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Effectiveness of a Computer-Based Program for Improving the Reading Performance of Deaf Students

Kenneth L. Moore
Georgia State University

ACCEPTANCE

This dissertation, EFFECTIVENESS OF A COMPUTER-BASED PROGRAM FOR IMPROVING THE READING PERFORMANCE OF DEAF STUDENTS, by KENNETH LEE MOORE, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

William Curlette, Ph.D. Committee Chair	Susan Easterbrooks, Ed.D. Committee Member
Randall Dobbs, Ph.D. Committee Member	Jennifer Esposito, Ph.D. Committee Member

Date

William Curlette, Ph.D.
Chair, Department of Educational Policy Studies

R. W. Kamphaus, Ph.D.
Dean and Distinguished Research Professor
College of Education

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Kenneth Lee Moore
1273 Euclade Court NE
Atlanta, GA 30329

The director of this dissertation is:

Dr. William Curlette
Department of Educational Policy Studies
College of Education
Georgia State University
30303-3083

CURRICULUM VITAE

Kenneth Lee Moore

ADDRESS: 1273 Euclade Court NE
Atlanta, GA 30329

EDUCATION:

Ph.D.	2012	Georgia State University Educational Policy Studies
M.A.	1998	University of West Florida Educational Leadership
B.A.	1993	University of West Florida Middle School Education

PROFESSIONAL EXPERIENCE:

2011-Present	Division of State Schools Director Georgia Department of Education, Atlanta, Georgia
2009-2011	School Director Atlanta Area School for the Deaf, Clarkston, Georgia
2007-2009	Assistant Director Atlanta Area School for the Deaf, Clarkston, Georgia
2005-2007	School Improvement Specialist Georgia Department of Education, Atlanta, Georgia
2004-2005	Education Program Specialist Georgia Department of Education, Atlanta, Georgia
2002-2004	Education Research and Evaluation Specialist Georgia Department of Education, Atlanta, Georgia
2001-2002	Administrative Assistant Georgia Department of Education, Atlanta, Georgia
2000-2001	English Teacher Taylor Road Middle School, Alpharetta, Georgia
1993-2000	English Teacher Wedgewood Middle School, Pensacola, Florida

PROFESSIONAL SOCIETIES AND ORGANIZATIONS:

2006-Present	Georgia Association for the Deaf
2005-Present	American Association of School Personnel Administrators
2005-Present	Council for Exceptional Children
2004-Present	Conference of Educational Administrators of Schools and Programs for the Deaf

ABSTRACT

EFFECTIVENESS OF A COMPUTER-BASED PROGRAM FOR IMPROVING THE READING PERFORMANCE OF DEAF STUDENTS
by
Kenneth Lee Moore

The purpose of this study was to determine if the use of the reading component of Ticket to Read®, a computer-based educational program, developed to improve hearing students' fluency could improve deaf students' fluency in order to improve comprehension. Fluency, the ability to read text accurately and automatically, forms a bridge from decoding to comprehension. This research is significant because the median reading level of deaf students who graduate high school has remained around a fourth grade level equivalent for the past thirty years, and there is a paucity of research that examines evidence-based practices to improve the reading performance of deaf students. There were 27 subjects in this study from an urban day school for the deaf. A dependent *t*-test was conducted using the subjects' scores on a pretreatment and posttreatment reading assessment after nine weeks of treatment. No significant difference from pretreatment to posttreatment assessment was found, $t(26) = 1.813$, $p > .05$. In addition, an exploratory analysis using treatment and control groups was conducted using a quasi-experimental design based on mean gain scores from a pretreatment and posttreatment reading assessment. Twenty-seven pairs of subjects were matched on ethnicity, gender, and grade level to determine the main effect of treatment, the interaction effect of treatment and gender, and the interaction effect of treatment and grade level. No significant difference was found for the main effect of treatment, $F(1,42) = 1.989$, $p > .05$. Statistical significance was not found for the interaction between treatment and

gender, $F(1,50) = 1.209$, $p > .05$. Statistical significance was not found for the interaction between treatment and grade level, $F(2,48) = .208$, $p > .05$. The results of this study have implications in the field of deaf education and are congruent with the findings of similar studies involving Repeated Readings to influence comprehension. Although significant tests were non-significant regarding students' improvement on the reading assessment after the intervention, the direction and magnitude of the mean differences effect sizes for students in the treatment group support the need for further research regarding the evaluation of computer-based educational programs that can be used as effective educational strategies to improve deaf students' reading performance.

EFFECTIVENESS OF A COMPUTER-BASED PROGRAM FOR IMPROVING THE READING PERFORMANCE OF DEAF STUDENTS

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ABBREVIATIONS

ASL	American Sign Language
dB	Decibels
MAP	Measures of Academic Progress
NRP	National Reading Panel
RR	Repeated Readings
RIT	Rasch unIT
TTR®	Ticket to Read®
WCPM	Word Count Per Minute

CHAPTER 1

INTRODUCTION

The median reading level of deaf students who graduate high school has remained around a fourth-grade-level equivalent for the past 30 years (Babbidge, 1965; Commission on the Education for the Deaf, 1988; Holt, Traxler, & Allen, 1997; National Agenda, 2005). There is a paucity of research regarding effective instructional strategies to increase language acquisition of deaf students (Easterbrooks, 1999; Schimmel & Edwards, 2003). These two facts fuel the growing sense of urgency to investigate and implement effective evidence-based interventions targeted at improving the reading performance of deaf students.

For deaf students to learn to read higher than a fourth grade level by graduation, teachers need to use effective instructional strategies to improve students' reading skills. According to the National Reading Panel (NRP), all readers need to become proficient in regard to phonemic awareness, phonics, vocabulary, fluency, and comprehension to become skilled readers (National Institute of Child Health and Human Development, 2000). The current study focused specifically on improving deaf students' reading fluency in order to improve their reading comprehension through the use of a computer-based educational program.

Fluency is the ability to read text accurately, automatically, and with prosody. Prosidy refers to intonation and inflection in spoken language (Pikulski & Chard, 2005; Gunning, 2010). Although deaf students who do not speak cannot verbally read aloud, the students can read text automatically and accurately (Easterbrooks & Huston, 2008). According to Thurlow and van den Broek (2006), fluent readers are able to read

automatically and accurately and can focus on comprehension without directing a large concentration of mental resources to decoding words. Comprehension is the ability to construct meaning from text (Dahl, 1979; Kuhn & Stahl, 2003; Therrien, 2004).

Fluency can form a bridge from decoding to comprehension (Rasinki, 2003). Hacker (2004) stated that in order to comprehend text effectively, a reader must use higher order thinking processes including cognitive and metacognitive strategies that consume attention. Because comprehension is the means through which information is acquired from text, it is essential to increase the fluency recognition of text by deaf students who read slowly to allow them to concentrate on comprehending text.

According to the NRP (National Institute of Child Health and Human Development, 2000), the relationship between fluency and comprehension can be explained as follows:

> Why do problems with reading accuracy, speed, and expression interfere with comprehension? To answer this question, we need to examine the reading process in terms of two basic cognitive tasks. The reader must recognize the printed words (decoding) and construct meaning from the recognized words (comprehension). Both decoding and comprehension require cognitive resources…If the word recognition task is difficult, all available cognitive resources may be consumed by the decoding task, leaving little or nothing for use in interpretation. Consequently, for the nonfluent reader, difficulty with word recognition slows down the process and takes up valuable resources that are necessary for comprehension. Reading becomes a slow, labor-intensive process that only fitfully results in understanding. (p. 3-8)

Purpose of the Study

The purpose of this study was to examine to what extent Ticket to Read® (TTR®), a computer-based educational program that incorporates the Repeated Readings method (RR), can improve deaf students' fluency in order to improve comprehension. RR involves reading text multiple times so that more of a reader's attention can focus on

comprehension instead of the decoding of the text (LaBerge & Samuels, 1974; Samuels, 1979). Only the reading component of TTR® was used. The phonics component of TTR® was not used.

Using computer-based learning to improve students' reading performance is a promising intervention being implemented in education for students with and without disabilities (Gentry, Chinn, & Moulton, 2005; Luckner, Sebald, Cooney, Young, & Muir, 2006). The NRP (2000) identified computer technology as a viable service delivery option for reading instruction but emphasized that additional research was needed to directly examine the effects of technology as it is used in the classroom to support reading instruction. A key feature of computer-based learning is its ability to concentrate instruction without putting additional burdens on teachers (Mathes, Torgesen, & Allor, 2001). Another feature of computer-based learning is its ability to engage and motivate students (Alvermann, 2002).

Research Questions

In this study, I examined the use of TTR® as a reading intervention for deaf students. There was one primary research question. In an exploratory analysis, there were three secondary questions.

Primary Research Question

What are the differential effects of Ticket to Read® on deaf students' reading comprehension skills after using the computer-based educational program for nine weeks?

Exploratory Analysis - Secondary Research Questions

1. What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
2. Based on gender, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
3. Based on grade level, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?

Significance of the Study

As stated previously, there is a lack of evidence-based research pertaining to literacy and deafness (Easterbrooks, 1999; Schimmel & Edwards, 2003). Considering the lack of existent research regarding evidence-based interventions for improving reading performance of deaf students, this study and its findings have made a contribution to the field of deaf education. This study explored the efficacy of TTR® as an educational tool used during class time to improve the fluency of deaf students in order to increase comprehension. Existing research supports that the use of TTR® improves the fluency of hearing students (Peyton and Macpherson, 2009). The use of multimedia tools including computer-based educational programs is a promising strategy that can be used as an instructional and supplemental classroom activity with deaf students to increase motivation to complete academic tasks (Pipp-Siegel, Sedey, VanLeeuwen, & Yoshinaga-

Itano, 2003; Cannon, Fredrick, & Easterbrooks, 2010; Dangsaart, Naruedomkul, Cercone, & Sirinaovakul, 2008). The NRP (2000) stated that the use of technology in reading instruction "is an area that needs a great deal of exploration" (p. 6-2).

Theoretical Framework

The guiding framework for this study was the theory of automaticity in reading. TTR®, the intervention in this study, is grounded in the theory of automaticity through the use of RR. LaBerge and Samuels (1974) are credited with developing the theory of automaticity and defined automaticity as quick, correct, and effortless word recognition at the single word level. LaBerge and Samuels' theory contends that a reader's cognitive attention is limited; therefore, if too much attention is focused on decoding words, there will be limited attention available to focus on comprehension. Samuel's stated that "According to the automaticity theory, a fluent reader decodes the text automatically−that is without attention−thus leaving attention free to be used for comprehension" (1979, p. 406). In regard to deaf students, Kelly (2003) found that having the ability to process text using automaticity distinguishes skilled from less skilled readers and that processing automaticity is a primary source of the difference in comprehension as well.

Terms and Definitions

The following terms and definitions are provided to offer a more concise explanation of language used in this study.

Accuracy. Accuracy is the ability to accurately identify words within the context of a text (Schatschneider & Torgesen, 2004).

