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The Effects of the Online Remediation of Phonological Processing Deficits on Functional Reading Abilities in Students With Dyslexia

Fletcher Bowden

THE EFFECTS OF THE ONLINE REMEDIATION OF PHONOLOGICAL PROCESSING DEFICITS ON FUNCTIONAL READING ABILITIES IN STUDENTS WITH DYSLEXIA

by

Fletcher Bowden

Bachelor of Arts
Duke University, 1991

Masters of Arts
University of North Carolina at Greensboro, 1995

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Accepted by:

Leigh D'Amico, Major Professor

Terrance McAdoo, Committee Member

Suha Tamim, Committee Member

Tim Conway, Committee Member

Tracey L. Weldon, Interim Vice Provost and Dean of the Graduate School

DEDICATION

Over my lifetime I have been gifted with family members who have influenced me as a teacher and as a learner. This work is dedicated to them.

My parents, Tim and Sally Timmerman, were my first teachers. They saw academic potential in me that I did not recognize in myself, and they nurtured it faithfully. I learned to push myself because they pushed me first, setting the academic expectations high for our family. They wanted all of their children to be thinkers instead of grade earners, and their early lessons are still with me today.

Margaret and Anna, from the minute you each were born, you have been my favorite students ever. When you said “Mom, will you please just TEACH me how to read already?” and “SHE got reading lessons. When will you give ME reading lessons?” I realized the joy that teaching children to read can bring. The two of you inspire me daily with your intelligence, your kindness, your work ethic, your sense of humor, and your dedication to what you care about and believe in.

And finally, to my husband Mark – my biggest supporter and most faithful friend. For 30 years I have watched you balance your love for your family with your passion for helping others through your work and I have wanted to be more like you. I am in awe of your mind, your talent, your vision, and your ability to make everyone and everything around you better. You are the one thing that I know.

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Dr. Conway and my colleagues at the NOW! Company (especially Michael, Michelle, Julie, Harris, and Diana) were an integral part of this study, particularly during the data collection period. I appreciate your willingness to adapt some of the standard operating procedures of the company in order to accommodate my requests. I hope that this is just the beginning of a collection of evidence supporting the powerful work the company is doing.

And lastly, the students of North Charleston Elementary School ended up not being the subjects of this research, but they were the inspiration for it. Thank you for a wonderful six years.

ABSTRACT

Dyslexia affects between 5% and 18% of Americans and is caused by difficulty with phonological processing. This study investigates the impact of an online intervention designed to remediate phonological processing deficits on reading accuracy, fluency, and comprehension. It also investigates changes to student self-concept and parent perceptions of their children's reading attitudes and abilities as a result of the online intervention.

Ten students participated in the intervention; assessments were administered at the beginning and at the midpoint of the treatment. Scores in Phonological Processing and Alternate Phonological Processing, as measured by the CTOPP-2, demonstrated large to very large effect sizes, indicating that the intervention improves students' abilities to perceive and manipulate the individual sounds in words, which is the foundation of good reading.

Functional reading abilities (accuracy, fluency, and comprehension) were measured using the WIAT-IV. At the midpoint of the intervention, these scores demonstrated effect sizes that were small to moderate.

Parents noted qualitative changes in their children's attitudes toward reading, including a greater willingness to read in general. The Piers-Harris Self-Concept Scale did not demonstrate significant changes to student self-concept.

Keywords: dyslexia, phonological processing, accuracy, fluency, comprehension, online

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LIST OF ABBREVIATIONS

CTOPP-2.....Comprehensive Test of Phonological Processing – Second Edition

MSLI .....Multisensory Structured Language Instruction

NF....NOW! Foundations for Speech, Language, Reading and Spelling® program

NOW! Company.....Neuro-development of Words - NOW!® Company

Piers-Harris 3 ..... Piers-Harris Self-Concept Scale, Third Edition

WIAT-IV ..... Wechsler Individual Achievement Test – Fourth Edition

CHAPTER ONE: INTRODUCTION

“I just don’t understand it,” the mother says helplessly as she speaks to our Parent Liaison and Community Outreach Coordinator. “None of our other children ever had this problem. His dad and I both love to read, and we read in front of him all the time. We started taking him to the library when he was still in a stroller. We have hundreds of books in our playroom, and we read to him every night. He went to the best preschool in our area, and his elementary school teachers have been wonderful. He’s been getting extra help at school every day for two years, but he just can’t keep up with the other kids in his class. He’s very, very smart. He understands things that children his age shouldn’t have any grasp of at all. His vocabulary is great, his eyesight is fine, he can do math like nothing you’ve ever seen. But then he looks at the word on page 7 that he just read on page 6, and it’s like he’s never even seen it before. What are we doing wrong? What is wrong with him? Why can’t he read? And what can you do to help him?”

At the same time, our Director of Instructor Training meets with a fourth-grade student. He sits sullenly, eyes downcast, and answers my colleague reluctantly. “I hate reading,” he says when asked how he feels about school. “It’s stupid. Books are boring and I’d rather be playing basketball or playing video games. School is dumb anyway. My teachers hate me, and they say I don’t even try. They get mad at me for making mistakes, and they say I’m lazy. But I don’t care. I’m not going to college anyway. I'm going to play in the NBA.”

Conversations like this occur a dozen times per month with our intake staff and administrative team. Parents all over the country who have children who struggle to read are desperate to find help for them, and children are equally desperate for school not to be so difficult. There are many options for remediating reading difficulties, and parents and students alike want to know that if they are going to invest time and energy into a potential solution, it is going to be effective.

The global Covid pandemic has been enormously disruptive to schools in the United States and all over the world. Concerns about spreading Covid have decreased the amount of time that students have been in school and limited the amount of face-to-face interaction they have had with teachers. Students who already found learning to read difficult are at risk of falling farther behind. For a variety of reasons, students do not always have access to high-quality, in-person remediation services; the efficacy of online options is more important now than ever.

Problem of Practice

A quick Google search of the term “dyslexia” yields over a million results. The term “causes of dyslexia” has over 4 million hits, and “treatment for dyslexia” will bring up over 7 million entries. Parents who suspect that their children might have dyslexia can quickly become overwhelmed in their search for information and help.

Many misconceptions about dyslexia exist. Some people believe that children with dyslexia see letters and numbers backwards or that words jump

around on the page as they are trying to read. Dyslexia simulation worksheets show text written in wavy lines or with portions of letters missing. Parents whose children reverse the letters b and d search for information on learning disabilities and become convinced that their children are dyslexic. According to the International Dyslexia Association, however,

> dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. (Lyon et al., 2003, p. 2)

Depending on the study, the prevalence of dyslexia in the United States ranges anywhere from 5% of the general population to 18% (Shaywitz, 1998). Dyslexia is based on the Greek words “dys” meaning difficulty or trouble and “lexia” meaning words or language. “Trouble with words,” or poor reading ability, can be the result of many factors, including poor vision and/or hearing, weak cognitive abilities overall, or lack of exposure to oral or written language. As is evident from the IDA definition, however, dyslexia is not related to any of those issues or problems and in fact can exist in the absence of them.

Although students with dyslexia are protected under the federal Individuals with Disabilities Educational Act (IDEA) of 2004, the services offered to students with dyslexia vary and are often inconsistent from one state to another. In terms of how students are identified and when, what interventions and

accommodations are offered and to whom, and who is eligible to receive remediation services, there are no national guidelines in place (Youman & Mather, 2012). Although early intervention is critical in the effort to alleviate the effects of dyslexia and improve outcomes for individuals (Foorman et al., 1997), it is left up to individual states to determine the interventions which are offered and to whom. The interventions with the highest success rates are administered intensively by highly trained reading specialists (Moats, 2009), but the programs that are offered to students vary by state, by district, and sometimes even by classroom.

Parents looking for help for their children are often left to navigate the confusing options in dyslexia treatments on their own. Commercially available materials like workbooks and flashcards, school-based services like pull-out classes and special education teachers, and private fee-for-service options are plentiful and can often be expensive. Particularly during a global pandemic, when opportunities for face-to-face instruction with teachers or with trained reading specialists are limited, remote learning options focused on the remediation of learning difficulties are appealing to parents, and it is incumbent upon providers to offer evidence regarding the efficacy of the treatment being offered.

Research Questions

Research states that dyslexia is based on “deficits in the phonological component of language” (IDA 2002). This definition implies that the remediation of deficits in phonological processing should have a positive impact on functional

reading abilities such as accuracy, fluency, and comprehension. Secondarily, an improvement in reading abilities may influence student self-concept.

To look more specifically at the relationship between the improvement of phonological processing and functional reading abilities as well as the impact of reading difficulties on student self-concept, the following questions were investigated:

1. What effect, if any, does the online remediation of phonological processing deficits have on reading accuracy, fluency, and comprehension?
2. What effect, if any, does this online treatment have on student self-concept?
3. What effect, if any, does this online treatment have on parents' perceptions of their children's reading abilities?

Purpose

The purpose of this study is to determine the impact, if any, an online intervention designed to remediate phonological processing deficits has on reading accuracy, fluency, and comprehension. It also examines whether student self-concept changes during the first 60 – 65 hours of the intervention and if parents' perceptions of their children's reading abilities change as the result of the intervention provided.

Decades of research about dyslexia has made very clear that the underlying cause of most reading difficulties is a deficit in the phonological processing system (Liberman & Shankweiler, 1985), and therefore many

interventions, including the one investigated in this study, address that deficit. Often of more interest to parents and students, however, is the functional effect of this treatment. Parents look for interventions for their children not necessarily because they want phonological processing to improve, but because they want their children to be able to read grade level text more accurately and fluently, and they want them to be able to understand what they have read.

The Neuro-development of Words - NOW!® Company uses an approach to remediation which focuses on the development of phonological awareness. This methodology has been utilized for several decades at clinics in Florida, and, more recently, in Alabama and in Trinidad. Post testing in the clinics often indicates substantial improvements in a student's ability to perceive, conceptualize, and manipulate the individual sounds in words as well as improvements in their functional reading abilities (T. Conway, personal communication, February 4, 2020).

Because of the locations of the clinics and the costs associated with relocating for several months to receive treatment, however, this in-person option is unrealistic for many families. This study was designed to investigate the connection, if any, between the online remediation of phonological processing deficits and changes in reading accuracy, fluency, and comprehension. The intervention being investigated is the same as the one offered at the NOW!® Company clinics, but the instructor and student meet via an online workspace, rather than in person. The materials used online are identical to the ones in the clinic, but they are manipulated in two dimensions rather than three. This online

intervention is therefore available to any students who have access to a computer and an internet connection, no matter where they live.

Theoretical Framework

According to the Phonological Processing Deficit Theory, children and adults with dyslexia have difficulty with the perception, representation, retrieval, and manipulation of sounds associated with speech. In other words, a student who hears the sounds /c/, /a/, and /t/ might have a hard time blending those sounds together to make the word “cat.” Similarly, when a student with dyslexia hears the word “cat,” he may have difficulty identifying the three sounds (phonemes) that make up the word. It may be difficult for the student to remove one of the sounds from the word (changing “cat” to “at”), or he may not be able to identify the word that is made when the first sound and the last sound are switched (“cat” becomes “tack”). When a student with phonological processing deficits is asked to change the middle sound in “cat” to “o,” he might not realize that the new word is “cot.” When the graphemes (letters) and phonemes (sounds) that are associated with speech are poorly represented, associated, or retrieved, learning to read becomes very difficult (Liberman & Shankweiler, 1985).

The effective treatment of dyslexia requires specific remediation of these phonological processing deficits. For students with dyslexia to become proficient readers, they need systematic, explicit, intensive instruction (Fallon & Katz, 2020; Foorman et al., 1997). Multisensory Language Instruction is often used in the treatment of dyslexia. First utilized by Dr. Samuel Orton in the early 1920s, this

teaching methodology uses multiple sensory pathways (visual, auditory, and kinesthetic) simultaneously as students learn to read and spell. As letters, sounds, and words are learned, students make connections between the letters and words they see (the visual pathway), the sounds they hear (the auditory pathway) and what they feel (the kinesthetic pathway). Most often, the kinesthetic pathway refers to the formation of the letter as it is traced, copied, or written. Fine and gross motor skills are utilized as students sky write letters, trace them on sandpaper, or manipulate three dimensional letters (International Dyslexia Association [IDA], 2009).

This study combined Phonological Processing Deficit Theory and Multisensory Structured Language Instruction but focused on the oral motor component of language as the kinesthetic pathway being trained. Rather than focusing on gross and fine motor skills as they wrote letters, students in this study attended to the articulatory movements their mouths made as they produced sounds. Students were taught to focus on the individual parts of their mouths (lips, tongue, teeth, jaw) as they created the distinct consonant and vowel sounds in the English language.

Research Design

Action Research is designed to generate knowledge that leads to improved practice for educators and better outcomes for students. In an effort to bring struggling readers to grade level proficiency in reading, we used a mixed methods research design and collected both qualitative and quantitative data to measure the effectiveness of the intervention.

This action research study was designed to investigate both changes in phonological processing and functional changes in reading as a result of the intervention. It also investigated student self-concept and parent perceptions of student reading abilities. For this reason, it was appropriate to collect both standardized assessment data and qualitative survey data.

The 10 participants involved in the study ranged in age from 8 to 16 and were enrolled in the NOW! Foundations for Speech, Language, Reading and Spelling® program (NF), which is a multisensory intervention program that can be delivered online by a trained reading instructor. Students who participated in the intervention worked either from their homes or from a school setting; they received at least 5 but as many as 10 hours per week of one-on-one individualized instruction over a 6- to 12-week period. Some students had been formally diagnosed with dyslexia, but some simply acknowledged that reading and spelling were hard for them, and they were looking for ways to make it easier. The children participating in the program were enrolled by their parents or guardians. There was an hourly cost associated with the intervention, and scholarships were available to those with documented financial need.

Data Collection and Analysis

Students enrolled in NF were administered a battery of tests before the intervention began and again after 60 – 65 hours of treatment, which is approximately the midpoint of the intervention. These tests were designed to measure changes in phonological processing and in functional reading abilities as well as to measure student self-concept across a variety of domains. The

battery of tests included the Comprehensive Test of Phonological Processing - Second Edition (CTOPP-2), the Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV), and the Piers-Harris Self-Concept Scale, Third Edition (Piers-Harris 3).

According to Pearson Education, “the CTOPP-2 has four principal uses: (1) to identify individuals who are significantly below their peers in important phonological abilities, (2) to determine strengths and weaknesses among developed phonological processes, (3) to document individuals' progress in phonological processing as a consequence of special intervention programs, and (4) to serve as a measurement device in research studies investigating phonological processing.” (Pro-Ed, n.d) Focusing primarily on use # 3, the researcher collected data to determine a Phonological Awareness Composite Score (PACS) using the Elision, Blending Words, and Phoneme Isolation subtests and an Alternate Phonological Awareness Composite Score (APACS) using the Blending Nonwords and Segmenting Nonwords subtests.

The WIAT-IV was administered in order to collect data on each student’s reading accuracy, fluency, and comprehension using the Word Reading, Pseudoword Decoding, Reading Comprehension, and Oral Reading Fluency Subtests. Using the Q-Global scoring system, standard scores and percentiles were collected.

In order to answer Research Question #2, the Piers-HarrisTM 3 Self-Concept Scale was administered to all students enrolled in the study. The Piers-HarrisTM 3 Self-Concept Scale is a 58 question assessment that measures self-

concept along the following domains: Behavior Adjustment, Freedom from Anxiety, Happiness and Satisfaction, Intellectual and School Status, Physical Appearance and Attributes, and Social Acceptance. The researcher read all 58 questions aloud to the participants and recorded their yes or no answer. Nationally normed scores were generated with particular attention paid to the Total Self-Concept score and the Intellectual and School Status subtest score.

The researcher also administered a survey to parents of children enrolled in the program. The survey included both 5 point Likert scale questions and open-ended questions about parent perceptions of changes in reading attitudes and abilities over the course of the treatment. Open-ended questions indicated several clear themes, including student strengths, parental disappointment in previous remediation, academic manifestations of dyslexia, and other impacts that reading difficulties had on their children.

Researcher Positionality

As a lifelong educator, primarily at the elementary school level, I have always been fascinated by the teaching of emergent and struggling readers. The years I spent as a classroom teacher, as a reading interventionist, and as a private tutor have given me a wealth of experience with a variety of teaching methodologies as well as the many ways that reading difficulties manifest themselves. For most of that time, I focused on addressing the difficulties themselves: how could I help students sound out or decode words more accurately? What strategies could I put in place to improve fluency? How could students interact with text to make sure they were understanding what they were

reading? It was not until I began working at The Morris Center in Gainesville, Florida, that I began to understand the root causes of reading difficulties and how important it was to address those causes before looking at the individual components of the reading process.

The Morris Center (TMC) is a transdisciplinary clinic with over 30 years of experience treating children and adults with language-based learning disorders such as dyslexia. Founded by pediatrician Dr. Ann Alexander, the clinic is now owned and run by neuropsychologist Dr. Tim Conway. The clinic uses a team of speech-language pathologists, occupational therapists, nurses, psychologists, and reading instructors to identify weaknesses in students' phonemic awareness and phonological processing skills and develop individualized treatment plans to address those weaknesses. I worked as a reading instructor at The Morris Center in Gainesville, Florida, for two years beginning in July 2008.

In May 2020, I joined the staff of the NOW!® Company as a reading instructor working on-line one-on-one with students all over the country. The NOW!® Company is an online company developed by Dr. Conway in 2013 which uses the same methodology to remediate phonological processing deficits (NF) that is used at TMC. Students who participate in NOW!® Company programs do not have access to the transdisciplinary team of occupational therapists, speech-language pathologists, and psychologists that the students at The Morris Center do; the NOW!® Company is designed to be more affordable, more accessible, and less intensive than TMC. In addition to my instructional work with students who have dyslexia, I am a member of the Quality Control team; in this capacity, I

oversee and provide support to a group of online instructors to make sure they are delivering our interventions with fidelity.

As the researcher, my responsibilities were two-fold: I administered all assessments both prior to treatment and at the approximate midpoint of the intervention, and I supervised the delivery of instruction for some, but not all, of the students who participated in the study. I did not serve as an instructor for any of the students who participated in the study.

