level change deteriorated from moderate to low-to-moderate levels. To assess trend, the split-middle method (White & Haring, 1980), wherein data sets for each treatment were divided into two groups and the intersection of sessions and scores were used to create a trendline, were used. This method was chosen over a freehand method of determining a trendline because the split-middle method yields more accurate results with variable data sets (Gast & Ledford, 2014). The trend direction was improving and variable.

Human reader. Human reader comprised four sessions. Priscilla's mean score was 62.5 with the range of 50. The standard deviation was 17.85 (rounded to the nearest hundredth). (See Table 3).Using the median score of 60, the researcher created a stability envelope (Gast & Ledford, 2014) to assess level and trend. The level was variable, but the level change deteriorated slightly and was in the high to moderate levels. The split-middle method (White & Haring, 1980) of trend analysis revealed the trend direction was zero-celerating and was variable.

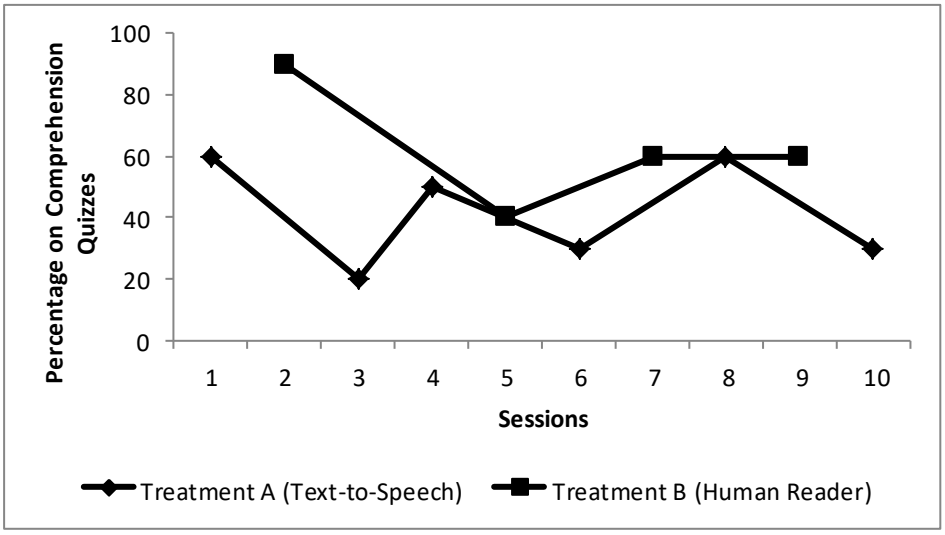

Figure 4. Percentage of correctly answered listening comprehension question by Priscilla.

Social Validity

Students were surveyed and interview to assess the social validity of the treatment. Students were asked about the value of the activity and how they felt about it. One student said TTS "...can be useful to help break down what I am reading in other classes because I don't like to read because it is hard." Another student discussed that TTS would have a negative impact on learning because "it was difficult to understand what she was saying sometimes."

Surveys were given to nine English teachers. Six of nine surveys (66.67%) were returned. Teachers (42.85%) agreed that students have difficulty reading English class texts. While all teachers (99.99%) agreed that students used MacBooks® for class assignments, teachers were divided about reading texts studied in English class to students, even though a large majority (85.71%) of teachers agreed that students were able to understand texts better when they listened to the text and followed along with the

text simultaneously. (See Table 4). Additionally, teachers reported TTS was useful for higher comprehension, differentiation by ability, and a more inclusive environment. While all nine teachers knew that TTS was available, none of the teachers surveyed were using TTS in their classrooms. However, six teachers (66.67%) said that, if they had proper training on (a) how to use TTS, and (b) how to train students to use TTS, they would be willing to try it in their classrooms, especially since students were required to bring and use their devices on a daily basis. The three teachers (33.33%) who said that they were not willing to try TTS in their classroom viewed TTS as a tool for students to use independently, outside of the classroom, if needed. It is important to note that these three teachers were nearing retirement within the next two years, and expressed distain at the idea of receiving additional training for technology they were not using and did not plan to use before retirement.

Table 4

Teacher Survey Results (n=6)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
My students have difficulty reading English class texts.	28.57%	14.28%	28.57%	28.57%	
I read texts studied in English class to all students.	28.57%	28.57%		42.85%	
I use audiobooks in class instead of reading texts to students.		28.57%	57.14%	14.28%	
Students use MacBooks® for class assignments.	42.85%	57.14%			
Personal technology positively impact student learning.	28.57%		42.85%	14.28%	14.28%
I use class and instruction time to read to students.	42.85%	28.57%	28.57%		
Students are capable of reading English class texts independently.	14.28%	42.85%	14.28%	28.57%	
The understanding of English class texts is increased when students listen to the text while following along with the written version of the texts.	28.57%	57.14%	14.28%		
Accessibility of English class texts is important.	71.42%	14.28%			
I encourage students to listen to audiobooks of English class texts outside of class.	42.85%	42.85%	14.28%		

Note. Percentages rounded to nearest hundredth.

Discussion

The purpose of this research was to examine the effect of two treatments, or instructional adaptations, (a) TTS, and (b) human reader on listening comprehension by students identified with having LD. Students in special education need instructional adaptations pertaining to the general education curriculum to help achieve academic success. Reading is an often challenging task for students with disabilities. Although much academic literature about technology use exists for students in general education (e.g., Doty et al., 2001; Pearman, 2008; Segers et al., 2004), 1:1 technology initiatives (Bebell & O'Dwyer, 2010) in schools and the ubiquitousness of technology holds promise for students with disabilities, there is a gap in the academic literature concerning the use of technology and listening comprehension for students with learning disabilities.

Earlier studies that examine decades-old forerunners of today's TTS, such as DECtalk (a talking computer) (e.g., Leong, 1995; Wise & Olson, 1994) and PowerPad (a touch pad connected to a tape recorder that allowed any word selected to be replayed) (Reitsma, 1988), found that TTS improved comprehension when it was paired with visual components. Because this study examined listening comprehension, participants did not receive the listening comprehension questions before or during the treatments. This was done so as to not allow participants to read the listening comprehension questions before or during the treatments. Such a circumstance would involve reading comprehension in addition to listening comprehension, potentially skewing the listening comprehension data.

I am going to discuss the results based on the research objectives. Objectives 1 and 2 measured listening comprehension scores for TTS and human reader treatments,

objective 3 compared the scores, and objective 5 collected social validity information from teachers.

