2004

The Effects of the Handwriting Without Tears Program on the Handwriting of Students in Inclusion Classrooms

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THE EFFECTS OF THE HANDWRITING WITHOUT TEARS® PROGRAM ON THE HANDWRITING OF STUDENTS IN INCLUSION CLASSROOMS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

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June, 2004

Acknowledgements

Throughout the thesis process, I have been amazed by everyone who has offered help and support. I will begin by thanking my thesis advisors, Janet Watts and Jayne Shepherd. Without their tireless support, this process would have been impossible. I am also very thankful for my other committee member, James McMillan, for his time and guidance. I am lucky to have a group of friends who listened to hours of confusion and frustration, especially Kristina, Kelly, Andi, Amy, and Anita. In addition, my parents have continually supported me during my educational endeavors and never doubted my desire or ability to complete this thesis.

There are countless administrators, principals, teachers, and faculty in Chesapeake Public Schools who have been instrumental in helping with my thesis including: Sue Jacques, Liz Stublen, Jolie Collins, Kelly Shute, Mrs. Babb, Mrs. Brinn, Ms. Edmondson, and Mrs. Barber. I am also grateful to Butts Road Primary School for supplying the materials used during this study.

Additionally, I am grateful to a group of professionals who were instrumental in the development of interrater and intrarater reliability including: Dianne Koontz-Lowman, Molly Snow, Shelly Lane, and Judith Reisman. I would also like to thank representatives at HWT®, especially Emily Knapton and Kirstin Parsons, who were always ready to help and provide handwriting training to the teachers in this study.

Finally, I must also thank the 81 students who participated in this study and their families. Without their time and approval, this study would not have been possible.

Table of Contents

Page

List of Tables

Page

Abstract

THE EFFECTS OF THE HANDWRITING WITHOUT TEARS® PROGRAM ON THE HANDWRITING OF STUDENTS IN INCLUSION CLASSROOMS

By Lisa L. Owens, M.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

Virginia Commonwealth University, 2004

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Many handwriting programs are currently used in schools, but little research has been conducted on their effectiveness. A quasi-experimental non-equivalent comparison group pretest posttest design examined effects of the Handwriting Without Tears® program with special and general education students enrolled in inclusion classrooms. Two experimental classes received instruction with the HWT® method while two comparison classes received instruction using traditional methods. Handwriting performance was measured using the Minnesota Handwriting Assessment. One-way analysis of covariance tested the differences between rates of handwriting improvement for experimental and comparison groups while controlling for pretest

scores. Students in the experimental classes showed no statistically significant improvement in overall handwriting skill compared to the classes receiving traditional handwriting instruction. However, the HWT® program was found to be effective in improving the areas of size ($p = .008$) and spacing ($p = .014$) within a 10-week period, regardless of educational status or gender.

CHAPTER ONE

Introduction

Handwriting is one of the first tasks introduced to young students (Chu, 1997) and tends to be the primary means through which academic knowledge is demonstrated. McHale and Cermak (1992) report that students spend a large portion of their school day engaged in fine motor driven tasks such as coloring, cutting, and pasting. Elementary school children spend 30-60% of their class time in fine motor writing tasks, however, fine motor deficits are experienced by nearly 10% of all elementary school aged children. Ultimately, deficits in fine motor skills can lead to lowered self-esteem and frustration as well as poor school performance (McHale & Cermak, 1992).

Less time continues to be devoted to teaching this skill even though many students are experiencing handwriting deficits. Accordingly, handwriting is an area increasingly addressed by occupational therapists and tends to be one of the most common reasons for occupational therapy referrals in the school system (Oliver, 1990; Schneck & Henderson, 1990; Reisman, 1991; Woodard & Swinth, 2002). The teacher is primarily responsible for handwriting instruction while therapists identify underlying foundational skills that seem to be associated with handwriting issues such as motor, process skills or underlying body functions related to postural control. The therapist then creates activities that address these skills (Cornhill & Case-Smith, 1996). The idea

that handwriting is less uniformly and formally taught in the public school system, but encompasses such a large portion of a student's day appears to be a widespread concern that the profession of occupational therapy is especially prepared to address (Ediger, 2002).

Many theories, principles, and strategies are available to promote handwriting in school-aged children (Case-Smith, 2002). Several of the most commonly used school-based theories include Zaner-Bloser (2002), D'Nealian (Thurber, 1993), and McDougal Littell Handwriting (1990). In addition, occupational therapists may use other specific approaches based on perceptual motor, visual motor, ergonomic, kinesthetic, and/or multisensory modalities. Most therapists use an eclectic approach to treatment with a sensorimotor approach used most frequently (Feder, Majnemer, & Synnes, 2000). However, very little research has been conducted on the effectiveness of handwriting interventions (Berninger, Graham, & Weintraub, 1998; Clark-Wentz, 1997; Graham, Harris, & Fink, 2000).

The Handwriting Without Tears® (HWT) method is one of the most widely used approaches. It has been adopted by twelve state boards of education, including California and Texas, although there is limited research to support its effectiveness (Olsen, 2001). This multi-sensory program that was designed to teach students with varied learning styles, using visual, auditory, manipulative, tactile, and kinesthetic methods (Olsen, 2001). According to Olsen (2001), the program may help "eliminate problems with letter formation, reversals, legibility, sentence spacing, and cursive connections" (p. 1). Research related to this program focuses on slanted versus vertical

manuscript handwriting, handwriting in relation to speed and legibility, and readiness skills. No known published research focuses specifically on the HWT® program. It is often used by occupational therapists due to its multisensory nature and its ability to be used with children of all ability levels.

Pontello (1999) completed an unpublished Master's level thesis on the topic that assessed the effectiveness of the HWT® program with grade one students using a multiple group time series design with a pretest. The Minnesota Handwriting Assessment was used for baseline and subsequent measurements. Two experimental groups received instruction using the HWT® program and another control group was instructed using the "ball and stick" method. This study found that students in the control class were faster writers than students in the experimental groups, yet improvement in the handwriting of students in Class 1 and Class 2 indicate that a multi-sensory structured handwriting program, particularly Handwriting Without Tears®, may be more effective in improving handwriting legibility than a traditional ball and stick method of instruction.

Due to the widespread use and limited empirical research on HWT®, the current study will address the effectiveness of the HWT® program. In particular, it will examine the effects of the program with special and general education students enrolled in inclusion classrooms in a medium size suburban school system.

CHAPTER TWO

Literature Review

In this chapter, current and relevant literature about handwriting will be explored. Occupational therapy in the public school system will be addressed including legislation, delivery methods, and perceptions of therapists. The role of occupational therapy in handwriting, including the importance of handwriting to student performance and changes in how handwriting is taught will be covered. In addition, the ever-growing increase in handwriting problems will be examined. Handwriting approaches will be divided into school-based approaches (Zaner-Bloser, D'Nealian, and McDougal Littell) and occupational therapy-based approaches (perceptual-motor, ergonomic, kinesthetic, and multisensory). Specific handwriting interventions will be explored, including the Handwriting Without Tears® method. Finally, this chapter will review occupational therapy evaluation methods and procedures for handwriting.

Occupational Therapy in the Public School System

Legislation

Occupational therapy is included as a related service under the Individuals with Disabilities Education Act (P.L. 105-17) (IDEA, 1997). As defined by Part B of this act, occupational therapy services are indicated to improve, develop, or restore functions impaired or lost through illness, injury or deprivation and improve the ability

to perform tasks for independent functioning when functions are impaired or lost. In addition, occupational therapy serves to prevent, through early intervention, initial or further impairment or loss of function (Rapport, 1995). According to the Act, all children with disabilities have available to them a free and appropriate public education that emphasizes special education and related services designed to meet their unique needs, as necessary, within the school system. This free and appropriate education could include handwriting interventions to help students express their knowledge in the school setting, if deemed to be educationally relevant.

Delivery Methods

Several delivery methods are currently used in occupational therapy practice within the public school system. These include direct and consultative services and these are selected based on the individual child's needs. Occupational therapists use direct and indirect services, as well as assistive technology and environmental modifications, to collaborate with parents, teachers and other educational staff to help implement a child's special education program (American Occupational Therapy Association, 2001). According to Chu (1997), "therapists could use a continuum of service delivery models that allows for more flexibility, fluidity, and responsiveness to the individual child's needs" (p. 518). In addition, students can be seen in individual or group sessions and in a variety of settings throughout the school.

Palisano (1989) compared two methods of service delivery provided to students with learning disabilities. Nineteen students were in the therapist directed group and 15 formed the consultation group of students from five special education classes who were

matched for age, intelligence, previous therapy, and perceptual and motor development. Each group was pre and post-tested using the Test of Visual-Motor Skills (TVMS), the Test of Visual-Perceptual Skills (TVPS), and the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). Group progress on these tests was compared by analysis of covariance and indicated that the consultation group made greater improvements on the BOTMP and the therapist-directed group made greater improvements on the TVPS, but this finding was not statistically significant. In addition, both groups made comparable progress on the TVMS. Davies and Gavin (1994) compared individual and group consultation methods for 18 preschool children with developmental delays. Preschoolers were randomly assigned to either a direct therapy or a consultation group and assessed initially and 7 months later. Three standardized tests were used to assess fine and gross motor skills, functional home skills, and nonverbal intelligence. The results showed that students in both groups had significant increases in fine and gross motor skills as assessed by the Peabody Developmental Motor Scales. The lack of statistically significant findings between the efficacies of the two treatment methods suggests that a combination of group and consultative therapy may be as effective as individual therapy sessions. Dunn (1990) conducted a similar study with a sample of 14 randomly assigned preschool and kindergarten students, measuring goal attainment and teacher satisfaction. Goal attainment was commensurate for both groups, but 60% of teachers receiving consultation services reported greater contributions of OT to goals and more satisfaction (65%) with services provided. Thus, occupational therapy services can be effective if provided by either a consultative or direct method, but

teacher satisfaction and attainment of goals may be more effective in the consultative delivery method.

Perceptions of Therapists

Case-Smith and Cable (1996) conducted a survey of 216 school-based occupational therapists to determine the percent of therapists using direct and consultative models of service delivery and therapist attitudes toward different service delivery models. They found that therapists spend 47% of their time providing pullout direct therapy services and 53% of their time in the classroom and consultation. The respondents did not believe that children with disabilities were best served when pulled out of the classroom. Respondents reported using a variety of service delivery models, often combining direct and consultative services. In addition, respondents believed that children were best served when direct and consultative therapies were combined within the classroom. Thus, effective practice urges occupational therapists to deliver handwriting intervention in a method that best suits the individual child and in collaboration with the classroom teacher. A number of handwriting interventions are currently being widely used in public schools, some which allow for this combination of direct and consultative therapy.

Role of Occupational Therapy in Handwriting

Importance of Handwriting to Student Performance

McHale and Cermak (1992) report that handwriting is the primary way students communicate their understanding of academic content. Elementary school children spend 30-60% of their class time in fine motor and writing activities, with writing as the

predominant task. Additionally, fine motor deficits are experienced by nearly 10% of all elementary school aged children. Research has found that fine motor deficits can eventually lead to lowered self-esteem and frustration as well as poor school performance (McHale & Cermak, 1992). For example, perceptions about a child's competence as a writer can be affected and handwriting difficulties can interfere with the composing process during the act of writing. In addition, consciously paying attention to the mechanics of handwriting can interfere with the student's ability to process what is being learned (Graham, Harris, & Fink, 2000).

Changes in How Handwriting is Taught

The methods of handwriting instruction and the time devoted to this skill have shifted in the past twenty years, likely due to the fact that curriculums have apportioned more content to their day without extending the length of the school day (Wallace & Schomer, 1994). The amount and type of handwriting instruction can vary from one school to the next. In schools that maintain formal handwriting instruction, students generally learn to print in kindergarten or first grade and move on to cursive handwriting in late second or third grade. In addition, instruction typically takes place as a group activity rather than as individualized instruction. Group lessons take place daily in grades one to four, but after that, lessons are less frequent and usually last from 15 to 20 minutes (Ediger, 2002).

A great variety of materials and methods for teaching printing and cursive handwriting exist today. Despite all available materials and techniques, it has become surprisingly common for schools to teach handwriting in a less formal way, assuming

that students will pick it up on their own (Ediger, 2002). Unfortunately, little research has been conducted on the current state of handwriting instruction in public schools.