Automaticity. Automaticity is the ability to do things without occupying the brain with the low-level details required, allowing it to become an automatic response pattern (Brown, Roos-Gilbert, & Carr, 1995).

Comprehension. Comprehension is the ability to grasp the meaning and understand something (Rasinski, 2003).

Computer-based Learning. The term computer-based learning is defined in the Merriam Webster dictionary as "any use of computers to aid or support the education or training of people" (2011).

Deaf. The term "deaf" refers to an individual who has a hearing impairment that is so severe that the individual is impaired in processing linguistic information through hearing, with or without amplification (Individuals with Disabilities Education Act, 2004).

Fluency. Fluency is the ability to read a text quickly, accurately, and with proper phrased expression (Allinder, Dunse, Brunken, & Obermiller-Krolikowski, 2001).

Fluent. The term fluent is defined in the Merriam Webster dictionary as one who is "capable of using a language easily and accurately or effortlessly smooth and flowing" (2011).

Literacy. Literacy is the ability to read and write (Cambourne, 2002).

Prosody. Prosody is "the rhythm of spoken language, including the stress and intonation, or the study of these patterns" (Encarta Dictionary, 2011).

Summary

In this chapter, I presented an introduction and rationale for the current study. Additionally, I discussed the purpose of the study, research questions, significance of the study, theoretical framework, and terms and definitions. The findings of this study add to the limited empirical body of research that has been conducted in deaf education focusing on improving deaf students' fluency and comprehension through the use of computer-based educational programs.

CHAPTER 2

REVIEW OF THE LITERATURE

The purpose of this review of relevant research is to provide a context for understanding RR as it is used in this study. The following chapter is a six-part review of the literature that is limited to approximately the last 10 years unless an older study merits noteworthy discussion. The first part focuses on background information regarding the population of deaf students. The second part focuses on the link between fluency and comprehension on state assessments. The third part focuses on the development of RR as a reading intervention. The fourth part focuses on RR as a reading intervention for regular education students. The fifth part focuses on RR as a reading intervention for special education students. The sixth part focuses on RR as a reading intervention for deaf students.

Deaf Students: Population Information

Having general background knowledge regarding deaf students is important in order to put the current study in context with respect to the research that will be discussed. According to the Government Accountability Office (2011), hearing loss can vary by type, level of severity, age at onset, and cause. There are generally three major types of hearing loss: conductive, sensorineural, and mixed. Conductive hearing loss results when sounds are prevented from going through the outer or middle ear, such as by a malformation of part of the ear or ear infections. This type of hearing loss can often be corrected with medicine or surgery. Sensorineural hearing loss occurs when there is a problem in the way the inner ear or hearing nerve works, such as from illness or noise exposure. Sensorineural hearing losses are usually not correctable with medicine or

surgery, with the exception of the use of cochlear implantation. Mixed hearing loss includes both conductive and sensorineural hearing loss.

Besides the types of hearing loss, there are degrees of hearing loss. A hearing loss of 20-40 decibels (dB) is described as mild. A hearing loss of 40-60 dB is described as moderate. A hearing loss of 60-80 dB is described as severe, and a hearing loss that is greater than 80 dB is considered severe to profound (American Speech-Language-Hearing Association, 2007). For this reason, we refer to the population of children with all degrees of hearing loss as "deaf and hard-of-hearing." When referring to one or the other category, we apply the term, "deaf or hard-of-hearing," as an individual cannot be both deaf and hard-of-hearing.

The U.S. Department of Education (2008) reported that 78,000 deaf children aged 3-21 in the 50 states received services under the Individuals with Disabilities Act, Part B. This is approximately one percent of all students served under the Individuals with Disabilities Act, Part B (See Figure 1). The one percent may be considered low since the federal reporting only reflects primary disability eligibilities. Some students may have multiple disabilities, and a deaf eligibility may be a secondary or tertiary eligibility.

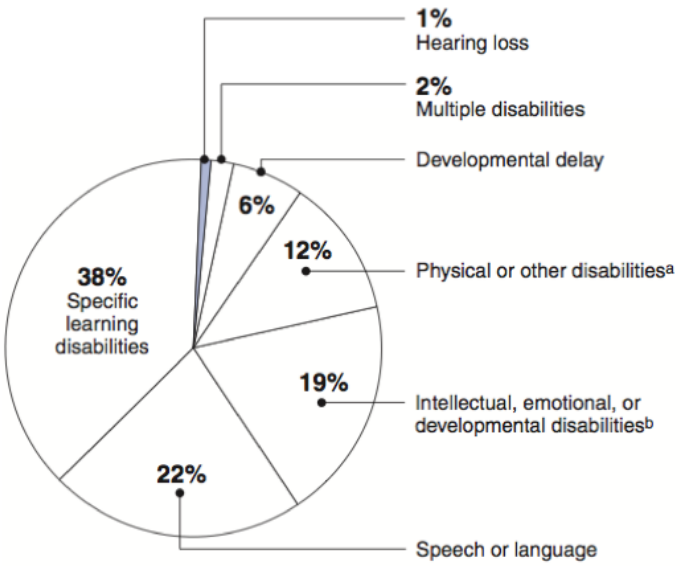

Figure 1. Percentage of primary disability eligibilities. *Source*: U.S. Department of Education (2011).

The setting for the current study was a separate school educating students with a hearing loss. Students in this school communicated using American Sign Language (ASL). The Government Accountability Office (2011) stated that only 8.2% of deaf students ages 6-21 years old attended a separate school for educating children with a hearing loss. The majority of deaf students, 91.8%, are educated in a general classroom setting for part or all of the school day. All participants in this study used ASL as their primary mode of communication. The Gallaudet Research Institute (2008) reported that only 11% of deaf students used sign language as their primary mode of communication (see Figure 2). Consequently, deaf students form a low-incidence population, meaning the population is small. This is important because low-incidence populations typically do not attract the financial support for research afforded to high incidence populations, a further justification of the need for this study.

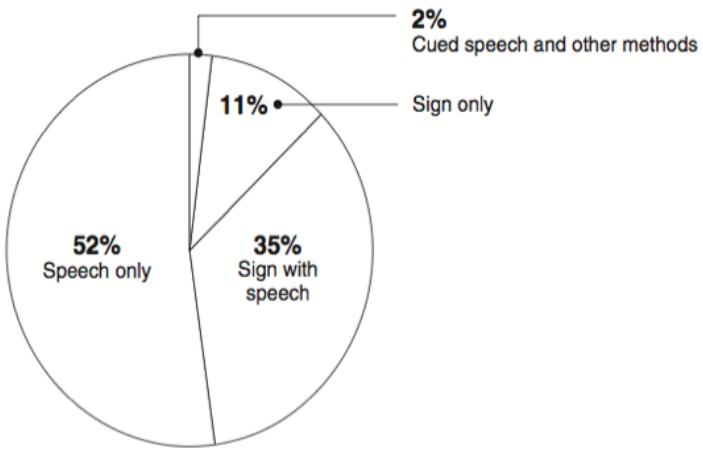

Figure 2. Deaf Students' Primary Communication Mode Used for Instruction. *Source:* Gallaudet Research Institute. (2008, November). Regional and National Summary Report of Data from the 2007-08 Annual Survey of Deaf and Hard of Hearing Children and Youth. Washington, DC: Author.

In 1917, Pitner and Patterson conducted an educational survey, and the results of the survey indicated that deaf students were reading at or below the fourth grade level. Almost a century later, little has changed (Babbidge, 1965; Commission on the Education for the Deaf, 1988; Holt et al., 1997; National Agenda, 2005). One primary reason why deaf students struggle to become skilled readers is that they do not have similar access to language and exposure to sounds that their hearing peers receive, especially during the early years of language development.

This lack of language exposure results in many deaf students acquiring limited vocabulary and general background experiences that are critical in becoming a fluent reader (Coryell & Holcomb, 1997; Kelly, 1996; Yoshinaga-Itano & Apuzzo, 1998). Poor language development leads to poor literacy development (Power & Leigh, 2000).

Many of the instructional interventions used for hearing students are challenging to apply to students with a hearing loss because the teaching methods are often based on the use of auditory elements such as reading aloud. Unless a student with a hearing loss has access to sound, the student will not benefit from instruction based on auditory input. Considering the minimal number of computer-based educational programs that are created specifically for deaf students, the study of computer-based programs that are designed for hearing students, meaning they have auditory features, merits investigation to determine to what extent the programs can benefit deaf students.

Link Between Fluency and Comprehension

Now that the basic demographic data and literacy challenges that deaf students face has been examined, the link between fluency and comprehension can be addressed before discussing research related to RR. In building a bridge between decoding and comprehension, hearing students' fluency has been shown to be correlated with positive outcomes on state level reading achievement assessments. Pinnell, Pikulski, Wixson, Campbell, Gough, and Beatty (1995) compared the reading oral fluency rates of 1,136 fourth grade students to their scores on the National Assessment of Educational Progress. The researchers found that higher levels of fluency were associated with higher average reading proficiency scores on the National Assessment of Educational Progress. For example, students who were rated as the most fluent had an average reading proficiency of 249. Students who were rated as least fluent had an average proficiency score of 179. The National Assessment of Educational Progress reading scale ranges from 0 to 500.

Stage and Jacobsen (2001) reported that fluency scores were correlated with 4th grade reading scores on the Washington Assessment of Student Learning. The

researchers assessed the utility of curriculum-based measures oral reading rates to predict performance on a state-mandated fourth grade reading assessment. One hundred seventy-three students were administered curriculum-based measurement oral reading probes in the fall, winter, and spring of fourth grade. Each student was given a 250 word passage and a one minute timed reading trial. Only the number of correct words read was recorded. These scores were then compared to students' performance on the spring administration of the Washington Assessment of Student Learning reading assessment. The results indicated that the fluency scores improved the prediction of reading assessment performance above that based on the base rates of students passing and failing the Washington Assessment of Student Learning reading assessment. Because only one state assessment was studied for one year, generalizability could be an issue.

In 2004, McGlinchey and Hixson replicated Stage and Jacobsen's study and found similar results with a different state fourth grade reading test across 8 years involving 1,362 students. The researchers investigated the predictive validity of a curriculum-based measures of a reading probe in relation to performance on the Michigan Educational Assessment Program's fourth grade reading test. The researchers found a positive correlation between fluency and performance on the state's reading assessment. For example, at 10 word count per minute (WCPM), no students at that reading rate or below passed the state assessment. Twenty-six percent of students who passed the state assessment read less than 100 WCPM. Alternatively, 74% of students who passed the state assessment read 100 WCPM or greater. The cumulative percentage of students who passed began to rise above 50 WCPM.

