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# A Cognitive, Self-Monitoring Intervention for Handwriting with Second-Grade Students

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## ABSTRACT

A pre-test post-test design was used to deliver the Size Matters Handwriting Program to 19 second-grade students using an occupational therapist-teacher collaborative teaching model. Outcomes from the Minnesota Handwriting Assessment indicate statistically and clinically significant gains for students in legibility, form, alignment, size, and spacing. Students' perceptions of self-monitoring, collected via a brief self-report measure, reveal that most students agreed that self-monitoring played an important role in their learning by understanding the rules of handwriting and learning proper spacing strategies when writing. These results support the effectiveness of employing the Size Matters Handwriting Program and teaching self-monitoring strategies.

## ARTICLE HISTORY

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## KEYWORDS

Occupational therapy; handwriting; cognitive approach; self-monitoring; Size Matters Handwriting Program; collaboration; Minnesota Handwriting Assessment

## Introduction

The Common Core State Standards are a set of educational standards in the United States for teaching and testing English and Math in kindergarten through twelfth-grade (Common Core State Standards Initiative, 2018). The Common Core State Standards have been adopted by 41 out of the 50 states and the District of Columbia since 2010 and reflect the content and skills that students must have to transition successfully into adulthood (Common Core State Standards Initiative, 2018). The primary purpose of these standards is to encourage skill mastery in reading, writing, listening and speaking as well as to utilize evidence from the student's writing to demonstrate the student's critical thinking skills. Handwriting is one of the foundational skills within the Common Core Standards for students in kindergarten through fifth-grade. By the end of the first-grade school year, all students are expected to print all upper- and lower-case letters (Common Core State Standards Initiative, 2018). These standards play an important part in the success of a student as they help define what skills and knowledge a student must achieve to be successful during school and life after graduation.

Proficiency in handwriting is correlated with academic achievement and is an indicator of overall learning capabilities of students (Feder & Majnemer, 2007). Handwriting impacts a student's written language. As handwriting becomes more automatic, the student will need to spend less cognitive energy on the mechanics of handwriting, thereby increasing the opportunity to plan, compose, and edit what is written (McCarney, Peters, Jackson, Thomas, & Kirby, 2013). Moreover, difficulties in writing and nonverbal expression directly impact how students perceive their abilities (Engel-Yeger, Nagauker-Yanuv, & Rosenblum, 2009). As early as

first grade, students are required to complete written assignments, and when an assignment is illegible, teachers may interpret the written responses incorrectly which results in lowered grades. Studies have demonstrated that assignments exhibiting more legible handwriting received better grades (Hammerschmidt & Sudsawad, 2004; Peterson & Nelson, 2003). Two additional studies revealed that students who display poor handwriting skills may fall behind academically and their success in the classroom can be significantly impacted (Graham et al., 2008; Graham & Weintraub, 2001).

Despite the increased use of technology in schools, handwriting remains an integral part of a child's academic life and is a main occupation in the classroom (Feder & Majnemer, 2007; McCarney et al., 2013; McMaster & Roberts, 2016). Fine motor activities which involve paper and pencil comprise between 27–60% of an elementary student's typical day (Marr, Cermak, Cohn, & Henderson, 2003, p. 554; McHale & Cermak, 1992, p. 901; McMaster & Roberts, 2016, p. 44). As early as kindergarten, time spent on paper and pencil activities can be as high as 42% of each school day (Marr et al., 2003, p. 554). Although there has been a decrease of time spent on fine motor activities in the classroom over the past twenty years, paper and pencil tasks continue to comprise 85% of fine motor activities in the classroom (McMaster & Roberts, 2016, p. 44).

The role of an occupational therapist in the school setting is to help students participate in the general education curriculum and to facilitate the inclusion of students with special needs with typically developing peers in all aspects of the school day. Handwriting is one of the principle school-based occupations of elementary students; therefore, it is not surprising that the primary referral for occupational therapy services in schools is to address problems with handwriting (Case-Smith, 2002; Hammerschmidt & Sudsawad, 2004; Marr & Dimeo, 2006). Students, with or without an Individualized Education Plan, who are having difficulty with handwriting, may be referred by teachers for occupational therapy screenings or strategies when the general education classroom practices and techniques are not sufficient to promote quality handwriting skills.

In creating a handwriting curriculum to implement in the classroom, occupational therapists and teachers need to consider numerous factors in deciding how best to support students struggling with handwriting. Factors including the method of delivery, type of handwriting program, the structure of the program, and collaboration with teachers should all be considered when creating a handwriting curriculum. Multiple studies demonstrate the effectiveness of classroom instruction to address any student's fine motor concerns rather than providing individual intervention outside of the classroom (Case-Smith, 2002; Case-Smith, Weaver, & Holland, 2014; Howe, Roston, Sheu, & Hinojosa, 2013; Zylstra & Pfeiffer, 2016). Positive gains were noted in studies where interventions, lasting 20–60 minutes each, occurred one to five days a week over a period of 2–6 weeks or a minimum of 10–12 sessions. (Berninger et al., 2006; Howe et al., 2013; Peterson & Nelson, 2003; Zwicker & Hadwin, 2009; Zylstra & Pfeiffer, 2016). Improved handwriting legibility, letter formation and size, as well as upper and lower case letter recognition were specific outcomes noted in the literature when collaboration with the teacher was incorporated into the instruction (Case-Smith, 2002; Case-Smith et al., 2014; Howe et al., 2013; Pfeiffer, Rai, Murray, & Brusilovskiy, 2015; Zylstra & Pfeiffer, 2016). These studies described various modes of collaboration between teachers and occupational therapists to improve students' handwriting. Collaborative planning to embed strategies for long-term implementation, such as the use of small groups and learning stations to