Increasing Incidence of Handwriting Problems

Wallace and Schomer (1994) postulate that the increase in handwriting problems may be attributed to the dramatic shift from printing to cursive handwriting in the 3rd grade. Students are given two to three years to master printed writing strokes, at which time they begin to focus on writing content. At that point, their attention is diverted away from the content of their writing and redirected back to learning a new writing form again focusing on mechanics and possibly lowering the content component of handwriting until they master cursive.

Handwriting difficulties tend to be one of the most common reasons for occupational therapy referrals in the school system (Oliver, 1990; Schneck & Henderson, 1990; Reisman, 1991). According to Oliver (1990), handwriting problems often serve as the educationally relevant route to occupational therapy. In addition, the teacher is primarily responsible for handwriting instruction, but the occupational therapist may intervene with postural, motor, sensory, or perceptual deficits that may be interfering with handwriting skills. Therapists identify underlying foundational skills that seem to be associated with handwriting issues. The therapist then creates activities that address these skills (Cornhill & Case-Smith, 1996). The idea that handwriting is less uniformly and formally taught in the public school system, but encompasses such a large portion of a student's day appears to be a widespread concern (Ediger, 2002). The

profession of occupational therapy is especially prepared to address these types of deficits as a consultant and sometimes as a direct service provider (Case-Smith, 2001).

General Handwriting Approaches

School-Based Approaches

School systems are replete with handwriting curriculums, with Zaner-Bloser (2002), D'Nealian (Thurber, 1993), and McDougal Littell Handwriting (1990) among the most popular. Almost all current handwriting programs are directly descended from the Palmer style (Zaner-Bloser, 2002), either as an enhancement of that method or as a reaction to it. Zaner-Bloser is the most frequently used handwriting program in the United States today (Zaner-Bloser, 2002). It is based on the Palmer method and offers both a traditional alphabet and a more contemporary version. According to the program, it employs easy to use materials and has received much support (Zaner-Bloser, 2002). McDougal Littell Handwriting is similar to Zaner-Bloser with minor variations in style and teaching methodology. D'Nealian handwriting was developed in the 1960s in an effort to ease the transition from manuscript to cursive. It features a unique manuscript alphabet that reflects the cursive forms of each letter. Ultimately, many studies have suggested various problems associated with learning a separate alphabet for reading and writing. In addition, D'Nealian does not work with a child's natural developmental pattern, but requires them to learn a new system and may be more difficult for students with learning disabilities (Thurber, 1993).

With teaching any skill, choices are made regarding the method of instruction. When teaching handwriting, school systems decide whether to use the vertical

manuscript letter forms, such as the Zaner-Bloser method or a slanted alphabet, such as the D'Nealian approach (Koenke, 1986). According to Graham (1992), the vertical alphabet has certain benefits, as it is more developmentally appropriate and is easier to read and write as well as being easier for educators to teach. On the other hand, the slanted alphabet, which was originally designed to ease the move from printing to cursive, has not been shown to meet its original goal and may have created some problems for learning handwriting (Graham, 1992). In addition to these school-based approaches, a number of therapist-based interventions are available and commonly used in practice and may include perceptual or visual motor, ergonomic, kinesthetic and/or multisensory approaches.

Occupational Therapy-Based Approaches

A multitude of theories, principles, and strategies are currently available to promote handwriting in school-aged children (Case-Smith, 2002). Most therapists use an eclectic approach to treatment with a sensorimotor approach used most frequently (Feder, Majnemer, & Synnes, 2000). Woodward and Swinth (2002) conducted a survey of 313 school-based occupational therapists regarding the use of multisensory modalities in treatment. They found that a multisensory approach to handwriting treatment was being used by 92.1% of school-based occupational therapists. Findings revealed that, of the 25 multisensory modalities presented, six were used very often or often by at least 60% of respondents. These included chalk and chalkboard, markers or felt pens, verbal description of letter shapes while the student writes, viscous substances for finger writing, and copying and tracing letters on regular lined paper. This finding

was surprising as it was expected that therapists would have reported using the 25 listed modalities more often, as they are often cited in literature. To the contrary, researchers found that 114 additional modalities were mentioned by respondents, indicating that 36.9% of these therapists used five or more modalities per student. This exemplifies the wide range of multisensory modalities being used to address handwriting problems (Woodward & Swinth, 2002).

Perceptual-motor and visual-motor approach. Handwriting involves the integration of fine motor, visual perceptual, and cognitive skills. Occupational therapists may break down the task of handwriting into component parts for remediation. Weil and Amundson (1994) examined the relationship between the performance of 60 typically developing Kindergarten children on the Developmental Test of Visual-Motor Integration (VMI) and letter copying ability. A moderate and significant relationship ($r = .47$, $p < .001$) was found between letter copying ability and scores on the VMI, showing that as scores on the measure increased, so did letter copying ability. The relationship between improvement and gender were explored, but no significant differences between boys and girls were found. Malloy-Miller, Polatajko, and Anstett (1995) added to these findings by studying 66 children aged 7 to 12 with mild motor difficulties to explore the relationship between error patterns and perceptual-motor abilities. This study was correlational without very clear causal links from visual and/or perceptual motor intervention to handwriting improvement. The results indicated three handwriting error patterns: visual-spatial factor, aiming factor, and execution factor with the latter two being associated with visual-motor abilities.

While these studies were correlational, they do suggest ties between perceptual and visual motor skills and handwriting.

Cornhill and Case-Smith (1996) also examined factors that relate to good and poor handwriting. In this quantitative study, a sample of 48 typical first graders who were identified as good and poor writers by their teachers completed the Motor Accuracy Test, the Developmental Test of Visual Motor Integration, two tests of in hand manipulation including informal rotation and translation tasks, and the Minnesota Handwriting Assessment. This study investigated the relationship between the specific performance components of eye-hand coordination, visuomotor integration, in-hand manipulation, and handwriting skill. This study concluded that visuomotor integration and in-hand manipulation have significant association to handwriting skill.

Tseng and Chow (2000) investigated the differences in perceptual-motor measures and sustained attention between children with slow and normal handwriting speed and the relationship between these factors using the Chinese Handwriting Speed Test and the Upper Limb Dexterity and Speed subtest of the Bruininks-Oseretsky Test of Motor Proficiency. Thirty-four students with slow handwriting speed and 35 students with normal handwriting speed attending elementary school were given three perceptual-motor tests and a vigilance task to assess sustained attention. It was determined that slow and normal writers used different perceptual motor systems to respond to handwriting demands. Normal speed writers were affected by upper-limb speed and dexterity, whereas slow speed writers seemed to rely more on visually directed processes. In addition, handwriting speed was significantly correlated with age

for both slow and normal speed writers. The three significant predictors of handwriting speed for slow writers were age, visual sequential memory, and visual-motor integration as measured by the Chinese Handwriting Speed Test. While research into the association of visual-motor and perceptual-motor factors to handwriting is mostly correlational, they do substantiate the influence of perceptual motor and visual motor abilities to fine motor and handwriting skills. Thus, within the context of being educationally relevant, occupational therapists address perceptual motor and visual motor skills when assessing and treating children with handwriting difficulties.

Ergonomic approach. Ergonomics is the applied science of equipment design intended to maximize productivity by reducing operator fatigue and discomfort (Merriam-Webster, 2002). Improper seating can lead to fatigue, difficulty using devices, and impaired ability to interaction with the environment (Angelo, 1997). In relation to handwriting, this could include changing the student's body positioning for proper alignment while sitting at a desk or table or increasing or decreasing the size or length of the writing instrument.

Carlson and Cunningham (1990) studied the effect of pencil diameter on pencil management (grasp and control) and performance in 48 preschoolers using the Graphomotor Task Instrument. Children were observed individually as they used both large (5/16 of an inch) and regular (3/8 of an inch) diameter pencils. Findings showed that there did not appear to be differences in pencil management and performance that are related to pencil diameter, preference, or gender. Oehler, et al. (2000) completed a similar study, by examining the effect of pencil size and shape on the pre-writing skills

of Kindergartners using a sample of 126 children. The children's writing skills were evaluated using a triangular shaped pencil, a standard pencil, and a large diameter pencil. Results showed no effect of pencil size or shape on handwriting. In addition, Dennis and Swinth (2001) conducted a study of 46 typically developing fourth grade students to determine the influence of pencil grasp on handwriting legibility during short and long writing tasks. Short tasks consisted of 2 to 4 sentences, with 5 to 10 words per sentence whereas long tasks consisted of at least eight sentences. Regular class writing assignments were scored for word and letter legibility and compared using a mixed repeated-measures analysis of variance design. The study found that the type of grasp used did not affect legibility although students wrote more legibly on the short than on the long tasks.

Koziatek and Powell (2003) studied how the speed and legibility of fourth grade handwriters was affected by pencil grip. The Evaluation Tool of Children's Handwriting- Cursive (ETCH-C) was used to evaluate a handwriting sample of 95 typically developing students and 6 special education students. Pictures were taken of their hands as they wrote and one-way ANOVAs were used to compare legibility and speed by type of grip. The grips used included: dynamic tripod (38), dynamic quadripod (18), lateral tripod (22), lateral quadripod (21), four-finger pencil grip (1), and interdigital pencil grip (1). Mean handwriting speeds were similar for all grips except the interdigital grip. This study found that the lateral quadripod grasp and the four-finger pencil grip might be as functional as other previously identified functional grips.

The results obtained in these studies are important to occupational therapy practice. Therapists have put emphasis on pencil grasp, size, and shape in the past. These findings may prompt a change in the current understanding of the importance of ergonomic factors on handwriting production as they demonstrate that pencil grip and diameter may not have a significant impact on handwriting.

Benbow (1995) and Olsen (2001) recommend certain positions during handwriting, but no research currently exists to support these recommendations. Furniture should properly fit the student during handwriting tasks. The chair height should allow contact of the student's feet on the floor and the student's arm resting horizontally on the desk surface. In addition, the hips and knees should be flexed at 90 degrees. The desk should be two inches above the student's bent elbow. Finally, each desk should face the chalkboard to allow easier viewing with less movement. In addition, it is suggested that the paper should run parallel to the line of the student's writing arm (Benbow, 1995).

Kinesthetic approach. Sudsawad, Trombly, Henderson, and Tickle-Degnen (2002) further explored the current practice of handwriting remediation through a study of 45 first grade students randomly assigned to a kinesthetic training group, a handwriting practice group, or a no treatment group. The kinesthetic training group was given six training sessions, lasting 30 minutes each, during which they received two types of training. Runway task training asked the child to determine the height of his or her arms on two tabletop runways with their vision occluded. In pattern task training, the students were asked to complete a stencil pattern from least to most complex. The

students in the handwriting practice group were also given six sessions, lasting 30 minutes each, during which time they were given letters, words, or sentences to copy. The practice consisted of one of three types of handwriting styles, Zaner-Bloser, Palmer, or D'Nealian. The researchers did not find improvement of handwriting ability through the use of kinesthetic training in children as measured by the Evaluation Tool of Children's Handwriting (ETCH), but all teachers indicated improvement of handwriting legibility in the classroom in all groups, which may be explained by exposure to pre-testing or the effects of maturation. Pre and post testing were completed four weeks apart. In addition, each group showed significant improvements in kinesthesis as measured by the Kinesthetic Sensitivity Test. These findings do not support the use of kinesthetic training to improve handwriting legibility.

Multisensory approach. Multisensory modalities are another method frequently used in handwriting remediation. This type of treatment involves combining the components of more than one sense (olfactory, auditory, gustatory, visual, and tactile) during treatment. Oliver (1990) discussed the effects of using a handwriting readiness program that combines occupational therapy treatment with parent or teacher involvement. Twenty-four children aged 5 to 7 years randomly divided into three groups were tested using the Developmental Test of Visual-Motor Integration-Revised (VMI) to assess writing readiness skills before instruction. Group 1 consisted of 12 children with normal intelligence. Group 2 consisted of six children whom all had a significant disparity between verbal IQ and performance IQ and Group 3 contained six children in special education classes. The results of this study showed that children

with writing readiness deficits might benefit from individualized instruction emphasizing multisensory modalities. All 12 of the children in Group 1 mastered the nine writing readiness tasks on the VMI and four children in Group 2 and 3 mastered all nine designs. The remaining children mastered eight of the nine designs. Woodward and Swinth (2002) conducted a qualitative study of 198 school-based occupational therapist members of the American Occupational Therapy Association (AOTA) in an attempt to determine which multisensory modalities were most often used in treatment. Descriptive analysis was used to describe the current practices of school-based occupational therapists regarding their use of multi-sensory modalities in handwriting remediation. This study found that more than 130 different multisensory modalities and activities were documented with only 25 of these being previously documented in the literature. This exemplifies the wide range of multisensory modalities and activities being used to address handwriting problems.