My position as an employee of the NOW!® Company creates a level of bias within this research. As a member of the NOW!® Company team, I want the intervention being studied to work; I have a vested interest in being able to say that students' reading abilities will improve because of their participation in our programs.

Significance and Limitations of Study

Research has been done about the efficacy of NF and its predecessors, including Auditory Discrimination in Depth and the Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech (Torgesen et al., 2001). This study adds to the body of literature already in existence by focusing particularly on the online delivery of instruction, rather than in person instruction. The efficacy of the intervention being studied creates possibilities for parents looking to remediate their children's reading deficits but who don't have access to qualified instructors in their area.

The reading intervention offered by the NOW!® Company is expensive and lengthy. The standard cost of treatment is $75 per hour, and students

average 120 – 140 hours of intervention. Although there is a sliding fee scale and scholarships are available for students with documented financial need, this intervention still poses a significant financial investment for families. Parents also must provide a working computer, noise-cancelling headphones with a microphone, and a willingness to commit to at least an hour a day every day during the week, which is not insignificant when students also attend school. Parents who are hesitant to commit to the intervention may appreciate having data showing what kinds of improvements they might expect in their child's reading abilities.

As most students who participate in NF have approximately 120 hours of instructional time, the time frame of this research project did not allow for testing to be done at the conclusion of treatment. The data collection period was only 8 – 12 weeks long, so participating students had not completed the entire program by the time post testing was done. In order to allow for that, testing was completed before the students began treatment and again after only 60 - 65 hours of treatment. Consequently, we do not have an accurate picture of the degree to which reading accuracy, fluency, and comprehension will change as a result of the intervention. Students should be assessed again when they have completed NF to fully understand the impact of the intervention on reading skills.

Organization of the Dissertation

Chapter Two of the dissertation provides the theoretical framework upon which the study was based. Research relevant to the study, including Phonological Processing Deficit Theory and Multisensory Language Instruction,

is explored. Research related to the efficacy of NF and its predecessors, Auditory Discrimination in Depth and the Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech, are also examined.

Chapter Three describes the participants as well as the Research Design and Methods for the study. An explanation of the standardized tests being administered is provided, as are the interview questions that were answered by the parents of the enrolled students. The data analysis measures are included in this chapter as well.

Chapter Four provides the general findings of the study, while Chapter Five includes a summary of the research findings as well as recommendations for further investigations.

List of Definitions

Dyslexia: a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge (International Dyslexia Association, 2002).

Phonological Processing: the use of sounds (phonemes) to process spoken and written language.

Phonological Awareness: the awareness of the sound structure of a language and the ability to consciously analyze and manipulate this structure via a range of tasks, such as speech sound segmentation and blending at the word, onset-rime, syllable, and phonemic levels. Phonological awareness is the umbrella term; phonemic awareness applies when the units being manipulated are phonemes, rather than words, onset-rime segments, or syllables (American Speech-Language-Hearing Association).

Accuracy: the percentage of words in a text read correctly. This percentage is determined by dividing the number of words read correctly by the number of words read in total.

Fluency: a number calculated by determining the number of words read correctly in one minute.

Comprehension: a measure of how well students understand text that they read. Comprehension can be measured at the word, the sentence, and the passage level.

CHAPTER TWO: REVIEW OF THE LITERATURE

The development of proficient reading is one of the most important aspects of formal education. Beginning in kindergarten, children are taught the foundational principles of good reading, including phonemic awareness, phonics, fluency, vocabulary, and comprehension. It is widely acknowledged that for the first three years of school children “learn to read” so that for the remainder of their school experience and their lives they can “read to learn.” Once students enter the later elementary school years, much of the content being taught is delivered through text-based reading. Those for whom reading is difficult have a hard time accessing this content.

According to the National Center for Education Statistics, only 35% of fourth graders who were tested in 2019 scored “at or above proficiency” in reading (NAEP, 2020). Explanations for these poor results are numerous. Some children struggle to read because of vision, hearing, or language problems. Some lack exposure to print and oral language at an early age and come to school without the foundational skills necessary to read well. Some have weak cognitive abilities overall, and some, for a variety of reasons, do not have access to quality educational experiences.

Within the population of poor readers nationwide exists a subset of readers who are dyslexic. Dyslexia is loosely translated to mean “trouble with words,” and depending on the measures being used for identification,

researchers estimate that between 5% and 18% of school aged children in this country have dyslexia (Shaywitz, 1998). According to the International Dyslexia Association, “dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities.” (Lyon et al., 2003, p. 2).

This dissertation addresses the problem that a significant population of school aged children are unable to read proficiently despite adequate intellectual capabilities and effective classroom instruction. It investigates whether a treatment methodology that has been shown to be effective when delivered in person is as effective when delivered online.

Research Questions

This mixed-methods action research design asked the following questions:

1. What effect, if any, does the online remediation of phonological processing deficits have on reading accuracy, fluency, and comprehension?
2. What effect, if any, does this online treatment have on student self-concept?
3. What effect, if any, does this online treatment have on parents’ perceptions of their children’s reading abilities?

Purpose of the Study

The online intervention being assessed is Neuro-development of Words - NOW!® Company’s NOW! Foundations for Speech, Language, Reading and Spelling® program (NF). Designed to help students who struggle with reading

and spelling, NF is a one-on-one intervention that can be delivered on-line by instructors who have been trained in this methodology. NF is a multisensory approach to teaching reading in that it incorporates the oral motor awareness of individual sounds.

Students with phonological processing problems have difficulty perceiving the individual sounds in words, so NF teaches them to feel the sounds, rather than hearing them. Students discover articulatory movements - how their lips, tongue, teeth, and jaw move - as they make the individual vowel and consonant sounds in the English language. Once students are confident in what each sound looks, sounds, and feels like, they learn to put the sounds together to make words and to break words apart into their individual sounds. Phonological Processing is practiced through a series of discrete tasks including identifying the similarities and differences between two words, reading and spelling words that range from simple to complex to multisyllabic, discovering basic expectancies about the English language, and generalizing this new knowledge to reading and writing connected text (NOW! Programs, n.d.).

NF treatment is delivered five days a week for 45 minutes at a time and, when possible, the student sees the same instructor every day. The average length of treatment is 120 hours. Although the program follows a well-defined scope and sequence, sessions are tailored to meet the individual needs of each student and to address their specific weaknesses or deficits.

Effects of Reading Difficulties Long Term

The long-term effects of reading difficulties are well-known. Research indicates that students with dyslexia have increased anxiety about school (Jordan et al., 2014), are more likely to drop out of school (Bruck, 1987), and are less likely to go to college (Horn & Bobbitt, 1999) than those who do not have dyslexia. Those who struggle to learn how to read in school are more likely than their peers to repeat a grade or to drop out of school before graduation (National Center for Educational Statistics, 2020). Lack of a high school diploma can lead to lower paying jobs as well as higher incidences of unemployment, homelessness, mental health issues, and drug use (Macdonald et al., 2016). Studies also show that incarcerated males have significantly lower reading abilities that non-incarcerated males (Shippen et al., 2010).

Since the enaction of the No Child Left Behind Act and the Every Student Succeeds Act, school districts across the nation have focused their attention on best practices for teaching students to read. No Child Left Behind (NCLB) was signed into law in 2002 by President George W. Bush, and its successor, Every Student Succeeds Act (ESSA) became law in 2015 under President Barack Obama. Both pieces of legislation were designed to ensure that all students, particularly People of Color and those in low-performing schools, have “a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments” (U. S. Department of Education, 2015). This legislation includes an accountability component requiring all schools to report

their test data; these data help identify the lowest performing schools in the nation which are designated as schools “in need of improvement” (Association for Supervision and Curriculum Development, 2020).

The National Reading Panel provided guidance as to the foundational components of reading and what schools need to focus on and provide for students to become proficient readers (National Institute for Literacy, 2006). Teacher education programs focus on these elements of reading, and professional development courses provide opportunities for classroom teachers to hone their skills as reading teachers.

Despite the awareness and implementation of best practices for teaching reading, however, there remains a subset of children for whom reading is difficult (International Dyslexia Association, 2020). When students who received good classroom instruction are still not successful, parents look for additional support outside the school system. With a huge number of options available to parents, at various price points and levels of convenience, it is important to determine whether a particular treatment is effective. During the unprecedented global pandemic which began in 2020, face to face instruction both in the classroom and in intervention settings became rare, requiring students needing extra support to utilize remote learning options and the online delivery of instruction. This study attempts to determine what impact an online remediation of phonological processing deficits has on reading accuracy, fluency, and comprehension.

Purpose of the Literature Review

Machi and McEvoy (2016) define a literature review as “a written document that presents a logically argued case founded on a comprehensive understanding of the current state of knowledge about a topic of study” (p. 5). According to Merriam and Tisdell, “a familiarity with previous research and theory in the area of study is necessary for situating your study in the knowledge base of the field” (p. 95). In order to know what I want to study, I must needed to understand what has already been studied and what remains to be learned.

This review is based on information curated from several sources. Education Source and ERIC provided scholarly sources cited; combinations of the keywords dyslexia, phonological processing, reading disorders, cognitive neuroscience, and intervention led to much of the literature. The websites of Neuro-development of Words - NOW!® Company, the International Dyslexia Association, the U.S. Department of Education, and the National Institute for Literacy also provided information used in this review.

This literature review is intended to provide an understanding of dyslexia both from an historical perspective and in terms of current thoughts, definitions, and interventions. It also provides an explanation of the theoretical framework which underpins this study.

Historical Perspective

Although dyslexia is widely discussed and studied today, doctors and psychologists began studying it over a hundred years ago. Initially it was termed “word blindness,” not because those who suffered from it had any visual

impairments, but because they were not able to remember the visual images made by words and were therefore not able to make sense of print (Mather & Wendling, 2011). The term “congenital word blindness” was used for people who were never able to learn to read, while “acquired word blindness” was reserved for those who had been able to read but who had suffered some sort of trauma that made reading impossible for them (Schmitt, 1918).

In the early 1900s, medical professionals believed that word blindness was rooted in deficits in the visual processing areas of the brain (Mather & Wendling, 2011). Dr. Samuel Orton, a psychiatrist who practiced in the early 1900s, used the term strephosymbolia, or “twisted symbols” to describe the fact that students with word blindness often reversed letters as they wrote or disregarded the sequence of letters as they were reading (Orton, 1925). Orton attributed this characteristic to the theory that students had a lack of cerebral dominance in the left hemisphere. Essentially, he speculated that the images recorded in the dominant left hemisphere of the brain (e.g., on) were stored as mirror images in the nondominant right hemisphere (e.g., no). For individuals with dominant left hemispheres, this mirror image would be suppressed, but for children with mixed dominance, the image would not be suppressed and would, therefore, contribute to the reversals of letters and transpositions of words (e.g., was for saw) (Mather & Wendling, 2011). Although we know today that Orton’s theory of mixed cerebral dominance is not correct, many people still believe that students with dyslexia see letters and words backwards.

What is Dyslexia?

> According to the International Dyslexia Association,
>
> dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge. (Lyon et al., 2003, p. 2)

There are several very common characteristics in students with dyslexia. At an early age, dyslexic children may have difficulty rhyming and learning the names and sounds of letters of the alphabet. They often confuse words that look or sound like each other. They have difficulty sounding out unfamiliar words, and many have a hard time quickly recalling sight words like the, and, and of. Spelling difficulties are very common in children with dyslexia, and many read so slowly and disfluently that it impacts their comprehension. Still others, perhaps because of a dearth of reading experience, are unfamiliar with vocabulary words they encounter. Dyslexia is not related to overall intelligence, but students are often initially identified as having the disorder because their reading achievement does not match their observed abilities (Lyon et al., 2003; Mather & Wendling, 2011; Proctor et al., 2019).

Current treatments for Dyslexia

Although Dr. Orton's theory that dyslexic students see letters and words backwards was ultimately proven incorrect, we still credit him with developing a treatment for dyslexia that is widely used today. Dr. Orton believed that students with reading difficulties would benefit from a structured, systematic curriculum that explicitly taught the foundational pieces of the English language, including letters, sounds, and how sounds combine to form words. He said ". . .the logical training for these children would be that of extremely thorough repetitive drill on the fundamentals of phonic association with letter forms, both visually presented and produced in writing. . ." (Orton, 1925, p. 614). Additionally, Orton and his associate Anna Gillingham developed a multisensory approach to teaching, believing that students who had the opportunity to trace and write letters as they learned them were more likely to be successful. This visual-auditory-kinesthetic-tactile (VAKT) approach is widely accepted to be best practice for teaching struggling readers (Fallon & Katz, 2020; Royal, 2018; Schlesinger & Gray, 2017).

According to The International Multisensory Structured Language Education Council website (n.d.), the term Multisensory Structured Language Education "was adopted by the original International Dyslexia Association (IDA) committee as a generic designation of the shared characteristics of well-known Orton-Gillingham-based approaches to teaching reading and language skills." Birsh (2018) describes MSLI as "a deliberate and systematic incorporation of multimodal opportunities to hear, see, say, and move, while following a carefully

organized and sequenced approach to language structure" (p. 15). McIntyre and Pickering (1995) delineate these characteristics of MSLI:

- It is multisensory, meaning that students use at least two senses at the same time as they learn.
- It is systematic and cumulative, meaning that the curriculum starts with the most foundational aspects of reading and spelling and then builds upon what has already been learned.
- It is explicit, meaning that students are taught through direct instruction.
- It is individualized, meaning that teachers are continually assessing their students and making instructional decisions based on the learning that the students have already demonstrated.
- It is both analytic and synthetic, meaning that students are taught to put parts of language together to make a whole as well as to break down larger pieces of language into its constituent parts.

The Kinesthetic/Tactile component of Multisensory Structured Language Instruction generally refers to the use of fine and gross motor movements when forming letters. Children often write the letters as they say them, trace them with their fingers on sandpaper, "sky write" using their entire arm as a pencil, trace the letters in shaving cream or salt, or create letters out of clay or pipe cleaners (Cox, 2019).

The online intervention that is the subject of this research approaches the kinesthetic/tactile component of multisensory instruction from a different angle. Rather than focusing on hand and arm movements, NF focuses on oral motor

awareness. Students are taught the articulatory movements associated with each sound in English; they learn to feel and describe what their lips, tongue, teeth, and jaw are doing as they make sounds, and they also learn to identify voiced versus unvoiced sounds (NOW! Programs, 2020).

Although it is widely considered to be best practice, there is very little research about Multisensory Structured Language Instruction. The International Dyslexia Association states that “There is no substantial body of scientific research supporting the efficacy of the multisensory component in structured language reading instruction” (International Dyslexia Association, 2009, p. 2). Through the investigation of NF, this study is designed to investigate a potential connection between an alternate definition of multisensory (articulatory mouth movements, rather than fine or gross motor movements) and changes in reading accuracy, fluency, or comprehension.

A Cognitive Neuroscience Understanding of Dyslexia

Although dyslexia has been studied by scientists, psychologists, and medical doctors for over a hundred years, recent advances in science have contributed greatly to our understanding of reading disorders. The field of Cognitive Neuroscience provides critical information about the neurological basis of dyslexia.

According to www.Merriam-Webster.com, cognitive neuroscience is “a branch of neuroscience concerned with the biological processes of the nervous system which form the basis of cognitive functioning.” It focuses on the relationship between brain structure, activity, and cognitive performance and has

the goal of determining how the brain works and how it performs. Cognitive neuroscience combines biological sciences with behavioral sciences and is therefore considered to be a branch of both. According to Alfredo Pereira Jr (2007), “Cognitive neuroscience is an interdisciplinary area of research that combines measurement of brain activity (mostly by means of neuroimaging) with a simultaneous performance of cognitive tasks by human subjects.” (p.158).

Cognitive neuroscience has helped us to understand that the cognitive processes that contribute to reading primarily take place in the left hemisphere of the brain (D'Mello & Gabrieli, 2018; Shaywitz & Shaywitz, 2004). There are three regions of the brain that seem particularly significant in the development of reading: the inferior-frontal cortex, the parieto-temporal region, and the occipito-temporal region. Although these regions are certainly interconnected, each seems to play a different role in the development of fluent, accurate reading.

The inferior-frontal cortex is near the front of the brain and seems to be heavily involved with articulation and word analysis, in addition to verbal working memory. (Fiez & Petersen, 1998; Poldrack et al., 1999; Price, 2012). In typically developing readers, this area is used primarily to decode unfamiliar words. It seems to be used less and less as children grow older and as their phonological processing improves. The parieto-temporal region and the occipito-temporal region are found toward the back of the brain. The parieto-temporal region is involved with word analysis, while the occipito-temporal region is often called the Visual Word Form Area and is connected to rapid naming and fluent reading (D'Mello & Gabrieli, 2018). Typically developing readers use these areas when

they are reading words they have seen frequently and when they encounter sight words.

Scientists have used functional Magnetic Resonance Imaging (or fMRI) to study brain activation patterns in both typically developing readers and struggling readers. During fMRI, which is non-invasive and can be done frequently, a BOLD signal is captured. BOLD stands for Blood Oxygen Level Dependent signal and is used to measure the amount of blood use in the brain during specific cognitive tasks. The amount of blood oxygen measured is thought to represent the amount of activity happening in nearby brain cells while the task is being attempted and accomplished (Arthurs & Boniface, 2002).

fMRI data indicate that struggling readers develop compensatory neural pathways as they read, including in the front sections and even in the right hemispheres of their brains, which contributes to the fact that reading is often more effortful and less fluent for dyslexic readers than for typically developing readers. There are “differences in structure and function in the same neural circuits” (D'Mello & Gabrieli, 2018, p. 801) which are not as efficient as the circuits in non-dyslexic brains.

The work of cognitive neuroscience has helped us develop a clear understanding of the neural pathways in the brain and how these pathways (and lack thereof) can contribute to fluent or disfluent reading. This understanding has influenced the development of reading intervention programs, which often focus on improving decoding skills and increasing visual memory for sight words.

Theoretical Framework

The theory underpinning this research is the Phonological Processing Deficit Theory, which was introduced by Dr. Isabelle Liberman in the early 1970s. According to this theory, children with dyslexia have difficulty with the perception, representation, retrieval, and manipulation of sounds associated with speech. When the graphemes (letters) and phonemes (sounds) that are associated with speech are poorly represented, associated, or retrieved, learning to read becomes very difficult (Liberman & Shankweiler, 1985).