improve writing and handwriting were included in these studies (Howe et al., 2013; Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). Other modes of collaboration included providing adaptations and supports necessary to accommodate all students (Case-Smith, 2002; Case-Smith et al., 2014). Furthermore, in several studies, students were frequently assessed, and progress was monitored through a collaborative process to finalize plans for upcoming handwriting instruction (Case-Smith, 2002; Case-Smith et al., 2014).

Evidence confirms that handwriting does not improve without intervention and students who struggle early on with handwriting will continue to struggle without intervention (Feder & Majnemer, 2007). Occupational therapists employ a variety of approaches to remediate handwriting skills. Those interventions that employ a cognitive approach to handwriting have demonstrated the most effective and successful outcomes for students (Denton, Cope, & Moser, 2006; Howe et al., 2013; Hoy, Egan, & Feder, 2011; Pfeiffer et al., 2015; Zwicker & Hadwin, 2009; Zylstra & Pfeiffer, 2016). A cognitive approach to handwriting intervention is based on learning theories that involve direct handwriting instruction, and that includes repetition, reinforced practice, and feedback to elicit improved performance (Zwicker & Hadwin, 2009). Three studies compared the outcomes related to use of a cognitive approach to handwriting, versus traditional handwriting instruction (Case-Smith et al., 2014; Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). In each of these studies, statistically and clinically significant improvements in handwriting legibility were noted in the groups that received the cognitive handwriting support. The control groups which received traditional handwriting instruction support, showed improvement in handwriting legibility but not statistically significant improvements (Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). Traditional handwriting instruction often involves a variety of practices depending on the school district's curriculum and grade level to teach and practice handwriting for legibility. Traditional practices include work books, visual models and discussion of the letters to practice that are often taught in alphabetical order (Case-Smith et al., 2014; Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). Teaching and practicing handwriting for legibility, is often limited or nonexistent because teachers do not feel adequately prepared to teach handwriting or they devote more effort to other subjects (Applebee & Langer, 2011; Graham, Harris, Bartlett, Popadopolou, & Santoro, 2016). In light of the evidence which supports a cognitive approach to handwriting deficits, schools should consider instituting a preventive cognitive handwriting program to promote student success in this area (Asher, 2006).

In addition to literature that substantiates use of a cognitive approach to handwriting instruction and collaboration with teachers, the use of self-monitoring by students also promotes handwriting legibility and self-directed learning (Peterson & Nelson, 2003; Pfeiffer et al., 2015; Weintraub, Yinon, Hirsch, & Parush, 2009; Zwicker & Hadwin, 2009). Self-monitoring is defined as the skill of the student to be able to both observe and evaluate his or her skill which plays an important role in a student's overall handwriting development. Self-monitoring encompasses many strategies that foster learning and improved handwriting legibility. Some examples include teaching the students the rules of handwriting by using mnemonics to assist with letter recall and memorization, providing students with explicit self-monitoring questions to ask themselves while writing, as well as teaching the students how to self-evaluate their handwriting or that of their peers (Liu, Lu, Wu, & Tsai, 2016; Peterson & Nelson, 2003; Pfeiffer et al., 2015; Weintraub et al., 2009; Zwicker & Hadwin, 2009). Additionally, other self-monitoring strategies to

assist the student do his or her best work include allowing the student to pick the type of writing paper or pencil used for handwriting instruction. Allowing a student to pick paper that is vertically or horizontally aligned or a pencil of different sizes or design promotes self-monitoring. Four studies that used a cognitive approach to handwriting also incorporated self-monitoring and demonstrated significant improvements in the handwriting legibility of the participants (Peterson & Nelson, 2003; Pfeiffer et al., 2015; Weintraub et al., 2009; Zwicker & Hadwin, 2009). Although these studies incorporated self-monitoring strategies, they did not include an outcome measure specifically related to self-monitoring or discuss the practical implications of incorporation of these strategies. Therefore, the purpose of this pilot study was to determine whether a cognitive approach to handwriting combined with multiple self-monitoring strategies, embedded into a second-grade classroom curriculum with teacher and occupational therapist collaboration, was effective for improving handwriting legibility and students' perceptions of self-monitoring strategies.