In addition, Lockhart and Law (1994) conducted a single case experimental design to evaluate the effectiveness of a multisensory writing program for improving cursive writing ability of four children. Visual and statistical analysis indicated that handwriting improved following use of this program.

Peterson and Nelson (2003) used a pretest posttest experimental design with random assignment of subjects to determine whether occupational therapy intervention improved printing in a school setting with economically disadvantaged first graders. The sample of 59 children was divided into intervention and control groups with the intervention group receiving 10 weeks of training twice a week for 30-minute sessions.

Treatment sessions consisted of five minutes of individualized multisensory techniques, 20 minutes of strategies for improving letter size, line use, and spacing, and five minutes of actual practice of D'Nealian handwriting. Students were pre and post-tested with the Minnesota Handwriting Test. A multivariate analysis of variance showed that students in the occupational therapy intervention group had significant gain in printed handwriting as compared to the control group (F= 6.43, p< .0001). While research is limited, the findings suggest that the use of multisensory modalities in handwriting intervention by occupational therapists is warranted, but that further research is needed to determine which modalities are efficacious.

Specific Handwriting Interventions

Occupational therapists and other related professionals have developed a variety of programs to help children acquire legible handwriting. These programs often use a combination of approaches such as sensorimotor, kinesthetic, and/or ergonomic components. Unfortunately, reports of these programs are often descriptive and little research about their effectiveness can be found.

Loops and Other Groups

Benbow (1991) developed Loops and Other Groups, which uses movement patterns to teach cursive writing. This program is used with second grade through high school aged children with learning disabilities and perceptual delays. Reportedly, students can learn cursive writing along with their non-disabled peers in a typical mainstreamed classroom. In this program, letters are taught in groups that share common movement patterns. Easy-to-remember motor and memory cues help students

visualize and verbalize while experiencing the "feel" of the letter. In addition, Benbow (1991) recommended that students use small length pencils in order to help them grasp the pencil closer to the point and to facilitate a tripod grasp. This program integrates kinesthetic, auditory, and ergonomic factors, creating a multisensory approach to handwriting. Information on the Loops and Groups program, up to this point, has been largely informational in nature and does not note the efficacy of this program.

Callirobics

Callirobics (Laufer, 1991) consists of repeating simple writing patterns (straight and curved lines) to music and integrating a kinesthetic modality. The music is reported to relax the child and adds rhythm to their handwriting. With music, writing becomes fun instead of a chore. Music also benefits children who learn better through auditory, instead of visual means. By consistent practice of simple patterns, the child's hand learns to perform basic elements of writing movements and the eye learns to focus on details. The accompanying music helps the child get better rhythm and flow in the writing. Reportedly, parents, occupational therapists, speech therapists, teachers, and activity directors can easily use Callirobics. This program has been deemed appropriate for students with low-developmental ability or for younger students who are just beginning to write (Laufer, 1991). As noted previously, the information available on this program is largely informational and does not refer to the effectiveness of this method of handwriting instruction.

TRICS for Written Communication

Amundson (1998) developed TRICS for Written Communication as an intervention resource focusing on children who experience mechanical and organizational difficulty during written communication and other school tasks. This program focuses on making accommodations and modifications in the classroom setting and assisting children to be successful and functional as soon as possible. It includes multisensory techniques, body and hand strengthening activities, and strategies for improving hand function and manipulation in the classroom. TRICS contains sections addressing handwriting in academics, legibility mechanics, handwriting biomechanics, foundations of function, and computer technology. This program is geared toward school professionals, child specialists, and parents. In addition, TRICS was designed to be an intervention complement to the Evaluation Tool of Children's Handwriting (ETCH). This handwriting program combines kinesthetic and ergonomic techniques, creating a multisensory program. Similarly, research on TRICS has been largely informational and does not reference the effectiveness of this program.

Big Strokes for Little Folks

In addition, Big Strokes for Little Folks, developed by Rubell (1995) helps to develop letter and number formation by grouping symbols according to similar characteristics and may be used for children ages six through twelve who exhibit moderate to severe difficulties performing basic printing skills. This program is designed for children who already recognize most letters but have had limited success in learning to form them. Big Strokes presents a wide variety of tactile and kinesthetic

activity suggestions to develop printing skills and teaches the therapist, and then the teacher, to develop a customized writing approach to meet each student's specific learning style. This program can reportedly be used with students whose cognitive levels range from the average intelligence to students who are educable mentally retarded. In addition, the manual reports that students with learning disabilities respond very well to this approach. Big Strokes is always therapist directed and can be used with consultative service delivery models or with a direct pull out service delivery model. It is a clinical intervention approach requiring the interpretation and analysis of an occupational therapist (Rubell, 1995). As noted with other handwriting methods, the research on this method thus far, has been mainly informational and does not indicate the effectiveness of this program.

Handwriting Without Tears®

Handwriting Without Tears® (HWT) is a multi-sensory program that was designed to teach all learning styles including visual, auditory, manipulative, tactile, and kinesthetic (Olsen, 2001). It was developed by an occupational therapist and reportedly can be used for all children in the classroom, including children with special needs. In addition, HWT® is a total method that takes the child from preprinting readiness skills to a mastery of cursive.

The program is developmentally based and is sequenced from kindergarten to the sixth grade, dividing skills into small tasks, arranging them from simple to complex, and beginning with what is familiar. Reportedly, with less than 10 minutes per day of instruction, students can learn to write well in either individual and classroom

instruction. One key feature of HWT® is the use of consistent, child-friendly language and step-by-step directions (Olsen, 2001).

The readiness component of the program addresses the development of correct and comfortable habits and provides the foundational skills necessary to prepare children to write well. The primary tools used during this portion of the program are Capital Letter Wood Pieces and Letter Cards as well as the HWT® Slate Chalkboard. In addition, *Letters and Numbers for Me*, a workbook focusing on correct letter and number formation and placement as well as consistent printing habits is utilized. The printing component of the program features the HWT® Slate Chalkboard in addition to *My Printing Book*, a grade one workbook and *Printing Power*, a grade two workbook. The cursive handwriting program introduces a vertical cursive alphabet strip as well as the *Cursive Handwriting* workbook for grade three and *Cursive Success*, for grade four (Olsen, 2001).

Research related to this program focuses on slanted versus vertical manuscript handwriting, handwriting in relation to speed and legibility, and readiness skills. No known published research focuses specifically on the HWT® program. According to Berninger, et al. (1998), "Slanted manuscript letters are no more successful than traditional manuscript letters in enhancing the transition to cursive writing or in improving the overall legibility of students' manuscript writing" (p. 291).

Pontello (1999) completed a Master's level thesis on the topic, which assessed the effectiveness of the HWT® program with grade one students using a multiple group time series design with a pretest. The Minnesota Handwriting Assessment was used for

baseline and subsequent measurements. Two experimental groups received instruction using the HWT® program and another control group was instructed using the "ball and stick" method. A one-way ANOVA was utilized to compare results. This study found that the experimental groups improved significantly ($p < 0.001$) in handwriting skills, especially in the area of alignment and sizing. Girls in both experimental groups demonstrated more improvement in overall printing, alignment, and size, whereas boys in experimental groups had more improvement in the areas of legibility and spacing. This study found that students in the control class were faster writers than students in the experimental groups. Improvement in the handwriting of students in experimental groups indicate that a multi-sensory structured handwriting program, particularly Handwriting Without Tears®, may be more effective in improving handwriting legibility than a traditional ball and stick method of instruction.

Although a variety of handwriting interventions are currently in use in public school systems, the Handwriting Without Tears® method has widespread use and has been adopted by twelve state boards of education, including California and Texas, although there is limited research to support its effectiveness (Olsen, 2004). According to Olsen (2001), the program may help "eliminate problems with letter formation, reversals, legibility, sentence spacing, and cursive connections" (p. 1). This program is often used by occupational therapists due to its multisensory nature and its ability to be used with children of all ability levels. In order to examine the efficacy of the HWT® program, an evaluation tool must be selected which best suits the school-based population.

Occupational Therapy Evaluation Methods and Procedures

The current practice of occupational therapy with handwriting intervention involves a combination of assessment procedures and treatment techniques. Occupational therapists frequently evaluate children who are experiencing problems with handwriting. The role of the therapist is to determine what components of handwriting are difficult for the student. Therapists tend to choose assessments that are readily available and have desirable characteristics such as cost and time effectiveness, standardization, reliability, test construction, and validity (Burtner, et al., 1997). When selecting an assessment tool, the therapist should look at characteristics of each as well as strengths and weaknesses in relation to reliability and validity (Chu, 1997). The assessment should be able to describe the students' abilities and weaknesses, predict current or future problems, and document changes (Burtner, 1997). Commonly used assessments include: the Evaluation Tool of Children's Handwriting (Amundson, 1995), Children's Handwriting Evaluation Scale- Manuscript (Phelps & Stempel, 1987), and the Minnesota Handwriting Assessment (Reisman, 1999). Each tool has different characteristics such as age or grade range, components tested, and scoring processes that must be taken into account before selection.

The Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M) (Amundson, 1995) examines manuscript handwriting legibility and speed with children in grades 1 and 2 or possibly children in grade 3 who have not yet had 10 to 12 weeks of consecutive cursive handwriting instruction. Legibility components such as form,

spacing, sizing, and alignment along with sensorimotor skills are assessed. The ETCH-M was designed for children with mild developmental delays, learning disabilities, and/or mild neuromuscular impairments. Students with mental retardation, emotional disturbances or cerebral palsy may not be appropriate candidates for this assessment. In reliability testing, assessments completed by two groups of children (N = 59) were scored by three occupational therapists. Pearson product-moment correlation coefficients as well as intraclass correlation coefficients (ICC) were assessed for legibility scores. The following Pearson correlations for experienced raters were found: total letters (.92), total numbers (.85), and total words (.85). As for Pearson correlation for experienced and inexperienced raters, the following scores were obtained: total letters (.90), total numbers (.87), and total words (.75). Finally, ICC found total letters (.84), total numbers (.82), and total words (.48) correlations (Amundson, 1995).

Diekema, Deitz, and Amundson (1998) conducted a study to determine the stability of the ETCH-M legibility scores. A convenience sample of 31 children (24 boys, 7 girls) was obtained. Each child had identified handwriting deficits and was either in the first or second grade. The ETCH-M was administered on two different occasions using a 7-day time interval by a primary investigator. During every 10^{th} or 12^{th} test, a second person sat in to record procedural correctness and the primary investigator checked scoring competency according to the examiner's manual instruction. In all cases, scoring competence was at or above 90%. Descriptive statistics were examined for test and retest for individual tasks and total scores. The investigators found that the test-retest reliability of handwriting legibility as assessed by

the ETCH-M was lower than desirable, but within the range of other assessment tools. Reliability coefficients for individual tasks ranged from .20 to .76 and ranged from .63 to .77 for the total scores. Individual task scores appeared less stable over time than the total scores. Results revealed no substantial practice effect and no test-retest scores changed more than 20% for total letter legibility scores indicating that a change of more than 20% is likely due to clinical change.

The Children's Handwriting Evaluation Scale- Manuscript (CHES-M) is a diagnostic test for manuscript writing in grades 1 and 2. This assessment has 57 letters and includes all letters of the alphabet except i, q, v, x, and z. Students copy a passage containing these letters as well as possible on unlined paper. The test is administered for two minutes in either group or individual sessions. Quality and rate are evaluated on a ten-point scale and can be reported as standard scores and percentiles. Phelps and Stempel (1987) conducted a study that included 643 students in regular and resource classes from Dallas County Schools. Each student was given a sheet of paper with the spelling subtest of the Wide Range Achievement Test-Revised (WRAT-R) on one side and the CHES-M on the other. Two professional examiners administered all the tests. The author's scores were compared using the Spearman-Brown formula. Intraclass reliability was .81 and .65 for grades 1 and 2 respectively. Judgments coincided with no more than one point difference 76% of the time for grade 1 and 72% for grade 2. No rating diverged more than two points. The limited results found by this study suggest that the CHES-M is a reliable diagnostic tool, although Reisman (1991) reports that this measure does not have a well-defined scoring system.