The National Reading Panel (2000) offers the following important definitions:

- **Phonological Processing** refers to the automatic use of the individual sounds in words to process and understand written and spoken language.
- **Phonological Awareness** refers to the awareness of the sound structure of spoken words and the ability to manipulate the sounds in tasks such as rhyming, syllabication, identifying onset and rime, blending sounds, and deleting sounds from words.
- **Phonemic Awareness** is the subset of phonological awareness that deals with the smallest units of sound (phonemes) in a word, rather than syllables or groups of sounds.

Reading difficulties are understood to be based on deficits in the language structures of the brain (Shaywitz & Shaywitz, 2004). Spoken language begins to develop very early in a child's life, well before formal reading instruction. Under most circumstances, oral language develops naturally and instinctively, but reading only begins when children can make the connection between oral

language and the words written on the page. If readers are unable to correlate the letters on the page to sounds that make up spoken words, discovering how to put the letters together to read becomes very difficult (Shaywitz, 2003).

The first step in this process of understanding the phonetic code begins with oral language: children must understand that spoken words are made up of individual sounds, and that individual sounds can be put together to make words. This is phonemic awareness (Liberman & Shankweiler, 1985). It is now widely understood that children with dyslexia have phonological processing deficits that contribute to their reading difficulties (Christo & Davis, 2008; Liberman & Shankweiler, 1985; Marshall et al., 2013; Vellutino, 1987). Although these deficits can present themselves in several ways, most commonly, children have a difficult time understanding that words are made up of parts such as syllables, phonemes, and morphemes (Liberman & Shankweiler, 1985).

Vellutino (1987) discusses the fact that students with dyslexia have difficulty storing and retrieving the names of printed words. They have “limited facility in using language to code other types of information” (p. 34) meaning that they look at letters and words printed on a page and have no meaning or sound associated with them. Beginning readers attack words in two different ways: they rely on visual memory and read the whole word at once, and they use sound-symbol associations to decode words. Relying on one of these methods at the expense of the other can contribute to difficulties with reading. Students who can only analyze words sound by sound do not read fluently, while those who rely on

visual memory are more likely to confuse words like was and saw, house and horse.

There are several ways to assess phonological processing. Students are often asked to blend a series of sounds together to make words, both real and nonsense. As this is a relatively simple task which is very often taught in schools, blending is perhaps not the most accurate way to determine phonological processing deficits (Marshall et al., 2013). Another aspect of phonological processing is elision, or removing specific sounds from words. Students are given a word orally and asked to remove the initial sounds, the medial and/or final consonants, or a phoneme within a cluster of sounds. This is a more difficult task and more linguistically complex than blending, so Marshall et al. believe it to be a better predictor of reading difficulties than the ability to put sounds together to make words.

Another aspect of phonological processing is rapid naming, or the ability to recall the names of letters, shapes, colors, and pictures of common objects quickly and easily. Wolf et al. (2000) refer to the “double deficit” model of dyslexia, meaning that some students have both phonological processing problems and difficulties retrieving word names quickly. These students are likely to struggle both with decoding and with fluent reading.

NF explicitly and systematically addresses deficits in phonological processing by teaching students to perceive and manipulate the individual sounds in words. Beginning with single phonemes, students are taught the oral motor movements that are associated with each vowel and consonant sound.

Using mouth pictures that represent these movements, students practice putting sounds together to make words and breaking words apart into their constituent sounds. The length and complexity of the words being manipulated increases as students demonstrate mastery.

Related Research

Significant research has been done about the effects of the remediation of phonological processing deficits on reading accuracy, fluency, or comprehension, but few studies have examined all three of these components at the same time. The research that has been conducted focuses exclusively on the in-person delivery of instruction, and to date, no attention has been paid to online or remote learning options for remediating phonological processing deficits.

A review by Torgesen in 2000 looked at five treatment methodologies used to improve word reading skills in elementary school students. The author examined the results of these interventions and the characteristics of the 2% - 6% of students who did not respond well to the treatments. He discovered that explicit, systematic, direct instruction in phonological processing tasks (phonemic awareness and decoding skills) produced gains in word level reading in many students who were identified as being at risk of reading failure. A small percentage of students (2% - 6%) did not improve significantly in their word reading skills despite intervention. “We have not yet discovered the conditions that need to be in place for children with the most serious disabilities to acquire adequate word-level reading skills in early elementary school, although we clearly know how to reduce sharply the number of children who leave first and

second grades with weak skills in this area." (p. 62). One of the interventions that Torgesen studied was the precursor to NF; changes have been made to the protocol that may have an impact on the treatment resisters.

A year later, Torgesen et al. (2001) attempted to determine whether one of two instructional approaches could close the reading achievement gap in students with severe reading disabilities. (One of the interventions investigated was the approach that eventually became NF). A total of 60 students between the ages of 8 and 10 who had been labeled learning disabled received a total of 67.5 hours of intervention focused either on phonemic awareness activities at the word level or phonemic awareness activities at the connected text level. Students received 2 50-minute treatment sessions each school day in a one-on-one tutoring session led by a trained educator. Students in both groups made large gains in reading accuracy and were able to maintain those gains two years after the completion of the intervention. About 40% of the students were able to move back to the general education classroom out of the special education classroom. There were no significant differences in the results of the two approaches despite very different instructional methods. This study did not investigate reading comprehension apart from phonemic awareness and decoding.

Schlesinger and Gray (2017) tried to determine if the use of a multisensory approach (visual, auditory, kinesthetic) has a significantly different impact on letter name and sound production, word reading, and word spelling for non-impaired and impaired 2nd grade readers than a structured literacy approach that does not incorporate at least two modalities. Specifically, they

investigated “whether simultaneous multisensory input, in addition to structured language instruction, would promote better letter name, letter sound production, word decoding, and encoding in young children with typical development and dyslexia than structured language instruction alone” (p. 222). According to the authors, “Participants were taught two created alphabets using non-English grapheme names and their associated English phonemes (sounds.)” (p. 226). Students were taught using a structured literacy approach or a multisensory approach and were expected to learn the letter names, the letter sounds, and how to read and spell words using the created alphabet letters. The multisensory approach was not more effective than the structured literacy approach for neuro-typical or dyslexic readers. Both approaches yielded positive results, although the study was very small (only 12 total participants) and the interventions themselves were limited (one to three sessions per week over 6 – 7 weeks.) NF is also multisensory, but rather than a kinesthetic approach focused on gross and fine motor movements, the sensory modality used in NF is oral motor movements. This is an entirely different aspect of multisensory teaching than what is usually expected; it will be important to understand if some multisensory approaches to teaching might be more effective than others.

For her dissertation, Royal (2018) conducted a study to determine if a multisensory, structured literacy intervention (Alphabetic Phonics) had any impact on the reading comprehension scores of students with dyslexia as measured by the STAAR (State of Texas Assessments of Academic Readiness). Participants in the study were elementary school students (grades 1 – 5) in a

public charter school in Texas. The students had been identified as dyslexic and participated in the intervention for one, two, or three years. Students participated in “Language Science” class in addition to their general education language arts curriculum; each class met for 45-50 minutes per day, 5 days per week, in groups of no more than 6 students. The curriculum used in the Language Science classes was Alphabetic Phonics, which is an Orton-Gillingham based multisensory program. Although the author expected that improvements in decoding at the word level would improve reading comprehension, the data did not support this expectation. The study was conducted in only one elementary school, however, with a limited number of participants (30). The demographic make-up of the participants was not reflective of the general population of students with dyslexia, so the results might not be transferable. This study is significant in that it specifically addresses changes to reading comprehension scores after the completion of a multisensory intervention. Again, the NF program defines multisensory differently than other interventions do, in that it focuses on oral motor awareness rather than fine and gross motor movements, so this study will help answer the question about different types of multisensory approaches having different impacts on reading comprehension.

Ring et al. (2017) compared the efficacy of Alphabetic Phonics and the Dyslexia Training Program, an Orton-Gillingham based approach to small group reading intervention for dyslexic students, to Take Flight, which in addition to teaching phonics and vocabulary, also focuses on phonological awareness, reading fluency, and reading comprehension. The authors are attempting to add

to the research on Orton-Gillingham based programs. Participants in the study were part of a hospital-based learning disabilities program. Most were in 3rd through 5th grades. The authors compared an historical control sample of 37 students who only received the Dyslexia Training Program to 87 patients who also received the Take Flight curriculum which had the added components addressing reading fluency and reading comprehension. The intervention was implemented in small groups of 2 to 6 students in a 60 minute or 90-minute session 5 days per week. The intervention lasted 2 years for a total of 280 treatment hours. The study did not find significant differences in reading fluency rates between the two groups, but there were statistically significant differences in comprehension. Comparing this treatment approach to the intervention used by the NOW!® Company will provide another data point about the efficacy of this multisensory approach compared to others.

The research indicates that some types of multisensory language instruction interventions have a positive effect on word reading, but no research has been done examining the effect on reading comprehension. Studies that have focused on reading comprehension have used a multisensory approach that is different than the one being investigated in this study. This study will contribute to the body of research already in existence by examining reading accuracy, fluency, and comprehension using a multisensory approach that focuses on articulatory mouth movements and which is delivered exclusively online.

Summary

A great deal has been learned about dyslexia over the past century. We now know that it is a neurobiological issue due to atypical neural connections and functionality of the language areas of the brain. Students with dyslexia demonstrate deficits in phonological processing, including the inability to perceive and manipulate the sounds in words and the ability to rapidly retrieve language. Although there is a great deal of anecdotal evidence about the value of multisensory structured language programs on the treatment of dyslexia, there is little empirical data to support those claims. Additionally, the multisensory aspects being examined do not often include the oral motor component of language production.

This study is an attempt to combine what we know about cognitive neuroscience and phonological processing deficits and multisensory language instruction to determine the efficacy of the online delivery of NF.

CHAPTER THREE: RESEARCH DESIGN AND METHODS

The term “dyslexia” comes from the Greek words “dys,” meaning trouble or difficulty, and “lexia,” meaning words or language. The basic definition of the word dyslexia, therefore, is “trouble with words.” Dyslexia manifests itself in many ways, including slow and inaccurate word reading, poor spelling, and difficulty with comprehension (U.S. Dept of Health and Human Services, 2000; Wolf et al., 2000; Lefly & Pennington, 1991; Shaywitz, 2003). Depending on the method of identification, the prevalence of dyslexia in the United States is anywhere from 5% to 18% of the population (Shaywitz, 1998). There are many potential causes of poor reading, including vision and hearing impairments, cognitive weaknesses, and lack of appropriate instruction and/or reading materials; true dyslexia, however, is neurobiological in origin and can exist even in the absence of these potential causes (Lyon et al., 2003).

The treatments for dyslexia are extensive and varied. Tutoring programs, vision therapies, technology-based solutions, and school sponsored treatments all offer hope to parents who are struggling to get help for their children. Navigating the potential treatments can be overwhelming to parents, particularly when cost is a factor and when in person options are limited. Because the root cause of dyslexia is a deficit in phonological processing, or the ability to distinguish and manipulate the individual sounds in words (Wagner & Torgesen, 1987), this research investigates a treatment that specifically remediates this

deficit. The purpose of this study is to determine the impact that an online remediation of phonological processing deficits has on reading accuracy, fluency, and comprehension. A secondary purpose is to determine student self-concept and parents' perceptions of their children's reading abilities based on participation in an online treatment.

Research Design and Research Questions

The intervention being assessed is the Neuro-development of Words - NOW!® Company's NOW! Foundations for Speech, Language, Reading and Spelling® program (NF). Designed to help students who struggle with reading and spelling, NF is a one-on-one intervention that can be delivered on-line by instructors who are trained in this methodology. NF is a multisensory approach to teaching reading in that it incorporates an awareness of the oral motor movements associated with individual sounds. Students with phonological processing problems have difficulty perceiving the sounds in words, so they are taught to feel the sounds instead. Students discover how their lips, tongue, teeth, and jaw move as they make the consonant and vowel sounds in the English language. Once students are confident in what each individual sound looks, sounds, and feels like, they learn to put the sounds together to make words and to break words apart into their individual sounds. Phonological processing is practiced through a series of discrete tasks including identifying the differences between two similar words, reading and spelling words ranging from simple to complex to multisyllabic, discovering basic expectancies about the English

language, and generalizing this new knowledge to reading and writing connected text.

NF is delivered 5 days a week for 45 minutes at a time and, when possible, the student sees the same instructor every day. The average length of treatment is 120 hours. Although the program follows a well-defined scope and sequence, sessions are tailored to meet the individual needs of each student and to address their specific weaknesses or deficits.

This mixed-methods action research design asked the following questions:

1. What effect, if any, does the online remediation of phonological processing deficits have on reading accuracy, fluency, and comprehension?
2. What effect, if any, does this online treatment have on student self-concept?
3. What effect, if any, does this online treatment have on parents' perceptions of their children's reading abilities?

To address Research Question #1, the researcher administered four subtests of the Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV). The WIAT-IV is designed to be administered individually and is an instrument which measures the academic achievement of examinees ages 4 through 50 by evaluating listening, speaking, reading, writing, and mathematics skills. The Word Reading, Pseudoword Decoding, Oral Reading Fluency, and Reading Comprehension subtests were administered both before treatment and after 60 – 65 hours of intervention to obtain both standard scores and percentile ranks.

The Comprehensive Test of Phonological Processing - Second Edition (CTOPP-2) was also administered both before participation in the NF and again after 60 - 65 hours of intervention. This assessment determined a Phonological Awareness Composite Score (PACS) using the Elision, Blending Words, and Phoneme Isolation subtests and an Alternate Phonological Awareness Composite Score (APACS) using the Blending Nonwords and Segmenting Nonwords subtests. Standard scores and percentile ranks were obtained.

In order to answer Research Question #2, the Piers-HarrisTM 3 Self-Concept Scale was administered to all students enrolled in the study. The Piers-HarrisTM 3 Self-Concept Scale is a 58 question assessment that measures self-concept along the following domains: Behavior Adjustment, Freedom from Anxiety, Happiness and Satisfaction, Intellectual and School Status, Physical Appearance and Attributes, and Social Acceptance. The researcher read all 58 questions to the participants and recorded their yes or no answers.

According to Merriam & Tisdell (2015), the purpose of qualitative research is “to understand how people make sense of their lives and their experiences” (p. 24). To address Research Question #3, the researcher administered a survey to the parents of students enrolled in the program to gather information about parent perceptions of their child’s reading ability. Data acquired from the surveys was added to the information gained during the quantitative assessments.

Participants

Participants in this study included male and female students ranging in age from 8 to 16 who were enrolled in the NOW! Company’s online program.

Maximum variation sampling was utilized to determine if there are students for whom this treatment is more effective than for other students. According to Patton (2015), “Any common patterns that emerge from great variation are of particular interest and value in capturing the core experiences and central, shared dimensions of a setting or phenomenon” (as quoted by Merriam & Tisdell, 2016, p. 98). As the purpose of this study was to determine the efficacy of the online treatment being offered, maximum variation provided the researcher with information to determine whether some students respond more positively to treatment than others.

Participants in this study had been identified as having difficulty with reading and/or spelling. Some had an official diagnosis of dyslexia, while some had not been diagnosed but had been identified by teachers or parents as needing intervention to improve their reading skills. At any given time, there are approximately 150 students participating in NF instruction. Over the past 9 years, more than 500 students have been treated by dozens of different instructors. At the time that research participants were chosen, every effort was made to ensure an equal mix of ages, sexes, locations, and reading levels at onset of treatment.

Students participating in this research have chosen (or their parents have chosen) to seek remediation for their reading problems. They have the financial means to pay for treatment and can dedicate both time and technology (computer, internet connection, headphones with microphone) to participate in the NF program. Although a sliding fee scale is offered for all families, it was a

limitation of this study that families who are not financially able to afford the treatment could not participate.

Data Collection Methods

To answer Research Question #1, the researcher administered subtests of the Comprehensive Test of Phonological Processing - Second Edition (CTOPP-2) and the Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV).

The CTOPP - 2 provided both a Phonological Awareness Composite Score (PACS) and an Alternate Phonological Awareness Composite Score (APACS). Subtests comprising the PACS include Elision (the ability to remove phonological segments from spoken words to form other words), Blending Words (the ability to synthesize sounds to form words), and Phoneme Isolation (the ability to isolate individual sounds within words). The APACS consists of Blending Nonwords and Segmenting Nonwords subtests.

Subtests included in the WIAT-IV are Word Reading, Pseudoword Decoding, Oral Reading Fluency, and Reading Comprehension. The Word Reading subtest is designed to measure letter and sound knowledge and single word reading. Students were asked to read lists of regular and irregular words out loud. The Pseudoword Decoding subtest is designed to measure decoding skills. Students were asked to read a list of nonsense words out loud. Both subtests were untimed. The Oral Reading Fluency subtest is designed to measure the number of words a student reads accurately in a given time period. Students read two passages aloud, and both the number of words read correctly

and the amount of time needed to read the passages were calculated. The Reading Comprehension subtest measures comprehension skills at the word, sentence, and passage level. Students were asked to read narrative and expository passages either silently or out loud and then to answer literal and inferential questions about those passages. This subtest is untimed, and students were able to refer to the passages when answering the questions.

To shed light on the experience of dyslexia, quantitative and qualitative data were collected to answer Research Questions #2 and #3. The Piers-HarrisTM 3 Self-Concept Scale was administered orally to all students enrolled in the research study. The 58 yes/no questions were read aloud to students and their responses were recorded. Standard scores for total self-concept as well as scores for Intellectual and School Status subtest were collected.