Objectives One and Two: The measurement of listening comprehension scores of students with LD using TTS function (objective one) and human reader (objective two) to read an excerpt of *To Kill a Mockingbird.*

Explanation of findings. Students were subjected to TTS in sessions 1, 3, 4, 6, 8, and 10. After listening to each of these excerpts using TTS, students answered 10 multiple-choice listening comprehension questions. In this treatment, scores showed variability: Three study participants had score ranges of 40, and one participant had a score range of 70. Students were subjected to the human reader treatment and sessions 2, 5, 7, and 9. After listening to a human reader read each of these excerpts, students answered 10 multiple-choice listening comprehension questions. In this treatment, scores showed variability as well: Two study participants had score ranges of 30. One participant had a score range of 50. One participant had a score range of 10. (See Tables 3 and 6). The TTS treatment (Treatment A) showed wider variability in the scores of each individual participant when compared to the human reader treatment (Treatment B). This wider variability during the TTS treatment may mean that students were uncomfortable and unfamiliar with using TTS to read literature passages. As students use TTS more, their level of comfort and familiarity may lead to less variability in listening comprehension scores (Dolan, Hall, Banerjee, Chun, & Strangman, 2005).

Each of the study participants, although diagnosed with a learning disability in reading, were reading at a level close to their peers without disabilities. Contrary to students with more severe learning disabilities, who may need highly modified texts,

these students were able to comprehend *To Kill a Mockingbird* as it was presented to their peers without disabilities. Using the same text created the LRE for these students. To help illustrate this, Lexile levels for the text excerpts and the comprehension questions were measured. Lexile levels for the reading comprehension questions were consistently below the Lexile levels for the text excerpts. (See Table 2). Therefore, the possibility that study participants did not understand the context of the words used in the questions or discriminators can be discounted. Overall, when comparing the comprehension scores to Lexile levels for each text excerpt, there is no identifiable correlation between Lexile level and scores. Comprehension scores were lower for all study participants on Day 3, likely due to the fact that this day was the first Friday of the first full week of school and students were eagerly waiting for the end of the day. (See Table 5).

Table 5

TTS Treatment (Treatment B) Comparison

Participant	Date	Day	Scores	Chapter	Lexile	GE
Chad	W 8/22	1	60	22	690	3 – 4
	F 8/24	3	30	24	850	5 – 6
	M 8/27	4	70	25	800	4 – 5
	W 8/29	6	50	27	1010	7 – 8
	M 9/5	8	40	29	660	3 – 4
	F 9/7	10	30	31	600	3 – 4
Ivan	W 8/22	1	60	22	690	3 – 4
	F 8/24	3	60	24	850	5 – 6
	M 8/27	4	70	25	800	4 – 5
	W 8/29	6	60	27	1010	7 – 8
	M 9/5	8	50	29	660	3 – 4
	F 9/7	10	30	31	600	3 – 4
Nancy	W 8/22	1	100	22	690	3 – 4
	F 8/24	3	40	24	850	5 – 6
	M 8/27	4	30	25	800	4 – 5
	W 8/29	6	60	27	1010	7 – 8
	M 9/5	8	90	29	660	3 – 4
	F 9/7	10	100	31	600	3 – 4
Priscilla	W 8/22	1	60	22	690	3 – 4
	F 8/24	3	20	24	850	5 – 6
	M 8/27	4	50	25	800	4 – 5
	W 8/29	6	30	27	1010	7 – 8
	M 9/5	8	60	29	660	3 – 4
	F 9/7	10	30	31	600	3 – 4

Note. GE = grade equivalent; W = Wednesday; F = Friday; M = Monday

Since this is a small-n study, with four participants, the study results are specific to each participant. However trends could be seen in the study participants' experiences and results. We can look at these results by analyzing TTS and human reader treatments separately. Participants' experiences and scores were more or less similar depending on the treatment breaking down to look at TTS and human sessions reader sessions in a group. For example, Chad and Ivan shared similar experiences and results in the TTS treatment, while the results for the human reader treatment are best analyzed in two distinct pairs.

Chad and Ivan. Chad's and Ivan's highest reading comprehension scores of 70 during the TTS treatment occurred on Day 4. The Lexile level for this text excerpt was 800, but both scored significantly lower on Day 3 with a slightly higher Lexile level for the text excerpt. In Day 4's text excerpt, study participants learned about Tom Robinson, including his home, wife, and neighborhood. This content was likely more engaging for these two participants than some other chapters. Because of this, their focus on the excerpt was enhanced.

Nancy. Nancy's comprehension score on Day 1 was 100%. This score was significantly higher than the comparable scores of the other study participants for Day 1. Before the researcher started the TTS for this excerpt, Nancy remarked that she was nervous that she would not understand the TTS because she had never used it before. Her nervousness likely caused her to remain focused during the excerpt. In the same way, Nancy also had a comprehension score of 100% on Day 10. Before the researcher started the TTS for this excerpt, Nancy remarked that she needed to pay attention "really well" on this day because it was the last day of the study. On Day 8, the text excerpt explained

how Mr. Ewell broke Jem's arm and tried to hurt Scout in retaliation for Atticus's defense of Tom Robinson. When the excerpt ended, Nancy expressed annoyance that she would not get to hear what happened next. This engagement in the excerpt likely helped her to focus on the excerpt and likely helped her to obtain a comprehension score of 90% on Day 8.

Priscilla. Priscilla's comprehension scores for the TTS treatment were within 20% of at least two other study participants in each day of data collection for this treatment. Of note was that she was the only participant with a low score of 30% on the comprehension questions on Day 6 when the Lexile level jumped to 1010. This excerpt contained much dialect (e.g., who'd've, lemme, etc.) that may have been difficult to understand when presented through TTS, thus reflecting a 20% drop in comprehension scores from Day 4 to Day 6.

Although variability in scores was still present in the human reader treatment (Treatment B), there was a smaller range of scores in three of four participants. Additionally, listening comprehension mean scores for the human reader treatment (Treatment B) ranged from 62.5% – 80%. (See Tables 3 and 6).

Table 6

Human Reader (Treatment A) Comparison

Participant	Date	Day	Score	Chapter	Lexile	GE
Chad	R 8/23	2	100	23	890	5 – 6
	T 8/28	5	80	26	930	6 – 7
	R 8/30	7	70	28	800	4 – 5
	R 9/6	9	70	30	730	3 – 4
Ivan	R 8/23	2	90	23	890	5 – 6
	T 8/28	5	60	26	930	6 – 7
	R 8/30	7	60	28	800	4 – 5
	R 9/6	9	60	30	730	3 – 4
Nancy	R 8/23	2	80	23	890	5 – 6
	T 8/28	5	70	26	930	6 – 7
	R 8/30	7	70	28	800	4 – 5
	R 9/6	9	80	30	730	3 – 4
Priscilla	R 8/23	2	90	23	890	5 – 6
	T 8/28	5	40	26	930	6 – 7
	R 8/30	7	60	28	800	4 – 5
	R 9/6	9	60	30	730	3 – 4

Note. GE = grade equivalent; R = Thursday; T = Tuesday.

Chad and Nancy. Chad and Nancy had similar comprehension scores for the human reader treatment (Treatment B). With the exception of Chad's score of 100% on Day 2, the rest of their scores are either 70% or 80%.