The Minnesota Handwriting Assessment (MHA) assesses manuscript (Palmer and Zaner-Bloser) and D'Nealian handwriting styles and is given individually or in a classroom setting. This assessment is used with students in Grades 1 and 2 and assesses rate and five quality categories including: legibility, form, alignment, size, and spacing. This assessment utilizes near point copy and requires students to copy words from a printed stimulus sheet onto lines below. The words contained in this assessment are a variation of the sentence "The quick brown fox jumped over the lazy dogs." The test is timed for 2.5 minutes to establish a rate score. The MHA can be given by a range of professionals such as special or general education teachers, psychologists, and occupational and physical therapists, but should only be interpreted by those who have an understanding of perceptual motor skills and the handwriting process (Reisman, 1991).

Conclusions

Research has shown that handwriting tasks make up a large part of the student's day. In addition, a majority of occupational therapist's caseloads consist of children with handwriting deficits. The research identified that therapists use a variety of service delivery models, programs, and multisensory modalities in the treatment of handwriting deficits. Inadequate information is available regarding the efficacy of modalities currently used in handwriting remediation. The literature identifies general remediation techniques such as kinesthetics and various multisensory modalities, but does not address specific handwriting remediation programs. Currently, many programs such as Callirobics, Loops and Other Groups, Big Strokes for Little Folks, and Handwriting

Without Tears® are used by occupational therapists or have even been adopted by state school boards. In particular, HWT® has been adopted by 12 school systems (Olsen, 2004). However, there is limited research on the effectiveness of these programs. Since the Handwriting Without Tears® program is so widely used, this study will examine the effectiveness of this program with public school students with and without disabilities. In addition, this study will address whether the HWT® program improves handwriting for children in inclusion classrooms over a 10-week period of time.

CHAPTER THREE

Methodology

Study Design

The purpose of the proposed study was to investigate the effectiveness of the Handwriting Without Tears® (HWT) program (Olsen, 2001) for children in second grade inclusion classes who were learning or refining manuscript handwriting. The Minnesota Handwriting Assessment (MHA) (Reisman, 1999) was used to collect and analyze handwriting samples. A quasi-experimental non-equivalent comparison group pretest posttest design was used to measure student changes in handwriting quality and rate during a 10-week period.

Hypotheses

This study will produce pre, interim, and posttest data from handwriting samples measuring manuscript quality and rate. Classes one and three were experimental groups and Classes two and four were comparison groups. In this study, it is expected that:

1. In the final administration of the MHA, students who received HWT® instruction will have higher scores on the MHA than students who did not receive HWT® instruction.

2. General education students receiving HWT® instruction for 10 weeks will have greater statistical improvements on the MHA than special education students receiving the same instruction.

3. Female students receiving HWT® instruction for 10 weeks will have greater statistical improvements on the MHA than male students receiving the same instruction.

4. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting legibility than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

5. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting form than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

6. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting alignment than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

7. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting size than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

8. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting spacing than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

9. The students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting rate than the comparison group as evidenced by pretest, interim, and posttest data using the MHA as an evaluation tool.

Variables

The main independent variable in this study was handwriting instruction using the Handwriting Without Tears® (Olsen, 2001) program. Other variables included: age, handedness, gender, receipt of occupational therapy intervention, receipt of other handwriting instruction, and special education status. The dependent variable is the improvement in handwriting in relation to quality and rate. Rate was measured by the number of letters a student completes legibly in 2.5 minutes. Quality was determined by measuring the variables of legibility, form, alignment, size, and spacing.

Subject Selection

There were four classes participating in this study. Two experimental groups received HWT® instruction and two comparison groups received the handwriting instruction that typically occurred daily in the classroom. The students in each group were enrolled in inclusion classrooms within one primary school in a medium size

suburban school system (enrollment 38, 325). Teachers were selected on the basis of principal opinion of what teachers would be interested and would provide an average level of instruction.

The subjects in the experimental and comparison groups were kept as intact classes. The teachers in the experimental group attended a Handwriting Without Tears® workshop in the fall of 2003 at no cost to them. In addition, they were provided with all necessary teaching materials and instructional books. Each classroom had printing display cards, desk strips, and notebook paper and each student had their own HWT® Printing Book and chalk slate. Additionally, teachers were consulted once a week via email or personal communication to allow the opportunity for concerns of questions. All teachers were supplied contact information if they had any additional questions between consultations.

Eligibility Criteria

All children in selected classrooms were eligible for participation unless they were unable to read English or had significant visual impairments that would have prohibited them from receiving the full benefit HWT® instruction. In addition, any second grader who could hold a pencil, see, and concentrate/understand the task was eligible to take the MHA (J. Reisman, personal communication, January 23, 2003). No children in the classes used were part of the investigator's therapy caseload during this study, but they may have been on another occupational therapists' caseload. In this situation, the school therapist was aware of which students were involved in this study

and they did not receive any additional Handwriting Without Tears® specific intervention outside of the scope of this study. Virginia Commonwealth University Institutional Review Board approval, Chesapeake Public Schools approval, and principal, as well as teacher, consent was required before an explanation letter were sent to parents of students in each classroom.

Instrumentation

The assessment took approximately 10 minutes to administer and was done in a group setting. The MHA asked students to copy a sample from near point. The sample sat on the desk as opposed to being written on the blackboard. The words utilized were a derivative of the sentence, "The quick brown fox jumped over the lazy dogs." The words were mixed in this sample to eliminate the potential for memorization, thus, increasing the probability that each student would have to read each word before they wrote it. A total of 2.5 minutes was provided to copy as many words as possible (Appendix A). At that time, the students were asked to circle the last letter they printed. They were then allowed to finish the writing sample. The words written within the 2.5 minutes time frame created the score for rate and the quality of the sample was determined by assessing legibility, form, spacing, alignment, and size.

Scoring Criteria

A score for rate is determined by the amount of letters a student forms in 2.5 minutes. Five different categories are assessed by the MHA to determine the quality score including: legibility, form, alignment, spacing, and size. Each letter is scored individually and a ruler may be necessary in some instances and is given one point for

each category and a maximum of five points may be earned for each letter. The total maximum point score on the test is 170. (Reisman, 1999).

Legibility

Scoring for legibility requires looking at each letter in isolation and without regard to the printed stimulus or other letters. Legibility is weighted more heavily than the other categories in this assessment as evidenced by the fact that if a letter loses a point for legibility, then it earns a zero in the other four categories. The maximum point score for this category is 34 (Reisman, 1999).

Form

In order to earn one point in this category per letter, the lines should be curved or pointed in certain parts of the letter and gaps or line extensions grater than 1/16 inch cannot be presented. The maximum point score for this category is 34 (Reisman, 1999).

Alignment

This category relates to the position of the letters on the line. A letter will earn an error point if it does not rest within 1/16 of an inch above or below the bottom line. The maximum point score for this category is 34 (Reisman, 1999).

Size

Each letter is judged in size in reference to the solid top line, the dotted line, or the lower dotted line. In order to receive a point, the letter must be within 1/16 of the lines that should be touched by the letters. The maximum point score for this category is 34 (Reisman, 1999).

Spacing

This category includes letter and word spacing. Letter spacing is the space between two letters of a word and word spacing is the space between two words. A ruler is used to judge specific criteria for too narrow or too wide spacing. The maximum point score for this category is 34 (Reisman, 1999).

MHA Reliability and Validity

According to Reisman (1993), the Minnesota Handwriting Assessment "was designed to meet the need of occupational therapists for a norm-referenced test that is sensitive to small changes in the performance of younger students" (p. 43). Several interrater reliability studies have been completed since the test's inception. The first was completed using a pilot version of the Minnesota Handwriting Test (MHT), which was later named the Minnesota Handwriting Assessment, using six research assistants who were novice scorers. This study found an interrater reliability correlation using Pearson correlation in the .77 to .88 range. The second reliability study used the research version of the test. Two experienced raters and one inexperienced rater scored twenty samples independently. The interrater reliability for the experienced scorers using Pearson correlation was .90 for form and .99 for alignment and size. Interrater reliability between the inexperienced rater and the test author ranged from .87 to .98. The author, one experienced rater, and one inexperienced rater scored identical sets of 20 samples to estimate intrarater reliability. The following correlations were found: rate (1.00), legibility (.96), form (.97), alignment (.99), size (.99), and spacing (.97).

Legibility is an essential prerequisite to assessing all other handwriting qualities. All scoring, and thus, validity, on the MHA revolves around the legibility component. In addition, form, alignment, size, rate, and spacing were added as they each contribute to letter quality. All components of this assessment, except legibility and portions of form can be judged on the basis of ruler measurement, insuring objectivity in scoring. In addition, the derivative sentence was chosen to reduce speed and memory advantage (Reisman, 1999).

The validity of the MHA has been examined in several studies. Cornhill and Case-Smith (1996) tested the following hypotheses: (a) specific performance components will be associated with handwriting skill, (b) these performance components will predict handwriting skill, and (c) combined performance measures will correctly classify subjects as good or bad handwriters. They used a sample of 48 typical first graders who were identified as good and poor handwriters by their teachers. Each child completed the Motor Accuracy Test, the VMI, two tests of in-hand manipulation, and the MHT. All hypotheses were supported, with discriminant analysis correctly classifying 98% of subjects correctly as good or bad handwriters. This supports a claim to construct validity.

The MHA validity was also examined in a study completed by Reisman (1991). This study examined the appropriateness of children who were referred for occupational therapy services by testing the hypothesis that students referred to occupational therapy for poor handwriting and those not referred would have statistically significant different scores on the MHT. This study used a convenience

sample of all of the second graders in 27 public elementary school classes throughout the country (N = 565), with all classes containing at least one special education student who was receiving occupational therapy services. All students received handwriting instruction with no control over amount or type of instruction, but no student received additional handwriting instruction in occupational therapy. The study was divided into four groups including: Group 1- students in regular education classrooms who were receiving no special education services (n = 428), Group 2- mainstreamed students in the same regular classrooms who spent part of their day in special education, but did not receive occupational therapy (n = 30), Group 3- students in regular education classrooms receiving no special education, but who were identified as having poor handwriting (n = 56), and Group 4- mainstreamed students who spent part of the day in special education and who received occupational therapy for handwriting problems (n = 51). The Minnesota Handwriting Test (MHT) was used to assess handwriting skills. An occupational therapist or teacher administered the MHT and most tests were scored by the occupational therapists in each cooperating school district who were blind to group placement. A single-factor analysis of variance was then performed on the students' scores to determine differences among the groups followed by Scheffe post hoc analysis for a comparison of groups. This study found that the students with the lowest scores on the MHT were the students who required handwriting intervention, according to teacher report. The differences among the groups were statistically significant ($F = 218.7$, $p < .0001$). In addition, all post hoc comparisons were

significant at the 99% level (Reisman, 1991). This supports a claim to the instrument's construct validity.

A threat to internal validity in this study was selection, as the possibility existed that the groups may not have been equivalent. In this case, any group differences on the dependent variable could have been the result of these differences versus the effect of the independent variable (Polit & Hungler, 1995). In addition, a threat of maturation existed in this study due to the fact that the subjects matured simply due to a passage of time rather than due to effects of variables. A final threat to internal validity was testing, which could be seen in pre, interim, and post-testing using the same assessment. The MHA has attempted to influence this threat by mixing up words derived from the sentence "The quick brown fox jumped over the lazy dogs" in order to eliminate the potential for memorization (Reisman, 1999).

Several threats to external validity existed in this research study. The novelty effect was evidenced when subjects or researchers altered their behavior in response to new treatment. They may have reacted either enthusiastically or skeptically about the new method. In addition, measurement effects may have been threats to the external validity of this study. In this case, the results may not be applicable to another group who were not exposed to the same types of data collection (Polit & Hungler, 1995). Although threats to reliability and validity do exist, overall, the MHA has relatively better characteristics of validity and reliability, making it preferable for this study.

Use with Children with Disabilities

According to J. Reisman (personal communication, January 23, 2003), the MHA can be administered to children with a variety of disabilities. Since this is a test of handwriting, it is appropriate for any first or second grader who can hold a pencil, see, and concentrate/understand the task.