Parents of students enrolled in the program were given the opportunity to complete a two-part survey. In the first section, Likert scale questions provided parents with extreme poles, intermediate options, and a neutral choice regarding their perceptions of their child's reading abilities. The second section gave parents the opportunity to answer open-ended questions about their child's reading. Survey questions are listed below:

Likert Scale Survey Questions (responses range from strongly agree to strongly disagree):

1. My child can read unfamiliar words
2. My child can read fluently
3. My child understands what s/he reads

4. My child enjoys reading

5. My child avoids reading

6. My child is confident in his/her reading ability

Open-ended questions included the following:

1. Why did you enroll your child in the NOW! Foundations program?

2. What strengths does your child have in terms of his/her reading ability?

3. What areas of your child's reading are you concerned about?

Data Analysis Methods

Descriptive statistics were used to analyze and summarize the data collected using the CTOPP-2 and the WIAT-IV. Standardized scores and percentile rankings were collected both before treatment began and after 60 – 65 hours of participation in the program, which is approximately the midpoint of treatment for most students. Since the students participating in the study were heterogeneous in terms of age, grade, and level of reading ability, the data analysis looked at growth over time in students' phonological processing skills as well as their reading accuracy, fluency, and comprehension. Due to small sample sizes, high between subject variance, and likely non-normal distributions, no statistical tests were run. Effect sizes (Cohen's d) for each variable were calculated using the following formula: ES = Mean(post) – Mean(pre)/Standard Deviation(pre). Descriptive statistics were used to analyze and summarize the data collected using the Piers-HarrisTM 3 Self-Concept Scale.

Qualitative data analysis began with open coding of survey responses. Parent responses were read through carefully and the researcher identified ideas

and concepts that were interesting or noteworthy. Themes from the data were identified and recorded using the participants' own words and phrases. The researcher began with the assumption that parents are concerned about their child's reading abilities, so particular attention was paid to language that either confirmed or denied that assumption. Once the transcripts were open coded, analytic coding began. The researcher created large categories into which several ideas fit.

CHAPTER FOUR: RESULTS

Despite a tremendous amount of knowledge regarding best practices for teaching reading and a large investment in training and resources in schools all over the country, there remains a group of children for whom learning to read accurately and fluently is a problem. Even in the absence of other conditions such as visual or hearing problems, lack of exposure to print, or poor reading instruction, some students are unsuccessful at learning to read.

Highly qualified, well-trained teachers know how to successfully remediate the underlying problems causing reading difficulties, but not all students have access to in-person instruction with these qualified individuals. Additionally, events of the past 24 months have taught us that we need to be prepared to offer instruction remotely in the event of another global pandemic.

This study explored the impact of the online delivery of the NOW! Foundations for Speech, Language, Reading and Spelling® program (NF) on the reading accuracy, fluency, and comprehension of struggling readers. NF is a multisensory reading intervention that can be delivered online and is available to children and adults all over the world, provided they have access to a computer and an internet connection. If NF has a positive impact on the functional reading abilities of students who have struggled to learn to read, it might provide treatment options for students who otherwise do not have access to appropriate instruction.

Ten students participated in the research study. The sample included a mix of male and female students ranging in age from 8 years to 16 years old. The students live in the United States, Trinidad, and Panama, and all participated in daily sessions either from their homes or from a school setting for a 6-to-12-week period. The instructors assigned to work with each student are from the United States or Trinidad, and whenever possible, the student worked with the same instructor for each session. Instructors were assigned to students following the normal protocols of the company; i.e., those assigning instructors to students were unaware of student participation in the study.

Data regarding phonological processing abilities and functional reading abilities were collected online prior to each student beginning treatment and again after students had received at least 60, but no more than 65, hours of NF. Student self-concept questionnaires and parent surveys were also collected prior to treatment and after 60 – 65 hours of intervention.

Intervention

The intervention being assessed is the NOW!® Company's NOW! Foundations for Speech, Language, Reading and Spelling® program (NF). Designed to help students who struggle with reading and spelling, NF is a one-on-one intervention that can be delivered on-line by trained instructors. It is a multi-sensory approach to teaching reading in that it incorporates an awareness of the oral motor movements associated with individual sounds. Because students with phonological processing problems have difficulty perceiving the sounds in words, this intervention teaches them to feel the sounds instead.

Students discover how their lips, tongue, teeth, and jaw move as they make each sound in the English language. Once students are confident in what each individual sound looks, sounds, and feels like, they learn to put the sounds together to make words and to break words apart into those individual sounds. Phonological processing is practiced through a series of discrete, hierarchical tasks. This methodology has been used in clinic settings for several decades; the difference between the online delivery of instruction and the in-person delivery is that materials used to represent sounds (mouth pictures and colored blocks) are manipulated in two dimensions via an online workspace rather than in three dimensions on a table.

The research questions addressed in this study are the following:

1. What effect, if any, does the online remediation of phonological processing deficits have on reading accuracy, fluency, and comprehension?
2. What effect, if any, does this online treatment have on student self-concept?
3. What effect, if any, does this online treatment have on parents' perceptions of their children's reading abilities?

Assessment Results

The Comprehensive Test of Phonological Processing – 2nd Edition (CTOPP-2) was administered to 10 participants prior to their beginning NF and again after 60 – 65 hours of intervention. This assessment, which includes the Elision, Blending Words, Phoneme Isolation, Blending Nonwords, and

Segmenting Nonwords subtests, was selected to measure changes in phonological processing upon completion of the intervention. Data were collected to determine a Phonological Awareness Composite Score (PACS) using the Elision, Blending Words, and Phoneme Isolation subtests, and an Alternate Phonological Awareness Composite Score (APACS) using the Blending Nonwords and Segmenting Nonwords subtests.

Elision refers to a student's ability to omit a syllable or a sound in spoken language. To assess this skill, a student might be asked to say the word "cowboy" without saying "boy" or to say the word "cup" without saying /k/. Standard scores for the Elision subtest of the C-TOPP are found in Figure 4.1. Eight of the participating students demonstrated growth in standard scores ranging from 1 point to 7 points, while standard scores for 2 of the students remained the same. Mean standard score prior to treatment was 6.6, while the mean score after 60 – 65 hours of treatment was 9.4. The mean change in standard scores for the Elision subtest was 2.8, which demonstrates an effect size of 1.39. Originally defined by Cohen (1988) and expanded upon by Sawilowsky (2009), d (.01) = very small, d (.2) = small, d (.5) = medium, d (.8) = large, d (1.2) = very large, and d (2.0) = huge (Cohen, 1988; Sawilowsky, 2009).

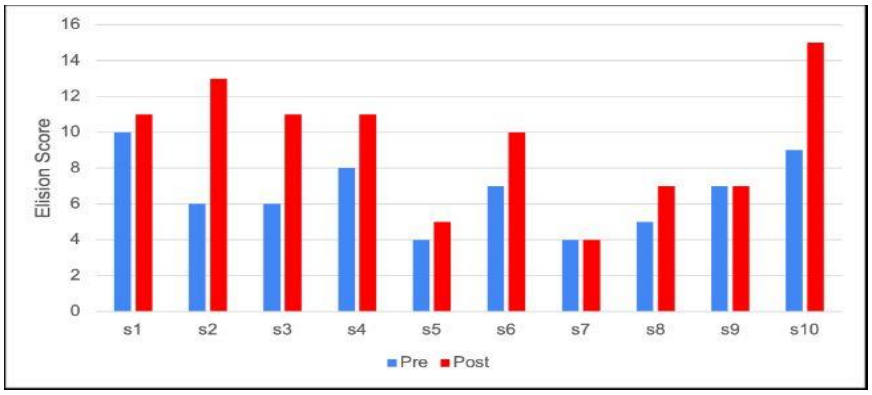

Figure 4.1 Elision Standard Scores

Percentile scores for the Elision subtest of the C-TOPP are found in Figure 4.2. While two of the participating students did not show any growth in percentile scores on this subtest, the eight other participants did. The growth on this subtest ranged from 3 percentile to 75 percentile points; 5 of the 10 participants demonstrated growth of at least 30 percentile points. Mean percentile score prior to treatment was 17.1, while the mean percentile after 60 – 65 hours of treatment was 45.7. The mean change in percentile for the Elision subtest was 28.6, which demonstrates a very large effect size of 1.8.

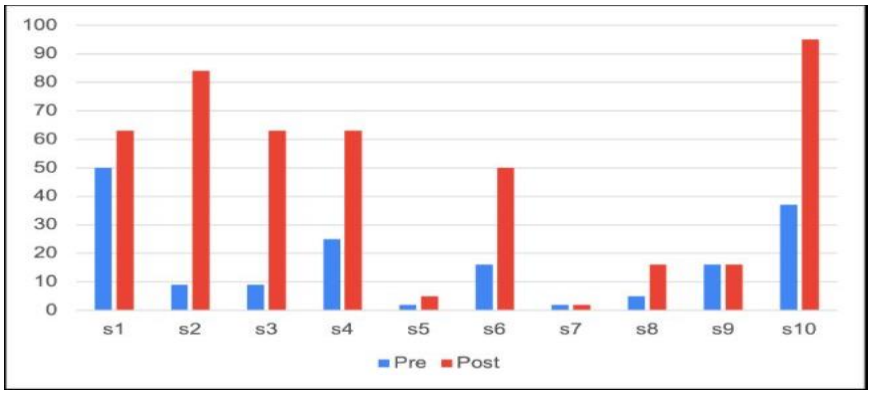

Figure 4.2 Elision Percentile Scores

The Blending Words subtest of the C-TOPP measures a student's ability to combine sounds or syllables into words. For example, the student might be

asked what word the sounds “pen” and “sel” make when put together, or what word the sounds /t/ and /oi/ make when they are combined.

Standard scores for the Blending Words subtest of the C-TOPP are found in Figure 4.3. Two of the students did not improve their standard scores at all on this subtest, while changes for the 8 students who showed growth ranged from 1 standard score point to 7 standard score points. Mean standard score prior to treatment was 7.4, while the mean score after 60 – 65 hours of treatment was 10.9. The mean change in standard scores for the Blending Words subtest was 3.5, which demonstrates a large effect size of 1.03 (Cohen, 1988; Sawilowsky, 2009).

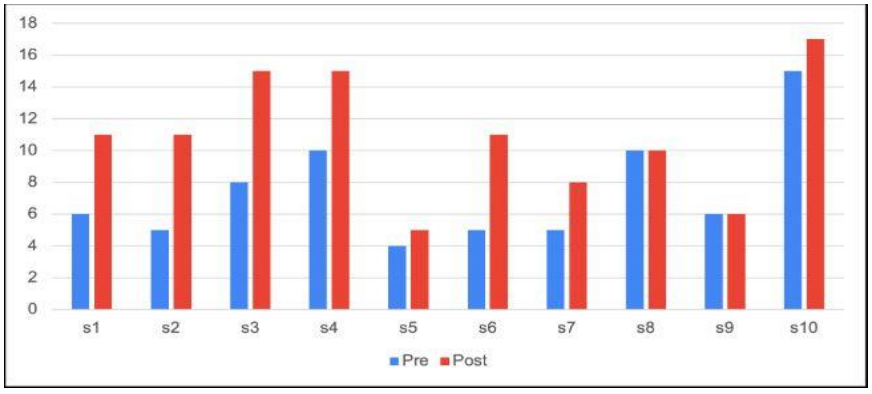

Figure 4.3 Blending Words Standard Scores

Percentile scores for the Blending Words subtest of the C-TOPP are found in Figure 4.4. Of the eight students who demonstrated growth, two of them grew by 3 and 4 percentile points while the other six showed growth ranging from 20% to 70%. Mean percentile score prior to treatment was 25.5, while the mean percentile after 60 – 65 hours of treatment was 56.7. The mean change in percentile for the Blending Words subtest was 31.2, which demonstrates a large effect size of 1.02 (Cohen, 1988; Sawilowsky, 2009).

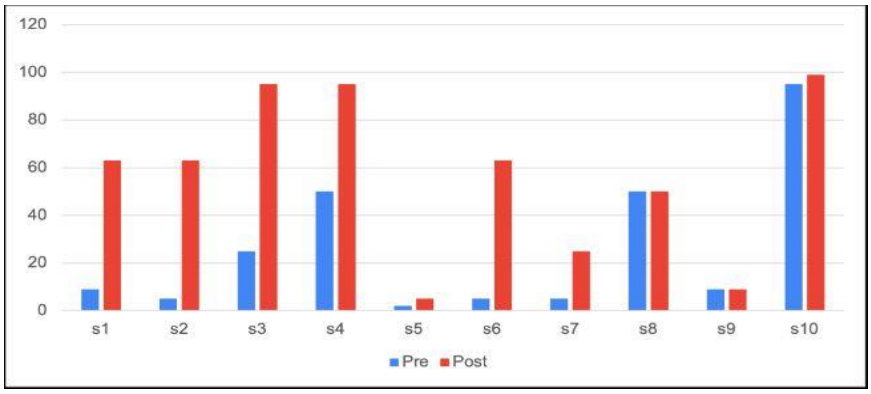

Figure 4.4 Blending Words Percentile Scores

Phoneme Isolation refers to a student's ability to identify one sound in a word they hear. For example, a student might be asked "what is the first sound in the word 'bath'?" or "what is the fourth sound in the word 'waves'?"

Standard scores for the Phoneme Isolation subtest of the C-TOPP are found in Figure 4.5. This subtest showed the least amount of growth of the five subtests. One student did not improve his standard score at all, while six students only grew by one or two standard score points. Mean standard score prior to treatment was 8.2, while the mean score after 60 – 65 hours of treatment was 10.2. The mean change in standard scores for the Phoneme Isolation subtest was 2.0, which demonstrates a moderate effect size of 0.61 (Cohen, 1988; Sawilowsky, 2009).

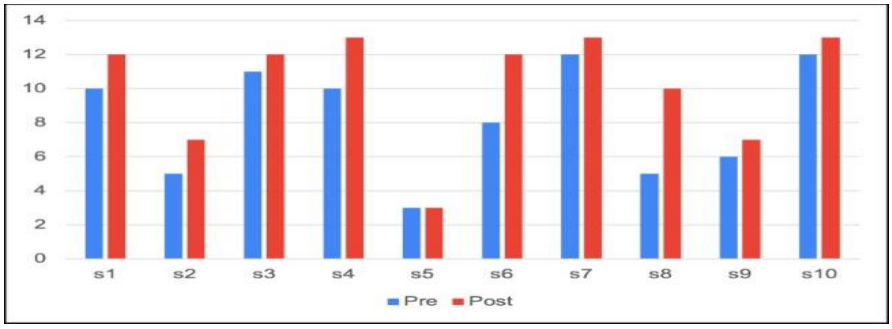

Figure 4.5 Phoneme Isolation Standard Scores

Percentile scores for the Phoneme Isolation subtest of the C-TOPP are found in Figure 4.6. Of the nine students that demonstrated growth, five of them grew from 7 percentage points to 12 percentage points. The four students whose growth ranged from 25% to 50% seemed to drive up the mean. Mean percentile score prior to treatment was 35.8, while the mean percentile after 60 – 65 hours of treatment was 56.0. The mean change in percentile for the Phoneme Isolation subtest was 20.2, which demonstrates a moderate effect size of 0.67 (Cohen, 1988; Sawilowsky, 2009).

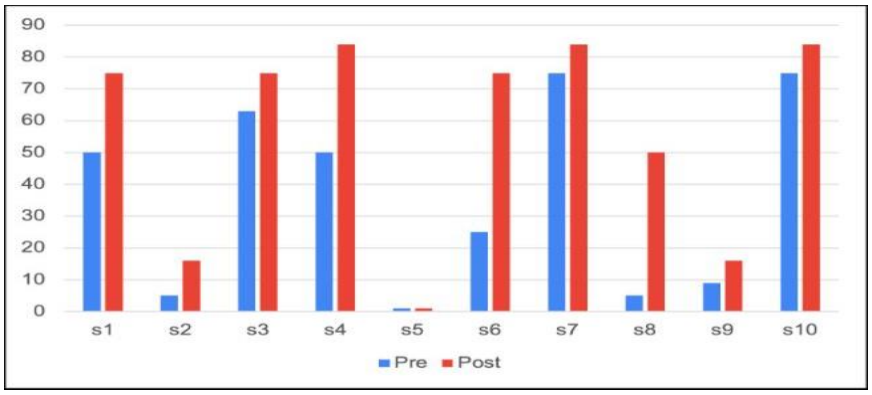

Figure 4.6 Phoneme Isolation Percentile Scores

Blending Nonwords is a C-TOPP subtest which measures a student's ability to put sounds and syllables together to create made up words. Students might be asked to put together syllables such as "nim" and "by" or sounds such as /n/ /a/ /s/ to make nonsense words.

Standard scores for the Blending Nonwords subtest of the C-TOPP are found in Figure 4.7. All students showed at least 1 point of growth while most showed between 2 and 5 points. The mean standard score prior to treatment was 5.3, while the mean score after 60 – 65 hours of treatment was 9.7. The mean

change in standard scores for the Blending Nonwords subtest was 4.4, which demonstrates a very large effect size of 1.31 (Cohen, 1988; Sawilowsky, 2009).

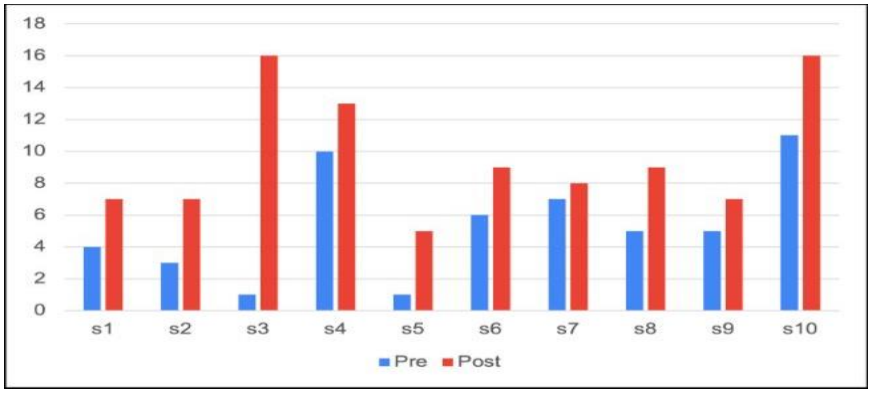

Figure 4.7 Blending Nonwords Standard Scores

Percentile scores for the Blending Nonwords subtest of the C-TOPP are found in Figure 4.8. The smallest percentage change was 4 points, while the largest was 97 points. Mean percentile score prior to treatment was 15.3, while the mean percentile after 60 – 65 hours of treatment was 43.2. The mean change in percentile for the Blending Nonwords subtest was 27.9, which demonstrates a very large effect size of 1.24 (Cohen, 1988; Sawilowsky, 2009).