Repeated Readings Method

Now that a brief discussion of current research regarding the link between students' fluency and their performance on state reading assessments has been provided, I will provide a discussion of the development and procedures of RR since RR is the basis for the intervention used in this current study. Dahl (1974) and Samuels (1979) are credited with conducting research that led to the development of RR based upon the theory of automaticity. RR has been discussed in research literature as a means to improve fluency that in turn allows a reader to focus more attention on comprehension. Samuels (1979) explained that RR involves rereading a short passage several times until a satisfactory level of fluency is reached. RR can have many variations including but not limited to oral RR and silent RR. Chard, Ketterlin-Geller, Baker, Doabler, and Apichatabutra (2009) provided a concise rationale in support of RR when they stated:

> As students repeatedly read the same content, it is likely that they will practice the same words multiple times, increasing the likelihood they'll be able to automatically retrieve those same words in future exposures. Simultaneously, they reduce the attention required to read the words and can focus more intently on the meaning of what they are reading. (p. 265)

In addition, RR with guided and informed feedback can also be an effective method for improving fluency and reading achievement. When a student makes a reading error, guided and informed feedback involves the teacher immediately attending to helping the student correct the error by scaffolding instruction and providing support (Chard, Vaughn, & Tyler, 2002; Homan, Klesius, & Hite, 1993; Herman, 1985; O'Shea, Sindelar, & O'Shea, 1985).

Repeated Readings Method and Regular Education

The largest body of existing empirical research focusing on RR involves students without a hearing loss. As far as can be determined, Peyton and Macpherson (2009)

conducted the most closely related research to the current study by using the same intervention, TTR® based on RR, as part of a study involving hearing students. Since this was the most closely related study to the current study, it will be examined first.

During a summer school session in 2008, the researchers conducted a study that involved 2,134 students in 1st through 5th grade across the United States. TTR® was used as an optional technology component in conjunction with *TimeWarp Plus*, a summer learning program designed to prevent summer learning loss. The researchers used a pretest and posttest quasi-experimental design analyzing mean growth gains of WCPM read aloud and effect sizes. A matched set of students was formed using a case control methodology. The treatment group included 1,067 students who used TTR® and read 10 or more passages spending 2 to 2.5 hours reading text beyond instruction during the summer school program. The control group consisted of 1,067 students that did not read any passages using TTR®.

The Reading Connected Text (RCT) measure was used as an assessment to measure fluency gains. The RCT is a standardized test of fluency with connected text administered to students individually by teachers. Students had to read a passage aloud for one minute. Words that were omitted or substituted were scored as errors. Hesitations of more than three seconds were scored as errors. If a word was self-corrected within three seconds, it was not counted as an error. The number of WCPM from the passages served as the oral fluency rate reported as the RCT. Teachers entered data into a management system produced by the company that developed TTR® and *TimeWarp Plus.*

The results indicated that for each grade students who used TTR® showed greater oral fluency gains than students who did not use TTR®. The mean gain scores of words per minute growth for the 1st grade were 3.19 for the control group and 6.20 for the treatment group, a difference of 3.01 words per minute. The mean gain scores of words per minute growth for the 2nd grade were 5.76 for the control group and 10.04 for the treatment group, a difference of 4.28 words per minute. The mean gain scores of words per minute growth for the 3rd grade were 18.3 for the control group and 22.34 for the treatment group, a difference of 4.03 words per minute. The mean gain scores of words per minute growth for the 4th grade were 3.96 for the control group and 6.63 for the treatment group, a difference of 2.67 words per minute. The mean gain scores of words per minute growth for the 5th grade were 14.03 for the control group and 15.03 for the treatment group, a difference of 1 word per minute.

The researchers analyzed effect sizes to determine how much the mean of the group moved as a result of the treatment. Effects sizes were based on initial and final RCT means. Effect sizes for the 1st grade were 0.18 for the control group and 0.34 for the treatment group. For 2nd grade, effects sizes were 0.21 for the control group and 0.37 for the treatment group. For 3rd grade, effects sizes were 0.64 for the control group and 0.82 for the treatment group. For 4th grade, effects sizes were 0.15 for the control group and 0.23 for the treatment group. For 5th grade, effects sizes were 0.48 for the control group and 0.54 for the treatment group. The effect size for the students in the treatment group by grade were .06 to .18 larger than the control group and were statistically significant ($p < .0001$) for all grades.

Years before Peyton and Macpherson (2009) conducted their study, the NRP produced one of the most influential publications to support RR, specifically oral RR, as a potential reading intervention (National Institute of Child Health and Human Development, 2000). In the report, the NRP conducted a meta-analysis that identified 98 studies that met inclusion criteria for their analysis of RR. The following criteria were used to determine whether or not a study was included in the review: published in English in a refereed journal; focused on children's reading development in the age and grade range from preschool to 12th grade; and used an experimental or quasi-experimental design with a control group or a multiple-baseline method.

Fourteen of the 98 studies demonstrated improvements in students' fluency of the same passage of text following an RR intervention. Twelve of the studies focused on single-subject designs that measured the effects of RR and guided oral reading methods on students in kindergarten through 12th grade who had significant reading problems. The NRP concluded that RR provided evidence for improving reading and stated that "fluency develops from reading practice" (p. 3-1). Students with disabilities were included to some degree in the report; however, the report did not address their needs in any significant detail.

In a different meta-analysis, Wolf and Katzir-Cohen (2001) reviewed 10 fluency studies and focused on three areas of analysis. One area was the duration of the RR intervention and what it achieved such as gains in fluency and comprehension. The second area was student grade level and the subsequent developmental level of reading addressed. The third area reflected specific fluency intervention components. The researchers found that most fluency interventions in the studies reviewed lasted between

1 and 15 days and that fluency increased for each subject in each study. They stated that they believed that explicit instruction is required to link phonological, orthographic, semantic, and morphological processes to sublexical and word-level subskills. The authors concluded that more studies need to be conducted that measure the impact of comprehension and transfer effects as a result of implementing an RR intervention.

Steventon and Fredrick (2003) found similar results regarding RR and fluency gains when they conducted a multiple baseline across subjects study design involving three general education students to examine the effects of RR on fluency rate and accuracy on both practiced and unpracticed reading passages. Reading passages were used from the *Corrective Reading Decoding Strategies Level B2* (Engelmann, Meyer, Carnine, Becker, Eisele, & Johnson, 1999). The results indicated an increase in fluency rate for practiced passages but not unpracticed passages.

In addressing the body of RR research that was conducted prior to the aforementioned studies, Therrien (2004) conducted a meta-analysis on RR regarding fluency and comprehension. The analysis focused on RR research between 1977 to 2001. The analysis involved 33 studies. The researcher found that RR improved the fluency scores of students with an average increase of .83. In addition, he found an average increase of .67 in students' comprehension scores.

Repeated Readings Method and Special Education

In addition to research that has been conducted using non-disabled students as the subjects, empirical evidence exists that supports that RR can increase fluency for students with disabilities as well. Mercer, Campbell, Miller, Mercer, and Lane (2000) conducted a study that examined the impact of RR in letter-sound correspondences, sight words, and

connected text on 49 middle school students with specific learning disabilities. RR was used in conjunction with the *Great Leaps Reading Program* (Campbell, 1995) over the course of 6 to 25 school months when the students were available. Results indicated statistically significant improvements in reading fluency and grade level reading scores for the students who used RR.

In continuing to examine RR and students with learning disabilities, Chard et al., (2002) conducted a meta-analysis and analyzed 24 studies that examined two interventions on fluency with elementary students with learning disabilities: RR and word practice. Twenty-one of those studies examined the influence of RR without a model. Nine studies were examined that used RR with a model. Examples of models included adults, peers who were fluent readers, or technology, e.g., computer or audio recording. Of these studies, eight used a multiple group design, five used a single group design, and 11 were case studies or single subject design. The results of the synthesis also supported the use of RR as an intervention to improve fluency and comprehension.

To further address the use of RR as an intervention for students with learning disabilities, Therrien, Wickstrom, and Jones (2006) synthesized components of RR and question generation into a program called *Reread-Adapt* and *Answer-Comprehend*. Thirty students, 16 of which were students with learning disabilities, in the 4^{th}, 5^{th}, 7^{th}, and 8^{th} grades participated in a four-month study. Results of the study indicated significant improvement in fluency of practiced and unpracticed passages. The authors recommended that future research examine the significance of each intervention component, RR and question generation, as compared to the combination of the two.

Research has also found that RR can be effective for students with other disabilities as well such as emotional and behavior disabilities. For example, Scott and Shearer-Lingo (2002) used a multiple baselines across subjects study design to examine the influence of RR on fluency and on-task behavior of three seventh grade male students with emotional and behavioral disabilities. Two intervention programs were used: *Teach Your Child to Read in 100 Easy Lessons* and *Great Leaps Reading*. Each student's reading level was a minimum of 3 years below grade level. One student's WCPM jumped from 58 words during the baseline phase to over 81 WCPM. A second student's WCPM moved from 0 WCPM during the baseline phase to 85 WCPM at the end of treatment. The third student's WCPM increased from 25 WCPM during the baseline phase to 36 WCPM. The students' on-task behavior improved as well based on interval on-task behavior observations.

Strong, Wehby, Falk, and Lane (2004) also conducted research that involved students with emotional and behavioral disabilities. The researchers implemented a multiple baseline across subjects study design with six middle school students with emotional and behavioral disabilities. They sought to measure the impact of *Corrective Reading* supplemented by an RR intervention on oral reading fluency and comprehension. Pretreatment assessments were administered to measure fluency and comprehension. In addition, curriculum-based assessment probes were conducted during the intervention implementation. Results indicated an improvement in 4 out of the 6 students in fluency based on WCPM and effect sizes that ranged from 1.28 to 2.75. Comprehension results were mixed. The results ranged from no change in the number of correct responses after RR to two additional correct responses. The researchers suggested

that more research needs to be conducted focusing on fluency and comprehension through the use of additional supplemental programs in combination with contingent reinforcement procedures.

Finding somewhat similar results as Strong et al., (2004), Alber-Morgan, Ramp, Anderson, and Martin (2007) conducted a multiple baseline across subjects study design using four middle school students with emotional and behavioral disabilities. They examined the combined effects of RR with error correction and performance feedback on student fluency and comprehension. Students were given multiple timed fluency assessments using reread passages based on correct WCPM. After the passage reading, students were given a comprehension assessment that included literal and inferential questions. Reading rates ranged from 38.8 to 91.6 in the baseline phase and 95.6 to 133.7 in the RR phase. Regarding comprehension, RR had an immediate effect on literal comprehension but a delayed effect on inferential comprehension.

Repeated Readings Method and Deaf Education

As discussed previously there is a significant body of research regarding the use of RR and its effect on nondisabled students and disabled students with special education eligibilities including students that have a learning disability or an emotional and behavioral disability. An exhaustive review of literature revealed a minimal number of evidence-based studies in which RR was used with deaf students. Although the research is limited, this section focuses three studies that support the use of RR as a fluency intervention for deaf students. In regard to improving comprehension through the use of RR, the findings were mixed.

Ensor and Koller (1997) investigated the use of RR with deaf students. These researchers conducted a five week study at Missouri residential school for the deaf that involved 42 students. The students were between the ages of 15 and 19 years old. They were randomly assigned to a treatment group or a control group based on age, gender, level of hearing loss, metal ability prior to starting the treatment, and reading achievement. To reduce confounding, students that had disabilities in addition to being deaf were excluded from the study. Students could not have biological parents that were deaf in order to limit the possibility that the etiology of the disability was related to genetics.