Ivan and Priscilla. Ivan's scores are also stable and are similar to Priscilla's comprehension scores. For Ivan, after Day 2, all of his comprehension scores for the human reader treatment are 60%. For Priscilla, there is a sharp drop in her comprehension score on Day 5 (40%) from 90% on Day 2. While her comprehension score recovered during subsequent human reader treatments (to 60%), the drop in comprehension scores

on Day 5 is notable. This text excerpt, from chapter 26, mostly discussed Scout's third grade class. However, the comprehension questions contained two questions that required inference and interpretation skills. Question five asked study participants to recall an event from earlier in the novel about Scout, Jem, and Dill spying on Boo Radley. Additionally, question six asked study participants to interpret the meaning of the simile comparing summer to smoke in a closed room. (See Appendix B). For Priscilla, these necessary additional skills embedded in the comprehension questions impacted her comprehension score.

Objectives Three and Four: The comparison of both conditions on listening comprehension scores of students with LD and identification of the condition yielding the highest listening comprehension scores

Explanation of findings. In comparing the two treatments, text-to-speech (Treatment A) and human reader (Treatment B), listening comprehension scores for the human reader treatment were higher and more consistent. (See Tables 5 and 6). The human reader treatment consisted of four data collection points compared to six data collection points with the TTS treatment. Still, mean listening comprehension scores were higher during the human reader treatment (Treatment B). (See Table 3).

Objective Six: Social validation provided by teachers and using technology to gain access to the general education curriculum

Explanation of findings. For teachers in the classroom, personal technology's effect on student learning is mixed. Even the results from the teacher surveys showed that 28.57% of teachers agreed that personal technology positively impacted student learning. However, the same percentage of teachers disagreed with this statement. Every student in

a classroom has individual learning needs, and not every student learns in the same way. Therefore, laptops can be a useful tool to differentiate instruction and to allow students to work at an individual pace. However, technology, such as TTS which, on its face holds potential, numerous issues may be preventing teachers from fully implementing it in the classroom. Text-to-speech, although built into MacBook® operating systems, requires teacher training on not only how to operate and how to teach its operation to students, but also requires teachers to learn ways to build its use into regular classroom practice. As teachers become more comfortable with using this type of technology through training and practical experience, they will likely integrate it into the classroom more regularly.

Additionally, TTS, as used in this study, was free. Free software, like TTS built into MacBook®, has limitations. For example, it often does not correctly pronounce dialect, does not have the ability to add words to its lexicon, does not allow for adjustments to pronunciation, etc. Using purchased software that was designed specifically for TTS, to accommodate students with disabilities, that can compensate for the issues seen in this study (e.g., use of wrong tenses, mispronunciations due to dialect, no pauses at punctuation, etc.), would be appealing to many teachers interested in differentiating instruction and making English texts more accessible to all students. However, many districts are not knowledgeable about or have the funds to investigate or purchase additional software beyond the built in software on the devices.

Overall Contributions to the Literature

Research studies examining the effectiveness of TTS using today's technological devices are limited (Balajthy, 2005; Edyburn, 2007; Meyer & Bouck, 2014). While

students have greater access to technology through mobile devices and laptops, especially through 1:1 initiatives as in this school district, more access does not automatically equate to TTS being more effective (Segers et al., 2004; Takacs et al., 2014). The findings of this study concur with Balajthy (2005), and research studies by Hecker, Burns, Elking, Elking, and Katz (2002) as well as Disseldorp and Chambers (2003), who found that the effectiveness of TTS varied based on individual experiences and reading ability (Disseldorp & Chambers, 2003) and preferences, such as reading speed (Hecker et al., 2002).

Preferences. In this study, participants' preferences were limited. As part of the design, the default voice at the default speed were chosen for all of the TTS excerpts. Participants were not able to choose one of the different voice options or adjust the reading speed slower or faster to suit their individual needs. Additionally, as a reading strategy, students were taught in middle school to read comprehension questions before reading an excerpt and to follow along with the text as it was read. By design, study participants did not have access to comprehension questions or written forms of the excerpts to refer to when answering questions. For those students, who preferred to follow along with the text or focus on reading to find comprehension question answers, the design of this study – as listening comprehension – was outside of their comfort zone. While teachers did not re-read text excerpts or comprehension questions on a regular basis, the option to have a question repeated was available, if needed, as part of regular classroom practice.

Study participants were also limited to using MacBook® TTS. For those who preferred to use other TTS software or phone apps, they were not able to exercise their

preferences during this study. Students listened to the excerpts as a group using MacBook's® TTS feature. However, TTS would also be useful on an individual basis. For example, students could use TTS to read or re-read independently a text excerpt on their own time and at their own pace, or in conjunction with class discussion to make the use of TTS more natural (Parr, 2012).

Additionally, since neither the excerpts nor the comprehension questions were repeated, and read only one time, students did not have the opportunity to ask for a rehearing of the question(s) or hearing a repetition of part or all of the excerpt as needed. This decision was made because data were collected during a high school class as a group repetitions of questions or excerpts would have cause distractions to other participants who may not have been working at the same pace as other students needing repetitions. In normal daily practice, students would have the option to have a question repeated, if necessary. Due to time constraints and out of concern to keep forward class momentum, students would not have the opportunity to have texts or text excerpts repeated.

Individual experiences. According to Wood et al., (2017), the mixed findings in academic literature, similar to the findings in this study, may be affected by subtle differences in TTS systems, such as voice, rate, and the ability of text to be highlighted as the text was read. Not every student was comfortable with TTS. Because many of the students had no prior experience using TTS in English class to read excerpts, some students were uncomfortable with relying on an unfamiliar intervention, such as TTS, to read to them instead of a more familiar intervention, of a human reader. Using TTS earlier, before the study began, would have allowed students the opportunity to learn how to use TTS and would have made them more comfortable with this technology.

Additionally, not every student with LD has the same needs. Some students with LD have more developed decoding skills – TTS may not benefit every student with LD the same way and not every student with LD need TTS (Wood et al., 2017). For these students, TTS may not have been as helpful to them.

Limitations of the Present Study

School calendar. The school calendar may have contributed to some of the variability of the participants' comprehension scores. While only 10 days of data collection occurred for this study, these 10 days spanned three weeks due to an extended weekend, a professional development day, and a national holiday. Data collection took 17 calendar days to collect 10 days of data. (See Table 7). This may have caused study participants to be somewhat unfocused while listening to the text excerpts and completing the listening comprehension questions. It may help to explain Nancy's score fluctuation during the TTS intervention.