Data Collection Procedures

Subjects were recruited based on principal and teacher agreement to participate in this study. Principals and teachers from one school were contacted (see Appendix B, C and D). Once those agreements were made, students enrolled in inclusion classrooms in this school were selected based on convenience and teacher interest. Recruitment was completed by the school principal (Appendix E). Parents of each child in the classroom were contacted to allow their child to be in either a comparison or an experimental group, depending on the classroom in which they were enrolled (Appendix E). Data from the study were kept in a locked file by the principal investigator in her home office.

Confidentiality was maintained in this study in a number of ways. Each subject was given a subject number rather than using names. In addition, the school principal coordinated subject recruitment. Since handwriting is an individual task and scores can vary greatly among classes, individual scores were obtained. This is also necessary due to the increasingly inclusive nature of classrooms, with classrooms consisting of both children with and without identified disabilities. Teachers for each classroom carried out pre, interim, and post-testing. The special education chairperson for the school coded the assessments before the researcher

had access to them. Only the chairperson had access to student names as equated to codes. This individual was not otherwise involved with the study.

The teachers in the experimental group were trained in the Handwriting Without Tears® method by attending a HWT® sponsored in the fall of 2003. The fee for attendance at this workshop was sponsored by the HWT® Company, except for fees for materials, which were funded by the project. At this workshop, teachers were instructed in writing readiness including handedness, pencil grasp, visual perceptual skills, and language for letters. In addition, they were instructed in printing capitals, numbers, and lower case letters.

Data were collected using the MHA before intervention, in a pre-testing format, once during intervention, and after intervention in a post-testing format. Prior to MHA administration, students completed a student data form (Appendix G) attached to the MHA score sheet. Intervention was carried out for ten weeks; thus, data were collected in each month and a month before intervention began. The pre, interim, and post-testing were conducted to determine the levels of handwriting ability before and after intervention. In addition, teachers kept daily checklists, which they turned in monthly to show when they used the HWT® method and how long (Appendix F).

The primary researcher completed scoring of the MHA. The researcher was blind to subject, as tests were coded for class and subject. The scorer learned how to score the components on the MHA and completed sample assessments to score for interrater reliability. In addition, the scorer was blind to the condition of the group, thus, not knowing which subjects were in the experimental or comparison groups.

Pilot Reliability Estimates

Prior to scoring the MHA tests, a group of professionals with extensive experience in pediatric handwriting assessments trained the primary researcher to score the MHA. One attendee routinely assessed children's handwriting problems and completed a research study in handwriting for her Master's degree in Occupational Therapy. The other attendees consisted of those with a Doctor of Education in Special Education and a Special Education degree and a Master's degree in Occupational Therapy. This group of professionals met on 10-27-03 at Virginia Commonwealth University to build consensus and reliability with scoring of the Minnesota Handwriting Assessment. The attendees were familiar with the MHA from reviewing the manual. The attendees scored two sample assessments together, talking about each letter and category as the assessments were scored. Then the attendees scored two assessments separately, reaching somewhat close consensus about scoring. In addition, an experienced pediatric therapist and researcher scored 10 evaluations and these scores were compared to the group scores for discussion.

The researcher and the experienced clinician also completed the self-guided tutorial in the Minnesota Handwriting Assessment examiners manual. Both the researcher and the clinician scored an additional 10 assessments and the following Pearson correlations were obtained: Rate 1.00, Legibility .83, Form .889, Alignment .977, Size .877, and Spacing .810. In addition, the researcher scored the same ten protocols a week later and established the following Pearson correlation estimates of intra-rater reliability: Rate 1.00, Legibility .940, Form .988, Alignment .979, Size .963, and Spacing .943.

Data Analysis

Interval-level data were used in this study. According to Polit and Hungler (1995), "Interval measurement occurs when the researcher can specify both the rank-ordering of objects on an attribute and the distance between those objects" (p. 441). In addition, a one-way analysis of covariance (ANCOVA) technique was used to determine the difference between the experimental groups and the comparison groups. An ANCOVA adjusts for selection differences that may exist and is particularly useful in research when random assignment to groups is not possible. In using a one-way ANCOVA technique, a post hoc statistical control is possible, allowing for a more precise estimation of the group differences. Extraneous variables must be controlled for at the beginning of the study. According to Polit and Hungler (1995), "ANCOVA tests the significance of differences between group means after first adjusting the scores of the dependent variable to eliminate the effects of the covariate" (p. 517).

There were three data collection points: pretest, interim at five weeks, and posttest after ten weeks of instruction. This allowed the identification of points of change and amount of change. The data were analyzed according to two specific testing periods: pretest to interim and pretest to posttest. These periods show the change from beginning to end of the study and from beginning to the midway point.

CHAPTER FOUR

Results

This chapter presents the results, including descriptive statistics and analyses for each hypothesis. The findings from each hypothesis are presented including scores for the sub-categories of legibility, letter formation, alignment, size, spacing, and rate.

Demographic Characteristics

Table 1 summarizes the ages of students in the study sample. In addition, Table 2 gives information about receipt of occupational therapy services and educational status (special or general). Three to four children who were identified with special education needs were in both of the experimental and the comparison groups. The average age for males in experimental groups was 8 years, 3 months old, whereas the average age for males in comparison groups was 8 years, 2 months old. The average age for females in experimental groups was 8 years, 4 months and the average age of females in comparison groups was 7 years, 9 months. The experimental group consisted of 41 students, comprising 50.6 percent of the sample. The comparison group had 40 students, making up 49.4 percent of the study sample.

Table 1

Age of the Study Sample (N = 81)

	Experimental Group (n =41)					Comparison Group (n =40)				
	Mean	Range	SD	n	%	Mean	Range	SD	n	%
Age										
Male	8-3[a]	1-10	0.68	23	56.1	8-2	2-10	0.83	21	52.5
Female	8-4	1-11	0.75	18	43.9	7-9	1-11	0.78	19	47.5

[a] Mean age and range in years and months

* Standard Deviation in years

Table 2

Characteristics of the Study Sample (N = 81)

	Experimental Group (n =41)		Comparison Group (n =40)	
	n	%	n	%
Gender				
Male	23	56.1	21	52.5
Female	18	43.9	19	47.5
Hand Preference				
Right	31	75.6	36	90
Left	10	24.4	4	10
OT Received				
Yes	3	7.3	4	10
No	38	92.7	36	90
Special Education				
Yes	8	19.5	7	17.5
No	33	80.5	33	82.5

Interpretation of Results

A one-way analysis of covariance (ANCOVA) was used to analyze the difference between total and category scores on the Minnesota Handwriting Assessment (MHA) for experimental and comparison groups. An ANCOVA adjusts for selection differences that may exist and is useful in research when random assignment to groups is not possible. An ANCOVA was used to statistically control for differences in pretest MHA scores because it was not possible to randomly assign students to experimental and comparison groups. Intact groups were used for the comparison group. Classes one and three comprised the experimental group that received HWT® instruction, and classes two and four comprised the comparison group that received the usual classroom handwriting instruction. The average daily instructional time was greater in the experimental group. Efforts were made to control this extraneous variable by having the principal select teachers who would be interested in this study and would likely provide similar amounts of instructional time (see Table 3).

Study Findings

The Minnesota Handwriting Assessment consists of five categories including: legibility, letter formation, alignment, sizing, and spacing. In addition, rate is assessed by how many characters a student can produce in a certain amount of time. MHA total and category scores were analyzed for experimental and comparison groups to determine whether there were changes in mean scores, while controlling for the

Table 3

Average Amount of Time Spent Teaching Handwriting [a]

	Experimental Group	Comparison Group
Week 1	79 min	66 min
Week 2	93	80
Week 3	79	46
Week 4	74	24
Week 5	72	56
Week 6	61	54
Week 7	77	60
Week 8	68	56
Week 9	76	52
Week 10	79	50
Average minutes of instruction per week	75.8	54.4

[a] Amount of time presented in minutes

covariate of pretest scores. Table 4 shows the ANCOVA analysis mean scores for experimental and comparison groups for the Minnesota Handwriting Analysis total and category scores.

Table 4

ANCOVA for Experimental and Comparison Groups Mean Scores for the Minnesota Handwriting Assessment Total and Category Scores

	Experimental Group (n=41)		Comparison Group (n=40)			
	Mean	SD	Mean	SD	*F*	*p*
Total	188.10	10.67	183.45	11.66	3.467	.066
Legibility	32.44	4.24	33.15	3.09	.711	.402
Letter Formation	33.41	1.02	33.00	.99	3.678	.096
Alignment	29.22	2.92	28.98	2.85	.379	.540
Size	31.15	3.38	29.40	3.55	7.306	.008**
Spacing	29.90	3.46	27.13	6.06	6.315	.014
Rate	32.22	2.26	31.80	1.87	.956	.331

* $p < .05$ ** $p < .01$

Hypothesis One

Hypothesis one states: In the final administration of the MHA, students who received HWT® instruction will have higher scores on the MHA than students who did not receive HWT® instruction. Table 4 provides the ANCOVA analysis for experimental and comparison group mean scores for total and category scores, controlling for the covariate of pretest scores. Appendix I reports the number, mean,

and standard deviation for each class for total test scores and for each category. Appendix J reports scores broken by class.

An ANCOVA was performed, controlling for the covariate of pretest MHA scores, followed by a *t*-test to determine if classes accounted for any change. The difference between the mean total posttest score of the experimental group (188.10) and the comparison group (183.45) was not statistically significant ($p = .066$) while controlling for pretest scores. Thus, the two experimental groups appear to have demonstrated similar improvement. Therefore, HWT® instruction was not found to have a significant effect on the overall handwriting of students in experimental groups. The first hypothesis was not supported.

Hypothesis Two

Hypothesis two states: General education students receiving HWT® instruction for 10 weeks will have greater statistical improvement on the MHA than special education students receiving the same instruction. The differences between educational status scores for those receiving HWT® intervention using a 2x 2 ANCOVA that controlled for pre-test scores are presented in Table 5.

Table 5

ANCOVA for General and Special Education Experimental Groups Students' Mean Scores for Minnesota Handwriting Assessment Total and Category Scores with the Covariate of Pretest Scores Being Controlled

	Experimental Group					
	General Education (n = 33)		Special Education (n = 8)			
	M	SD	M	SD	*F*	*p*
Total	188.88	10.51	184.88	11.43	0.061	.806
Legibility	32.61	4.12	31.75	4.95	.130	.720
Formation	33.39	1.09	33.50	.756	.156	.695
Alignment	29.30	2.88	28.88	3.27	.225	.753
Size	31.33	3.48	30.38	3.02	.168	.684
Spacing	30.33	3.01	28.13	4.73	2.525	.120
Rate	32.21	2.37	32.25	1.91	.064	.802

After controlling for pretest MHA scores, there was no statistically significant difference (p = .806) in posttest MHA scores between subjects receiving general and special education HWT® instruction. After controlling for pretest score, neither educational status group (general or special) showed more improvement after receiving HWT® instruction than the other group. This hypothesis was not supported.

In addition, the ANCOVA examined interaction effects between the variable of educational status and the variable of group. There was no interaction (p = .806) between these variables (See Table 6).

Table 6

Interaction Effects of Variable of Educational Status with Variable of MHA Category Scores

	F	*p*
Total	0.061	.806
Legibility	.130	.720
Letter Formation	.156	.695
Alignment	.225	.753
Size	.168	.684
Spacing	2.525	.120
Rate	.064	.802

Hypothesis Three

Hypothesis three states: Female students receiving HWT® instruction for 10 weeks will have greater statistical improvements on the MHA than male students receiving the same instruction. Much of the current literature on handwriting suggests a difference between males and females in handwriting skills. Thus, the findings from this study also present the differences between handwriting change scores for male and female students who received Handwriting Without Tears® instruction. Table 7 shows

the 2x2 ANCOVA analysis for gender scores of group mean scores on MHA total and category scores.

Table 7

ANCOVA for Gender Scores for Experimental Group Mean Scores on Minnesota Handwriting Assessment Total and Category Scores

	Experimental Group					
	Males (n = 23)		Females (n = 18)			
	M	SD	M	SD	F	*p*
Total	188.87	8.66	187.11	12.99	.227	.636
Legibility	33.17	3.20	31.50	5.23	1.737	.195
Formation	33.57	.843	33.22	1.22	1.683	.202
Alignment	29.17	2.25	29.28	3.68	.011	.915
Size	31.26	2.65	31.00	4.22	.077	.783
Spacing	29.52	3.58	30.39	3.33	.628	.433
Rate	32.61	1.31	31.72	3.06	1.576	.217

After controlling for pretest MHA scores, there was no statistically significant difference ($p = .636$) in posttest MHA scores between females and males. Hypothesis three was not supported. In addition, the ANCOVA examined interaction effects between the variable of gender and group. There was no interaction ($p = .110$) between these variables (See Table 8).