## **Materials and Methods**

### ***Research Design***

A single group, pre-test post-test study was conducted in a second-grade, military-connected elementary school located in the southeast United States to investigate the effect of a whole-class handwriting program employing a cognitive approach combined with self-monitoring on handwriting legibility and students' perceptions of self-monitoring strategies. Students' handwriting legibility was assessed using the Minnesota Handwriting Assessment prior to and immediately following the 6-week implementation period of the Size Matters Handwriting Program. Students also completed a self-assessment on their perceptions of their self-monitoring skills after the implementation period. Permission to complete this study was provided by the Chatham University Institutional Review Board and by the military-connected school district.

### ***Participants***

One full-time, general-education, second-grade teacher was recruited via a recruitment flyer provided to all second-grade teachers at the school. Seven out of the eight teachers contacted the first author (an occupational therapist) to express interest in the study; of these seven, one was randomly selected and notified. The selected-teacher attended a 2-hour training session with the first author. This training covered the basic concepts of the Size Matters Handwriting Program and the self-monitoring skills to be facilitated with the students. The selected second-grade teacher reported having 22 years of teaching experience ranging from grades kindergarten to adults with disabilities. She was entering her 10th year with teaching second-grade at the time of this study. Additionally, she also had experience working with students with Individualized Education Plans, 504 Plans, Response to Intervention, and English as a Second Language support services.

Convenience sampling was used to recruit students after the teacher recruitment was complete. Student participants were eligible for inclusion if enrolled in the selected teacher's classroom at the time of the study. This general education, second-grade

classroom included five students receiving special education support (Individualized Education Plan), including speech-language, occupational therapy, behavioral intervention support, and Response to Intervention support in reading as well as 14 students without support services. Students from this classroom were recruited via an informational flyer that was provided to parents at an Open House event or sent home in the home communication folder if they did not attend the event. Parental consent and student assent was obtained for all 19 students in the class to participate in the study. Only one classroom teacher and the student participants in that classroom were selected in order to effectively manage the intervention during the 6-week long pilot study.

Participating students included 11 males and 8 females, ranging in age from 7.1 to 8.2 years old. One student received Response to Intervention reading services. Four students received special education services and had Individualized Education Plans; each received special education support for math, reading, and speech/language. Additionally, two of the students that had Individualized Education Plans received occupational therapy support services, and one of these students also received behavioral intervention services. The average number of handwriting sessions that the participating students attended was 22, with the range of sessions attended being 16–24. There were no dropouts in this pilot study.

## **Procedures**

The implementation phase consisted of a whole class intervention approach over a period of six weeks, with 20-minute handwriting instructional classes using the Size Matters Handwriting Program curriculum provided to students four times per week (Moskowitz, 2013). The first author, also an occupational therapist, came into the classroom for three of the four weekly handwriting sessions to teach collaboratively with the teacher. The teacher alone taught the fourth handwriting session focusing on review and sustainment of already learned letters for a total of 24 handwriting lessons over the 6-week timeframe. The teacher and occupational therapist met weekly to discuss upcoming lessons, students' needs for small group instruction to address gaps in knowledge, and collaborative teaching times for the week.

### ***Size Matters Handwriting Program***

The Size Matters Handwriting Program was chosen as an evidence-based curriculum for improving handwriting skills in students who are in the regular education classroom as well as those students with an Individualized Education Plan and Response to Intervention services (Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). This handwriting program promotes self-monitoring while supporting school-wide Common Core Standards. The Size Matters Handwriting Program curriculum manual was used to create all lesson plans which align the student experience with the Common Core Standards with emphasis on student-centered learning (Meeks, 2014). The Size Matters Handwriting Program teaching posters, the Size Matters Handwriting Program Alphatrangle (an exemplar of the letters of the alphabet that shows correct letter sizes and sound symbol correspondence within the student's line of vision), classroom Smartboard, and an overhead projector were used to supplement handwriting instruction.

The entire alphabet, both upper- and lower-case letters were taught collaboratively by the occupational therapist and the teacher during the course of 6 weeks using the Size Matters Handwriting Program curriculum. The program focuses on three letter sizes (Size 1, Size 2, and Size 3) which are easy for the students to remember and apply. In addition to teaching all upper- and lower-case letters, students were taught names of writing lines, letter lines, rules and jingles for Size 1, 2, and 3 Letters, Super C (concept that minimizes potential letter reversals), proper starting points, self-monitoring strategies, proper spacing between letters and words, and punctuation and capitalization rules when writing. Self-monitoring techniques included teaching the students the rules of handwriting by using mnemonics to assist with letter recall and memorization as well as teaching the students how to self-evaluate their handwriting (Pfeiffer et al., 2015; Weintraub et al., 2009; Zylstra & Pfeiffer, 2016). Students were also offered various size pencils and adapted writing paper with broad writing lines (vertically or horizontally aligned) from the Size Matters Handwriting Program, when having to complete written tasks. During each session, information from the prior session or sessions was reviewed to ensure knowledge and understanding. The teacher and occupational therapist collaborated to determine which students needed to work in smaller groups to refine their learning based on the students' areas of need. The occupational therapist and teacher lesson plans and time allocation are further outlined in Table 1.