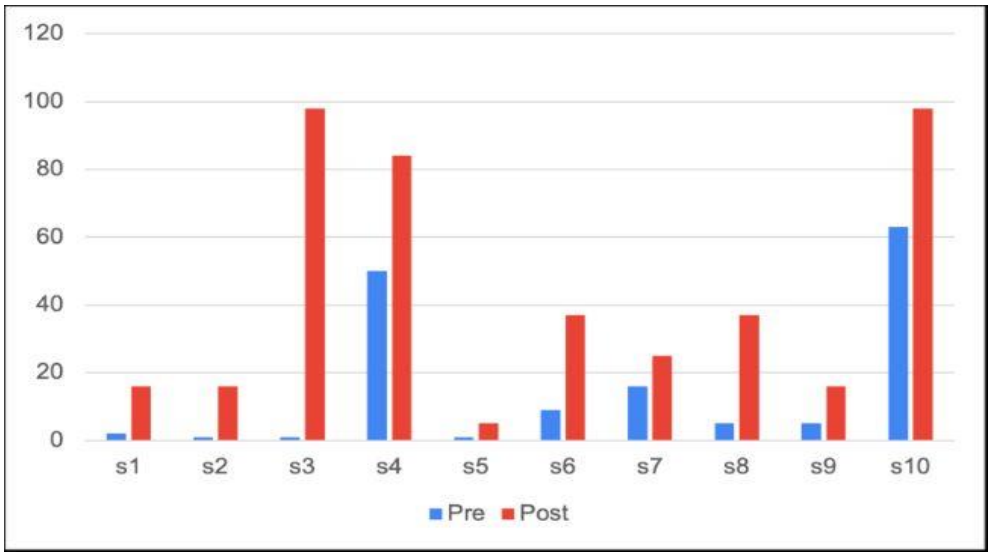

Figure 4.8 Blending Nonwords Percentile Scores

Segmenting Nonwords refers to the ability to take a made-up word and name its individual sounds. For example, a student is asked to repeat a made-up word like “pasp” and then say the word one sound at a time (/p/ /a/ /s/ /p/).

Standard scores for the Segmenting Nonwords subtest of the C-TOPP are found in Figure 4.9. This is the only subtest in the assessment for which one student scored worse on the post-treatment testing than on the pre-treatment testing (change of –1). Improvements to scores showed changes ranging from 1 point to 6 points. Mean standard score prior to treatment was 8.4, while the mean score after 60 – 65 hours of treatment was 11.6. The mean change in standard scores for the Segmenting Nonwords subtest was 3.2, which demonstrates a large effect size of 1.11 (Cohen, 1988; Sawilowsky, 2009).

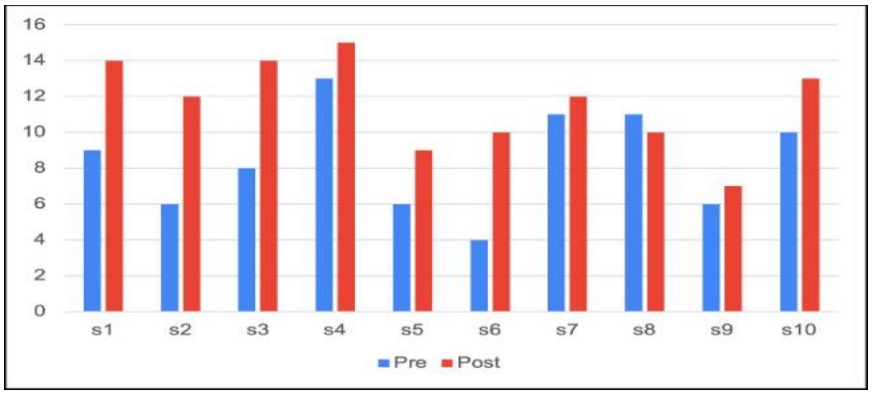

Figure 4.9 Segmenting Nonwords Standard Scores

Percentile scores for the Segmenting Nonwords subtest of the C-TOPP are found in Figure 4.10. One student showed a change of –13 percentage points, while the other nine students showed growth ranging from 7 percentage points to 66 percentage points. Mean percentile score prior to treatment was 35.1, while the mean percentile after 60 – 65 hours of treatment was 66.4. The mean change in percentile for the Segmenting Nonwords subtest was 31.3,

which demonstrates a large effect size of 1.09. This demonstrates a large difference between pre-treatment and post-treatment scores (Cohen, 1988; Sawilowsky, 2009).

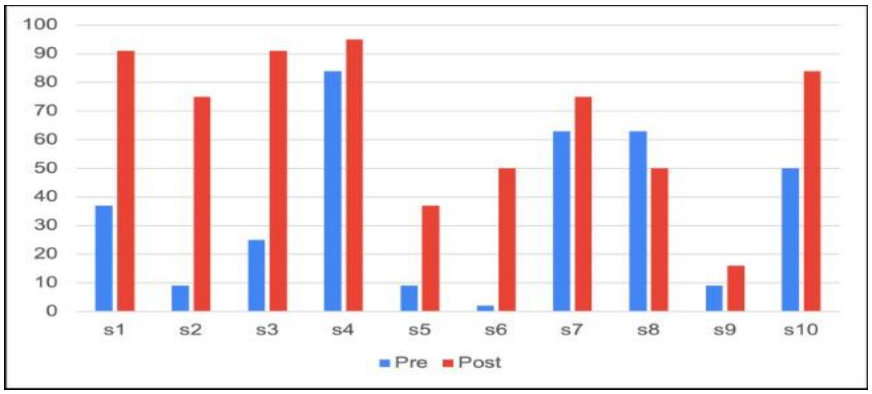

Figure 4.10 Segmenting Nonwords Percentile Scores

The Phonological Awareness Composite Score (PACS) is a combination of the Elision, Blending Words, and Phoneme Isolation subtests. Scaled scores from each subtest are added together, and the sum of the three subtests are converted into scaled scores and percentile ranks.

Phonological Awareness composite scores are shown in Figure 4.11. All ten participants in the study demonstrated growth in PA, ranging from 3 standard score points to 32 standard score points. Mean standard score prior to treatment was 84.2, while the mean score after 60 – 65 hours of treatment was 102. The mean change in standard scores for the Phonological Awareness Composite Score was 17.8, which demonstrates a very large effect size of 1.20 (Cohen, 1988; Sawilowsky, 2009).

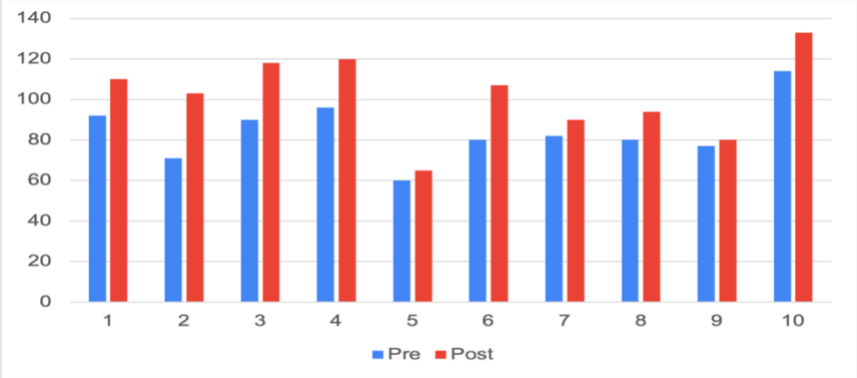

Figure 4.11 Phonological Awareness Composite Scores

Phonological Awareness percentile scores are found in Figure 4.12. One of the participants in the study did not show any growth in this area, while the other nine students improved anywhere from 3 percentile points to 64 percentile points. Half of the students showed gains of 45 percentile points or higher. Mean percentile score prior to treatment was 22.0, while the mean percentile after 60 – 65 hours of treatment was 55.0. The mean change in percentile for the Phonological Awareness Composite score was 33.0, which demonstrates a very large effect size of 1.28 (Cohen, 1988; Sawilowsky, 2009).

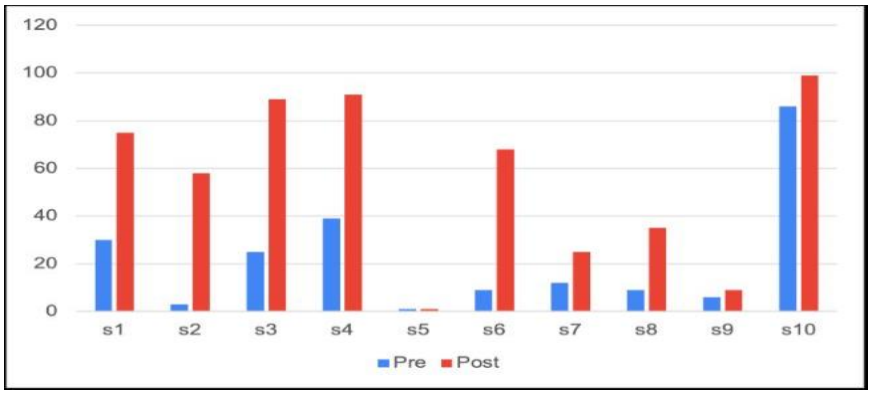

Figure 4.12 Phonological Awareness Percentile Scores

The Alternate Phonological Awareness Composite Score (APACS) is a combination of the Blending Nonwords and Segmenting Nonwords subtests.

Scaled scores from each subtest were added together, and the sum of the two subtests was converted to a composite score and a percentile rank.

Alternate Phonological Awareness standard scores are shown in Figure 4.13. One of the students in the study decreased by 24 standard score points, while all other participants improved. Sixty percent of the students improved by 20 standard score points or more. Mean standard score prior to treatment was 84.4, while the mean score after 60 – 65 hours of treatment was 105. The mean change in standard scores for the Alternate Phonological Awareness Composite Score was 20.6, which demonstrates a large effect size of .95 (Cohen, 1988; Sawilowsky, 2009).

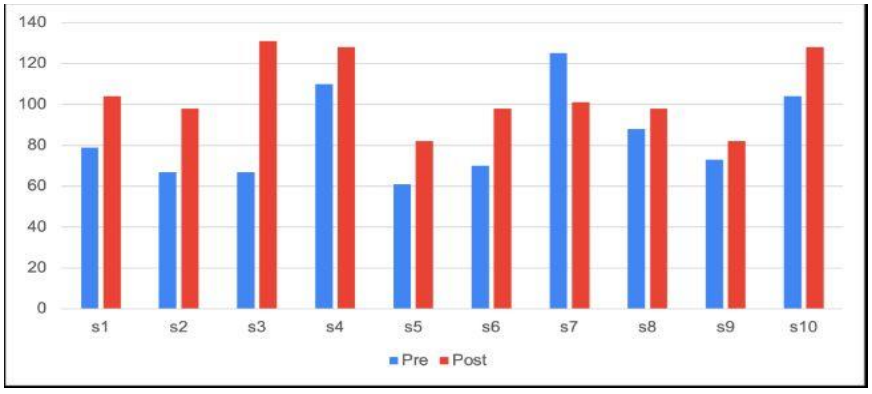

Figure 4.13 Alternate Phonological Awareness Composite Scores

Alternate Phonological Awareness percentile scores are found in Figure 4.14. Again, one student showed a large decrease in percentile ranking, while the other nine participants showed growth ranging from 9 percentile points to 97 percentile points. Mean percentile score prior to treatment was 26.8, while the mean percentile after 60 – 65 hours of treatment was 56.3. The mean change in percentile for the Alternate Phonological Awareness Composite Score was 29.5, which demonstrates a large effect size of .82 (Cohen, 1988; Sawilowsky, 2009).

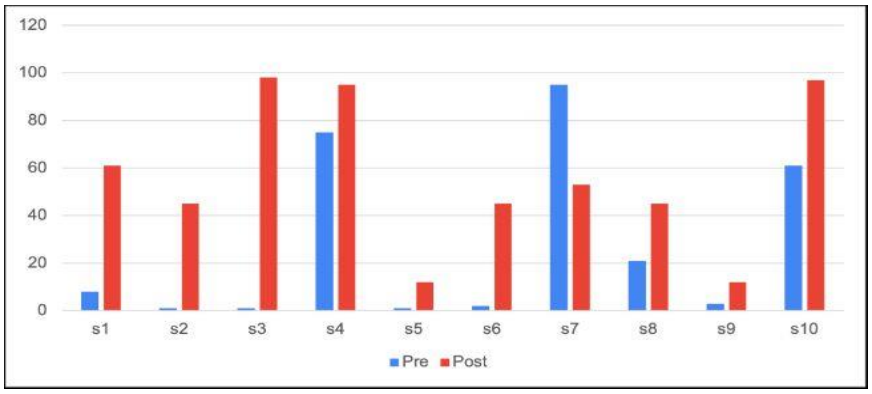

Figure 4.14 Alternate Phonological Awareness Percentile Scores

The data from the C-TOPP indicate that phonological processing deficits in all ten participants improved upon completion of the intervention. The largest standard score gains were in Blending Nonwords, while the smallest gains were in Phoneme Isolation. All subtests and composite scores except Phoneme Isolation demonstrated a large or very large effect size; the effect size in Phoneme Isolation would only be considered moderate. Mean changes in standard scores and percentiles are shown in Figures 4.15 and 4.16.

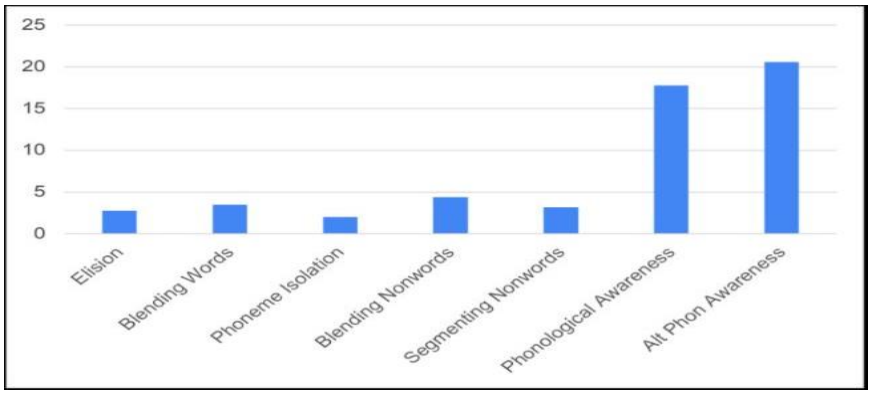

Figure 4.15 Mean Changes to Standard Scores

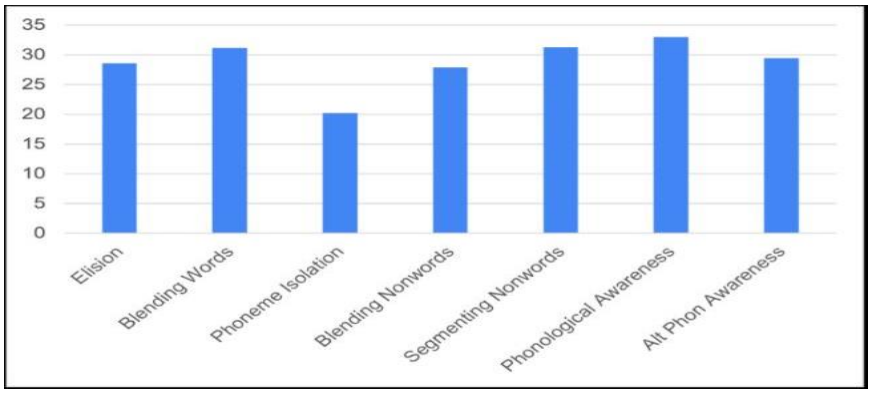

Figure 4.16 Mean Changes to Percentile Scores

The Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV) was also administered to 10 students prior to their beginning NF and again after 60 – 65 hours of intervention. This assessment was selected to collect data on each student's functional reading abilities, including reading accuracy, fluency, and comprehension. Subtests administered included Word Reading, Pseudoword Decoding, Reading Comprehension, and Oral Reading Fluency Subtests. Using the Q-Global scoring system, nationally normed standard scores and percentiles were collected.

The Word Reading subtest assessed each student's ability to read words in isolation. The 75 words presented to the students became progressively more difficult, beginning with "in" and ending with "quincuncial." Administration of the test was stopped after 4 consecutive errors.

Standard Scores for the Word Reading Subtest of the WIAT-IV are shown in Figure 4.17. Four of the study participants had lower standard scores after 60 – 65 hours of treatment than they did prior to starting the intervention, while the other six showed growth ranging from 1 point to 16 points. Mean standard score prior to treatment was 80.5, while the mean score after 60 – 65 hours of

treatment was 83.3. The mean change in standard scores for the Word Reading subtest was 2.8, which demonstrates a very small effect size of 0.16 (Cohen, 1988; Sawilowsky, 2009).

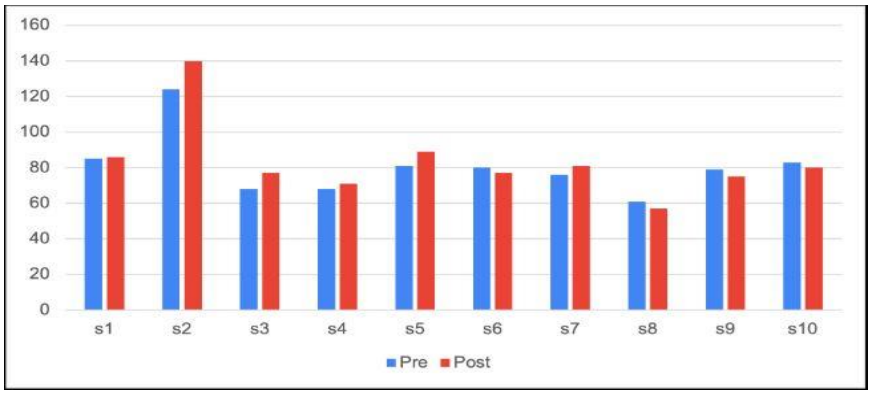

Figure 4.17 Word Reading Standard Scores

Percentile scores for the Word Reading subtest of the WIAT-IV are found in Figure 4.18. Again, four students showed negative growth while six showed an improvement in their scores ranging from 1 percentage point to 13 percentage points. Mean percentile score prior to treatment was 16.05, while the mean percentile after 60 – 65 hours of treatment was 17.98. The mean change in percentile for the Word Reading subtest was 1.93, which demonstrates a very small effect size of 0.07 (Cohen, 1988; Sawilowsky, 2009).