Table 7

School Calendar

Week	Date	Session
1	Wednesday, August 22	1
	Thursday, August 23	2
	Friday, August 24	3
	Saturday, August 25	Weekend
	Sunday, August 26	Weekend
2	Monday, August 27	4
	Tuesday, August 28	5
	Wednesday, August 29	6
	Thursday, August 30	7
	Friday, August 31	Labor Day Vacation
	Saturday, September 1	Weekend
	Sunday, September 2	Weekend
3	Monday, September 3	Labor Day – no school
	Tuesday, September 4	Professional Day – no school
	Wednesday, September 5	8
	Thursday, September 6	9
	Friday, September 7	10

Timing of data collection. For numerous reasons, it was necessary to collect data for this study at the beginning of the school year. While the beginning of the school year gave time without numerous student absences for school activities **(**e.g., sports, drama

productions, etc.), other complications presented during the time of data collection. Results show there was a decrease in listening comprehension scores on Day 3 of data collection for all study participants. This day was the first Friday of the first full week of the school year. Sustained focus of study participants was shorter than usual as participants were eagerly awaiting the end of the school day may two hours after data collection that day.

Another consideration was that data collection occurred in the middle of the afternoon. Study participants, who were high school students, often had personal experiences and high school life to navigate before and after data collection. Students who had positive and negative experiences earlier in the day may have been less able to focus on the excerpts due to being preoccupied with personal concerns.

MacBook® text-to-speech anomalies. The MacBook® TTS function had several anomalies in pronunciation and incorrect speech (e.g., use of incorrect verb tense, use of homophones, etc.), coupled with the lack of vocal inflection and natural pauses for punctuation and breathing that a human reader would employ when reading aloud. These issues may have added additional layers of complexity to the listening task. (See Table 8).These anomalies likely would have been eliminated had purchased TTS software (e.g., Ivona, Natural Reader, Zabaware TTS Reader, etc.) been used in place of the MacBook® TTS function. Also, due to the dialect present throughout *To Kill a Mockingbird*, using a different grade-level text would have shown more consistent results as well as more distinct functional relationships between the TTS and human reader treatments.

Table 8

TTS Anomalies

Chapter	Text	TTS
24	Diningroom	Dining room
	Who'd've	Who'd ē-ver
	Nooo	Unintelligible
	Tears	Tares
	Ma'am	Mom
	Lead	Led
	Darky's	Darkis
	– Mrs.	M R S
	Darkey	Darket
25	..my cot. September	My cot September
	Putting	Putt-ing
	Lemme	Lem
	Read (past tense)	Read (present tense)
27	Deas	De-as
	Wouldn't've	Won't ē-ver
29	Chasin'	Chassin
	M'shoes	M shoes
	– Mr.	M R
	Khaki	Cocky
31	Readin'	Rea-din
	H'rm	H rim

Note. Words appearing in multiple chapters are only listed in chapter of first occurrence.

Instructional support English class. All study participants were served in an instructional support English class. Repeating this study with a larger sample size and an extended data collection period, comprised of students with LD, who are in less restrictive educational settings, may result in less variability due to a differently-structured academic environment that would allow for higher-level questioning. For example, Bloom's taxonomy (Krathwohl, 2002) indicates six levels of understanding: (1) remember, (2) understand, (3) apply, (4) analyze, (5) evaluate, and (6) create. Most multiple-choice questions used in this study were written at the "remember" level: e.g., What newspaper is Atticus reading when Scout and Jem awaken? For example, a revised question applicable for students with LD in a less restrictive educational setting, may use Bloom's "application" level: e.g., How is what Mr. Ewell did to Helen Robinson similar to what Mr. Ewell did to Scout Finch?

Future Research

Future areas of research should be extended to individuals with identified disabilities other than LD, since their areas of need are identified when they are diagnosed with having reading and comprehension issues. While this study was conducted with individuals requiring more focused educational support in English, research should be conducted on other disability categories as well as for individuals with LD in less restrictive settings, such as co-taught English classes where students with and without disabilities learn in the same class at the same time. Additionally, research should be conducted using TTS with fewer restrictions. For example, giving study participants the ability to choose reading speed, voice, and TTS software or apps used may increase

comprehension because study participants could make choices based on individual need. Purchased software or apps often can be used on all devices, including smartphones and tablets, providing increased flexibility and increased opportunity for use in academic and non-academic settings. Because this software is purchased, more features are often available, such as the ability of the app or software to highlight the word(s) being read, repeat a words or one word in isolation, or define words as needed.

Implications and Recommendations

There are implications for practice as a result of this study. The use of assistive technology (AT), especially TTS – while not shown in this study to be as effective as a human reader for listening comprehension – still has value for students (Bouck, Maeda, & Flanagan, 2012; Wood et al., 2017). The first implication is that when TTS is used as a supplement to, and not as a substitute for, explicit instruction from a teacher, TTS can be another avenue for comprehension support and assistance (Parr, 2012). Students can use TTS in numerous ways to be take more ownership of the reading supports they may need in the classroom, such as using TTS (a) to work at an individual pace, (b) to review what has already been discussed in class, and (c) to catch up in cases of absence from academic instruction. Another implication is that technology, for all its potential uses, does not outweigh the need for an experienced teacher in the classroom to provide support and instruction to the students they serve. A teacher is able to read the text with vocal inflection and breathing at punctuation. For instance, in chapter 25 of *To Kill a Mockingbird*, the text reads:

> Sighing, I scooped up the small creature, placed him on the bottom step and went back to my cot. September had come, but not a trace of cool weather with it, and we were still sleeping on the back screen porch. (Lee, 2011, p. 273)

A teacher would make a slight pause at commas to accentuate the phrases and pausing longer still at the period between "cot" and "September," opposed to TTS reading "my cot September." Such subtle changes allow for clarity and understanding and, in turn, the potential for improved listening comprehension.

A third implication is that school districts should be diligent when choosing to purchase technology without proper software to support the technology. When this happens, 1:1 technology initiatives are not as successful. This study showed that a human reader was consistently more effective on listening comprehension scores for students with LD when compared to TTS. While this district purchased Apple® products, more research into ways TTS could be used, especially for students with LD, would have been helpful. If the district were to purchase other TTS software, instead of relying on MacBook's® TTS functionality, TTS may have a different effect on listening comprehension than what was found in this study. Using purchased software with additional features, such as word highlighting and word defining, would likely prove more beneficial to students with learning disabilities in reading. Furthermore, having this TTS technology available on mobile devices (e.g., tablets and smartphones) would allow students to use the technology more often in academic and real-world settings. Having the opportunity to use TTS technology across devices and in real-world settings would decrease stigma of its use for students with LD in academic and real-world situations. For teachers, training on how to use and implement this technology in the classroom is

paramount to its continued use and success. Simply having TTS technology, even though free, is not always the best. Although this technology creates the opportunity to explore its usefulness, having TTS software that fits the needs of students and is easy to use and implement in the classroom, would present an opportunity for greater learning and collaboration.