Students in both the treatment and control groups were videotaped signing the passages during an initial reading. For three days after the initial reading, students in the treatment completed daily 15 minute practice sessions after receiving a passage that they had read the previous day. On the day after the final practice session, the students were videotaped signing a passage during a final reading. This procedure was followed three times during the course of the study. Students in the control group followed a similar pattern; however, they did not read the passages from any previous practice sessions. They received new passages during each session. Two independent evaluators reviewed the videotapes and evaluated the timing and accuracy of the students' reading rate which was recorded in WCPM.

The results indicated that no simple main effect was found between the treatment and control groups for reading rate, $F(1,40) = 0.03$, $p > .86$. There was no simple main effect found between the treatment and control groups for reading accuracy, $F(1,40) =$

0.11, $p > .73$. There was no simple main effect found for the treatment and control groups for combined reading accuracy, $F(1,40) = 0.09$, $p > .77$.

The passage factor provided a significant main effect for reading rate, $F(4,360) = 19.10$, $p < .001$. The passage factor provided a significant main effect for reading accuracy, $F(4,360) = 18.69$, $p < .001$, and the passage factor provided a significant main effect for combined reading accuracy, $F(4,360) = 18.98$, $p < .001$. A significant main effect was found for the difference between the pre and posttests for reading rate, $F(1,360) = 23.91$, $p < .001$. A significant main effect also was found for the difference between the pre and posttests for reading accuracy, $F(1,360) = 9.82$, $p < .001$, and for the difference between the pre and posttests for combined reading accuracy, $F(1,360) = 10.03$, $p < .001$. The findings support that RR can be an effective reading intervention for deaf students. The researchers recommended that future research should be conducted to examine to what extent gains in fluency through the use of RR improve reading comprehension.

In 2007, Krammer extended the research of Ensor and Koller (1997). Krammer extended Ensor and Koller's research when she investigated the extent to which gains in reading rate produced by RR transferred to gains in reading comprehension. Twenty students were involved in the study. Instead of using participants that were between the ages of 15 and 19 years old, the participants in Krammer's study were between the ages of 6 and 11 years old. The students were placed in three groups according to their level of hearing. Ten students had no hearing loss. Five students were deaf, and five students were hard-of-hearing.

During the first week, all students participated in RR. On the first day, students read the first passage and were either videotaped if the communication modality was sign language or the investigator listened to and scored the passage as it was read by the students with no hearing loss. After the reading, students were given a set of corresponding comprehension questions to answer. Students then received copies of the same passage they had just read and practiced reading the passage aloud for 15 minutes during the next three days. On the fifth day, students were videotaped or observed reading the same passage as the initial reading and answered the same set of comprehension questions from the first day.

In the second week of the study, all three groups participated in an assisted reading intervention in which they were read to by a voiced audiotape or a signed videotape for 15 minutes a day following their initial reading of the passage. In the subsequent three days between the initial and final reading someone played an audiotape or videotape of the same passage. On the fifth day, students were videotaped or observed reading the same passage from the first day and given the same set of comprehension questions from the first day. During the third week, none of the groups were exposed to any intervention. A fluency and comprehension sample for each student was obtained from a passage at the students' instructional level.

The primary investigator measured fluency by the number of WCPM, and comprehension was measured by scoring the initial and final comprehension tests. Fluency improved for all groups. In regard to assessing comprehension, dependent *t*-tests were conducted to determine if there was a difference between the initial pretest for comprehension on the first story and the final comprehension test that was given in week

three with no intervention. The hearing student group showed improvement. There was no statistically significant effect for comprehension for the hard-of-hearing student group. Also, there was no significant effect for comprehension for the deaf student group, t(9) = -1.976.228, $p < .05$. Krammer concluded that both RR and assisted reading were effective interventions for increasing fluency for deaf students. She found that RR and assisted reading were not as effective for increasing reading comprehension for the students with a hearing loss in the study.

Similar to Krammer's (2007) findings, Schirmer, Therrien, Schaffer, and Schirmer (2009) conducted a study to investigate the effect of RR on the fluency and reading achievement of six second grade deaf elementary students that resulted in increased fluency and no improvement in comprehension. The researchers used an experimental design with a combination of single subject and quasi-experimental using pre and post measures. The study incorporated the *Reread-Adapt* an *Answer-Comprehend* intervention as a supplemental program to regular reading instruction that did not include reading fluency. The students read a story aloud or in sign language depending on individual preference. The teacher timed the reading and recorded any errors. The teacher used Running Records and measured fluency and comprehension based on subtests of the Woodcock-Johnson III Achievement Tests. The student then read the story again aloud or in sign until he or she reached the criterion level of correct words per minute. The student then answered comprehension questions about the story. Pre and postassessment measures were used to analyze growth. The researchers found significant results for the two measures used. For the first measure, Running Records indicated significance at the $p < .05$ level. For the second measure, the Reading Fluency subtest indicated significance

at the $p < .01$ level. The researchers then used a Cohen's *d* as a measure of effect size. They found a large effect size for Running Records and a small to moderate effect size for Reading Fluency. A Running Record involves a student reading out loud and the teacher recording every error made on a duplicate copy of the text. Overall, the researchers found that RR improved students' reading speed on passages that were reread. They also found that comprehension did not improve and that students performed just as well on the inferential questions as they did on the factual questions. A limitation of this study is that generalizability is made difficult because of the small sample size. The researchers suggested that future studies involve a greater number of deaf students at different grade levels.

Summary

In this chapter, I provided background information regarding the population of deaf students. I also examined the link between fluency and student achievement on state reading assessments. Additionally, I reviewed RR as an educational reading intervention used in regular education, special education, and deaf education. Many of the studies found that RR, especially oral RR, can be an effective reading intervention for nondisabled and disabled students in regard to improving fluency. As the review of literature indicated, there is a significant need for the continued investigation of RR through evidence-based research especially involving students with a hearing loss to determine to what extent fluency gains lead to gains in comprehension. In particular, studies are needed that examine the use of RR in conjunction with computer-based educational programs to add to a limited yet growing body of research.

CHAPTER 3

METHODOLOGY

Research Design

The purpose of this study was to investigate to what extent the use of a computer-based reading program could improve the fluency of deaf students in order to improve comprehension after nine weeks of treatment. The primary study involved 27 students, and the exploratory data analysis involved 54 students in 27 matched pairs. Three teachers facilitated the implementation of the intervention in their language arts classes.

This study's research design involved inferential and descriptive statistics in order to address the primary research question. I used a dependent *t*-test to determine the differential effects of the intervention on deaf students' reading comprehension after nine weeks of treatment to address the primary research question. I analyzed the mean differences in the treatment group participants' pretreatment and posttreatment reading assessment scores.

In an exploratory data analysis, I used three ANOVAs, scatter plots, and mean plots to address the three secondary research questions and find patterns. Exploratory data analysis is an approach that postpones the usual statistical assumptions about what kind of statistical model to follow with the more direct approach of allowing data to reveal the underlying structure which allows a researcher to use insight to make interpretations of the data. This assists the researcher to draw on human pattern-recognition and comparative abilities in the context of a series of graphical techniques applied to the data (Hoaglin, Mosteller, & Tukey, 2006). I used the treatment group and control group participants' pretreatment and posttreatment reading assessment scores to

examine the differential effects of treatment, the interaction effect of treatment and gender, and the interaction effect of treatment and grade level. I used descriptive statistics to analyze mean gain score differences between the treatment and control groups. I analyzed estimated marginal means and effect sizes also. The exploratory data analysis involved a quasi-experimental design because a true experimental design was not feasible for use in a singe school for the deaf setting since participants could not be assigned randomly to comparison and treatment groups given the small population of students at the school.

In the exploratory data analysis, participants in the treatment and control groups were matched on the variables of ethnicity, gender, and grade level. For the variable of grade level, participants were placed in grade level pairs as follows because of the small number of participants in individual grades: $7^{th}/8^{th}$ grades, $9^{th}/10^{th}$ grades, and $11^{th}/12^{th}$ grades. Because participants in the grade level pairs followed similar state student performance standards, grouping in grade level pairs was not viewed for the purposes of this study as an issue.

Social validity was investigated using data from the participants in the treatment group and the three teachers that facilitated the intervention. Participants in the treatment group completed a participant social questionnaire (Appendix B) based on a Likert scale one week after the treatment concluded. Teachers completed a teacher social validity questionnaire (Appendix C) one week after the treatment concluded.

Research Questions

This study investigated the use of TTR® as a reading intervention for deaf students. There was one primary research question. In an exploratory data analysis, I addressed three secondary research questions.

Primary Research Question

What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks?

Exploratory Analysis - Secondary Research Questions

1. What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
2. Based on gender, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
3. Based on grade level, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?

Setting

The setting for this study was an urban day school for students who are deaf located in a major metropolitan Southeastern area. The school enrolls students from preschool through 12th grade who are from 33 local school systems in and around the metropolitan area. There are approximately 200 students enrolled in the school ranging

from 3 to 21 years of age. This setting provides a homogenous sample of students who are deaf.

Participants

Table 1

Participants' Genders by Class Grouping

	Treatment Group		Control Group	
Grade	Female	Male	Female	Male
$7^{th}/8^{th}$	3	1	3	1
$9^{th}/10^{th}$	1	5	1	5
$11^{th}/12^{th}$	8	9	8	9

Fifty-four participants were in the study (see Table 1). The treatment group included 27 participants in 7^{th} through 12^{th} grade who used TTR® for 9 weeks. In the exploratory data analysis part of the study, a control group was added that consisted of 27 participants in 7^{th} through 12^{th} grade who did not use TTR®. Participants who were 18 years old or older signed consent forms to participate in the study. Parents of participants younger than 18 years old signed consent forms. Three teachers signed consent forms to participate in the study, and they facilitated the implementation of the intervention. All participants in this study used ASL as their primary mode of communication. Participation in the study was predicated on participants' placement in the language arts classes of the teachers who agreed to participate in the study. Because participation in this study was based upon students' class schedules, random assignment was not possible. Participants in the treatment group were matched with participants in

the control group based on ethnicity, gender, and grade level in addressing the three secondary research questions as part of the exploratory data analysis.

The inclusion criteria for the treatment group were: (a) deaf students in 7th through 12th grade; (b) students in 7th through 12th grade that read at the 6th grade level or below; (c) students in 7th through 12th grade that did not have disabilities in addition to being deaf; (d) students in the selected language arts classes in which the teachers consented to participate in the study; and (e) students in 7th through 12th grade that had scores on the January 2011 and May 2011 administrations of the Measures of Academic Progress (MAP) reading assessment. Exclusion criteria for the treatment group included (a) students in 7th through 12th grade that read above a 6th grade reading level; (b) students in 7th through 12th grade that had disabilities in addition to being deaf; (c) students that were not in the selected language arts classes in which the teachers consented to participate in the study; and (d) students in 7th through 12th grade that did not have scores on the January 2011 and May 2011 administrations of the MAP reading assessment.