Table 8

Interaction Effects of Variable of Gender for Experimental Group with Variable of MHA Category Scores

	F	*p*
Total	.227	.636
Legibility	1.737	.195
Letter Formation	1.683	.202
Alignment	.011	.915
Size	.077	.783
Spacing	.628	.433
Rate	1.576	.217

Hypothesis Four

Hypothesis four states: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting legibility than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. This hypothesis was tested using a 1x2 ANCOVA (See Table 4). After controlling for the covariate of MHA pretest scores, there was no statistically significant difference ($p = .402$) in posttest MHA scores between subjects in experimental and comparison groups. Thus, hypothesis four was not supported.

Hypothesis Five

Hypothesis five states: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting form than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool (See Table 4). After controlling for the covariate of MHA pretest scores, there was no statistically significant difference (p = .096) in posttest MHA scores between subjects in experimental and comparison groups. Thus, hypothesis five was not supported.

Hypothesis Six

Hypothesis six states: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting alignment than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool (See Table 4). After controlling for the covariate of MHA pretest scores, there was no statistically significant difference (p = .540) in posttest MHA scores between subjects in experimental and comparison groups. Thus, hypothesis six was not supported.

Hypothesis Seven

According to Hypothesis seven: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting size than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool (See Table 4). After controlling for the covariate of MHA pretest scores, a statistically significant difference

(p = .008) was seen in posttest MHA scores in the area of size. Thus, the posttest category size scores were significantly affected by HWT® instruction and hypothesis seven was supported.

Hypothesis Eight

Hypothesis eight states: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting spacing than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool (See Table 4). After controlling for the covariate of MHA pretest scores, a statistically significant (.014) difference was seen in MHA posttest scores in the area of spacing. Thus, the posttest category spacing scores were significantly affected by HWT® instruction and hypothesis eight was supported.

Hypothesis Nine

According to Hypothesis nine: Students receiving instruction from the Handwriting Without Tears® program for 10 weeks will demonstrate greater improvement in manuscript handwriting rate than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool (See Table 4). After controlling for the covariate of MHA pretest scores, there was no statistically significant difference (p = .331) in posttest MHA scores between experimental and comparison groups. Hypothesis nine was not supported.

Summary of Results

While controlling for pretest score, students who received HWT® instruction had higher mean total posttest MHA scores than students who did not receive HWT® instruction. But, the ANCOVA showed that the means between experimental and comparison groups were not statistically significant ($p = .066$) after controlling for pretest scores.

In addition, students receiving instruction from the Handwriting Without Tears® program for 10 weeks did demonstrate greater improvement than the comparison group in manuscript handwriting size ($p = .008$) and manuscript handwriting spacing ($p = .014$) as evidenced by pretest and posttest MHA data when controlling for MHA pretest scores. No significant difference was seen on MHA posttest scores for either educational status ($p = .806$) or gender ($p = .636$) after intervention with the HWT® program. Thus, these statistically significant improvements in size and spacing appear to apply to students regardless of educational status or gender.

CHAPTER FIVE

Discussion, Study Limitations, Suggestions for Future Research, and Conclusions

Introduction

This chapter discusses the findings presented in Chapter 4 in relation to this study and previous literature. In addition, study limitations, suggestions for future research, and study conclusions are presented.

Hypothesis Testing

Hypothesis One

Hypothesis one states that the final administration of the MHA, students who received HWT® instruction would have higher scores on the MHA than students who did not receive HWT® instruction. The experimental and comparison group mean posttest scores were not significantly different (p = .066) after controlling for pretest scores. Thus, within a 10-week period, the Handwriting Without Tears® method of handwriting instruction was not more effective in improving overall handwriting skill than traditional classroom methods.

These findings indicate that students in the experimental groups were not printing at a higher quality level at the end of the study than they were at the beginning.

This may prompt therapists, teachers, parents, and others to use the HWT® program with caution to address handwriting deficits or to teach handwriting in general.

These findings contradict those of Pontello's (1999) study that reported a statistically significant improvement ($p < 0.01$) of overall MHA test scores for students receiving HWT® programming for 1 year than those students receiving traditional handwriting instruction. Pontello indicated that a multi-sensory structured handwriting program, particularly Handwriting Without Tears®, may have been more effective in improving handwriting legibility than a traditional ball and stick method of instruction.

The findings of this study also differ with other studies of multisensory handwriting programs. Peterson and Nelson (2003) used a pretest posttest experimental design with random assignment of subjects to determine whether occupational therapy intervention improved printing in first graders. A multivariate analysis of variance showed that students in the occupational therapy intervention group had significant gain in printed handwriting as compared to the control group ($F = 6.43$, $p < .0001$). Lockhart and Law (1994) conducted a single case experimental design to evaluate the effectiveness of a multisensory writing program. Visual and statistical analysis indicated that handwriting improved following use of this program. While research is limited, the findings suggest that the use of multisensory modalities in handwriting intervention by occupational therapists may be warranted.

Hypothesis Two

Hypothesis two stated that general education students receiving HWT® instruction for 10 weeks would have greater statistical improvements on the MHA than

special education students receiving the same instruction. After controlling for covariates, no significant differences were found between educational groups. In addition, an ANCOVA explored the interaction effect of educational status and group. The analysis did not show an interaction between these variables. Thus, these variables do not appear to have interacted with each other in a way that would have significantly impacted the study findings.

These findings do show that students with special education status had similar results from engaging in the HWT® program to that of their general education status peers. This may be beneficial to the fields of occupational therapy and education. Based on McHale & Cermak's (1992) study, it was expected that students with general education status would improve more in handwriting with the HWT® program than would special education status students. This is based on the idea that students with general education status typically have less fine motor deficits. However, when controlling statistically for pretest MHA scores, the current study demonstrated comparable improvement between general and special education students. The multisensory nature of this program may prompt more educators, therapist, and parents to use the HWT® program with students with disabilities.

Hypothesis Three

Hypothesis three stated that female students receiving HWT® instruction for 10 weeks would have greater statistical improvements on the MHA than male students receiving the same instruction. After controlling for the covariate of pretest MHA score, no significant change was seen.

In addition, an ANCOVA was used to look at the interaction effect of gender and group. The analysis did not show an interaction between these variables. Thus, these variables do not appear to have interacted with each other in a way that would have significantly impacted the study findings.

The majority of current literature (Blote & Hamstra-Bletz, 1991; Graham, Berninger, Weintraub, & Schafer, 1998) indicates that males have lower performance in the area of handwriting. That was not true for the current study, which was conducted over 10 weeks. These findings are not congruent with Pontello's (1999) study. She reported that girls in experimental groups demonstrated more improvement in overall printing, alignment, and size, whereas boys in experimental groups had more improvement in the areas of legibility and spacing. Similar to the findings from the current study, Weil and Amundson (1994) found no significant differences between boys and girls on the Developmental Test of Visual-Motor Integration (VMI) and letter copying ability.

Hypothesis Four

Hypothesis four stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting legibility than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. After controlling for the covariate of pretest scores, no significant (p = .402) changes were seen in the effect of the independent variable of HWT® instruction on the dependent variable of post-test category scores. These findings agreed with those of Pontello (1999) in that legibility

did not improve significantly with the HWT® method in experimental groups after one year of intervention.

Hypothesis Five

Hypothesis five stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting form than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. After controlling for the covariate of pretest scores in a 1x2 ANCOVA, no significant ($p = .096$) changes were seen in experimental or comparison groups in relation to the effect of the independent variable of HWT® instruction on the dependent variable of posttest category scores. These findings tend to agree with those of Pontello (1999), finding that handwriting form did not significantly improve with the HWT® program after one year of intervention.

Hypothesis Six

Hypothesis six stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting alignment than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. No significant ($p = .540$) changes were seen in experimental and comparison groups after controlling for the covariate of pretest scores.

These results appear to differ from those of Pontello (1999) in that the experimental groups improved significantly ($p < 0.001$) in handwriting skills, especially in the area of alignment and sizing. In the area of size, the experimental group

demonstrated improvements at week 5, and continued to have steady improvements until week 10(see Appendix I). This suggests the HWT® method may effectively and quickly affect the area of size in a 10-week period. Ten weeks may not have been enough time to effectively address alignment. In addition, the results seen in this area may have been affected by the different types of paper used in the assessment and during intervention. The HWT® program uses two-lined paper whereas the MHA uses three-lined paper. This could have affected the area of alignment as it relies heavily on placement on the lines.

Hypothesis Seven

Hypothesis seven stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting size than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. After controlling for the covariate of pretest scores in a 1x2 ANCOVA, a significant change ($p = .008$) was seen between experimental and comparison groups on size.

This was also consistent with Pontello's (1999) findings that the experimental groups improved significantly ($p < 0.001$) in handwriting skills, especially in the area of alignment and sizing. The experimental group demonstrated the most significant improvements during both interim and posttesting periods (see Appendix I) in the area of size suggest that the HWT® method may effectively and quickly affect the area of size in a 10-week period.

Hypothesis Eight

Hypothesis eight stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting spacing than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. After controlling for the covariate of pretest scores in a 1x2 ANCOVA, a significant (.014) change was seen between experimental and comparison groups.

These findings tend to contrast with Pontello (1999) who did not find a significant change in the area of handwriting spacing. This difference may suggest that spacing is initially affected within a 10-week period, but after a year of handwriting instruction (HWT® and traditional methods), students learn spacing equally well.

Hypothesis Nine

Hypothesis nine stated that students receiving instruction from the Handwriting Without Tears® program for 10 weeks would demonstrate greater improvement in manuscript handwriting rate than the comparison group as evidenced by pretest and posttest data using the MHA as an evaluation tool. After controlling for the covariate of pretest scores in a 1x2 ANCOVA, no significant (p = .331) changes were seen in experimental and comparison groups. These findings are similar with Pontello (1999) who found no consistent significant improvements in the groups related to rate over the 1-year test period. Ten weeks may not have been enough time to effectively address the area of rate.

Study Conclusions

Overall, handwriting as measured by the MHA does not appear to improve with handwriting instruction, but shows improvements in the area of size and spacing. This suggests that students whose main handwriting deficits are in size and spacing may benefit from the HWT® program. After controlling for pretest MHA score, there was no significant difference in posttest MHA scores between general and special education students (p = .806) or between females and males (p = .636). Thus, students may see improvements in size and spacing regardless of educational status or gender.

Study Limitations

The results of this study must be considered with the study limitations. This study used intact classrooms for experimental and comparison groups rather than randomly assigning students to the two conditions. A typical school consists of multiple classes per grade and this study only used four 2nd grade classes.

The amount of time for completion of this study may have also been a limitation. As the HWT® program reportedly begins to see changes in several weeks, this study was carried out for 10 weeks. Some components of handwriting may require a longer time period before any significant changes are evidenced. This may explain the differences between Pontello's results (1999) (1 year study) and this study.

Another limitation is that students involved in this study may also have been a part of special education or resource programs. During these additional resources, students may have been exposed to additional handwriting interventions. Some students may have been receiving occupational therapy simultaneously. Although

these students did not receive additional intervention with the HWT® program, they may have received additional handwriting interventions using another program.

Different types of paper were used during assessment and intervention. The Minnesota Handwriting Assessment uses paper with three lines whereas the HWT® program uses two-lined paper. This could have given the student in the comparison groups an advantage during assessment as they also used a three-lined paper during their daily handwriting instruction. Thus, it is reasonable to speculate that this study limitation may have favorably impacted the comparison group's scores. This transition from one type of paper to the next could have confused experimental students and had an affect on study findings.

Finally, due to the fact that all four classes were taught handwriting by a different teacher, and for different amounts of time, the type of instruction received cannot be equally compared. Also, the amount of instruction time varied between the experimental and comparison groups. The experimental group had approximately 21 more minutes of handwriting instruction per week. Though four minutes of additional instruction per day does not seem like it would affect results, over a 10-week period of time, the cumulative effect may have made a difference. It is also unknown if the teachers had a different focus on which are the critical components of handwriting (e.g., spacing verses form) which may effect the results.