During the course of this study, the researcher learned that neither students nor teachers were aware fully of the TTS functionality available on the MacBook®. Many did not know (a) how to locate the TTS settings, and (b) how to activate TTS. Since TTS is free and readily available in these devices chosen for a 1:1 technology initiative, a fourth implication is teachers require early and ongoing administrative support, through professional development, to grow as professionals (Dingle et al., 2011; International Society for Technology in Education, 2018). Implementing technology, like TTS, can require a change in both teacher practice and school culture. Teacher professional development is an effective school change process for continual and sustainable improvement because it affords learning strategies that are amenable to adult learning styles. However, the lack of (a) administrator support, (b) resources, and (c) professional development, although vital to reform efforts, have left teachers feeling unsupported in their professional lives (Avalos, 2011; Haney & Lumpe, 1995; Javanova-Mitkovska, 2010; Taylor, Yates, Meyer, & Kinsella, 2011).

Professional development is a valid and essential form of professional learning (Avalos, 2011; Butler & Schnellert, 2012; Haney & Lumpe, 1995; Javanova-Mitkovska, 2010; Spillane & Thompson, 1997). It gives teachers the opportunity to hone their teaching skills and increases the benefit to the school as a whole because it serves to

improve the professional lives of teachers. To offer further support, recurring and continual professional development affords teachers the opportunity to engage in more complete and extensive learning while feeling supported by the school administrator and increasing their own sense of self worth (Levine & Stark, 1982; Purkey & Smith, 1983). In order to further school improvement through professional development, it is essential that teachers collaborate with one another in order to grow professionally and to build teacher capacity (Butler & Schnellert, 2012; Spillane & Thompson, 1997). Additionally, teacher leadership is essential for effective school improvement (Lambert, 2007; Muijs & Harris, 2006). When teachers are given leadership roles, involvement in internal and external programs, and support of a school administrator empowers all teachers and improves the school through knowledge that is disseminated by teachers (Lambert, 2007; Muijs & Harris, 2006). Ultimately, teachers become invaluable as resources and agents of school reform that can be sustained long-term (Clark, Lotto, & Astuto, 1984; Davidson, & Taylor, 1999; Murphy, Elliot, Goldring, & Porter, 2007).

In order to effectively learn and successfully implement technology, like TTS, into regular classroom practice teachers need to be prepared to implement technology in the classroom. Effective professional development ensures that (a) teachers have a shared vision of the benefits and pedagogical uses of technology, and (b) teachers receive sufficient professional development to build their self-confidence and their understanding of the potential that technology in the classroom setting possesses (Anderson & Dexter, 2005; Flanagan & Jacobsen, 2003; Isabelle & Lapointe, 2003; Papa, 2011). Through this professional development, teachers are able to learn to use technology through building-level collaboration. Additionally, the use of technology in the classroom gives students

to opportunity to use technology in a way that prepares them for life and the workplace after high school graduation. This process is especially important for students of low socioeconomic background who may not have regular exposure or opportunity to use technology outside of the school setting (Flanagan & Jacobsen, 2003; Papa, 2011). As support for classroom technology increases among students and teachers, support from external stakeholders, such as parents and other community members, will also increase as student learning improves as a result of pedagogically relevant technology integration continues (Anderson & Dexter, 2005; Flanagan & Jacobsen, 2003; Isabelle & Lapointe, 2003; Papa, 2011).

Students, too, are impacted by the use of technology, such as TTS, in the classroom. Periodic training for students is also essential so they can review how to use TTS and learn how to use it more effectively beyond basic levels, especially if the TTS has customizable features. Although TTS is an acceptable classroom accommodation, in order for it to be used as during state testing, students must use the accommodation regularly in the classroom setting (Oklahoma State Department of Education, 2018). For this reason, it is important that students receive training on how to effectively use TTS, and to be encouraged to use it when needed in the classroom setting. Additionally, TTS can be implemented into the IEP process for students with (learning) disabilities to facilitate and encourage student understanding and participation in the meeting. While this study used the TTS functionality that was built into the MacBook® operating system, paid software offers further flexibility, not only for software settings, but also for use on mobile devices.

In this study, the novel *To Kill a Mockingbird* was used as the text excerpts source because it fit into the academic curriculum for the time data collection for this study occurred. While the study participants were familiar with the novel and were prepared to answer the questions with the confidence of understanding about the roles of the characters and the characters' impact on the novel, using text excerpts of the lighter subject matter may make the process of integrating TTS into classroom practice easier, especially if students connect with and relate to the text excerpts content.

An additional recommendation is to experiment with the TTS settings for the voice and reading speed. In this study, Samantha was chosen for the voice because it was void of identifiable and potentially confusing language accents (e.g., British, German, etc.) and it was a female voice that was akin to what many students may be accustomed to hearing in a classroom. The reading speed was set to the default of normal speed, but decreasing or increasing the reading speed may better suit the students' needs and requirements.

Conclusion

Using AT, especially TTS, to support students with LD may benefit students who struggle with reading comprehension. As technology continues to advance and school districts implement the use of more technology, such as 1:1 initiatives, TTS is becoming more available. As researchers, we must continue to scrutinize TTS and grasp opportunities in which its use can facilitate student success. This study adds knowledge to the research base because it provided a better understanding of how to address issues and enhance the benefits of TTS, highlighted potential barriers, and offered recommendations to practitioners who may want to implement this technology in the classroom setting.

While TTS, in this study, was not as effective as a human reader, it was limited by numerous factors, including the school calendar, the dialect in the text excerpts, and the TTS function on MacBook® itself. However, this study explored TTS and its potential for assisting students diagnosed with learning disabilities in reading, TTS provides an additional avenue to gain support in listening comprehension, especially when TTS is combined with supportive features and used in appropriate situations.

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Appendices

Appendix A: Listening Comprehension Questions

Name: _____Date: _____

Chapter 22

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. From reading this excerpt, how does Jem feel about the trial verdict?
   A. Happy
   B. Scared
   C. Angry
   D. Bored

2. What newspaper is Atticus reading when Scout and Jem awaken?
   A. The Mobile Register
   B. The New York Times
   C. The Houston Chronicle
   D. The Chicago Tribune

3. What food item does Calpurnia say Tom Robinson's father sent over to the Finch's?
   A. A dozen eggs
   B. A chicken
   C. Pig's feet
   D. Bread pudding

4. How can you tell that Atticus is moved by the gifts of food?
   A. He says he is proud to get it.
   B. His eyes are filled with tears.
   C. He grinned when he found a jar of pickled pigs feet.
   D. All of the above

5. Who comes to visit Jem and Scout during breakfast?
   A. Mr. Ewell
   B. Walter Cunningham
   C. Dill
   D. Boo Radley

6. What did Miss Stephanie want to know from Jem, Dill, and Scout?
   A. The weather forecast
   B. The time
   C. Who gave permission for them to attend the trial
   D. What time Calpurnia leaves for the day

7. What dessert does Miss Maudie offer to Jem and the other children?
   A. Ice cream
   B. Pralines
   C. Pie
   D. Cake

8. To what does Jem compare Maycomb?
   A. A dog
   B. A cat
   C. A pig
   D. A caterpillar

9. According to the narrator, “court-appointed defenses were usually given to” what latest addition to the bar?
   A. Link Deas
   B. Dolphus Raymond
   C. Bob Ewell
   D. Maxwell Green

10. How do many of the townspeople feel about Atticus?
   A. They are proud of him even though he did not win at trial.
   B. They are angry with him because he lost at trial.
   C. They feel sorry for him so they brought him food.
   D. They hope he moves out of town.