The inclusion criteria for the control group involved students that were matched with treatment group students on ethnicity, gender, and grade level. Additional criteria included (a) deaf students in 7th through 12th grade; (b) students in 7th through 12th grade that read at the 6th grade level or below; (c) students in 7th through 12th grade that did not have disabilities in addition to being deaf; and (d) students in 7th through 12th grade that had scores on the January 2011 and May 2011 administrations of the MAP reading assessment. Exclusion criteria for the group included students who were not matched with treatment group participants based on ethnicity, gender, and grade level. Additional exclusion criteria included (a) deaf students in 7th through 12th grade that read above a 6th

grade reading level; (b) students in 7th through 12th grade that had disabilities in addition to being deaf; and (c) students in 7th through 12th grade that did not have scores on the January 2011 and May 2011 administrations of the MAP reading assessment.

Three teachers were involved in the study, one middle school teacher and two high school teachers. All three teachers taught language arts. The three teachers were recruited as facilitators of the intervention for this study based upon their expressed interests in using technology to support student learning. Inclusion criteria included (a) current certification in deaf education or English/language arts and (b) proficiency in ASL as determined by the school's evaluation of their skills. Exclusion criteria included (a) teachers without certification in deaf education or English/language arts and (b) teachers who were not proficient in ASL.

Instruments

This study used eight instruments. The first instrument was the MAP reading assessment. The second instrument was a teacher script (Appendix A). The third instrument was a participant social validity questionnaire (Appendix B). The fourth instrument was a teacher social validity questionnaire (Appendix C). The fifth instrument was a procedural fidelity checklist (Appendix D). The sixth instrument was a problem sheet for teachers (Appendix E). The seventh instrument was a student data collection spreadsheet (Appendix F), and the eighth instrument was a student attendance form (Appendix G).

Measures of Academic Progress

The MAP reading assessment provides detailed data about the progress of each student's reading comprehension skills. The MAP reading assessment presents the student with 48 to 52 questions. The MAP reading assessment adapts to a student's response as the student takes the test, so each assessment is individualized. If a student answers a question correctly, the test presents a more challenging item. If a student misses a question, the test presents a less challenging question. In this way, the test narrows in on a student's learning level while engaging the student with content that is appropriate and individualized for each student ("MAP," 2011). Upon completion of the assessment, the student's results are assigned a Rasch unit (RIT) score. According to the Northwest Evaluation Association, the company that produces the MAP assessments ("Understanding RIT," 2011), the RIT score is

> a unit of measure that uses individual item difficulty values to estimate student achievement. RIT scores create an equal-interval scale. Equal interval means that the difference between scores is the same regardless of whether a student is at the top, bottom, or middle of the RIT scale; it has the same meaning regardless of grade level. The RIT scale is used to measure how "tall" a student is on the curriculum scale and scores can be compared to tell how much growth a student has made, similar to measuring height on a yard-stick.

Teacher Script

Teachers in the study facilitated participants' use of TTR®. Teachers followed a script during each intervention session. The teacher script (see Appendix A) has six steps that teachers read to students using ASL.

Social Validity

I measured social validity by using two instruments: a participant social validity questionnaire (see Appendix B) and a teacher social validity questionnaire (see Appendix C). Teachers and participants completed the questionnaires to assess the social validity of using TTR® in the classroom. Both instruments were administered one week after all intervention sessions were completed.

Intervention Fidelity

I measured intervention validity by using a procedural fidelity checklist (see Appendix D) to ensure teachers followed the script and implemented the intervention correctly. I completed procedural fidelity checks by conducting observations of 20% of the 27 intervention sessions. The observations included 18 procedural fidelity checks, six for each of the three teachers in the study.

Intervention Procedures

Therrien and Kubina (2006) made reference to the time commitment required in implementing an effective RR intervention. Their research indicated that in order to see maximum gains in reading the RR intervention should last 10 to 20 minutes per session and should occur 3 to 5 times per week. I applied this research finding to the current study. Three teachers facilitated the implementation of TTR® for nine weeks. The sessions occurred 3 days a week for 20 minutes per session.

I provided a teacher workshop to discuss the procedures of the study and to demonstrate how the teachers were to facilitate the implementation of the intervention during the treatment sessions. The teachers trained the participants on how to use TTR® before the first intervention session. Cannon, Easterbrooks, Gagne, and Beal-Alvarez

(2011) suggested that teachers might become frustrated if they are not permitted to assist students by answering questions and providing support to them when the students use a multimedia software program. To minimize teacher frustration in the current study, teachers were permitted to provide support to participants and answer participants' questions during intervention sessions.

Materials

There were two materials necessary for the implementation of the intervention. One was a site license for participants to use the TTR® program simultaneously that was purchased by the school. Another was a computer for each participant equipped with keyboard and mouse controls that was provided by the school.

TTR® is a web-based computer program that promotes passage reading and is designed for students in 1st through 6th grade. The computer-based program provides students with leveled activities so that they can build fluency and vocabulary to increase comprehension skills. Since the median reading age of deaf graduates is on the fourth grade reading level, I selected TTR® because the reading level of the participants in the study fall within the 1st through 6th grade level reading range used in TTR®. TTR® consists of three parts that provide a computer-mediated learning environment. The first part is passage reading. The second part is electronic games. The third part is the Clubhouse that students can personalize and decorate by using tickets they earn for successfully reading passages and passing quizzes. Furthermore, I selected TTR® because it offers students engaging reading material that includes a mix of expository and narrative text. Peyton and Macpherson (2009) stated that TTR®

> has 16 levels with three to four books in each level and ten high-interest passages in each book. Topics for the passages include: cool people, fantastic places, amazing animals, exciting events, interesting things, and engaging stories. Reading difficulty of the passages ranges from 1.5 to 7.0. Passages are specifically written to incorporate key comprehension skills and strategies as well as high-utility and content-specific vocabulary words. The passages include a healthy mix of expository and narrative text, starting with a 30 to 70 percent mix in Level 1 to a 90 to 10 percent mix in later levels. (p. 3)

This is important because, according to Stanovich (1986), "poorer readers often find themselves in materials that are too difficult for them. The combination of lack of practice, deficient decoding skills, and difficult materials results in unrewarding early reading experiences that lead to less involvement in reading-related activities" (p. 3).

Computer generated characters in TTR® provide cues to students both visually through text on the computer screen and auditorily during reading activities. Dirkin, Mishra, and Altermatt (2005) purported that lifelike agents used in a computer program can have a motivational effect on students and can promote deeper cognitive understanding. The computer generated characters in TTR® also provide feedback on correct and incorrect answers through written and verbal cues to encourage students to try again when incorrect responses are given. Bracken and Lombard (2004) found that students respond to praise from a computer just as they would when they receive praise from a teacher. Furthermore, RR combined with corrective feedback increases students' fluency (National Institute of Child Health and Human Development, 2000; Chard et al., 2002).

Data Collection

The timeline for executing the research plan was nine weeks, three days a week for 20 minutes per session. The scores for each participant from the January 2011 and May 2011 MAP reading assessments were compiled on the student data collection

spreadsheet (see Appendix F). Teachers recorded participants' attendance on the student attendance form (see Appendix G). I completed procedural fidelity observation checks (see Appendix D) for 20% of the intervention sessions that consisted of eighteen observations during the study, six for each teacher. I assessed procedural fidelity of the intervention by the teachers by reviewing student reports from the TTR® system to monitor how many times participants logged into the system per week and the duration of their sessions. I also conducted spontaneous procedural fidelity observation checks to ensure teachers complied with the intervention procedures.

I assessed social validity by using questionnaires. The questionnaires served as an informal and subjective evaluation to examine the social validity of using the intervention in the classroom setting. Teacher social validity was assessed using a short questionnaire (see Appendix C) that was distributed a week after all the intervention sessions were completed. In addition, the teachers administered a participant social validity questionnaire to the participants one week after the intervention sessions were completed. The participant social validity questionnaire incorporated a 5-point Likert scale (see Appendix B). The teachers read the questions on the questionnaire to the participants in ASL, or the participants read the questions independently.

School staff provided MAP reading assessment scores for the January 2011 and May 2011 administrations of the assessment. I compiled the data in the student data collection spreadsheet (see Appendix F).

Data Analysis

I conducted a dependent *t*-test using the treatment group participants' pretreatment and posttreatment assessment scores to investigate the primary research question regarding the differential effects of TTR® on deaf students' reading comprehension. In an exploratory data analysis involving a treatment and control group, I conducted three ANOVAs based on participants' mean gain scores to investigate the main effect of the treatment, the interaction effect of treatment and gender, and the interaction effect of treatment and grade level. In order not to confound the effect of individual variables, only one variable at a time was used in each ANOVA. For example, in examining the main effect of treatment, the variables of gender and grade level were not included as variables in the analysis. In examining the interaction effect of treatment and gender, the variable of grade level was not included in the analysis. In examining the interaction effect of treatment and grade level, the variable of gender was not included in the analysis. I examined descriptive statistics and estimated marginal means plots to provide additional interpretation of data results. Also, I interpreted effect sizes because researchers have recommended that all results, including those that are statistically nonsignificant, be included in research reports (Wilkinson & APA Taskforce, 1999). Finally, I analyzed social validity data.

Assumptions

The first assumption of this study was that fluency gains through the use of TTR® translated to gains in comprehension. Prior research has indicted that when a student's fluency improves the student's comprehension improves.

The second assumption of this study was that the MAP reading assessment was an appropriate assessment to measure deaf students' reading comprehension skills. Also in

regard to the MAP, the results of this study were based on the assumption that the MAP reading assessment is a valid and reliable assessment.

A third assumption was that the quality of the data provided by the school was accurate. It is assumed that the data provided by the school met the requirements as discussed in the data collection section of this chapter.

The final assumption was that deaf students can use TTR® even though there are parts of the program that provide auditory support. It should be noted that the producers of TTR® do not market or advertise that TTR® is an effective reading tool for deaf students. Although some parts of the program are auditory in nature, it was hoped that deaf students would be able to understand what was happening on the computer screen based on the written cues and clues that appeared. For example, one activity in the program allowed the students to click on a word and hear the word. Deaf students are not able to hear the word; therefore, the students did not benefit from the pronunciation of the word. The students were able to see the word in the context of a sentence with written cues appearing on the screen that could have possibly assisted them in decoding the meaning of the word.

CHAPTER 4

RESULTS

I collected data from 27 participants in the treatment group to address the primary research question. I also collected data from 27 participants in a control group to address the three secondary research questions as part of an exploratory data analysis. To address the primary research question regarding the differential effects of the intervention on the reading comprehension abilities of the students in the treatment group, I used a dependent *t*-test using the treatment group participants' pretreatment and posttreatment reading assessment scores. In an exploratory data analysis to address the three secondary research questions regarding the main effect of treatment, the interaction effect of treatment and gender, and the interaction effect of treatment and grade level, three ANOVAs were conducted. The ANOVAs involved the treatment group and control group participants' pretreatment and posttreatment reading assessment scores, students' gender, and students' grade levels as variables. I examined estimated marginal means of gains scores and effect sizes to further interpret the data. In addition, I examined social validity data from the treatment group participants and the three teachers that facilitated the intervention.