Implications for Further Research

Future research needs to assess the effectiveness of using the HWT® program while controlling extraneous variable of instructional time and paper type between the

experimental and comparison groups. Each group needs to receive the same amount of time for handwriting instruction each day and use the same type of (2-lined) paper during assessment and instruction.

Future research would study the effectiveness of this program over a longer period of time. A study spanning an entire school year would show results based on the HWT® program and based on maturity. A longer study of several years would examine the carryover of this program from year to year and from readiness to printing to cursive. Additional studies could also focus on other components of the program such as readiness or cursive.

This study included students with and without identified disabilities. A majority of the students were diagnosed with Attention Deficit Hyperactivity Disorder, Specified Learning Disabilities, or Other Health Impairments. Future research could focus on other children with more significant motor disabilities such as children with autism, Down Syndrome, cerebral palsy, or other identified motor skill disabilities.

Finally, future research could utilize a larger sample size. This sample could include more students with and without disabilities, students from other grades, or students from other socioeconomic statuses.

Conclusions

Students in experimental groups did not have more significant improvement in overall handwriting skill than comparison groups during the 10-week pretest to posttest period as measured by the MHA. Thus, the Handwriting Without Tears® method of handwriting instruction was not more effective in improving overall handwriting skill

than traditional classroom methods. However, the HWT® program was found to be effective in improving the areas of size and spacing regardless of educational status or gender. Other components of handwriting (legibility, form, alignment, and rate) showed no difference with the comparison group. There were no significant differences measured between males and females or students in general education and special education during the 10-week study period.

This study did not find HWT® to be significantly more effective than traditional handwriting instruction within a 10-week intervention period. Yet, teachers who used the HWT® method during this study were overwhelmingly satisfied with the programs' effectiveness and usability and they continued to use the HWT® program after study completion. Thus, HWT® may be a handwriting program that is easier to use and more attractive to teachers and therapists for its desirable characteristics and components.

References

References

American Occupational Therapy Association (2001). *Parents ask about occupational therapy services in schools.* Retrieved on October 27, 2001 from the World Wide Web: http:/www.ldonline.org/ld_indepth/writing/ot_questions.html

Amundson, S. J. (1995). *Evaluation Tool of Children's Handwriting*. Homer, AK: O.T. KIDS.

Amundson, S. J. (1998). *TRICS for written communication: Techniques for rebuilding and improving children's school skills*. Homer, AK: O.T. Kids.

Angelo, J. (1997). *Assistive Technology for Rehabilitation Therapists* (p. 4-5). Philadelphia: F.A. Davis.

Benbow, M. (1995). *Understanding the hand from the outside in: Teaching strategies based on neuroanatomy and hand anatomy*. Neurokinesthetic Approach to Hand Function and Handwriting Handout. August 1995.

Benbow, M. (1991). *Loops and other groups: A kinesthetic writing system instructor's manual.* Tucson: Therapy Skill Builders.

Berninger, V. W., Graham, S., & Weintraub, N. (1998). The relationship between handwriting style and speed and legibility. *The Journal of Educational Research, 91*, 290-296.

Blote, A., & Hamstra-Bletz, L. (1991). A longitudinal study on the structure of handwriting. *Perceptual and Motor Skills, 72*, 983-994.

Burtner, P. A., Wilhite, C., Bordegaray, J., Moedl, D., Roe, R. J., & Savage, A. R. (1997). Critical review of visual perceptual tests frequently administered by pediatric therapists. *Physical & Occupational Therapy in Pediatrics, 17*(3), 39-61.

Carlson, K., & Cunningham, J. L. (1990). Effect of pencil diameter on the graphomotor skill of preschoolers. *Early Childhood Research Quarterly, 5,* 279-293.

Case-Smith, J., Rogers, J., & Johnson, J. (2001). *School-based occupational therapy*. In J. Case-Smith (Ed.), Occupational therapy for children (4th ed., pp. 757-779). St. Louis: Mosby.

Case-Smith, J. (2002). Effectiveness of school-based occupational therapy intervention on handwriting. *American Journal of Occupational Therapy, 56*, 17-25.

Case-Smith, J., & Cable, J. (1996). Perceptions of occupational therapists regarding service delivery models in school-based practice. *Occupational Therapy Journal of Research, 16,* 23-43.

Chu, S. (1997). Occupational therapy for children with handwriting difficulties: A framework for evaluation and treatment. *British Journal of Occupational Therapy, 60*, 514-520.

Clark-Wentz, J. (1997). Improving students' handwriting. *OT Practice, 2(10),* p. 29-33.

Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy, 50*, 732-739.

Davies, P. L., & Gavin, W. J. (1994). Comparison of individual and group/consultation treatment methods for preschool children with developmental delays. *American Journal of Occupational Therapy, 48,* 155-161.

Dennis, J. L., & Swinth, Y. (2001). Pencil grasp and children's handwriting legibility during different length writing tasks. *American Journal of Occupational Therapy, 55*, 175-183.

Diekema, S. M., Deitz, J., & Amundson, S. J. (1998). Test-retest reliability of the Evaluation Tool of Children's Handwriting- Manuscript. *American Journal of Occupational Therapy, 5, 2*48-255.

Dunn, W. (1990). A comparison of service provision models in school-based occupational therapy services: A pilot study. *Occupational Therapy Journal of Research, 10,* 300-319.

Ediger, M. (2002). Assessing handwriting achievement. *Reading Improvement,* 39, 103-108.

Feder, K., Majnemer, A., & Synnes, A. (2000). Handwriting: Current trends in occupational therapy practice. *Canadian Journal of Occupational Therapy, 67,* 197-204.

Graham, S. (1992). Issues in handwriting instruction. *Focus on Exceptional Children, 25*(2), 1-14.

Graham, S., Berninger, V., Weintraub, N., & Schafer, W. (1998). Development of handwriting speed and legibility in grades 1-9. *Journal of Educational Research, 92,* 42-52.

Graham, S., Harris, K., & Fink, B. (2000). Is handwriting causally related to learning to write? Treatment of handwriting problems in beginning writers. *Journal of Educational Psychology, 92,* 620-633.

Individuals with Disabilities Education Act Amendments (P.L. 105-17) (1997). Retrieved on February 16, 2003 from the World Wide Web http://www.ideapractices.org

Koenke, K. (1986*). Handwriting instruction: What do we know?* (Report No. ED272923). Chicago: ERIC Document Reproduction Service.

Koziatek, S. M. & Powell, N. J. (2003). Pencil grips, legibility, and speed of four-graders' writing in cursive. *American Journal of Occupational Therapy, 57*, 284-288.

Laufer, L. (1991). *Callirobics.* Charlottesville, VA: Callirobics Company.

Lockhart, J., & Law, M. (1994). The effectiveness of a multisensory writing programme for improving cursive writing ability in children with sensorimotor difficulties. *Canadian Journal of Occupational Therapy, 61*, 206-215.

Malloy-Miller, T., Polatajko, H., & Anstett, B. (1995). Handwriting error patterns of children with mild motor difficulties. *Canadian Journal of Occupational Therapy, 62*, 258-267.

Merriam-Webster. (2002). *Merriam-Webster's Collegiate Dictionary* (10th ed.). Springfield: Merriam-Webster.

McDougal Littell (1990). *McDougal, Littell Handwriting*. Evanston, IL: McDougal, Littell, & Company.

McHale, K., & Cermak, S. A. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy, 46*, 898-903.

Oehler, E., DeKrey, H., Eadry, E., Fogo, J., Lewis, E., Maher, C., & Schilling, A. (2000). The effect of pencil size and shape on the pre-writing skills of kindergartners. *Physical & Occupational Therapy in Pediatrics, 19*(3/4), 53-61.

Oliver, C. E. (1990). A sensorimotor program for improving writing readiness skills in elementary-age children. *American Journal of Occupational Therapy, 44*, 111-116.

Olsen, J. Z. (2004). *Handwriting without tears*®. Retrieved January 8, 2004 from http://www.hwtears.com

Olsen, J. Z. (2001). *Handwriting without tears*® (8th ed.). Potomac, MD: Author.

Palisano, R. J. (1989). Comparison of two methods of service delivery for students with learning disabilities. *Physical and Occupational Therapy in Pediatrics, 9*(3), 79-99.

Peterson, C. Q. & Nelson, D. L. (2003). Effect of an occupational intervention on printing in children with economic disadvantages. *American Journal of Occupational Therapy 57*, 152-160.

Phelps, J. & Stempel, L. (1987). *The children's handwriting evaluation scale for manuscript writing*. Dallas, TX: Texas Scottish Rite Hospital for Crippled Children.

Polit, D. F, & Hungler, B. P. (1995). *Nursing research: Principles and methods*. Philadelphia: Lippincott, Williams, & Wilkins.

Pontello, K. M. (1999) *The effectiveness of a structured handwriting program*. Unpublished Master's Thesis. Lakehead University, Ontario, Canada.

Rapport, M. J. K. (1995). Laws that shape therapy services in educational environments. *Physical and Occupational Therapy in Pediatrics, 15*, 5-32.

Reisman, J. E. (1999). *Minnesota handwriting assessment.* New York: Psychological Corporation.

Reisman, J. E. (1993). Development and reliability of the research version of the Minnesota Handwriting Test. *Physical and Occupational Therapy in Pediatrics, 13*(2), 41-55.

Reisman, J. E. (1991). Poor handwriting: Who is referred? *American Journal of Occupational Therapy, 45*, 849-852.

Rubell, B. (1995). *Big strokes for little folks*. New York: Psychological Corporation.

Schneck, C., & Henderson, A. (1990). Descriptive analysis of the developmental progression of grip position for pencil and crayon control in nondysfunctional children. *American Journal of Occupational Therapy, 44*, 893-900.

Sudsawad, P, Trombly, C. A., Henderson, A., & Tickle-Degnen, L. (2002). Testing the effect of kinesthetic training on handwriting performance in first-grade students. *American Journal of Occupational Therapy, 56*, 26-33.

Thurber, D. N. (1993). D'Nealian handwriting ABC book: Manuscript. Santa Monica, CA: Goodyear.

Tseng, M. H., & Chow, S. M. K. (2000). Perceptual-motor function of school-age children with slow handwriting speed. *American Journal of Occupational Therapy, 54*, 83-88.

Wallace, R. R., & Schomer, J. H. (1994). Simplifying handwriting instruction for the 21st century. *Education, 114*, 413-415.

Weil, M. J., & Amundson, S. J. C. (1994). Relationship between visuomotor and handwriting skills of children in kindergarten. *American Journal of Occupational Therapy, 48*, 982-988.

Woodward, S., & Swinth, Y. (2002). Multisensory approach to handwriting remediation: Perceptions of school-based occupational therapists. *American Journal of Occupational Therapy, 56*, 305-312.

Zaner-Bloser (2002). *Handwriting: Teacher's Edition*. Columbus: Zaner-Bloser.

APPENDIX A

Protocol for Minnesota Handwriting Assessment

Directions

1. Say, **"This is a handwriting paper. Print your name on the bottom line, then put your pencil down."** Allow students time for this and wait for pencils to be put down. Say, **"I'm going to be asking you to copy the words on this page. You will write each word one time. Do not skip around. Make sure the letters are the same size as the example. Write as you usually do when you are trying to use good handwriting. You will be copying each word on the lines below, starting here on the line with the little triangle."** Demonstrate by pointing to the first triangle on a test paper that you hold up or, if individually administered, by pointing to the first triangle on the student's paper. You may use nonverbal cues such as pointing from the sample words to the blank lines beneath to help the student understand what is required to complete the test. Say, **"When you run out of room on the first line, start writing on the next line that has a little triangle. When I say stop, hold your pencil up even if you are in the middle of a letter. Are there any questions?"**
2. Answer any questions.
3. Ask the student(s):
   "Where do you start copying the words?" (Next to the little triangle.)

   "Is it okay to skip around?"(No.)

   "What size should you make your letters?" (Same as the example.)

   "What should you do when I say stop?" (Hold the pencil up.)