Name: _____Date: _____

Chapter 23

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. As Atticus was leaving the post office, who spat on him and threatened to kill him?
   A. Boo Radley
   B. Calpurnia
   C. Mr. Ewell
   D. Jem

2. What store does Miss Stephanie Crawford say she was leaving when she saw Atticus get threatened?
   A. Sears
   B. Jitney Jungle
   C. Wal-Mart
   D. J. C. Penny's

3. Jem says of Atticus, "He told me havin' a gun around's an invitation" for what?
   A. Somebody to rob you
   B. Somebody to stab you
   C. Somebody to shoot you
   D. Accidents

4. Why were Jem and Scout not interested in eating or in their normal daily activities?
   A. They were scared.
   B. They were excited
   C. They were too busy reading magazines
   D. They were bored.

5. After Atticus says "we don't have anything to fear from Bob Ewell," what does Aunt Alexandra mean when she says "You know how those people are?"
   A. She is happy with the Ewells; they are nice people.
   B. She is grateful the Ewells live in her town because they always pay their debts.
   C. She is upset with the Ewells because they are rude.
   D. She is angry with the Ewells; they are poor, tell lies, and cannot be trusted.

6. Where is Enfield Prison Farm said to be?
   A. Clark County
   B. Chester County
   C. Jackson County
   D. Warren County

7. What will happen to Tom Robinson if he loses his appeal, according to Atticus?
   A. He'll be placed on parole.
   B. He'll spend life in prison.
   C. He'll spend 20 years in prison.
   D. He'll receive the death penalty.

8. What does Jem believe the justice system should get rid of?
   A. Verdicts
   B. Lawyers
   C. Judges
   D. Juries

9. Atticus says, "The one place where a man ought to get a square deal is in a courtroom. What does he mean?
   A. Courtrooms are only for men.
   B. Courtrooms should always be square, not rectangle or oval in shape.
   C. Courtrooms are places where deals are made.
   D. Courtrooms are the only place where someone can be judged without prejudice.

10. Based on this passage, how does Atticus feel about the verdict in the trial?
    A. He is pleased.
    B. He is unhappy, but he expected this to be the outcome.
    C. He doesn't care as long as he gets paid.
    D. He is happy to be going on vacation.

Name: _____Date: _____

Chapter 24

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. What month is it in the beginning of the excerpt?
   A. June
   B. July
   C. March
   D. August

2. Where have Jem and Dill gone at the beginning of the passage?
   A. The Colorado River
   B. Barker's Eddy
   C. Arkansas
   D. Montgomery

3. Why was Scout dressed in her Sunday clothes?
   A. Missionary circle meetings were events for which ladies dressed up.
   B. All of Scout's other clothes were too dirty to wear.
   C. Scout thought it was too hot to wear pants.
   D. Scout liked to wear dresses.

4. What day of the week does this excerpt take place?
   A. Monday
   B. Friday
   C. Saturday
   D. Sunday

5. What does Scout carry into the diningroom?
   A. Plates
   B. Cake
   C. Cookies
   D. Coffee

6. Why does Scout try to push the kitchen door with her behind like Calpurnia?
   A. She admires Calpurnia and wants to act like her.
   B. Her hands are dirty.
   C. Using her hands is not ladylike.
   D. Scout is lazy and was too tired to use her hands.

7. What does Scout say "Always filled me with vague apprehension and a firm desire to be elsewhere?"
   A. Groups of ladies
   B. Snakes
   C. Little kids
   D. Schoolteachers

8. Overall, how does Miss Stephanie Crawford feel about Scout?
   A. She thinks Scout is a silly little girl who doesn't understand the world around her.
   B. She thinks Scout is intelligent.
   C. She likes Scout and wants to get to know her better.
   D. She thinks Scout is nice.

9. Why did Miss Maudie close her hand tightly on Scout's?
   A. Miss Maudie was truing to shake hands with Scout.
   B. Miss Maudie was trying to keep Scout calm.
   C. Miss Maudie's hands were cold and she wanted to warm them.
   D. Miss Maudie wanted to give Scout a note.

10. How many children did Mrs. Merriweather have?
    A. Two
    B. Zero
    C. One
    D. Four

Name: _____Date: _____

Chapter 25

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. What bug is Scout about to kill when Jem tells her to take it outside?
   A. A wolf spider
   B. A cockroach
   C. A lightening bug
   D. A roly-poly

2. What did Jem teach Dill to do?
   A. Read
   B. Shoot a gun
   C. Bake cookies
   D. Swim

3. Jem and Dill had been heading home from where when they saw Atticus going to the Robinson home?
   A. Montgomery
   B. Barker's Eddy
   C. Church
   D. Sears

4. Where does Tom Robinson live?
   A. In the city
   B. Off the highway
   C. In Montgomery
   D. In a mansion

5. What does Dill say the children were playing in front of Tom Robinson's house when Atticus arrived?
   A. Marbles
   B. Poker
   C. Football
   D. Basketball

6. What is Tom Robinson's wife's name?
   A. Beth
   B. Susan
   C. Jennifer
   D. Helen

7. Why did the Ewells holler at Atticus's car when it drove past their house?
   A. They were upset with the noise late at night.
   B. The car headlights woke up everybody.
   C. They were happy to see Atticus.
   D. They were angry because Atticus went to see Helen.

8. How does the narrator describe Macomb's view of Tom's death?
   A. Typical
   B. Terrifying
   C. Surprising
   D. Shameful

9. Who writes a scathing editorial in the newspaper about the Tom Robinson ordeal?
   A. Emily Davis
   B. Link Deas
   C. Dolphus Raymond
   D. Mr. Underwood

10. Who "told Aunt Alexandra in Jem's presence ("Oh foot, he's old enough to listen.") that Mr. Ewell said it make one down and about two more to go?"
    A. Miss Stephanie Crawford
    B. Ruth Jones
    C. Emily Davis
    D. Mayella Ewell

Name: _____Date: _____

Chapter 26

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. Jem is in what grade in school in this excerpt?
   A. Fifth grade
   B. Seventh grade
   C. Fourth grade
   D. Sixth grade

2. What grade in school has Scout begun in this excerpt?
   A. Fourth grade
   B. Fifth grade
   C. Third grade
   D. Sixth grade

3. How did Jem and Scout know Boo was still living?
   A. They talked with him.
   B. They saw him on the porch.
   C. Miss Maudie told them.
   D. Nobody carried him out.