Primary Research Question One

What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks? I ran a dependent *t*-test to compare the mean difference between the pretreatment and posttreatment reading assessment scores. The mean on the pretreatment reading assessment was 183.6296 (*sd* = 12.34176), and the mean on the posttreatment reading

assessment was 181.4815 = (*sd* = 11.37261). No significant difference from pretreatment to posttreatment reading assessment was found, $t(26) = 1.813$, $p > .05$.

I conducted a descriptive mean gain score analysis of the treatment group participants' using the pretreatment and posttreatment reading assessment scores (see Table 2). In the treatment group, the one $7^{th}/8^{th}$ grade level male participant's mean gain score remained the same. The mean gain score for the three females in the $7^{th}/8^{th}$ grade level pair decreased by 7 points. For the $7^{th}/8^{th}$ grade level pair including males and females, the mean gain score decreased by 5.25 points. The mean gain score of the five male participants in the $9^{th}/10^{th}$ grade level pair decreased by three points. The mean gain score for the one female participant in the $9^{th}/10^{th}$ grade level pair increased by 3 points. For the $9^{th}/10^{th}$ grade level pair including males and females, the mean gain score decreased by 5.25 points. The mean gain score of the nine male participants in the $11^{th}/12^{th}$ grade level pair increased by 1.1 points. The mean gain score for the eight female participants in the $11^{th}/12^{th}$ grade level pair decreased by 3.3 points. For the $11^{th}/12^{th}$ grade level pair including males and females, the mean gain score decreased by 2.1 points.

Overall, there was regression in performance across gender and grade levels; however, some of the students had no regression and even showed progress. For example, the one $7^{th}/8^{th}$ grade level male participant's mean gain score was 0 points. The mean gain score for the one female participant in the $9^{th}/10^{th}$ grade level pair increased by 3 points. The mean gain score of the nine male participants in the $11^{th}/12^{th}$ grade level pair increased by .11 points.

Exploratory Analysis - Secondary Research Question One

What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®? I used a 2 x 2 (2 points in time x 2 levels of treatment) factorial design to determine if there was a significant difference between mean gain scores of the participants in treatment and control groups. There was no significant main effect was found for treatment, $F(1,42) = 1.989$, $p > .05$. Results are presented in Table 2.

Exploratory Analysis - Secondary Research Question Two

Based on gender, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®? A 2 x 2 (2 levels of gender x 2 levels of treatment) factorial design was used to determine if there was a difference between groups based on gender. Fifty-six percent of the participants were male, and 44% of the participants were female (see Table 1). When analyzing data collected, the overall results indicated no statically significant difference was found for the interaction effect of treatment and gender, $F(1,50) = 1.209$, $p > .05$. Results are presented in Table 4.

I conducted a descriptive analysis of mean gain scores by gender (See Table 2 and Table 5). Females in the treatment group had a mean gain score of -3.6667. Females in the control group had a mean gain score of -.4167. Males in the treatment group had a mean gain score of -.9333. Males in the control group had a mean gain score of 2.0667.

Table 2

Mean Gain Scores for Treatment Group

Grade	Gender	Pretest Mean	Posttest Mean	Mean Gain	N
7th/8th grade	Male	181	181	.0000	1
	Female	187.66	182.66	-7.0000	3
	Total	184.33	181.83	-2.5	4
9th/10th grade	Male	174.2	171.2	-3.0000	5
	Female	184	187	3.0000	1
	Total	179.1	179.1	.0000	6
11th/12th grade	Male	180.333	180.444	.1111	9
	Female	192	188.75	-3.2500	8
	Total	187.666	184.597	-3.069	17
Total	Male	178.511	177.548	-.963	15
	Female	187.866	184.752	-3.114	12
	Total	183.188	181.15	-2.038	27

Table 3

Factorial Analysis of Variance in Gain Scores

Source	df	Sum of Squares	Mean Square	F
TRT	1	130.667	130.667	1.768
Error	52	3842.370	73.892	
Total	54	3992.000		

$p > .05$

Table 4

Factorial Analysis of Variance in Gain Scores by Gender

Source	df	Sum of Squares	Mean Square	F
Gender	1	90.712	90.712	1.209
TRT	1	130.208	130.208	1.735
TRT*Gender	1	.208	.208	.003
Error	50	3751.450	75.029	
Total	54	3992.000		

$p > .05$

Table 5

Mean Gain Scores for Control Group

Grade	Gender	Pretest Mean	Posttest Mean	Mean	N
$7^{th}/8^{th}$ grade	Male	163.0	180.0	17.0000	1
	Female	165.66	168.0	2.34	3
	Total	164.33	174.0	6.0000	4
$9^{th}/10^{th}$ grade	Male	182.8	186.6	3.8000	5
	Female	185.0	183.0	-2.0000	1
	Total	183.9	184.8	0.9	6
$11^{th}/12^{th}$ grade	Male	186.333	185.777	-.556	9
	Female	188.875	187.625	-1.2500	8
	Total	187.604	186.701	-.903	17
Total	Male	177.377	184.125	6.748	15
	Female	179.845	179.541	-.304	12
	Total	178.611	181.833	3.222	27

Exploratory Analysis - Secondary Research Question Three

Based on grade level, what are the differential effects of Ticket to Read® on deaf students' reading comprehension skills after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®? A 3 x 2 (3 levels of grade x 2 levels of treatment) factorial design was used to determine if there was a difference in mean gain scores between the treatment and control groups based on grade level. Fifteen percent of the participants were in the $7^{th}/8^{th}$ grade level pair. Twenty-two percent of the participants were in the $9^{th}/10^{th}$ grade level pair. Sixty-three percent of the participants were in the $11^{th}/12^{th}$ grade level pair (see Table 1). The overall results indicated that there was no statically significant difference found for the interaction effect of treatment and grade level, $F(2,48) = .208$, $p > .05$. Results are presented in Table 6.

Descriptive Mean Gain Scores Analysis – Treatment and Control Groups

The results of comparing the mean gain scores for the treatment and control groups from pretreatment to posttreatment reading assessments were analyzed (see Table 2 and Table 5). In the treatment group, the one $7^{th}/8^{th}$ grade level male participant's mean gain score remained the same. His counterpart in the control group gained 17 points. The mean gain score for the three females in the treatment group in the $7^{th}/8^{th}$ grade level pair decreased by 7 points. Their control group counterparts' mean gain score increased by 2.3 points. For the $7^{th}/8^{th}$ grade level pair including males and females, the treatment group's mean gain score decreased by 5.25 points. Their counterparts' mean gain score in the control group increased by 6 points.

Table 6

Factorial Analysis of Variance in Gain Scores by Grade Level

Source	df	Sum of Squares	Mean Square	F
Grade	2	31.304	15.652	.208
TRT	1	292.268	292.268	3.880
TRT*Grade	2	195.483	97.741	1.298
Error	48	3615.583	75.325	
Total	54	3973.037		

$p > .05$

In the treatment group, the mean gain score of the five male participants in the $9^{th}/10^{th}$ grade level pair decreased by 3 points. Their counterparts' mean gain score in the control group increased by 3.8 points. The mean gain score for the one female participant in the treatment group in the $9^{th}/10^{th}$ grade level pair increased by 3 points. The mean gain score for her counterpart in the control group decreased by 2 points. For the $9^{th}/10^{th}$ grade level pair including males and females, the treatment group's mean gain score decreased by 5.25 points. The mean gain score for their counterparts in the control group increased by 2.8 points.

In the treatment group, the mean gain score of the nine male participants in the $11^{th}/12^{th}$ grade level pair increased by .11 points. Their counterparts' mean gain score in the control group decreased by .56 points. The mean gain score for the eight female participants in the treatment group in the $11^{th}/12^{th}$ grade level pair decreased by 3.3 points. The mean gain score for their counterparts in the control group decreased by 1.3 points. For the $11^{th}/12^{th}$ grade level pair including males and females, the treatment

group's mean gain score decreased by 2.1 points. The mean gain score for their counterparts in the control group decreased by .88 points.

When using descriptive statistics to analyze mean gain scores by treatment and control groups to determine direction of change, the findings indicated scores on the measure of reading assessment were somewhat sporadic for students in both the treatment and control group by subgroup categories such as gender and grade level pairs. Overall, the students in the treatment group showed a mean gain score loss 2.038 points while the students in the control group showed a mean gain score increase of 3.222 points.

Estimated Marginal Means of Gain Scores

Although statistical significance regarding differences was not found, examining just the increase or decrease in mean gain score data between the treatment group and control group provided differences that indicated the effects of intervention varied by some grade level pairs and by gender. From a graphic perspective, the profile plots of estimated marginal means of gain scores (see Figure 3 and Figure 4) indicated a similar analysis of differences visually as does the descriptive analysis of mean gain scores. Because of the small sample size, generalizability is limited.

In Figure 3, the profile plot of the estimated marginal mean gain scores for the treatment and control groups including gender indicated that the males and females in the control group had a higher mean gain score than the males and females in the treatment group. In Figure 4, the profile plot of the estimated marginal mean gain scores for the treatment and control groups based on grade level indicated the control group again had a higher mean gain score for all grade level pairs than the treatment group.

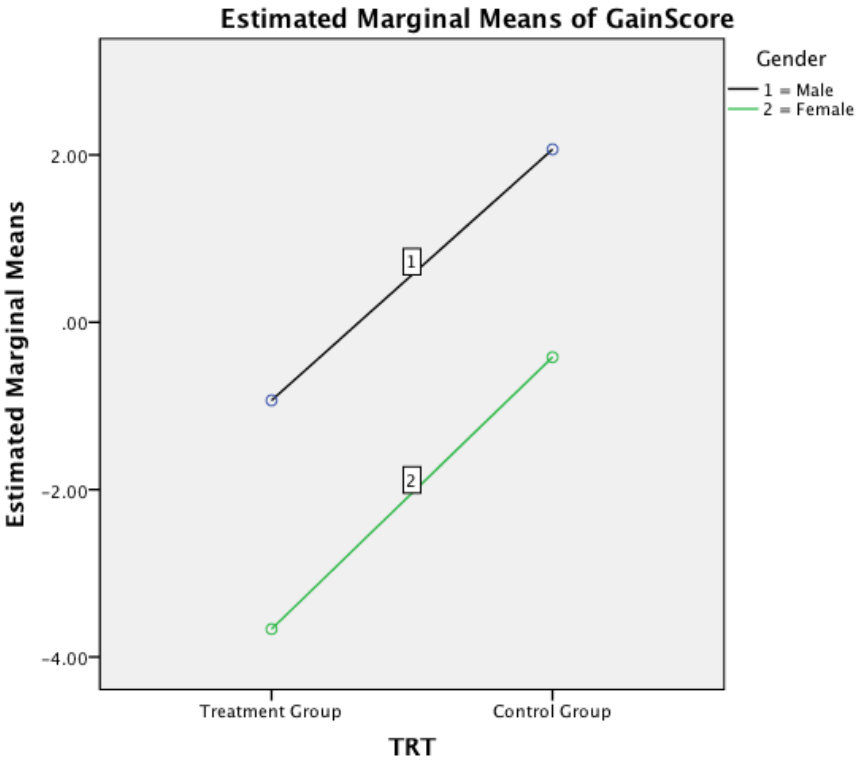

Figure 3. Profile Plot Comparing Estimated Marginal Means from Gain Scores of Treatment and Control Groups by Gender.