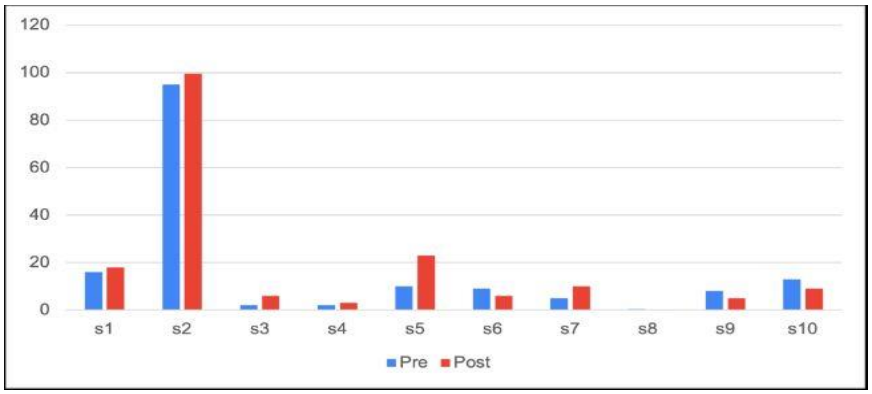

Figure 4.18 Word Reading Percentile Scores

The Reading Comprehension subtest measured each student's ability to answer questions about grade level passages that they read independently, either silently or aloud. The researcher read the questions aloud to each respondent and used a scoring guide to determine scores of 0, 1, or 2 for each question.

Standard Scores for the Reading Comprehension Subtest of the WIAT-4 are shown in Figure 4.19. Two of the ten participants showed negative or no growth in this area, three showed growth between 1 and 4 standard score points, and the remaining five students grew anywhere from seven to 16 points. Mean standard score prior to treatment was 86, while the mean score after 60 – 65 hours of treatment was 92.3. The mean change in standard scores for the Reading Comprehension subtest was 6.3, which demonstrates a small effect size of 0.48 (Cohen, 1988; Sawilowsky, 2009).

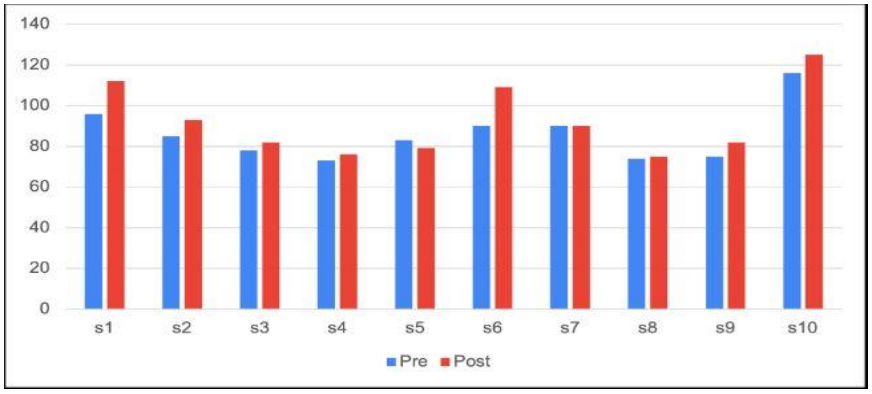

Figure 4.19 Reading Comprehension Standard Scores

Percentile scores for the Reading Comprehension subtest of the WIAT-4 are found in Figure 4.20. Two of the students showed negative or no growth in their percentile scores while four showed growth ranging from 1 point to 7 points. Four students demonstrated growth of between 9 percentile points and 48

percentile points. Mean percentile score prior to treatment was 22.4, while the mean percentile after 60 – 65 hours of treatment was 34.6. The mean change in percentile for the Reading Comprehension subtest was 12.2, which demonstrates a moderate effect size of 0.49 (Cohen, 1988; Sawilowsky, 2009).

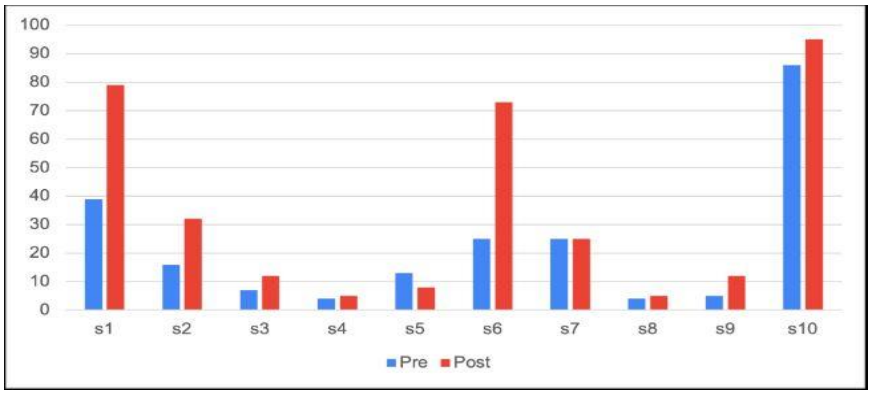

Figure 4.20 Reading Comprehension Percentile Scores

The Oral Reading Fluency subtest of the WIAT-4 measures the number of words a student reads correctly in two grade level passages and the time it takes them to read those passages.

Standard Scores for the Oral Reading Fluency subtest of the WIAT-4 are shown in Figure 4.21. Student 9 did not complete the initial passage within the time allowed, so her subtest was not able to be scored. Of the nine students whose assessments were scored, one demonstrated negative growth and the other eight showed growth ranging from 2 to 14 points. Mean standard score prior to treatment was 68.67, while the mean score after 60 – 65 hours of treatment was 74.22. The mean change in standard scores for the Oral Reading Fluency subtest was 5.56, which demonstrates a small effect size of 0.37 (Cohen, 1988; Sawilowsky, 2009).

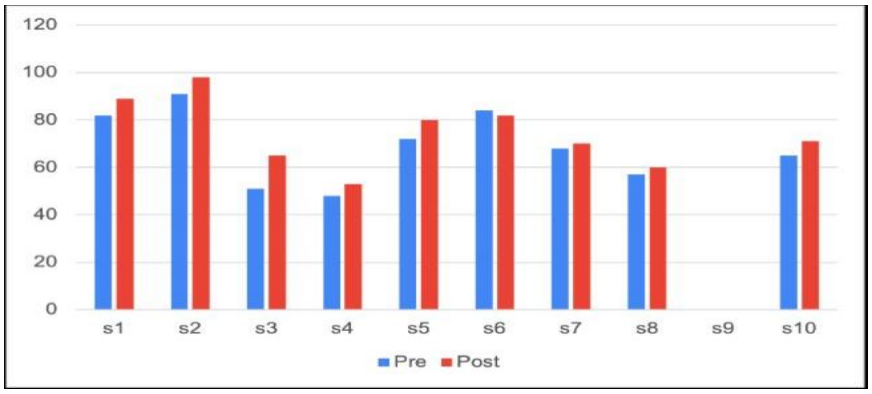

Figure 4.21 Oral Reading Fluency Standard Scores

Percentile scores for the Oral Reading Fluency subtest of the WIAT-4 are found in Figure 4.22. Student 9 did not complete the task within the time allotted and therefore has no score; students 3 and 4 had pre- and/or post-treatment scores <1 percentile which were too small to appear in the figure. Three of the nine scores demonstrated negative or no growth at all, while four showed growth ranging from .02 percentile points to 6 points. Two students grew either 11 or 18 percentile points. Mean percentile score prior to treatment was 6.6, while the mean percentile after 60 – 65 hours of treatment was 10.61. The mean change in percentile for the Oral Reading Fluency subtest was 4.01, which demonstrates a moderate effect size of 0.43 (Cohen, 1988; Sawilowsky, 2009).

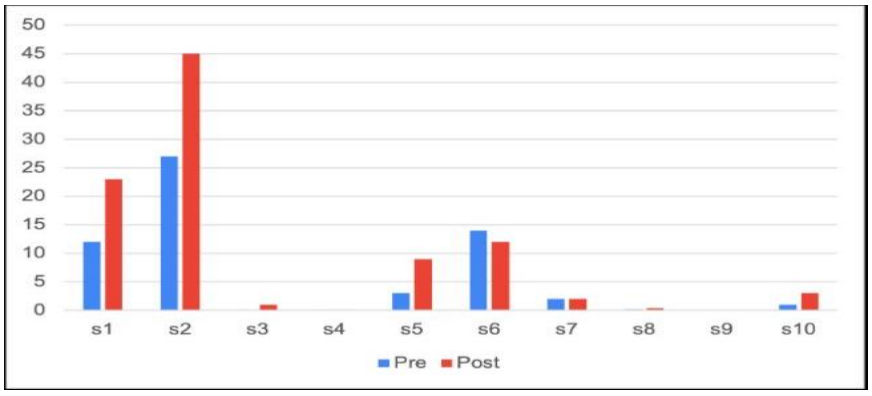

Figure 4.22 Oral Reading Fluency Percentile Scores

The Pseudoword Reading subtest of the WIAT-4 measures a student's ability to read nonsense words. A total of 52 words may be presented to the students, beginning with simple words like "ik" and "ab" and ending with "diphthalbarbadinyl." The test is stopped when the student reads 4 words in a row incorrectly.

Standard Scores for the Pseudoword Decoding subtest of the WIAT-4 are shown in Figure 4.23. One student demonstrated a negative change in standard score, while the other nine students showed positive gains ranging from 1 point to 28 points. Mean standard score prior to treatment was 80, while the mean score after 60 – 65 hours of treatment was 88.5. The mean change in standard scores for the Pseudoword Decoding subtest was 8.5, which demonstrates a moderate effect size of 0.71 (Cohen, 1988; Sawilowsky, 2009).

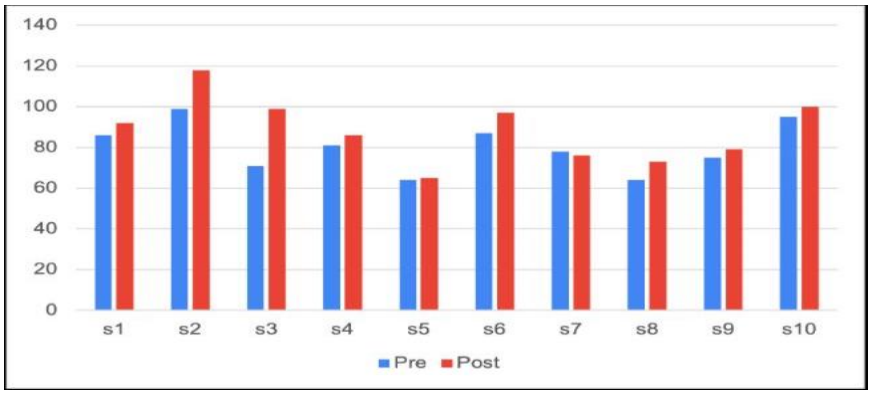

Figure 4.23 Pseudoword Decoding Standard Scores

Percentile scores for the Pseudoword Decoding subtest of the WIAT-4 are found in Figure 4.24. Again, one student showed negative growth on this subtest. The other nine students showed growth ranging from .2 percentile points to 44 percentile points. Mean percentile score prior to treatment was 14.76, while the mean percentile after 60 – 65 hours of treatment was 29.3. The mean change in

percentile for the Pseudoword Decoding subtest was 14.54, which demonstrates a large effect size of 0.92 (Cohen, 1988; Sawilowsky, 2009).

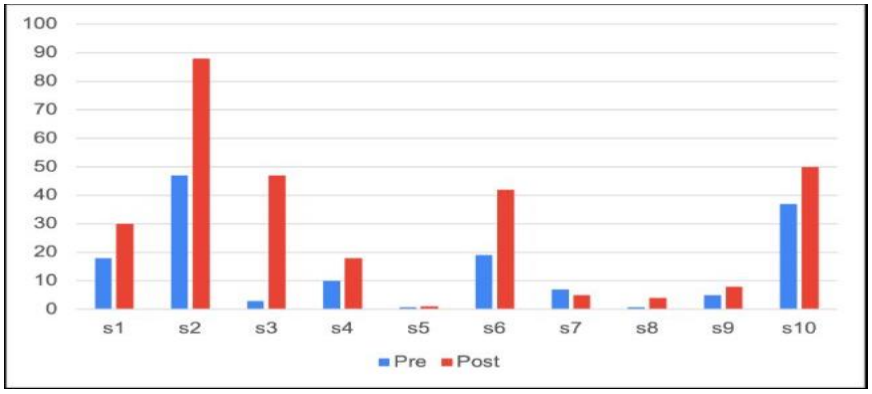

Figure 4.24 Pseudoword Decoding Percentile Scores

We also collected composite scores. The Reading Composite Score is made up of scaled scores from the Reading and the Reading Comprehension subtests, while the Decoding Composite Score consists of the Word Reading and Pseudoword Decoding subtests.

Results of the Reading Composite standard scores are shown in Figure 4.25. One of the ten students showed a negative score on the Reading Composite, but the other nine students showed growth ranging from 1 standard score point to 16 points. Mean standard score prior to treatment was 82.20, while the mean score after 60 – 65 hours of treatment was 87. The mean change in standard scores for the Reading Composite test was 4.8, which demonstrates a small effect size of 0.40 (Cohen, 1988; Sawilowsky, 2009).

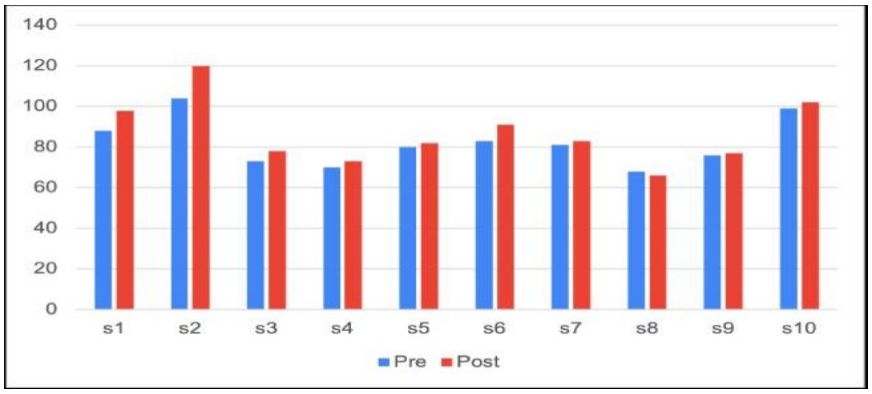

Figure 4.25 Reading Composite Standard Scores

Results of the Reading Composite percentile scores are shown in Figure 4.26. One student showed a decrease in score of one percentage point, while the other nine showed growth ranging from 1 percentage point to 30 percentage points. Mean percentile score prior to treatment was 17.4, while the mean score after 60 – 65 hours of treatment was 26.10. The mean change in percentile scores for the Reading Composite test was 8.7, which demonstrates a small effect size of 0.43 (Cohen, 1988; Sawilowsky, 2009).

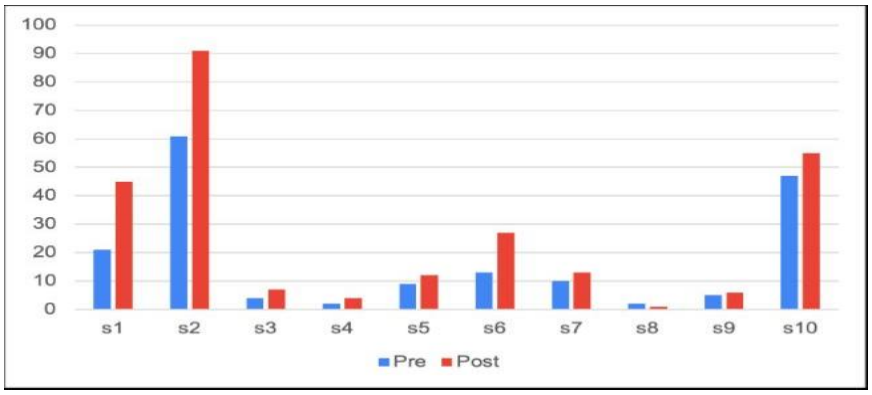

Figure 4.26 Reading Composite Percentile Scores

Results of the Decoding Composite standard scores are shown in Figure 4.27. One student did not demonstrate any growth on this composite measure. Seven students showed growth between one and four standard score points,

while two demonstrated growth between 15 and 21 points. Mean standard score prior to treatment was 82.20, while the mean score after 60 – 65 hours of treatment was 85.6. The mean change in standard scores for the Decoding Composite test was 5.4, which demonstrates a small effect size of 0.43 (Cohen, 1988; Sawilowsky, 2009).

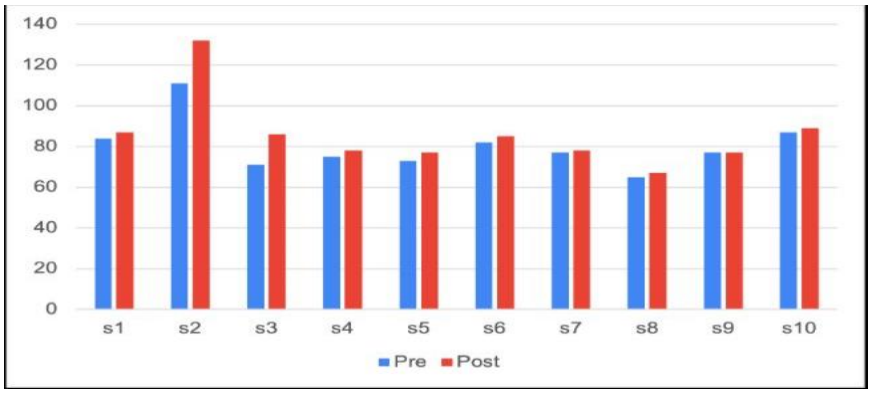

Figure 4.27 Decoding Composite Standard Scores

Results of the Decoding Composite percentile scores are shown in Figure 4.28. Eight students showed growth ranging from zero to five percentage points, while the other two demonstrated 15 and 21 percentage points of growth. Mean percentile score prior to treatment was 14.7, while the mean score after 60 – 65 hours of treatment was 20.1. The mean change in percentile scores for the Decoding Composite test was 5.4, which demonstrates a small effect size of 0.24 (Cohen, 1988; Sawilowsky, 2009).