4. How do you think Boo felt about Jem and Scout?
   A. He liked them and gave them gifts.
   B. He was angry with them for not visiting.
   C. He did not like them because they were too loud.
   D. He was afraid of them because their Aunt Alexandra was mean.

5. What does Atticus reveal that he knew despite Scout and Jem trying to kid it from him?
   A. Scout’s bad grade in math
   B. Dill doesn’t know how to swim.
   C. Jem and Scout were spying on Boo when Mr. Radley shot at them in the collard patch.
   D. Miss Maudie does not like Calpurnia.

6. When the narrator says “summer hung over us like smoke in a closed room,” what does she mean?
   A. Summer seemed to go on for a long time.
   B. There was a lot of air pollution.
   C. Summer made it hard to breathe.
   D. Summer was cold and people burned everything to stay warm, making a lot of smoke in the air.

7. What was Current Events period in Scout’s class?
   A. Free time when everyone played a game.
   B. Each student shared a story from the local newspaper with the class.
   C. A special party for students with birthdays coming soon
   D. A time when students read a book silently.

8. Who does Cecil Jacobs describe as having “been after Jews and he’s putin’ ‘em in prisons and he’s taking away all their property and he won’t let any of ‘em out of the country?”
   A. Adolf Hitler
   B. Benito Mussolini
   C. Saddam Hussein
   D. Benedict Arnold

9. What quotation does Scout cite when her teacher asks for the definition of Democracy?
   A. “Equal rights for all, special privileges for none.”
   B. “Practicing the same definition of ‘fair’ to everyone, regardless of color, gender, or age.”
   C. “Elected individuals to represent an entire community.”
   D. “Being fair, even when you don’t want to be.”

10. What kind of government does Miss Gates say Germany operates under?
    A. A monarchy
    B. A confederacy
    C. A democracy
    D. A dictatorship

Name: _____Date: _____

Chapter 27

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. Scout says that Bob Ewell is the "only man I ever heard of who was fired from the WPA for" what?
   A. Drinking
   B. Domestic abuse
   C. Cancer
   D. Laziness

2. Who does Scout refer to as the "Welfare lady?"
   A. Ruth Jones
   B. Mayella Ewell
   C. Miss Maudie
   D. Emily Davis

3. When Judge Taylor had an intruder, what did he keep across his lap?
   A. A shotgun
   B. A sword
   C. A knife
   D. A golf club

4. Put the three things that happened in October in this excerpt in the correct order.
   A. Bob Ewell lost a job, Judge Taylor's house was broken into, Helen Robinson got a job
   B. Helen Robinson got a job, Bob Ewell lost a job, Judge Taylor's house was broken into
   C. Judge Taylor's house got broken into, Bob Ewell lost a job, Helen Robinson got a job
   D. None of the above

5. Who has gone out of his way to make a job for Helen Robinson?
   A. Miss Maudie
   B. Miss Stephanie Crawford
   C. Mr. Dolphus Raymond
   D. Mr. Link Deas

6. Why did Helen have to walk an extra mile to work?
   A. She wanted exercise.
   B. She bought a new pair of shoes and wanted to break them in.
   C. The Ewells harassed her when she walked by their house.
   D. She refused to make left turns when walking or driving.

7. Why do you think the Ewells were harassing Helen?
   A. They were bored.
   B. They blamed her for Mayella's rape and trial and wanted to make her uncomfortable.
   C. They did not like people walking in front of their house.
   D. They wanted her to apologize to them.

8. When Atticus said "John looked at him (Mr. Ewell) as if he were a three-legged chicken or a square egg," Atticus meant that
   A. John thought Mr. Ewell was ordinary.
   B. John wanted to get to know Mr. Ewell better.
   C. John liked chickens with three legs.
   D. John thought there was something peculiar and not right with Mr. Ewell.

9. What does "NRA" refer to in this excerpt?
   A. National Retaliatory Act
   B. National Refurbishment Act
   C. National Recovery Act
   D. National Rifle Association

10. What was new about Halloween this year?
    A. Maycomb was celebrating it for the first time.
    B. Maycomb organized the holiday.
    C. Maycomb cancelled Halloween celebrations.
    D. Maycomb said Halloween was only for adults.

Name: _____Date: _____

Chapter 28

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. During what month does this excerpt take place?
   A. October
   B. December
   C. April
   D. June

2. What does Scout dress up as for Halloween?
   A. A mouse
   B. A cat
   C. A werewolf
   D. A ham

3. What does Jem tease Scout about being afraid of?
   A. Strangers
   B. Haints
   C. Gangsters
   D. Police officers

4. Scout describes the lament of the bluejay as a repetitive sounding of what phrase?
   A. Why me
   B. Too bad
   C. Poor will
   D. Oh no

5. From the excerpt, what time of day does the excerpt take place.
   A. Morning
   B. Afternoon
   C. Evening
   D. Night

6. Who scared Jem and Scout on their way to the auditorium for the Halloween pageant?
   A. Calpurnia
   B. Atticus
   C. Cecil
   D. Miss Maudie

7. How much money does Jem give to Scout to spend at the Halloween pageant?
   A. 2 dollars
   B. 1 dollar
   C. 10 cents
   D. 30 cents

8. Who does Jem leave Scout to hang out with at the Halloween pageant?
   A. John Taylor
   B. Stephanie Crawford
   C. Link Deas
   D. Cecil Jacobs

9. What did Cecil say was unsanitary?
   A. Restrooms
   B. Bobbing for apples
   C. Trees
   D. Boo Radley

10. Who was in charge of the Halloween pageant?
    A. Atticus
    B. Boo Radley
    C. Calpurnia
    D. Mrs. Merriweather

Name: _____Date: _____

Chapter 29

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. At the beginning of this excerpt, who blames themselves for what happened to Jem?
   A. Calpurnia
   B. Aunt Alexandra
   C. Scout
   D. Mrs. Merriweather

2. What was the prize for the best costume at the Halloween pageant?
   A. 1 dollar
   B. 5 dollars
   C. 2 cents
   D. 25 cents

3. Why didn't Atticus hear Jem scream?
   A. He was listening to the radio.
   B. He was reading a book.
   C. He was asleep.
   D. He was in Montgomery.

4. What does Sheriff Tate say he believes saved Scout's life?
   A. Her shoes
   B. Her wits
   C. Her uncle
   D. Her costume

5. When Mr. Tate said "Mr. Finch, there's just some kind of men you have to shoot before you can say hidy to 'em. Even then, they ain't worth the bullet it takes to shoot 'em. Ewell 'as one of 'em." What did he mean?
   A. Mr. Ewell liked guns.
   B. Mr. Tate hoped Atticus would start shooting guns again.
   C. Mr. Ewell was a bad man who will not be missed.
   D. Mr. Tate thinks Atticus would make more friends if he were friendlier.

6. How has Jem been injured?
   A. His ribs are broken.
   B. His collar bone is broken.
   C. His arm is broken.
   D. His leg is broken.