### **Outcome Measures**

Outcome data were collected using two quantitative outcome measures. First, the Minnesota Handwriting Assessment (Reisman, 1999) was used to assess changes in handwriting rate and legibility including form, alignment, size and spacing between letters and words after the implementation of the Size Matters Handwriting Program. This assessment was administered individually to each participating student prior to the start of the handwriting program and at the end of the 6-week program. The Minnesota Handwriting Assessment was chosen due to its alignment with the same components of the Size Matters Handwriting Program including quality categories of Legibility, Form, Alignment, Size, and Spacing. This assessment has demonstrated validity and reliability and is norm-referenced for children in second-grade, and was used in multiple prior studies (Howe et al., 2013; Peterson & Nelson, 2003; Pfeiffer et al., 2015). Within each quality category (Legibility, Form, Alignment, Size, and Spacing), students are scored as either 'Performing Well Below Peers', 'Performing Somewhat Below Peers', or 'Performing Like Peers' based on the scoring directions as outlined in the Minnesota Handwriting Assessment manual (Reisman, 1999).

For the second outcome measure, the students completed a post-intervention self-report measure developed by the first author. This self-report measure was designed to measure the students' perceptions of self-monitoring skills after participating in the Size Matters Handwriting Program. The self-report measure consisted of five Likert-style statements related to self-monitoring with five response choices including: (5) *Strongly Agree*, (4) *Agree*, (3) *Neutral*, (2) *Disagree*, (1) *Strongly disagree*. Questions probed choice of paper, choice of pencil, and use of strategies to learn rules of letter sizes and proper spacing between letters and words. A team of four expert occupational therapists with

**Table 1.** Occupational therapist and teacher educational lessons plans and time allocation.

Week	Intervention		Time Allocation	
	Student	Teacher	Participant	Participant
Week 1 Intervention Days 1, 2, 3, 4	Educational Module Week 1: Introduce 8 concepts; Size One Letters upper case letters A-M, self-critique, Star-Worthy letters		1 hour 20 minutes	1 hour 20 minutes
Week 2 Intervention Days 5,6, 7, 8	Collaboration with teacher	Educational Module Week 2: review letters A-M and introduce letters N-Z, Self-critique, Star-Worthy letters	0 minutes 1 hour 20 minutes	20 minutes 1 hour 20 minutes
Week 3 Intervention Days 9, 10, 11, 12	Collaboration with teacher	Educational Module Week 3: Size One Letters- upper case letters, lower case Size One Letters (b,d,f,h,k,l,t), self-critique, Star-Worthy letters	0 minutes 1 hour 20 minutes	20 minutes 1 hour 20 minutes
Week 4 Intervention Days 13, 14, 15, 16	Collaboration with teacher	Educational Module Week 4: Size Two Letters (a,c,e,i,m,n,o,r,s,u,v,w,x,z), self-critique, Star-Worthy letters	0 minutes 1 hour 20 minutes	20 minutes 1 hour 20 minutes
Week 5 Intervention Days 17, 18, 19, 20	Collaboration with teacher	Educational Module Week 5: Repeat rules of letter sizes 1 and 2; capital letters A-Z, self-critique, lower case b,d,f,h,k,l,t, a,c,e,i,m,n,o,r,s,u,v,w,x, Star Worthy letters	0 minutes 1 hour 20 minutes	20 minutes 1 hour 20 minutes
Week 6 Intervention Days 21, 22, 23, 24	Collaboration with teacher	Educational Module Week 6: Size Three Letters (g,j,p,q,y), self-critique, Star-Worthy letters; review Size 1,2,3 letters	0 minutes 1 hour 20 minutes	20 minutes 1 hour 20 minutes
Week 6	Collaboration with teacher	Collaboration with teacher/data/review	0 minutes 0 minutes	20 minutes 1 hour



over 40 years of combined school-based experience reviewed the measure and determined it to be relevant for student participants and to have adequate face validity.