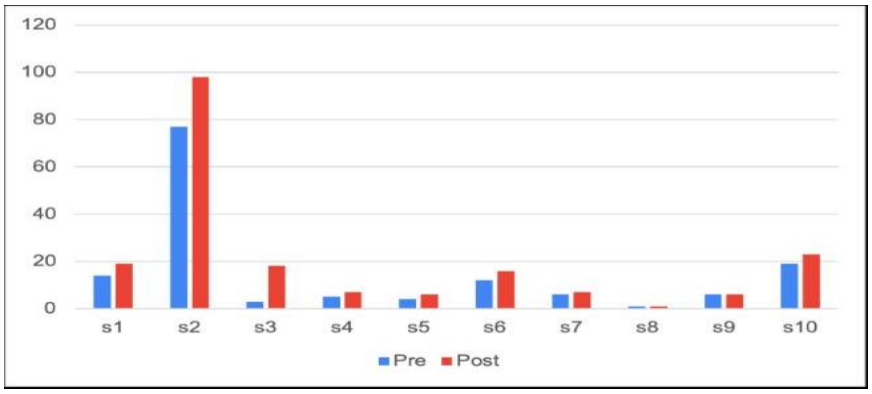

Figure 4.28 Decoding Composite Percentile Scores

Mean changes overall for the individual subtests of the WIAT-IV are shown in Figures 4.29 and 4.30. Pseudoword Decoding, which shows the largest mean change, requires that students read nonsense words that are orthographically regular. The Word Reading subtest, which includes both regular and irregular words (‘in’ and ‘bear’) requires more sight word knowledge, which is not addressed within the first 60 – 65 hours of the intervention being investigated. The Reading Comprehension subtest does not measure reading accuracy at all; students are allowed to read the passages silently rather than aloud.

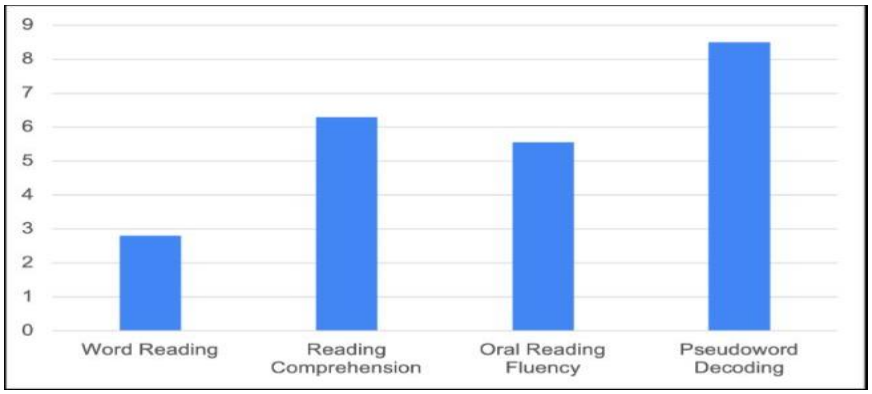

Figure 4.29 WIAT-IV Mean Standard Score Changes

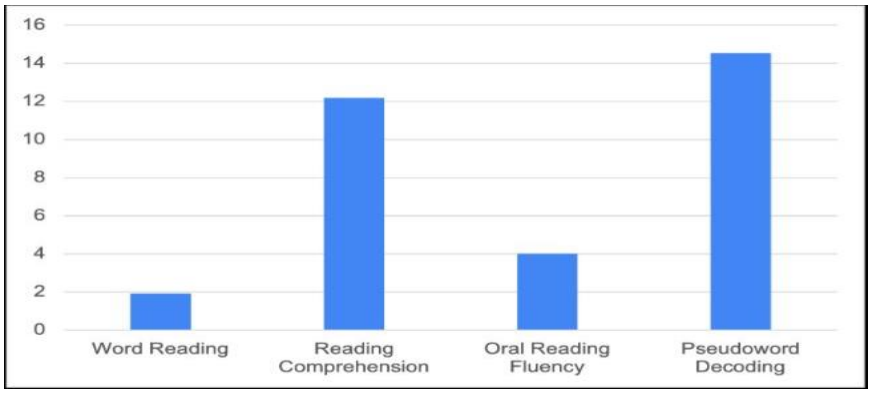

Figure 4.30 WIAT-IV Mean Percentile Score Changes

In order to answer Research Question #2, the Piers-HarrisTM 3 Self-Concept Scale was administered to all students enrolled in the study. The Piers-HarrisTM 3 Self-Concept Scale is a 58-question assessment that measures self-concept along the following domains: Behavior Adjustment, Freedom from Anxiety, Happiness and Satisfaction, Intellectual and School Status, Physical Appearance and Attributes, and Social Acceptance. The researcher read all 58 questions aloud to the participants and recorded their yes or no answer

Piers-Harris 3 Student Self-Concept Study was administered to 10 participants prior to their beginning the NOW! Foundations for Speech, Language, Reading and Spelling® program (NF) and again after 60 – 65 hours of intervention. The results listed below include scores along the Intellectual and School Status domain as well as a total self-concept score.

Results of the Intellectual and School Status scores are shown in Figure 4.31. Six of the students demonstrated either no change or a negative change regarding their feelings about their intellectual status. Of the four who did demonstrate positive change, that growth was measured between 4 and 16 standard score points. Mean standard score prior to treatment was 49.1, while

the mean score after 60 – 65 hours of treatment was 50.3. The mean change in standard score for the Intellectual and School Status subtest was 1.2, which demonstrates a very small effect size of 0.10 (Cohen, 1988; Sawilowsky, 2009).

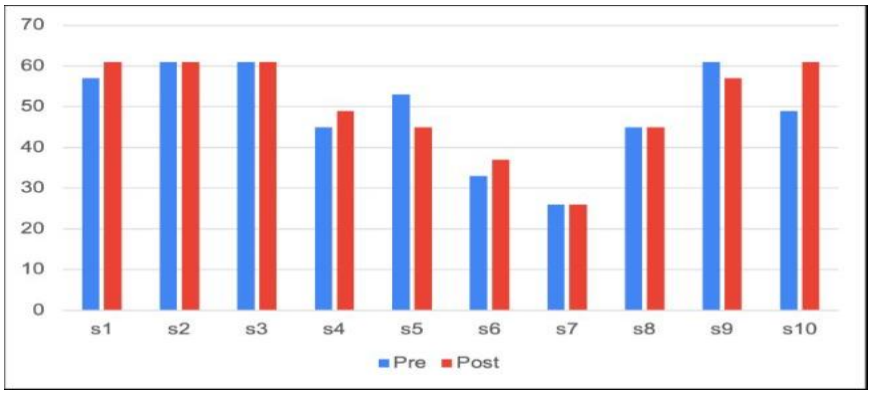

Figure 4.31 Intellectual and School Status Standard Scores

Results of the Intellectual and School Status percentiles are shown in Figure 4.32. Again, six students demonstrated negative or no growth in their Intellectual Status percentile scores, while the four that demonstrated growth ranged from six percentile points to 41 percentile points. Mean percentile score prior to treatment was 50.7, while the mean score after 60 – 65 hours of treatment was 53.6. The mean change in percentile score for the Intellectual and School Status subtest was 2.9, which demonstrates a very small effect size of 0.09 (Cohen, 1988; Sawilowsky, 2009).

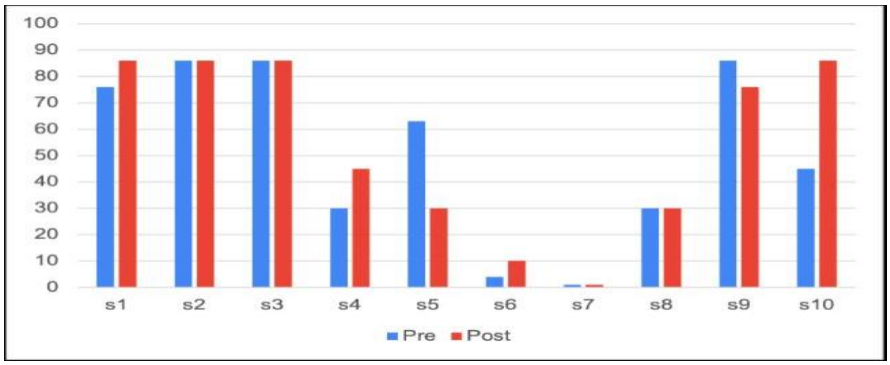

Figure 4.32 Intellectual and School Status Percentile Scores

Results of the Self-Concept Composite scores are shown in Figure 4.33. Only one of the participants demonstrated negative growth to overall self-concept, while the other nine had gains ranging from one to 12 standard score points. Mean standard score prior to treatment was 48.7, while the mean score after 60 – 65 hours of treatment was 52.8. The mean change in standard score for the Self-Concept Composite Score was 4.1, which demonstrates a small effect size of 0.42 (Cohen, 1988; Sawilowsky, 2009).

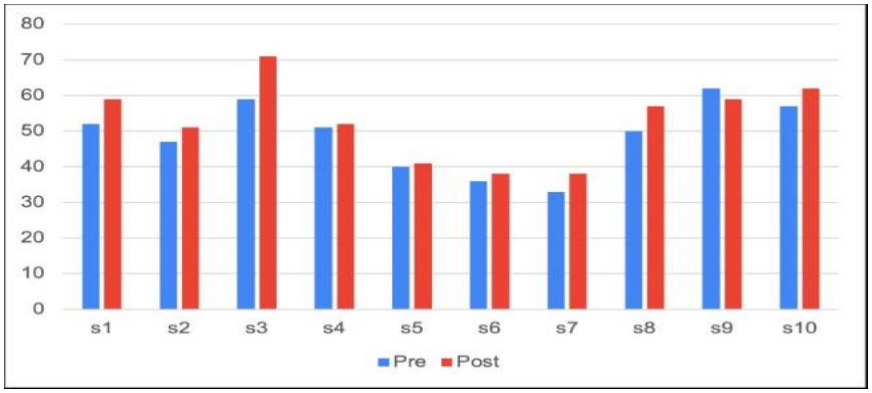

Figure 4.33 Self-Concept Composite Standard Scores

Results of the Self-Concept Composite percentile scores are shown in Figure 4.34. Changes in overall self-concept percentiles range from two percentage points to 26 percentage points. Mean percentile score prior to treatment was 47.5, while the mean score after 60 – 65 hours of treatment was 55.9. The mean change in percentile score for the Self-Concept Composite Score was 8.4, which demonstrates a small effect size of 0.27 (Cohen, 1988; Sawilowsky, 2009).

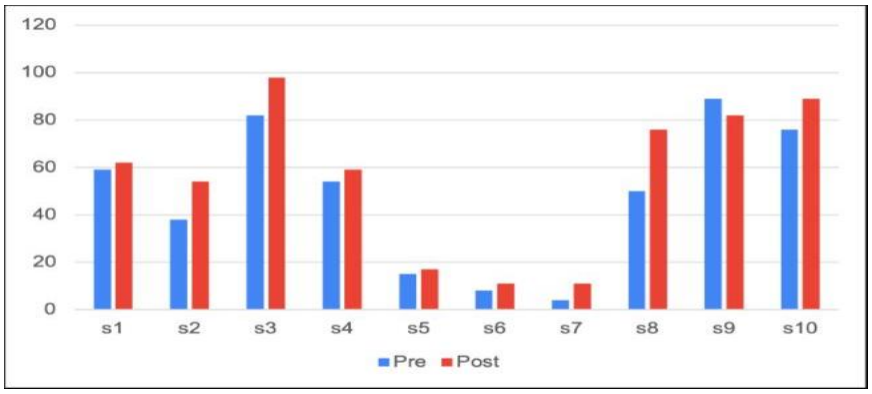

Figure 4.34 Self-Concept Composite Percentile Scores

In order to answer Research Question #3, a parent survey was administered to the parents of 10 participants prior to their beginning NF and again after 60 - 65 hours of intervention. Parents first answered questions about their child's reading using a Likert scale, with a score of 1 equating to “strongly agree” and a score of 5 indicating “strongly disagree.” These surveys were administered anonymously, so there is no way to match pre-treatment and post-60 hour responses. Despite multiple efforts to reach parents and guardians, only 8 of 10 completed the survey prior to beginning treatment and only 6 of 10 completed the survey after their child had completed 60 –65 hours of treatment.

Overall, parent perceptions of their children’s attitudes toward and skills related to reading began to trend toward the positive over the course of the 60 – 65 hours of treatment. For example, the statement “My child can read unfamiliar words” was answered “strongly disagree” by 62.5% of respondents prior to treatment but by only 16.7% of respondents after 60 hours of treatment. In addition, 75% of respondents “strongly disagreed” with the statement “My child is confident in his/her reading abilities” prior to treatment, while 0% of respondents

strongly disagreed with that statement after their child had completed at least 60 hours of treatment.

Responses to these questions are shown in Figures 4.35 – 4.40.

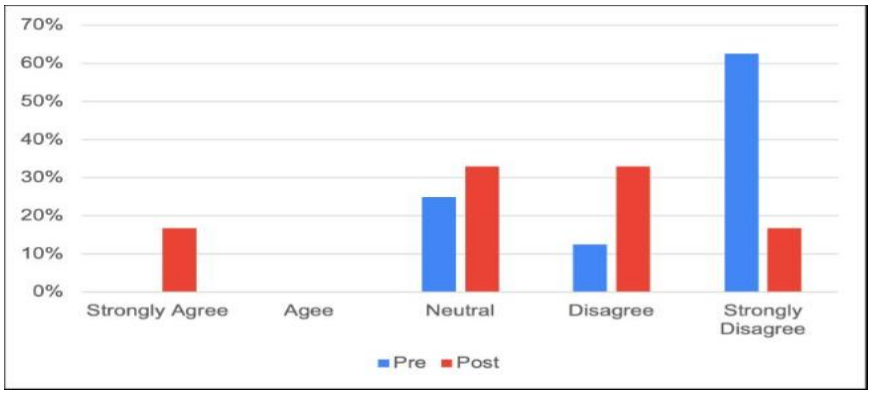

Figure 4.35 My Child Can Read Unfamiliar Words

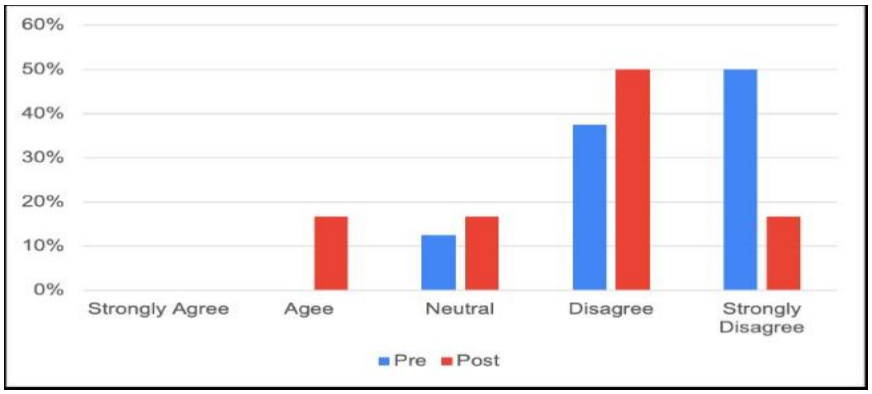

Figure 4.36 My Child Can Read Fluently

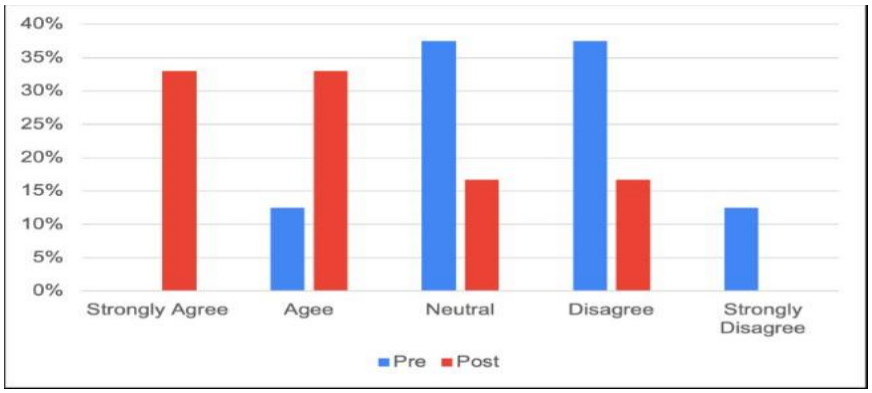

Figure 4.37 My Child Understands What S/he Reads

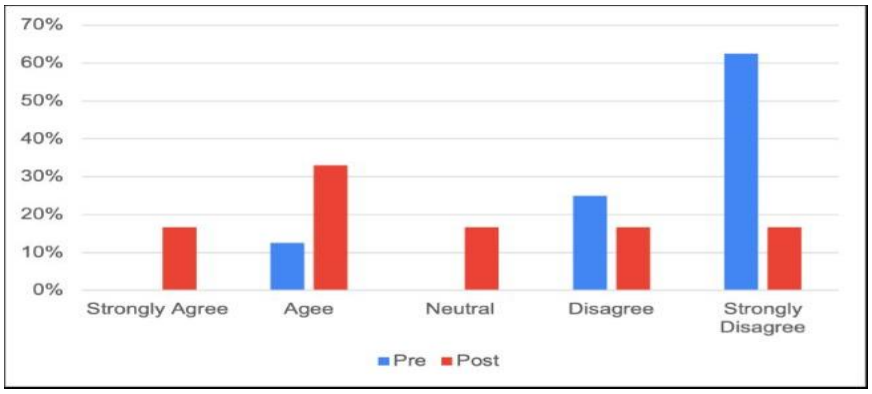

Figure 4.38 My Child Enjoys Reading

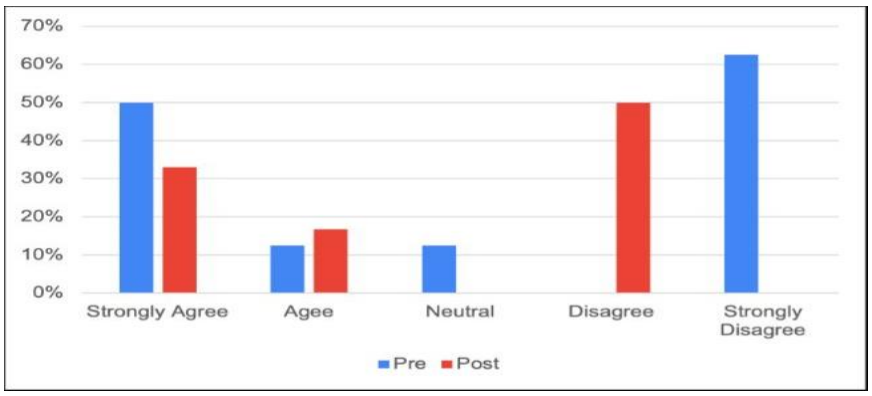

Figure 4.39 My Child Avoids Reading

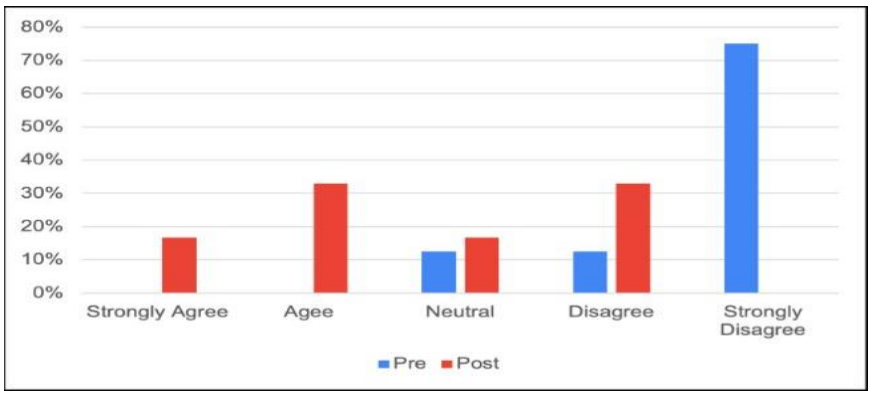

Figure 4.40 My Child is Confident in His/Her Reading Abilities

Parents who completed the survey also had the opportunity to provide responses to the following open-ended questions:

1. Why did you enroll your child in NOW! Foundations for Speech, Language, Reading and Spelling® program?

2. What strengths does your child have in terms of his/her reading ability?

3. What areas of your child's reading are you concerned about?

The researcher read each parent response carefully, looking for clear themes or common ideas. Responses varied in length from just one or two sentences to entire paragraphs, but their similarities and common themes were relatively easy to identify. Parents commented on the academic and personality strengths of their children, their disappointment in and frustration with previous remediation attempts, specific difficulties their children experienced academically, and other ways that poor reading and spelling impacted their children.

Overall, parents indicated that they believe their children to be intelligent and capable of learning. Comments such as "he is smart," "BRIGHT," and "hard worker" appeared on several of the surveys. Parents also expressed dissatisfaction with previous attempts at remediation and with the services provided by schools, both public and private. Respondents reported that "the intervention wasn't appropriate" or that there was "no progress. . .in school sponsored dyslexia program." Survey respondents referred to gaps in learning and an inability to "close the gap" between their children and same aged peers.

When asked to list specific concerns about their children's reading, parents provided a wide variety of responses. They specifically mentioned students missing or skipping over words when reading, having difficulty writing, demonstrating poor understanding of what they had read, struggling to spell accurately, and reading disfluently. Interestingly, parents connected these academic concerns to other significant problems in their children's lives, including

“very much bullied in school,” “school trauma and anxiety,” and “falling further and further behind.”

Survey responses to the same questions after 60 – 65 hours of treatment mentioned but did not dwell on specific academic and behavioral concerns. Instead, parents tended to use positive language to describe their children’s reading and made note of positive behavioral changes. Specific examples included children sounding more fluent when they read, asking to read out loud to a parent, and spontaneously attempting to read instructions that the student previously would have avoided.

Both quantitative and qualitative data indicate that, even before the completion of the full program, parents noticed positive changes in their children’s skills and in their attitudes toward reading.

Summary

Quantitative data collected through the CTOPP-2 demonstrate clear and large gains in phonological processing for students who completed 60 – 65 hours or intervention in the NOW! Foundations for Speech, Language, Reading and Spelling® program. These gains are potentially important as deficits in phonological processing are known to be the root cause of reading difficulties such as dyslexia.

Functional reading abilities did not show large gains after 60 – 65 hours of intervention, although moderate effect sizes were seen in Pseudoword Decoding. As these are the types of words that the students in the program are first taught to read and spell, it is not surprising that the largest gains would be seen in that

area. Reading Comprehension scores also increased, and these positive changes in Pseudoword Decoding and Reading Comprehension may relate to the improvements in the Reading Composite score and the Decoding Composite score.

Changes to student self-concept, both overall and within the Intellectual and School Status domain, were not noted after 60 – 65 hours of intervention. Parent comments indicated some positive changes to reading attitudes, including a willingness to read more and to try to sound out words that previously would have been avoided by their children.

CHAPTER FIVE: IMPLICATIONS

Dyslexia is a term that is widely used and often misunderstood in educational circles. Anywhere from 5% to 18% of the general population suffers from dyslexia (Shaywitz, 1998) whether they have been formally diagnosed or not, and treatment and remediation options for students can be overwhelming and difficult for parents to understand. The interventions with the highest success rates are administered intensively by highly trained reading specialists (Moats, 2009) but not all students have equal access to these programs. Particularly during a global pandemic, when opportunities for face-to-face instruction with teachers or with trained reading specialists are limited, remote learning options focused on the remediation of learning difficulties are appealing to parents. This study investigates the effect of one such remote learning opportunity.

The International Dyslexia Association states

> dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. (Lyon et al., 2003, p. 2).

To address the deficits in the phonological component of language identified by the IDA, this study utilized Phonological Processing Deficit Theory

and Multisensory Structured Language Instruction. Students enrolled in the study participated in NOW! Foundations for Speech, Language, Reading and Spelling® program (NF), a multisensory reading intervention program that remediated phonological processing deficits by focusing on the oral motor component of language as the kinesthetic pathway being trained. Students in this study discovered the articulatory movements their mouths made as they produced sounds, paying particular attention to the individual parts of the mouth (lips, tongue, teeth, jaw) as they created the distinct consonant and vowel sounds in the English language.

Ten students participated in the research study. The sample included a mix of male and female students ranging in age from 8 years to 16 years. The students lived in the United States, Trinidad, and Panama, and each participated in daily sessions over a 6- to 12-week period either from their homes or from a school setting. The instructors assigned to work with each student also lived in various parts of the Unites States or Trinidad. For the most part, the student worked with the same tutor for each session. Nine students received one 45-minute intervention session per day, 5 days per week, while one students took part in 2 sessions per day, 5 days per week.

This action research study was designed to investigate both changes in phonological processing and functional changes in reading upon completion of the intervention. It also investigated student self-concept and parent perceptions of student reading abilities. For this reason, it was appropriate to collect both standardized assessment data and qualitative survey data.

Students enrolled in NF completed a battery of tests before the intervention began and again after 60 - 65 hours of treatment. These tests measured changes both in phonological processing and in functional reading abilities. The assessments included the Comprehensive Test of Phonological Processing - Second Edition (CTOPP-2), the Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV), the Piers-HarrisTM 3 Self-Concept Scale, and a parent survey including both 5 point Likert scale questions and open-ended questions about parent perceptions of changes in reading attitudes and abilities over the course of the treatment.

Results

Research Question #1 asked what effect, if any, the online remediation of phonological processing deficits has on reading accuracy, fluency, and comprehension. Before looking at these functional reading abilities, it is important to examine whether phonological processing deficits were, in fact, remediated.

Data collected using the Comprehensive Test of Phonological Processing – 2nd Edition (CTOPP-2) indicate substantial improvements to phonological processing scores for the sample subjects as a group. Although the sample population was small (only 10 participants), mean changes to standard scores and percentiles on all subtests and on composite scores were large.

According to the IDA definition, phonological processing deficits are an impairment that lead to decreased function. The multisensory language instruction investigated in this study addresses the phonological processing deficit at the impairment level, rather than just treating the functional difficulties.

The conclusion we can draw from these data indicates that the online delivery of NF is an effective way to treat the underlying impairment.

The question then becomes whether the reduction in impairment translates into an improvement in functional reading abilities. The data collected from the Wechsler Individual Achievement Test – Fourth Edition (WIAT-IV) is inconsistent between subtests. The Pseudoword Decoding subtest indicates a positive change and a moderate effect size, but the Word Reading, Oral Reading Fluency, and Reading Comprehension subtests showed only a small effect size.

Based on these data, we could draw the conclusion that the online intervention being studied is not effective in improving reading accuracy, fluency, and comprehension. We would caution against this implication, however, based on the limited length of the data collection period and the fact that none of the ten students had completed the intervention when post-treatment data were collected. It is possible that with continued intervention, improved phonological processing may translate into improved accuracy, fluency, and comprehension.

NF, like other multisensory language instruction programs, is “a deliberate and systematic incorporation of multimodal opportunities to hear, see, say, and move, while following a carefully organized and sequenced approach to language structure” (Birsh & Carreker, 2018, p. 15). Students spend the first hours of the intervention examining the individual sounds that make up spoken and written language. Attention is paid to the articulation of each sound and how the parts of the mouth move for the creation of each sound. When students begin putting sounds together to “read” and “spell” words, they use mouth pictures,

rather than letters, until they have demonstrated mastery of each sound. Letters are often not introduced until after 30 or 40 hours of intervention, so it stands to reason that assessments that use letters would not demonstrate similar effects as the assessments that focus on oral language, as the CTOPP does.

Once letters are included in the instructional sequence of the program, students follow a hierarchical yet individualized progression of tasks, beginning with reading and spelling the simplest words in our language (words with one vowel sound and one consonant sound) and then being exposed to progressively more difficult words as they demonstrate mastery of the simpler structures. Similarly, as phonics expectancies are introduced, students practice with and demonstrate mastery of one expectancy at a time before being introduced to new rules. After 60 – 65 hours of treatment, many students in the program had not yet started working with multisyllable words, so it is not a surprise that effect sizes for word reading, oral reading fluency, and reading comprehension would be small. Data on functional reading abilities should be collected again after each student has completed the intervention (and that will be a different number of hours for each student, depending on age, level of deficit, and overall reading goals).

Research question #2 asks what effect, if any, the online remediation of phonological processing deficits has on student self-concept. The Piers-HarrisTM 3 Self-Concept Scale showed no change to overall student self-concept or to self-concept in the specific domain of Intellectual and School Status.

The self-concept scale includes statements such as “I get nervous when the teacher calls on me,” “I am smart,” “I am a good reader,” and “I am dumb

about most things." The initial phase of the intervention focuses on the underlying impairment or phonological processing difficulties, rather than functional reading abilities. If students participating in the program are not yet seeing improvements in their ability to read and understand grade level text, it is reasonable that questions focusing on traditional reading and spelling tasks would not demonstrate much change. Asking the same questions of each student at the completion of the intervention may show an improvement in these areas.

Parent perception of children's reading abilities were measured using a survey which included both open-ended questions and questions answered using a 5-point Likert scale. Questions on the Likert scale included:

1. My child can read unfamiliar words
2. My child can read fluently
3. My child understands what s/he reads
4. My child enjoys reading
5. My child avoids reading
6. My child is confident in his/her reading ability

Overall, parent perceptions of their child's reading attitudes and abilities were trending toward being more positive after 60 – 65 hours of intervention. Questions 1 through 4 and question 6 are all positive skills and feelings with which parents want to agree or strongly agree. For each of these questions, the percentage of "disagree and strongly disagree" answers went down, while the percentage of "agree and strongly agree" answers went up. For example, prior to beginning treatment, 62.5% of parents who responded to the statement "My child

can read unfamiliar words" answered "strongly disagree." After 60 – 65 hours of treatment, the percentage of parents who had answered that question with "strongly disagree" was down to 16.7%. Similarly, only 12.5% of parents answered "agree" or "strongly agree" to the statement "My child enjoys reading" prior to enrolling in NF, while after 60 – 65 hours of treatment that number had changed to 50%.

Results related to Theoretical Framework and Existing Literature

The theoretical frameworks upon which this study was based include the Phonological Processing Deficit Theory and the theory of Multisensory Structured Language Instruction. The results of this study add to the existing literature and provide insight into avenues for future research.

Phonological Processing Deficit Theory indicates that the root cause of dyslexia is an impairment in a student's ability to perceive, understand, and manipulate the individual sounds in words. The intervention which was investigated in this research is designed specifically to address this deficit, and data collected indicate that it certainly does. Post-treatment testing demonstrates improvements across all subtests and both composite scores, with large effect sizes throughout. Previous research as to the efficacy of this approach (Torgesen, 2000; Torgesen et al., 2001) focused on the in-person delivery of instruction; this research makes clear that phonological processing deficits can be remediated through online instruction as well.

Multisensory Structured Language Instruction is widely accepted as best practice in treating reading difficulties, although there is little empirical evidence

that this methodology is effective in improving functional reading abilities such as accuracy, fluency, and comprehension. The results of this study certainly support the assertion that this intervention – in which the kinesthetic component is defined differently than it is in other MSLI programs - is extraordinarily effective in remediating the phonological processing difficulties that precede reading troubles like dyslexia. This is the first study that examines the delivery of MSLI via an online format, rather than in person,

As is true for other MSLI programs, the instruction provided by NF is "systematic and cumulative." It starts with most foundational aspects of reading and spelling, including the ability to put sounds together to make words and take words apart into their individual sounds, and then builds on those skills. As letters are connected to the kinesthetic component of the intervention (oral motor movements), basic phonics expectancies are introduced and practiced, both in isolation and eventually within connected text in the form of leveled reading passages. Because of the finite nature of the data collection period, the researcher did not have time for the intervention to be fully implemented before collecting post-treatment data. Students had enough time for the underlying impairment to be addressed, but they did not necessarily have enough time for the functional deficits to be remediated.

Practice Recommendations

The implications of these results are very important, particularly for students who struggle to read and spell but who do not have access to highly trained instructors who know how to help. Clearly, phonological processing

deficits can be remediated online. Although teaching has historically been done face to face, remote instruction to address difficulties with understanding the nature of words can be effective. This creates possibilities for students in remote locations, students without qualified teachers nearby, and schools with limited resources who want to provide effective instruction for their students.

The NOW! Company is currently working with an independent school in Florida to provide online instruction for elementary aged students who have difficulty reading. The company is also negotiating with a large school district in the southeastern United States about the possibility of using ESSA funds to provide supplemental services to students at risk of reading failure as part of an after school enrichment program. Data from the current study provide evidence that students' phonological processing skills can certainly be improved using this intervention; administering the assessments at the conclusion of treatment will provide additional information about changes to functional reading abilities that schools and school districts can use as they make decisions about whether NF might be appropriate for their students.

Study Limitations

Although the findings of this research are positive, there are several limitations to the study that should be taken into consideration. First, the sample size is small. Only ten students participated in the study, and their ages, grades, and levels of impairment prior to treatment were quite varied. The NOW! Company routinely has between 90 and 100 students participating in NF; moving

forward, the researcher is hopeful that similar data will be collected on all enrolled students.

Second, and more importantly, because of the brevity of the data collection period, I collected “post-treatment” data before treatment was completed. Students participated in the post-treatment testing period after 60 – 65 hours of NF, while the average length of treatment for NOW! Company students is 120 hours. Students participating in the intervention do not complete a set number of hours; the amount of time each student spends getting remediated is determined on a case-by-case basis, and factors such as age, grade, level of impairment, and overall goals are taken into consideration when those decisions are being made by the Administrative Team. At the 60- to 65-hour mark, none of the students enrolled in the research study had reached a point yet where the recommendation had been made for them to exit the program. Data related to changes in functional reading abilities may not accurately reflect the changes in reading accuracy, fluency, or comprehension that students who complete the entire scope and sequence of NF might experience.

Recommendations for Future Research

In order to have a better understanding of the impact that the online remediation of phonological processing deficits has on reading accuracy, fluency, and comprehension, assessments should be re-administered after each student has completed treatment. Although the results in phonological processing scores are very positive, more research is needed to determine whether those

improvements translate into improvements in functional reading abilities as well. Follow-up studies could be conducted with students who completed the program; the same quantitative and qualitative measures could be used at fixed periods (perhaps one year post treatment or two years post treatment) to determine whether gains made in phonological processing remain or whether they lessen when students are no longer intensively receiving remediation.

Additionally, it would be worthwhile to examine results at the individual student level in order to determine potential correlational relationships between age, gender, level of impairment at beginning of treatment, and changes across subtest scores. It is possible that some students may respond more favorably to this intervention than other students do, and data collected and analyzed at the individual student level may help identify those for whom the intervention is most likely to be effective.

Finally, many parents who are seeking help for their children ask if the online treatment is as effective as going to one of the clinics, where the intervention is administered in person. Data collected at the clinics could certainly be compared to the data collected from the online students in order to see if similar gains are noted during similar time frames.

The small sample size is a limitation of this study. Therefore, all future students who are enrolled in the online program should complete this testing, both before they start treatment and again either after a certain number of hours or at the completion of treatment. This will naturally create a larger sample size, making the data more reliable and transferable.

Summary

This study provides important information about the online remediation of phonological processing deficits using a multisensory approach including the oral motor component of sound production. It adds to the body of research already in existence about MSLI and its impact on reading accuracy, fluency, and comprehension. The study also examines the effect of the intervention on student self-concept and parent perceptions of reading attitudes and abilities. Importantly, it demonstrates that remediation through an online platform can produce large changes in phonological processing skills. The online delivery of instruction has been critical during the recent COVID crisis and has potential for future learning opportunities for students as well.

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