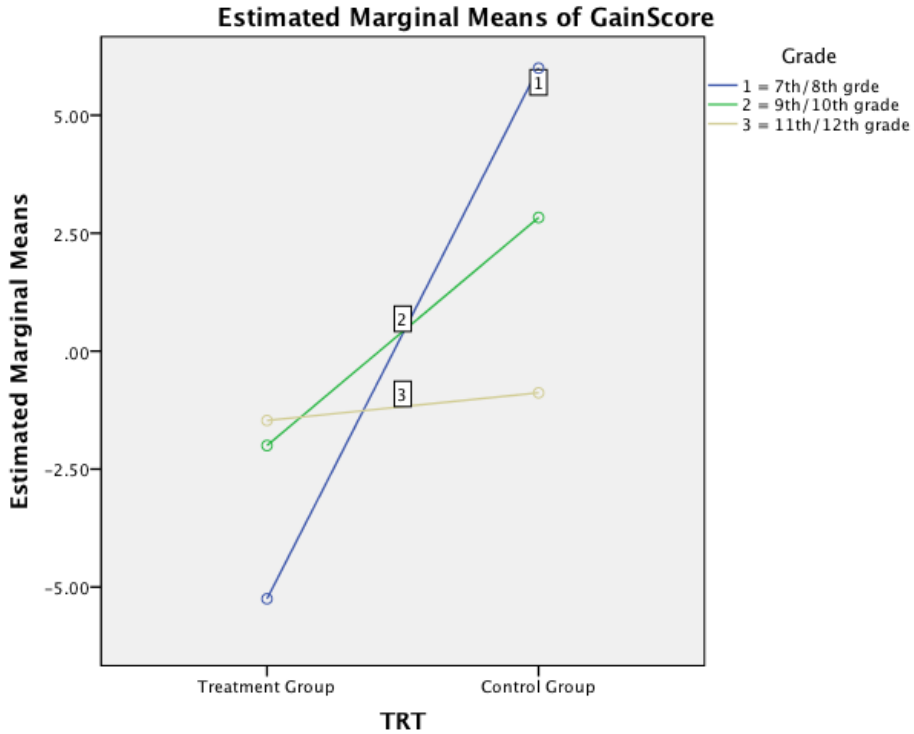

Figure 4. Profile Plot Comparing Estimated Marginal Means from Gain Scores of Treatment and Control Groups by Grade Level.

Effect Size

Effect sizes were calculated for all between group differences in this study. The APA Task Force on Statistical Inference reported that the educational research field is placing more importance on practical significance and not just statistical significance (Shea, 1996). Wilkinson and the APA Task Force on Statistical Inference (1999) reported that it is important to good research that effect sizes are reported and interpreted. If research expectations match the null hypothesis when the null hypothesis specifies no difference, the effect size would be zero within sampling error; however, if the expectations do not match the null hypothesis, the expected effect size would not be zero (Vacha-Haase & Thompson, 2004).

Cohen proposed that the terms "small, d = .2" "medium, d = .5" and "large, d = .8" are relative to each other and to the research method being used in an investigation. An effect size of 1.0 indicates that the treatment group mean was one standard deviation higher than the control group mean. This reflects a strong effect of treatment. An effect size of 0 indicates that treatment and control group means were identical. This reflects that the treatment had no effect.

In the current study, an interpretation of effect sizes indicated that there was a small effect size of 0.3643 for the females meaning that the treatment had a small effect on the females in the treatment group. An interpretation of effect sizes indicated that there was a large effect size of 1.5078 for the $7^{th}/8^{th}$ grade level pair meaning that the treatment had a large effect on the $7^{th}/8^{th}$ grade level pair. An interpretation of effect sizes indicated that there was a medium effect size of 0.6249 for the $9^{th}/10^{th}$ grade level pair meaning that the treatment had a medium effect on the $9^{th}/10^{th}$ grade level pair. The

aforementioned effect sizes indicated that the results should not be treated as zero, potentially leading to falsely accepting the null hypothesis.

Procedural Fidelity

I completed procedural fidelity checks (Appendix D) for 20% of the intervention sessions for 9 weeks. Six procedural fidelity checklists were completed for each teacher, 20% of the 27 intervention sessions. The results of the procedural fidelity checks indicated that the teachers followed the teacher scripts (Appendix B) during intervention for 100% of the observed sessions.

Social Validity

Teachers completed a teacher social validity questionnaire (Appendix C) one week after all the intervention sessions were concluded. The questionnaire consisted of five questions that were qualitative in nature. The responses varied among the teachers, and the results were mixed regarding the benefit and motivational nature of TTR®. For the responses to question one regarding if the teacher found the intervention to be easy or hard to implement, all three teachers responded “easy.” For the responses to question two regarding how the teacher thought the participants reacted to the procedure, all three teachers were asked to circle “Positively,” “Neutral,” or “Negatively.” One teacher answered “Positively.” One teacher answered “Neutral,” and one teacher answered “Negatively.” For the responses to question three regarding if the teacher planned to use the intervention now that the study was over, one teacher responded, “I believe I will continue to use occasionally. Many of the students liked the idea of reading and learning on the computer.” Another teacher responded “positively.” The third teacher responded “I would use it if the problems with the Ticket to Read program were fixed.” For the

responses to question four regarding how motivating the teacher thought the intervention was relative to other direct instruction of reading fluency the teacher used in the past one teacher responded, “Better.” Another teacher responded “Worse.” The third teacher responded “Worse.” For the responses to question five regarding if the teacher thought the results were worth replicating in other classrooms, one teacher responded “I think the program could have use as a supplementary support for students.” A another teacher responded “No, not relevant to specific content areas; passages discussed other content but not enough to get effective assessments.” One of the teachers that found the intervention not to be motivating wrote additional comments that may provide insight into the responses. The teacher wrote “My problem and my students’ problem is that the point of fluency is to increase your reading speed, but it (the computer program) forces them to slow down…I had a student get frustrated because it (the computer program) said she read too fast so she read it (a passage) again and it (the computer program) said she read too slowly.” The student responses on the participant questionnaire are not congruent with the teachers’ responses.

Participant social validity questionnaires (Appendix B) were completed during post intervention. Participants completed all survey questions, or a teacher read the questions to the participants using ASL depending upon the preference of the participants. There were seven questions in the survey. A Likert scale from 1-5 measured participant responses, where 1 indicated “Strongly Agree,” 2 indicated “Agree,” 3 indicated “Unsure,” 4 indicated “Disagree,” and 5 indicated “Strongly Disagree.” All 27 participants in the treatment group responded by completing the participant social validity questionnaire. Results are presented in Table 7.

For statement one "I enjoyed using Ticket to Read®," 85% of the participants strongly agreed or agreed, and 11% of the participants disagreed or strongly disagreed. For statement two, "I learned a lot using Ticket to Read®," 89% of the participants strongly agreed or agreed, while 11% of the participants disagreed or strongly disagreed. For statement three, "Ticket to Read® was fun," 78% of the participants strongly agreed or agreed, and 22% disagreed or strongly disagreed. For statement four, "I read faster now," 78% of the participants strongly agreed or agreed, and 7% disagreed or strongly disagreed. For statement five, "I understand what I read better now," 85% of the participants strongly agreed or agreed, and 8% disagreed or strongly disagreed. For statement six, "I would use Ticket to Read® at home," 70% of the participants strongly agreed or agreed, and 11% disagreed or strongly disagreed. For statement seven, "I would recommend Ticket to Read® to a friend," 81% of the participants strongly agreed or agreed, and 15% disagreed or strongly disagreed.

Table 7

Participant Social Validity Questionnaire Results

Questionnaire Item	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
1. I enjoyed using Ticket to Read®.	18	5	1	2	1
2. I learned a lot using Ticket to Read®.	16	8	0	3	0
3. Ticket to Read® was fun.	21	4	0	1	1
4. I read faster now.	12	9	2	2	2
5. I understand what I read better now.	18	5	2	2	0
6. I would use Ticket to Read® at home.	9	10	5	1	2
7. I would recommend Ticket to Read® to a friend.	18	6	1	2	0

Summary

In this chapter, I examined the results of a dependent *t*-test to address the primary research question regarding to what extent the treatment had an effect on the treatment group participants' reading assessment scores. The results indicated that there was no statically significant difference in the pretreatment and posttreatment reading assessment scores of participants in the treatment group, $t(26) = 1.813$, $p > .05$. I also conducted three ANOVAs using mean gain scores to address the three secondary research questions that were part of an exploratory data analysis. In addressing secondary research question one, there was no significant main effect found for treatment when comparing the assessment

scores of participants in the treatment and control groups, $F(1,42) = 1.989$, $p > .05$. In addressing secondary research question two, there was no significant effect found for the interaction of treatment and gender, $F(1,50) = 1.209$, $p > .05$. In addressing secondary research question three, there was no significant effect found for the interaction of treatment and grade level, $F(2,48) = .208$, $p > .05$. Estimated marginal means plots reflected that participants in the control group scored better on the posttreatment reading assessment than the participants in the treatment group across gender and grade levels.

An interpretation of effect sizes indicated that there was a small effect size of 0.3643 for the females. An interpretation of effect sizes indicated that there was a large effect size of 1.5078 for the $7^{th}/8^{th}$ grade level pair. An interpretation of effect sizes indicated that there was a medium effect size of 0.6249 for the $9^{th}/10^{th}$ grade level pair.

To address social validity, participants completed a participant social validity questionnaire one week after all the intervention sessions were concluded. The comments were overwhelmingly positive towards the use of the computer-based program during class time. In fact, many of the participants stated that they would recommend the program to a friend and that it helped them to read faster and understand what they read better. The teachers' responses on the questionnaires indicated that the teachers' thoughts about the intervention were mixed.

CHAPTER 5

DISCUSSION

The present study addressed one primary research question and as part of an exploratory data analysis three secondary research questions:

Primary Research Question

What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks?

Exploratory Analysis - Secondary Research Questions

1. What are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
2. Based on gender, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?
3. Based on grade level, what are the differential effects of Ticket to Read® on deaf students' reading comprehension after using the computer-based educational program for nine weeks compared to deaf students that did not use Ticket to Read®?

Discussion

The hypothesis that increasing fluency will increase comprehension seems like a matter of common sense; however previous research has shown that findings regarding the correlation between the two are mixed. In the current study, findings suggest that TTR® did not have a statistically significant effect on the reading comprehension assessment scores of students that were in the treatment group based on a pretreatment

and posttreatment reading assessment. In addition, findings suggest that TTR® did not have a statistically significant effect on the treatment group's reading comprehension assessment scores when compared to a control group as a whole and across the variables of gender and grade level.