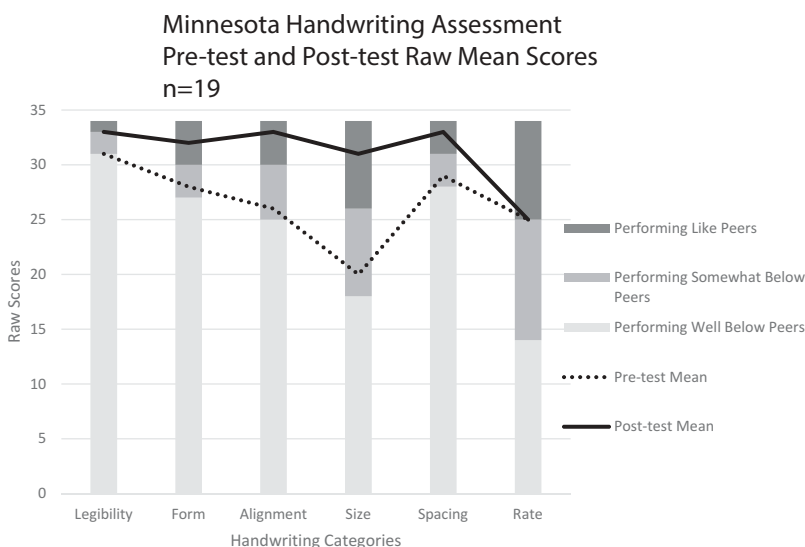
### **Data Analysis**

The Minnesota Handwriting Assessment was used to evaluate students' abilities before and after the handwriting intervention; this assessment measures six categories relating to the quality and speed of letter writing including: Rate, Legibility, Form, Alignment, Size, and Spacing. One score was assigned for Rate determined by the number of letters the student completed in a timed 2 minute 30 second portion of the test. Each of the 34 letters in the handwriting test was scored individually for the quality categories of Legibility, Form, Alignment, Size, and Spacing. A ruler included in the testing kit was used to score the categories of Alignment, Size, Spacing, and Form. Scores for Legibility, Form, Alignment, Size, and Spacing were recorded as the number of letters meeting the specific scoring directions as outlined in the Minnesota Handwriting Assessment manual (Reisman, 1999). Based on the scores for Rate and each of the quality categories, each student's performance level was then determined to be 'Performing Like Peers' level, 'Performing Somewhat Below Peers' level, or 'Performing Well Below Peers' level. An online software package ([www.socscistatistics.com](http://www.socscistatistics.com)) was used to calculate a paired *t* test to determine whether the increase in legibility, form, alignment, size, and spacing from pre- to post-test was statistically significant. Descriptive statistics were used to analyze the self-report measure; the mean score for each of the five Likert style questions asked was computed for the group in aggregate.

### **Results**

Pre-test mean scores on the Minnesota Handwriting Assessment indicate that 53% or more of the students performed 'Somewhat Below Peers' to 'Well Below Peers' in all five quality categories of handwriting and that 53% of the students performed 'Somewhat Below Peers' to 'Well Below Peers' with Rate before the handwriting intervention. Post-test mean scores on the Minnesota Handwriting Assessment reveal that 26% or fewer of the students performed 'Somewhat Below Peers' to 'Well Below Peers' in all five quality categories of handwriting and that 42% of the students performed 'Somewhat Below Peers' to 'Well Below Peers' with Rate. Although there was no significant difference in the mean Rate score from pre-test (mean = 24.5 for Rate of handwriting, standard deviation = 8.18), to post-test (mean = 25.47 in Rate of handwriting, standard deviation = 4.41);  $t(19) = 0.554876$ ,  $p < .2929$  in a paired *t*-test, the students were able to integrate the newly learned self-monitoring strategies and demonstrate improvement in the quality handwriting categories. The treatment effect for the group in aggregate was found to be statistically significant when comparing the baseline, pre-test scores (mean = 26.8 all quality categories of handwriting, standard deviation = 3.76) to the final week post-test (mean = 31.17 all quality categories, standard deviation = 3.18);  $t(19) = 3.570430$ ,  $p < .011683$  in a paired *t*-test.

When comparing pre-test and post-test scores on the Minnesota Handwriting Assessment, 100% of students improved in at least two quality categories of handwriting, while 53% of students improved in all quality categories of handwriting. The greatest areas

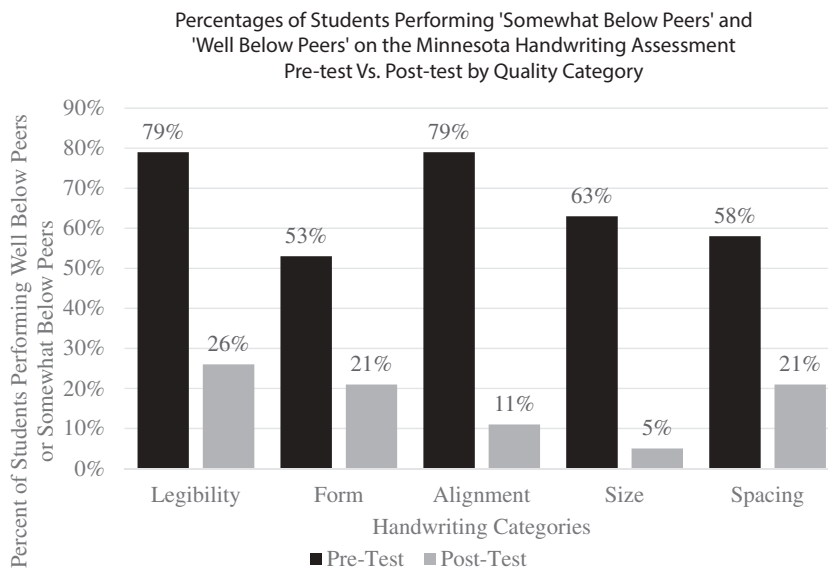


**Figure 1.** Student participant pre-test and post-test mean score results using the Minnesota handwriting assessment of all students with rate, legibility, form, alignment, size, and spacing.

of difficulty for students before the handwriting intervention were in the categories of Legibility, Alignment, and Size. The percentage of students performing ‘Somewhat Below Peers’ to ‘Well Below Peers’ was 63% in Legibility, 79% in Alignment, and 63% in Size. Post-test scores indicate that 26% or fewer of the students performed ‘Somewhat Below Peers’ to ‘Well Below Peers’ in quality categories of Legibility (26%), Alignment (11%), and Size (5%). After implementation of the Size Matters Handwriting Program, post-test scores show that 79% or more of the students performed ‘Like Peers’ in the quality categories of Alignment, Size, and Spacing. These outcomes are further illustrated in Figure 1.