4. Say, **"Okay, start."** Do not create an atmosphere that emphasizes speed or calls attention to timing the task. For example, do not set a timer or concentrate on your watch or wall clock to mark the passage of time. As you begin timing the students, glance at the second hand of a visible wall clock or your watch.
5. Time the student(s) for 2 ½ minutes.
6. Say, **"Stop. Hold your pencils up."** When you see that everyone has their pencils up, tell the student(s) to, **"Put a circle around the last letter you were writing when I said stop."**
7. Now tell the student(s) to **"Keep writing until you have finished copying all the words, then put your pencil down."** Allow the student(s) to finish copying all the words.

Note: Some students may be confused about where to begin because they are accustomed to copying each line directly under the sample line in workbook and other classroom assignments. If students do copy directly under each sample line, the test can still be scored. It is not essential that the students begin on the lines marked by triangles, although it does make scoring easier (Reisman, 1999).

APPENDIX B

Letter to Principals

April 18, 2003

Dear Principal-

I am currently enrolled at Virginia Commonwealth University in a Post Professional Occupational Therapy program. For degree completion, I am conducting a thesis examining the effects of the Handwriting Without Tears® (HWT) program on the handwriting of first grade general and special education students.

Handwriting Without Tears® is a multi-sensory program that was designed to teach all learning styles including visual, auditory, manipulative, tactile, and kinesthetic. It can reportedly be used for all children in the classroom, including children with special needs. The program is developmentally based and divides skills into small tasks, arranges tasks from simple to complex, and begins with what is familiar.

I am asking for your help in my research. I would like to implement this program in four classrooms within your school, with the program being carried out in two classes and two classes serving as comparison classes. The teachers agreeing to participate in the experimental groups must be willing to attend a Handwriting Without Tears® workshop on Saturday, September 27, 2003, free of charge. After this, all materials (workbooks, chalk slates, paper, letter strips, desk strips, chalk, pencils, etc.) will be provided by the project. The teachers in the classroom where this program is implemented would then be asked to teach handwriting for 10 minutes each day using this handwriting method for approximately 10 weeks. They will record how many minutes a day they teach handwriting.

In addition, after parent permission is obtained, the teachers in all four classes would take a 2.5 minute writing sample from each child prior to, during, and after the implementation of the HWT® program. This will take approximately 10minutes for each administration. After the handwriting samples are obtained, I will score them.

I will be available to answer any questions you or the teachers may have. Thank you for your help in this matter. You may contact me at 717-0138, by email at lisalowens@cox.net, or by pony mail to Norfolk Highlands Primary.

Sincerely,

Lisa Owens, OTR/L
Post-Professional Masters Degree Student
Virginia Commonwealth University

APPENDIX C

Letter to Teachers

April 18, 2003

Dear Teacher-

I am currently enrolled at Virginia Commonwealth University in a Post Professional Occupational Therapy program. For degree completion, I am conducting a thesis examining the effects of the Handwriting Without Tears® (HWT) program on the handwriting of first grade general and special education students.

Handwriting Without Tears® is a multi-sensory program that was designed to teach all learning styles including visual, auditory, manipulative, tactile, and kinesthetic. It can reportedly be used for all children in the classroom, including children with special needs. The program is developmentally based and divides skills into small tasks, arranges tasks from simple to complex, and begins with what is familiar.

I am asking for your help in my research, pending approval from your principal. If interested, you will be assigned to either an experimental or a comparison group. If assigned to the experimental group, you will be asked to attend a Handwriting Without Tears® workshop on Saturday, September 27, 2003, at no cost to you. After this, all materials (workbooks, chalk slates, paper, letter strips, desk strips, chalk, pencils, etc.) will be given to you. In return, you will teach handwriting for 10 minutes each day using this handwriting method for two months and will record the amount of time you spent teaching handwriting

In addition, teachers in both groups will be asked -to attend a 30 minute workshop on giving a handwriting assessment Each teacher will collect a 2.5 minute writing sample from each child prior to, during, and after the implementation of the HWT® program. This will take approximately 10minutes for each administration. After the handwriting samples are obtained, I will score them.

I will be available to answer any questions you may have. Thank you for your help in this matter. You may contact me at 717-0138, by email at lisalowens@cox.net, or by pony mail to Norfolk Highlands Primary.

Sincerely,

Lisa Owens, OTR/L
Post-Professional Masters Degree Student
Virginia Commonwealth University

APPENDIX D

Memo to Teachers

Memo

Date:

To: Teachers

CC: Jayne Shepherd, M.S., OTR/L and Janet Watts, Ph.D., OTR/L

From: Lisa Owens, OTR/L

RE: Handwriting Without Tears® Study

As you may remember, I am a student from the occupational therapy department at Virginia Commonwealth University and an occupational therapist with Chesapeake Public Schools. I am conducting a study of the Handwriting Without Tears® program. You will attend a conference on this program and then collect handwriting samples from your students in September, November and December. The data will be used to determine the effectiveness of the Handwriting Without Tears® program. Thank you for your support and cooperation.

APPENDIX E

Study Explanation Letter to Parents

September 3, 2003

Dear Parent or Guardian:

Starting in September 2003, a handwriting program called Handwriting Without Tears® will be started in some of our first grade classes. The program will be evaluated through the Department of Occupational Therapy at Virginia Commonwealth University (VCU) in conjunction with Chesapeake Public Schools. To judge the program's effectiveness, handwriting samples will be collected in September, November, and December to compare handwriting progress to other classrooms within the school that are learning handwriting by the general curriculum.

To participate in the study, the children will be asked to copy a sentence and print their names and birth dates. The children's names will not be used to compare papers, will not be given to the researcher, and will not be reported in the study. The handwriting exercises will take about 10 minutes per day and the 3 writing samples will take about 15 minutes each. These will be completed in the children's regular classrooms as a class activity. Every attempt will be made to insure that testing is conducted during times that will not conflict with educational requirements.

Participation in this study is voluntary and I would like, by this letter, to request your permission to have your child participate. Your child will be included as a part of this program unless you request that they not be. You may withdraw your child from this study at any time. This study is not expected to cause any physical, financial, or mental

harm. Your student may derive indirect benefit from learning handwriting with the Handwriting Without Tears® program.

If you have any questions about this study, please feel free to contact me, or the people conducting the study, our own occupational therapist, Lisa Owens, or her thesis advisors, Dr. Janet Watts or Ms. Jayne Shepherd. The school telephone number is 482-5820 where Lisa Owens and I can be reached. The VCU occupational therapy phone number is 804-828-2219. Thank you.

Sincerely,

Elizabeth S. Stublen
Principal

Lisa Owens, OTR/L
Chesapeake Public Schools
Occupational Therapist

APPENDIX F

Teacher Recording Form

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1 Date:	___ yes ___ no Time _____	___ yes___ no Time _____	__ yes __ no Time _____	__ yes___ no Time _____	__yes __ no Time _____
Week 2 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 3 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 4 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 5 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 6 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 7 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____
Week 8 Date:	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____	__yes __ no Time _____

√ =Done
W= Teacher Workday
S = Sick/ Absent from School
H= Holiday/Weather Related Absence

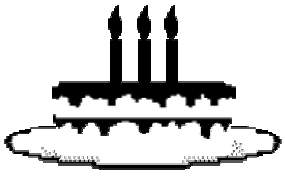
APPENDIX G

Data Collection Form

_____ boy  _____ girl 

_____ OT _____ no OT

_____ Right-handed  _____Left-handed 

Birthday: _____ 

 HERE!

Subject #: _____

Date: _____

APPENDIX H

Teacher Expectations for Participating in the Handwriting Without Tears® Study

	Experimental Groups	**Comparison Groups**
September	• Attend Minnesota Handwriting Assessment training for 30 minutes • Attend Handwriting Without Tears® conference 9-27-03 • Pretest students	• Attend Minnesota Handwriting Assessment training for 30 minutes • Pretest students
October	• Begin HWT® intervention 10-1-03 • Interim test	• Interim test
November	• Continue with HWT® intervention	
December	• End HWT® intervention • Posttest	• Posttest

APPENDIX I

Means and Standard Deviations for All Classes for Total Test Scores

	Experimental Groups						Comparison Groups					
	Class 1			Class 3			Class 2			Class 4		
Total Test	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Pre	21	173.57	15.97	20	170.75	18.37	22	178.50	14.57	18	166.83	16.87
Interim	21	182.00	13.71	20	181.50	12.87	22	181.73	11.97	18	177.78	13.35
Post	21	188.90	9.97	20	187.25	11.55	22	186.18	9.91	18	180.11	12.99
Legibility												
Pre	21	32.57	1.50	20	32.70	1.75	22	32.55	2.26	18	32.28	2.19
Interim	21	33.00	1.70	20	33.35	1.35	22	32.91	.971	18	32.61	2.12
Post	21	30.95	5.58	20	34.00	.000	22	33.81	.873	18	32.33	4.45
Formation												
Pre	21	29.00	2.63	20	25.70	3.77	22	27.73	6.76	18	24.94	4.21
Interim	21	27.48	3.64	20	27.55	3.90	22	27.36	3.79	18	27.94	4.47
Post	21	33.57	.68	20	33.25	1.29	22	32.95	.973	18	33.00	1.03
Alignment												
Pre	21	28.67	5.00	20	27.15	4.02	22	29.68	3.75	18	27.94	4.87
Interim	21	30.19	3.60	20	30.65	3.88	22	29.50	4.82	18	29.11	5.43
Post	21	29.14	2.94	20	29.30	2.98	22	28.48	2.91	18	29.50	2.83

	Experimental Groups						Comparison Groups					
	Class 1			Class 3			Class 2			Class 4		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Size												
Pre	21	26.10	7.93	20	26.55	6.17	22	29.27	3.43	18	26.00	6.09
Interim	21	28.33	5.78	20	29.90	4.19	22	28.05	3.68	18	28.22	3.72
Post	21	31.95	2.04	20	30.30	4.27	22	30.33	3.18	18	28.33	3.83
Spacing												
Pre	21	30.52	2.56	20	30.30	2.43	22	31.27	1.67	18	29.06	3.19
Interim	21	32.19	2.11	20	31.75	2.47	22	32.23	1.48	18	30.89	2.25
Post	21	30.90	3.13	20	28.85	3.54	22	28.48	4.55	18	25.17	7.13

APPENDIX J

Total Test Scores for Minnesota Handwriting Assessment Per Class

	Experimental Groups								Comparison Groups							
	Class 1				Class 3				Class 2				Class 4			
	n	Δ	*t*	*p*	*n*	Δ	*t*	*p*	*n*	Δ	*t*	*p*	n	Δ	*t*	*p*
Total Test Pre to Pos	21	15.3	-4.47	.000	20	16.50	-3.86	.001	22	7.68	-3.09	.006	18	13.28	-4.70	.000
Legibility Pre to Pos	21	-1.6	1.35	.194	20	1.30	-3.32	.004	22	1.27	-2.36	.028	18	.06	-.05	.965
Formation Pre to Pos	21	4.57	-8.12	.000	20	7.55	-8.35	.000	22	5.27	-3.87	.001	18	8.06	-8.26	.000
Alignment Pre to Pos	21	.48	-.45	.660	20	2.15	-2.39	.028	22	-1.10	1.17	.254	18	1.56	-1.25	.228
Size Pre to Pos	21	5.86	-3.35	.003	20	3.75	-2.63	.016	22	1.00	-1.63	.118	18	2.33	-1.69	.108
Spacing Pre to Pos	21	.38	-.45	.646	20	-1.45	1.51	.147	22	-2.60	2.58	.018	18	-3.89	3.02	.008

	Experimental Groups								Comparison Groups							
	Class 1				Class 3				Class 2				Class 4			
	n	Δ	*t*	*p*	n	Δ	*t*	*p*	n	Δ	*t*	*p*	n	Δ	*t*	*p*
Rate																
Pre to Pos	21	6.14	-3.5	.002	20	1.50	-.79	.469	22	3.82	-2.92	.008	18	5.17	-2.33	.032

VITA

Lisa L. Owens was born July 14, 1976 in Newport News, Virginia. She spent the first 20 years of her life in Mathews County, Virginia and currently resides in Virginia Beach, Virginia. Lisa is currently a graduate student in the Post-Professional Occupational Therapy program at Virginia Commonwealth University. Previously, she received a Bachelor of Science degree in 1998 from James Madison University and a Bachelor of Science degree in Occupational Therapy in 2000 from Virginia Commonwealth University.

Lisa is currently employed as an occupational therapist by Chesapeake Public Schools. She has also held part-time positions with Camp Gonnawannagoagain and the Chesapeake Center.