The finding that RR did not have a statistically significant effect on the reading comprehension of students in the treatment group was similar to the findings of two previous studies: Krammer (2007) and Schirmer et al., (2009). Although the studies did not utilize a computer-based program incorporating RR, the researchers in both studies did find that using RR with passages printed on paper did not have a statically significant effect on improving deaf students' comprehension although it improved the students' WCPM.

As discussed, there is existing research that found that RR improved the reading fluency of students. There is also research that found that computer-mediated learning can improve students' reading skills (Gentry et al., 2005; Luckner et al., 2006). In the current study, when the two were combined, there was no finding that student comprehension increased by any statistically significant degree. There are several factors that should be considered when reviewing the nonsignificant finding within the context of this study's setting and why the use of the intervention may not have resulted in a statistically significant difference in students' comprehension scores in the primary and exploratory data analysis. One, fluency in the current study was not directly measured, and comprehension was measured as a by-product of the fluency intervention. Using both a fluency assessment and a comprehension assessment as Krammer (2007) did may have provided a fuller picture regarding the students' progress.

In regard to the specific use of TTR®, Peyton and Macpherson (2009) used TTR® to assess hearing students' gains in fluency as measured by gains in accurate WCPM read orally and mean gain differences in regard to effect sizes of gains in WCPM. In their study, the treatment group students showed a greater increase in WCPM and higher mean effect sizes for WCPM than the students in the control group. Similarly in the current study, effect sizes were of value also. For the participants in the treatment group, the effect sizes indicated that there was small effect size for the females, a large effect size for students in the $7^{th}/8^{th}$ grade pair, and a medium effect size for students in the $9^{th}/10^{th}$ grade level pair after the fluency intervention meaning the treatment had some effect on the aforementioned subgroups. Although the significant tests were non-significant, the magnitude of the mean differences effect sizes in this study support the need for further research regarding the evaluation of computer-based educational programs that can be used as effective educational strategies to improve deaf students' reading performance.

There are a number of possible reasons as to why the students in the treatment group did not do as well on the comprehension assessment as the students in the control group. One reason could be that teachers in the control group taught the state's student performance standards during class time through direct instruction, and the assessment used in this study is aligned to the state's student performance standards in the area of reading. The intervention used by the students in the treatment group is not aligned to the state's student performance standards.

Also, students in the control group may have received targeted guided and informed feedback based upon individual reading abilities and their teachers' knowledge of best practices in deaf education for improving the literacy skills of deaf students. Providing guided and informed feedback can be an effective method for improving reading fluency and reading achievement (Chard et al., 2002; Homan et al., 1993; Herman, 1985; O'Shea et al., 1985). When a student makes a reading error, guided and informed feedback involves the teacher immediately attending to helping the student correct the error by scaffolding instruction and providing support. Direct instruction and guided feedback from a teacher has been proven to be the single most important factor in promoting student learning (Marzano, 2007). Students in the treatment group may not have received the same degree of direct reading intervention support through TTR® as the students in the control group did though their teachers.

The mean gain score analysis for the treatment group students did indicate that the results were somewhat sporadic. Overall, there was regression in performance across gender and grade levels; however, 11 of the 27 students of the students in certain categories either had no regression or showed progress. For example, the one $7^{th}/8^{th}$ grade level male participant's score remained the same with no increase or decrease from the pretreatment assessment to posttreatment assessment. The mean gain score for the one female participant in the $9^{th}/10^{th}$ grade level pair increased by 3 points. The mean gain score of the nine male participants in the $11^{th}/12^{th}$ grade level pair increased by 1.1 points. This means that 41% of students had no loss in reading comprehension abilities or showed progress from the pretreatment to posttreatment assessment. In comparison, there

was no overall regression for students in the control group, and their mean gain score on the reading assessment increased from pretreatment to posttreatment.

Finally in regard to social validity, treatment group participants' responses to the participant questionnaire and findings from the descriptive analysis were in line with previous research regarding students' motivation as related to the use of computer-based learning interventions (Gentry et al., 2005; Luckner et al., 2006). Students in this study clearly enjoyed using computer-mediated learning. It is interesting to note that the teachers that supervised the participants thought differently. A thorough analysis as to why this difference in perspective occurred was not possible based on the current study's design. From an anecdotal perspective based upon comments made by the teachers on the social validity questionnaire, it could be that teachers saw a disconnect from the content used in the computer program and course content which may have caused a sense of frustration. Future research should incorporate a more validated measure to be able to assess any differences between the student and teacher responses in a more in-depth manner.

Limitations of the Study

This study has some limitations. The first limitation was sample size. A true experimental design could not be used. A true experimental design requires that participants are assigned randomly to comparison and treatment groups. This is a necessary condition for true experimental design that cannot be met in the selected school setting. Participants could not be randomly assigned to control and treatment groups because of the limited sample of participants in the selected setting that met the inclusion criteria for this study. Participation in the treatment group was predicated on participants'

placement in three teachers' language arts classes that agreed to utilize TTR® for the duration of the study. Since participants were involved in the study based upon their class schedules and random assignment was not possible, there was no control regarding the percentage of each type of ethnicity, gender, and grade level represented. Because participants were not randomly assigned to the treatment and control conditions, causal inferences are more difficult to support, and threats to internal validity, especially history and selection, are heightened.

The second limitation was related to the class time use of participation in the TTR® educational intervention as an independent variable. Because identifying specific independent variables and activities related to them are difficult, identifying direct causation links from variable to outcome can be challenging. In spite of this challenge, it is important to conduct the research to add to the empirical body of research focusing on deaf education and literacy so that future research can expand upon the results of this study to potentially improve the reading performance of deaf students.

The third limitation of this study was that TTR® was designed for hearing students. Again, the producers of TTR® do not market or advertise that TTR® is an effective reading support for deaf students. There are parts of the computer-based program that are auditory in nature and potentially preclude students with a hearing loss in the study's setting from benefiting from the total reading supports provided by the program.

A fourth potential limitation of this study was the use of the MAP as the reading comprehension assessment. The assessment may not have been sensitive enough to measure reading comprehension gains within the context of the current study based on

the use of the computer-based reading program. Another assessment such as the Johns' Basic Reading Inventory may have been a more sensitive reading achievement measurement that would have reflected student progress in more detail based upon formative and summative assessments related to reading comprehension.

Summary and Recommendations for Future Research

In the current study, TTR® used during class time to improve the reading comprehension of deaf students through fluency gains did not yield any statistically significant results that would indicate that the use of the intervention was effective from a statistically significant perspective; however, the magnitude of the mean differences effect sizes based on gain scores from pretreatment to posttreatment reading assessment scores indicated that there was some effect on some of the subgroups. As discussed previously, there could be a myriad of reasons contributing to why statistical significance was not found. One possible obvious reason is that the computer-based program itself was designed for hearing students and not specifically for students with a hearing loss. There may be other computer-based programs made for hearing students that would be more beneficial in helping deaf students improve their reading performance. Future research should be conducted using those computer-based programs to assess their viability as an educational intervention for deaf students.

As seen in the current study one of the most significant barriers to conducting research in deaf education is the issue of small sample size. Creating a true experimental study design given the unique population characteristics of deaf students is challenging. Because only approximately one percent of students with a disability have a hearing loss, and their educational environments may vary from a special school to a regular school, it

is difficult to obtain a sample size large enough to include participants in randomized treatment and control groups. This does not mitigate the need for true experimental research to be conducted. Future researchers should consider research designs that would allow for the involvement of larger sample sizes. Longitudinal research would be of particular benefit. Given adequate funding and resources, researchers may be able to conduct research on a lager scale perhaps involving multiple schools or educational programs for deaf students. In 1997, Ensor and Koller made a recommendation that future research should be conducted to examine to what extent gains in fluency through the use of RR improve reading comprehension for deaf students. In 2007, Krammer extended the work of Ensor and Koller and made a recommendation that additional research should be conducted to examine reading comprehension gains of deaf students though the use of RR. In 2012, I take Ensor and Koller's and Krammer's recommendations a step further by suggesting that future researchers build upon the current study to continue to investigate to what extent computer-based educational programs involving RR can increase deaf students' fluency and lead to increased comprehension.

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APPENDIXES
APPENDIX A

Teacher Script

Step 1: Remember you are going to use Ticket to Read® for 20 minutes. Make sure that the computer on.

Step 2: Go to programs and choose Ticket to Read® and open the program.

Step 3: Type in the following:
Your username
Your password

Step 3: You will be in the Clubhouse. Click on the Ticket to Read® open book on the desk.

Step 4: Choose the passage that is of interest to you. T.J. Ticket, the ticket mascot, will guide you through the remaining steps. You must successfully complete 8 of 10 passages in the collection before moving to the next book.

Step 5: Let me know if you need any assistance.

Step 6: Ok. Time is up. Please log out of the program.

APPENDIX B

Participant Social Validity Questionnaire

Please read or listen to each sentence carefully. Circle the number that best fits your opinion.

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

1. I enjoyed using Ticket to Read®.	1	2	3	4	5
2. I learned a lot using Ticket to Read®.	1	2	3	4	5
3. Ticket to Read® was fun.	1	2	3	4	5
4. I read faster now.	1	2	3	4	5
5. I understand what I read better now.	1	2	3	4	5
6. I would use Ticket to Read® at home.	1	2	3	4	5
7. I would recommend Ticket to Read® to a friend.	1	2	3	4	5

APPENDIX C

Teacher Social Validity Questionnaire

1. Did you find the intervention easy or hard to implement? If hard, why?

2. How did the students react to the procedure? (Circle one and explain)

Positively Neutral Negatively

3. Do you plan to use the intervention now that the study is over? If no, why not?

4. How motivating did you think this task was relative to other direct instruction of reading fluency you have used in the past? (Circle one and explain)

Better Same Worse

5. Do you view the results as worth replicating in other classrooms?

APPENDIX D

Procedural Fidelity Checklist

Teacher States ___ Yes ___ No Step 1: Remember you are going to use Ticket to Read® for 20 minutes. Make sure that the computer on.

Teacher States ___ Yes ___ No Step 2: Go to programs and choose Ticket to Read® and open the program.

Teacher States ___ Yes ___ No Step 3: Type in the following:
Your username
Your password

Teacher States ___ Yes ___ No Step 3: You will be in the Clubhouse. Click on the Ticket to Read® open book on the desk.

Teacher States ___ Yes ___ No Step 4: Choose the passage that is of interest to you. T.J. Ticket, the ticket mascot, will guide you through the remaining steps. You must successfully complete 8 of 10 passages in the collection before moving to the next book.

Teacher States ___ Yes ___ No Step 5: Let me know if you need any assistance.

Teacher States ___ Yes ___ No Step 6: Ok. Time is up. Please log out of the program.

APPENDIX E

Problem Sheet for Teachers

Please write the date and any problems/concerns/comments below, and drop in my in-box. You can also e-mail me at kmoore33@student.gsu.edu if you have any problems. I will respond to you as soon as possible.

APPENDIX F

Student Data Collection Spreadsheet

Student Name	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n

APPENDIX G

Student Attendance Form

Student Name	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n	Session Date y/n