The greatest areas of improvement for students, which was determined by the percentage of students who improved, were in the categories of Form, Alignment, and Size. The percentage of students performing ‘Somewhat Below Peers’ to ‘Well Below Peers’ in these categories decreased to 16%, 11%, and 5%, respectively. In the category of Form, 79% of the students improved. Both Alignment and Size categories showed that 100% of the students demonstrated improvement. While improvements were noted for many students in the areas of Legibility and Spacing, these two categories represent those with the least improvements after the intervention. It is important to note that 37% of students did not show improvement in Legibility and 10.5% of students did not show improvement in the Spacing category because they had already received the highest possible score on the pre-test and continued to perform at this level on the post-test. Legibility, the area of lowest improvement, improved by 58% of the students. In the category of Spacing, 74% of students improved. These outcomes are further illustrated in Figure 2.

Scores on the Minnesota Handwriting Assessment were also analyzed by gender with similar results noted among males and females. Mean scores for both males and females reveal positive gains in all quality categories of Legibility, Form, Alignment, Size, and Spacing. The greatest improvement for both boys (45%) and girls (88%) was in the quality



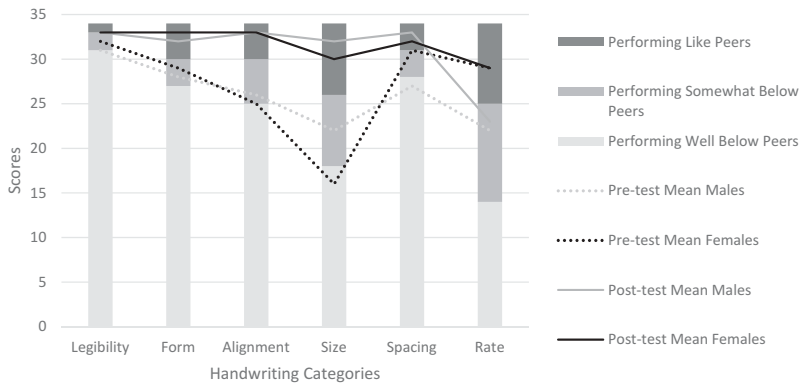
**Figure 2.** Percentages of students performing 'Somewhat below peers' and well below peers' on the Minnesota handwriting assessment pre-test vs. post-test by quality category.

category of Size, which is an expected outcome as the Size Matters Handwriting Program focuses largely on this component of handwriting. The second greatest area of improvement was noted in the Alignment category for both males (27%) and females (32%). The quality category with least improvement for both males and females was Legibility, with the males' mean score demonstrating a 6.5% increase and the females' mean score demonstrating a 3.1% increase from pre-test to post-test. The mean scores at post-testing of both males and females indicated that students were 'Performing Like Peers' in the quality categories of Form, Alignment, Size, and Spacing, but not in Legibility. These outcomes are further illustrated in Figure 3 (see Figure 3).

All five students (100%) receiving special education or response to intervention services demonstrated positive gains in the quality categories of Legibility, Form, Alignment, and Size. Four out of five students (80%) receiving support services showed positive gains in the quality category of Spacing. Positive gains in all quality categories ranged from a + 3% to a + 177% for this group of students. Specifically, in the categories of Alignment and Size, these students performed 'Well-Below Peers' before the handwriting intervention and performed 'Like Peers' after the handwriting intervention. In the categories of Legibility and Spacing, the students performed 'Well-Below Peers' before the handwriting intervention and 'Somewhat Below Peers' after the handwriting intervention. Although these students made positive gains in the category of Form with a 20% increase, their performance remained in the "Somewhat Below Peers' scoring level. A comparison of pre-test and post-test mean Rate scores were similar to the group in aggregate and indicates that the students made negative gains (-4%) and remained in the 'Somewhat Below Peers' performance level.

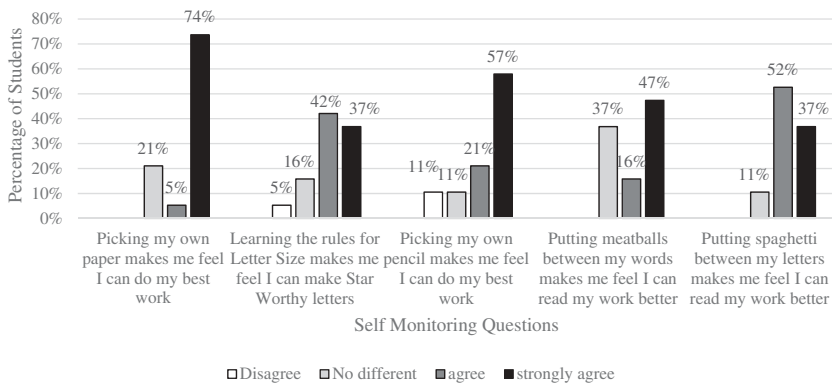
Students' perceptions of self-monitoring, collected via a brief self-report measure, revealed that most students agreed that self-monitoring played an important role in their learning by understanding the rules of handwriting and learning proper spacing strategies when writing.