7. How does Scout say Mr. Ewell tried to kill her?
   A. By shooting her to death
   B. By squeezing her to death
   C. By stabbing her to death
   D. By beating her to death

8. What was the man who saved Jem and Scout from Mr. Ewell wearing?
   A. Khaki pants and a denim shirt
   B. A suit and tie
   C. Shorts and a tank top
   D. A stocking hat

9. Who is Scout describing when she says “His face was as white as his hands, but for a shadow on his jutting chin.”
   A. Calpurnia
   B. Jem
   C. Boo
   D. Sheriff Tate

10. Who does Scout point out as the person that saved her and Jem from their attacker?
    A. John Taylor
    B. Cecil Jacobs
    C. Sam Levy
    D. Boo Radley

Name: _____Date: _____

Chapter 30

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. Why does scout run to Jem's bed when she realizes Boo is there?
   A. She thinks Boo will hurt Jem.
   B. She wants to wake up Jem.
   C. She wants to hide under the bed.
   D. None of these

2. Who is the doctor that has been called to see Jem?
   A. Dr. Reynolds
   B. Dr. Anderson
   C. Dr. Caffrey
   D. Dr. Smith

3. How is Dr. Reynolds sure that Jem is alive?
   A. Dr. Reynolds saw Jem breathing.
   B. Atticus said Jem was faking the injury for attention.
   C. Jem tried to kick Dr. Reynolds
   D. Jem told everyone he would be fine.

4. Why does Scout lead Boo to the rockingchair on the porch?
   A. There are no other chairs on the porch.
   B. Boo will be comfortable there because the chair is in a shadow away from everyone.
   C. Atticus told Scout to make him sit there.
   D. Boo only likes to sit in rockingchairs.

5. Why do you think Atticus is worried about Jem's age?
   A. Atticus is worried he forgot to plan Jem's birthday party.
   B. Atticus thinks Jem committed murder in self-defense and age 13 may change how Jem is charged with the crime.
   C. Atticus is proud that Jem is growing up.
   D. Jem wants to start dating, But Atticus said he cannot until he is 13 years old.

6. Who died in this excerpt?
   A. Calpurnia
   B. Jem
   C. Bob Ewell
   D. Aunt Alexandra

7. Why doesn't Atticus want Bob Ewell's death "hushed up?"
   A. Atticus likes to spread gossip.
   B. Atticus likes loud parties.
   C. Atticus doesn't want people to know that he knew Bob Ewell.
   D. Atticus does not want the town saying Jem was guilty, but his lawyer father kept him out of jail.

8. How does the Sheriff contend that Mr. Ewell died?
   A. He fell on his knife.
   B. He was stabbed by Boo Radley.
   C. He was shot by Scout Finch.
   D. He was stabbed by Jem Finch.

9. When Atticus says "I can't live one way in town and another way in my home," what do you think he means?
   A. Atticus must set a good example for his children all the time.
   B. Atticus is quiet at home, but likes to go to parties while at work.
   C. Atticus wants to move into his office so he can work more.
   D. Atticus hopes Heck Tate will take him out for lunch in town instead of coming to visit Atticus at home.

10. How old is Scout in this excerpt?
    A. Four
    B. Eight
    C. Twelve
    D. Ten

Name: _____Date: _____

Chapter 31

Multiple-Choice Questions

Directions: Choose the correct answer for each question below.

1. Boo's actions in the living room at the beginning of this excerpt show that Boo was
   A. Happy
   B. Angry
   C. Unsure
   D. Sad

2. Why didn't Jem know Boo came to visit?
   A. Jem was too busy reading a book.
   B. Jem was at a friend's house.
   C. Jem was asleep.
   D. Jem was in Montgomery with Miss Maudie.

3. Why do you think Boo came to the Finch's house?
   A. He was happy to see Atticus.
   B. Aunt Alexandra invited him.
   C. He was hungry.
   D. He was concerned about Jem.

4. Where does Boo want Scout to take him?
   A. To the store
   B. To home
   C. To church
   D. To his grandparents' house

5. Why does Scout ask Boo to bend his arm down when she walks him home?
   A. Scout wants it to look like Boo is escorting her down the sidewalk.
   B. Scout is tired and wants to lean on Boo.
   C. Boo hurt his arm and Scout wants to look at it.
   D. Scout wants to make sure Boo does not waive at people who may pass on the street.

6. After Scout walked Boo home, how many times did she see him again?
   A. Zero
   B. Three
   C. Five
   D. Ten

7. When Atticus said “You never really know a man until you stand in his shoes and walk around in them,” what did he mean?
   A. Put yourself in someone else’s place to best understand him or her.
   B. It is best to steal shoes if you need them.
   C. Walking is good for you.
   D. Walking with someone is a good way to get to know them.

8. What is the only thing Scout thinks she has left to learn?
   A. How to read
   B. How to do algebra
   C. How to drive a car
   D. How to send an email

9. What book does Atticus read in Jem’s room?
   A. The Gray Ghost
   B. The Life and Times of Andrew Jackson
   C. To Kill a Mockingbird
   D. The History of Maycomb

10. Overall, how do you think Scout feels about Boo?
    A. She is still afraid of him.
    B. She is angry with him for not talking to her sooner.
    C. She is sad that he is still alive.
    D. She respects him and wants to repay his kindness.

Appendix B: Student Social Validity Questions

1. What are positive aspects of using MacBook text-to-speech?
    a. Can you give me an example that has happened to you personally?
    b. Can you tell me about positive experiences you have had using MacBook text-to-speech?

2. When you think of English class, what kinds of thoughts come to your mind? Why?
    a. How can using MacBook text-to-speech change your current thoughts about English class?

3. How do you think using MacBook text-to-speech in class will affect your learning?
    a. How will using MacBook text-to-speech help you in English class?
    b. How will using MacBook text-to-speech hurt you in English class?
    c. How will using MacBook text-to-speech help you in other classes?

Appendix C: Teacher Survey

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	My students have difficulty reading English class texts.	1	2	3	4	5
2.	I read texts studied in English class to all students.	1	2	3	4	5
3.	I use audiobooks in class instead of reading texts to students.	1	2	3	4	5
4.	Students use MacBooks for class assignments.	1	2	3	4	5
5.	Personal technology (MacBooks, iPhone, iPad) positively impact student learning.	1	2	3	4	5
6.	I use class and instruction time to read to students.	1	2	3	4	5
7.	Students are capable of reading English class texts independently.	1	2	3	4	5
8.	The understanding of English class texts is increased when students listen to the text while following along with the written version of the texts.	1	2	3	4	5
9.	Accessibility of English class texts is important.	1	2	3	4	5
10.	I encourage students to listen to audiobooks of English class texts outside of class.	1	2	3	4	5

11. How will having students who know how to use MacBook text-to-speech change your classroom instructional plans?

12. Describe your observations about the students who use MacBook text-to-speech in your classroom.