### Minnesota Handwriting Assessment Pre-test and Post-test Mean Scores by Gender n=19



**Figure 3.** Student participant pre-test and post-test mean score results using the Minnesota handwriting assessment of all students by gender with rate, legibility, form, alignment, size, and spacing.

### Post Self Assessment of Self-Monitoring Skills



**Figure 4.** Post-test self-monitoring self-assessment mean percentage results of all students.

A majority (79%) of students agreed that choosing their own paper and pencil makes them feel they can do their best work. A similar majority felt that their work was enhanced by applying the ‘Spaghetti (90%) and Meatballs (63%)’ spacing concept between letters and words. Additionally, the majority of students (79%) agreed or strongly agreed that learning the rules of handwriting was effective in developing their handwriting skills. These outcomes are further illustrated in Figure 4 (see Figure 4).

## Discussion

The study’s results indicate that an occupational therapist-teacher collaborative model of instruction using the Size Matters Handwriting Program curriculum and materials for second-graders’ yielded statistically significant gains in the areas of handwriting

legibility, form, alignment, size of letters, and proper spacing between letters and words. Additionally, this study confirmed that self-monitoring is an important element of handwriting instruction and perceived as valuable to students. These results reinforce the value of using a cognitive approach and self-monitoring skills to address handwriting legibility and are consistent with findings reported in numerous prior studies (Peterson & Nelson, 2003; Pfeiffer et al., 2015; Weintraub et al., 2009; Zwicker & Hadwin, 2009; Zylstra & Pfeiffer, 2016). In this 6 week study, the Size Matters Handwriting Program intervention was found to improve handwriting in the quality categories of Legibility, Form, Alignment, Size, and Spacing for all students whether receiving special education or Response to Intervention support services, when comparing pre- and post-test data from the Minnesota Handwriting Assessment. There was no aggregate change in Rate, however males improved slightly (+4.5%) and students receiving special education and response to intervention support slowed slightly (-4.0%). There was no measurable change in Rate for females. These results echo the findings in Peterson and Nelson's (2003) study, where there were no significant differences in Rate between the intervention and control groups. The slower Rate score of students receiving special education or Response to Intervention services in this 6-week study could be the result of the students' slowing down to apply the learned rules of handwriting and self-monitoring. It should be noted that as students progress from each grade level, their handwriting speed gradually becomes faster (Graham, Weintraub, & Berninger, 1998). Prior research also indicated significant gains in the quality categories of Legibility, Form, Alignment, Size, and Spacing but no change in Rate according to the Minnesota Handwriting Assessment (Peterson & Nelson, 2003; Pfeiffer et al., 2015).

Prior studies illustrate the effectiveness of the whole-classroom intervention approach and collaboration between the teacher and occupational therapist related specifically to handwriting interventions (Case-Smith, 2002; Case-Smith et al., 2014; Howe et al., 2013; Zylstra & Pfeiffer, 2016). However, the studies did not discuss difficulties in scheduling whole-classroom interventions. The whole-classroom approach was indeed difficult to schedule for this study as students were removed for scheduled special education or Response to Intervention support services throughout the day. Scheduling required that the occupational therapist and teacher be flexible in scheduling the whole-classroom approach during blocks of time when all students were able to participate in the handwriting instruction. Further, during the implementation period, the teacher and occupational therapist discussed and addressed fine motor concerns of students noted during the handwriting instruction. Such collaboration between the teacher and occupational therapist is consistent with the findings in the literature (Case-Smith et al., 2014; Howe et al., 2013; Zylstra & Pfeiffer, 2016). The teacher asserted that the insights provided by the occupational therapist (first author) during the collaborative sessions positively contributed to her effectiveness in teaching handwriting. The Size Matters Handwriting Program intervention required the collaboration and teamwork of the classroom teacher and the occupational therapist and is supported by the literature reviewed (Case-Smith, 2002; Case-Smith et al., 2014; Howe et al., 2013; Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). Similar to this study, authors Zylstra and Pfeiffer (2016) and Pfeiffer et al. (2015) stress that the teacher and occupational therapist should jointly plan for the long-term by embedding strategies such as the use of small groups and learning stations to improve writing and handwriting into the curriculum. The collaborative aspect of this study

allowed the teacher and occupational therapist to communicate frequently, to assess the students' progress, and to finalize plans for upcoming weekly handwriting sessions.

Although the literature review supported the use of self-monitoring strategies and techniques to improve handwriting legibility, no study used an outcome measure to measure the students' perception of their self-monitoring skills. An important feature of this study was the outcome measure to measure the students' perceptions of their learned self-monitoring skills. The results indicated that a majority (79%) of students agreed that choosing their own paper and pencil makes them feel they can do their best work. When students are given a choice, it can facilitate self-determination skills as well as greater autonomy. A similar majority felt that their work was enhanced by applying the 'Spaghetti (90%) and Meatballs (63%)' spacing concept between letters and words. Providing students with a visual cue to understand the concepts of proper spacing that is also student-friendly can help students retain and apply the information learned. Additionally, the majority of students (79%) agreed that learning the Size Matters Handwriting Program rules was effective in developing their handwriting skills. Teaching students a systematic technique for learning handwriting can support their overall academic development as the rules of handwriting pertain to several learning standards and can be applied across instructional settings. Teaching the rules of handwriting can promote independence, attention to task, and completion of assignments. Based on the self-monitoring assessment results, students perceived that self-monitoring strategies played an important role and was a valuable tool in helping them to be independent and self-directed learners. Additionally, the self-monitoring strategies the students learned encouraged them to pay close attention to detail in their handwriting and promoted their best work to be successful in handwriting. In support of this project, multiple studies demonstrate the effectiveness of using and developing strategic self-monitoring strategies related to handwriting, and the positive impact it has on students' future academic success. The existing literature supports the relationship self-monitoring has on improved student engagement, productivity, grades, confidence, and academic behaviors (Rock, 2005; Wood, Murdock, & Cronin, 2002; Xu, Wang, Lee, & Luke, 2017). Based on the benefits identified in these studies, therapists and teachers should consider integrating and developing self-monitoring strategies into the school curricula for any skilled development, including but not limited to handwriting for optimal student performance.

### **Limitations and Recommendations for Future Study**

Limitations include the short duration of the 6-week study, the use of a small convenience sample, absence of a control group, investigator bias, the use of a self-report measure related to self-monitoring, and no direct parent involvement. The short 6-week timeframe of the study may have impacted outcomes and did not allow for long-term follow-up to determine if further gains or sustainment of skills occurred over time. Due to the absence of a control group, it is difficult to know if the improvements that the students made were the result of implementing the Size Matters Handwriting Program alone, or a combination of factors including maturation and other instructional methods. It is possible that all students in all classrooms made improvements in handwriting over this six-week period, but not to the extent of the classroom that was taught the Size Matters Handwriting Program. The use of convenience sampling and the absence of a control group limits the generalizability of results, though this design was

purposefully chosen for the pilot of this intervention in the setting. Additionally, two participating students received occupational therapy services during the time period of this study; both received 30-minute weekly occupational therapy sessions that addressed handwriting which may have influenced their outcomes. The occupational therapist (first author) had an established relationship with the school staff which may have impacted outcomes; however, use of the standardized handwriting assessment, peer-review of the self-report measure, and collaboration with the co-author related to study design and data analysis strengthen the findings. The first author had no prior interactions with the student participants in this study, which helps to reduce investigator bias. Next, the use of the self-report measure to determine students' perceptions of self-monitoring may be a concern. Students may have focused on more positive experiences during the handwriting instruction than negative ones or may not have answered the questions truthfully. Finally, parents or guardians were not trained to supplement the handwriting instruction in the home environment. Such training may improve handwriting outcomes by allowing parents to learn more about the handwriting curriculum taught and by extending learning beyond the school environment for students. Future studies are recommended with larger samples of teachers and students in general education classrooms as well as those receiving special education or Response to Intervention services. In addition, studies over a longer period of time could be conducted to determine the best duration for maximum gains and sustainment of skills. Lastly, occupational therapists are uniquely qualified to discuss the success and importance of this handwriting program with parents and provide a parent training so that the concepts of the Size Matters Handwriting Program could be used both at school and at home. Future studies that translate beyond the school and include the home environment are highly recommended to promote the long-term development of students. Collectively involving parents, teachers, and students in education could provide additional layers of support needed for students' academic success.

## Conclusion

Embedding the Size Matters Handwriting Program into the classroom curriculum provided an effective, evidence-based solution to helping all students with a variety of needs to maximize their educational potential and facilitated student participation within the school environment. Despite the advances in technology, handwriting continues to be a main occupation for elementary school students and plays an important role in the students' overall academic achievement (McMaster & Roberts, 2016). Given the statistically significant improvements in students' handwriting legibility in this study, incorporating the Size Matters Handwriting Program and teaching students self-monitoring techniques as a preventive handwriting program is suggested. These findings support the published literature that a cognitive approach combined with self-monitoring is an effective handwriting intervention. Additionally, the results support a whole-classroom approach utilizing teacher and occupational therapist collaboration, and this approach aligns with the Individuals with Disabilities Education Act by placing students in the least restrictive environment and by providing services in the general education classroom to the maximum extent possible. In pursuit of AOTA's Vision 2025, occupational therapists need to be advocates of schools adopting evidence-based handwriting curriculums and encourage other occupational therapists to reevaluate their current handwriting interventions, and to work closely with classroom teachers in the schools they serve.

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