Handwriting Intervention: Impact on the Reading and Writing Abilities of High School Students

Tamara McEachern, Hon. B.Sc.

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Faculty of Social Science, Brock University
St. Catharines, Ontario

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Dedication

I dedicate this thesis to my grandmother, whose attitude of thankfulness and courage to persist through life’s challenges has been a guiding example for me.
Abstract

Handwriting is a functional task that is used to communicate thoughts using a written code. Research findings have indicated that handwriting is related to learning to read and learning to write. The purposes of this research project were to determine if a handwriting intervention would increase abilities in reading and writing skills, in graphomotor and visual-motor integration skills, and improve the participants’ self-perceptions and self-descriptions pertaining to handwriting enjoyment, competence, and effort. A single-subject research design was implemented with four struggling high school students who each received 10.5 to 15.5 hours of cursive handwriting intervention using the ez Write program. In summary, the findings indicated that the students showed significant improvements in aspects of reading and writing; that they improved significantly in their cursive writing abilities; and that their self-perceptions concerning their handwriting experience and competence improved. The contribution of handwriting to academic achievement and vocational success can no longer be neglected.

Keywords: handwriting intervention, literacy, cursive writing, adolescence, single-subject research design
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CHAPTER ONE: GENERAL INTRODUCTION

Background Information

Literacy refers to the ability to read and write. In a report issued from Statistics Canada and the Organization for Economic Cooperation and Development (2005) it was stated that 40% of Canadian adults struggle with basic literacy skills. Similarly, as reported in the 2003 National Assessment of Adult Literacy, close to 43% of American adults have difficulty reading the print materials they encounter in everyday life (Kutner et al., 2007). These findings highlight the overall importance of literacy research, as well as the application of what the present investigation has found. It is of utmost importance that we better understand the processes impeding the learning of struggling readers and develop and test effective interventions capable of addressing their complex learning needs. It is therefore imperative to comprehend the underlying reasons for illiteracy so that improvement in the overall national literacy levels can begin.

The main focus in literacy research has been on reading. However, by comparison there has been very little research on writing which is a much more complex skill to acquire since it involves the processing as well as the production of print. The explanations offered for this are that reading is more valued than writing; separate professional organizations exist for reading and writing; and even though it is not supported by research, there is a belief that reading must first be acquired before writing acquisition is possible (Berninger & Abbott, 2010; Connelly, Campbell, MacLean & Barnes, 2006).
In the 1980s, Hayes and Flower proposed a cognitive model of writing that conceptualized skilled adult writing as including the three recursive cognitive processes of translation, planning and reviewing, to produce written output (Abbott & Berninger, 1993; Connelly et al., 2006). More recently Berninger et al. (2002) have adapted this model to address the developmental processes of how children learn to write. It is referred to as the “Simple View of Writing” and is illustrated as a triangle where transcription (handwriting and spelling) and executive functions (conscious attention, planning, reviewing, revising, strategies for self-regulation) are represented by the angles at the base and text generation (words, sentences, discourse) is positioned at the vertex of the triangle. Working memory (activating short- or long-term memory depending on the writing task) is considered to affect the whole writing process and this is represented by it being shown inside the triangle (Berninger & Amtmann, 2003). This model states that in the early stages of writing development the transcription processes are foundational and both handwriting and spelling are the basis from which the writer can translate the ideas he/she has into written text. The executive functions are regulated by assistance from teachers, parents and peers in these beginning phases of learning how to compose. However, as the writer matures he/she will become better able to self-regulate and so the various executive functions will transition into playing a more significant role in the writing process as transcription becomes more automatic (Jones & Christensen, 1999).

It was my intent to examine how handwriting, one of the Simple View of Writing’s transcription components, might impact literacy levels. It is important, for the purpose of maintaining clarity, to provide two definitions before continuing. The term handwriting will refer to the physical act of producing written symbols on paper. Other
terms used to describe handwriting are *penmanship* and *graphomotor skills*. There are two main types of handwriting commonly used, namely *printing/manuscript* and *cursive writing*. The term *writing* will refer to the language and ideas that are expressed in written format on paper. Writing can also be called *written expression* or *composition*.

Formal handwriting instruction in the public school system is being eliminated. Now, according to anecdotal reports from teachers, occupational therapists, parents and other educators, handwriting is no longer a required component of the Ontario Curriculum. Rather it is something that is considered optional. In fact, the Ontario Ministry of Education’s Grades 1 to 8 Language Curriculum does not mention handwriting when introducing the four overall expectations of the writing strand (Ontario Ministry of Education, 2006). Based on the statistic that upwards of 30% of school age children experience writing difficulties, this reduced focus on the instruction of handwriting is questionable (Feder & Majnemer, 2007). By conducting this research project it was my hope to lend some evidence-based findings that will help to shed more light on the importance of handwriting.

My project serves to fill in recognized gaps within the current literature. There are a limited number of studies published on handwriting interventions and even fewer on how handwriting corresponds to other cognitive abilities (i.e. reading). The majority of the studies that have been published focus on young children, whereas in my research project I chose to work with a group of older youth (ages 13 to 18). Several years of clinical experience has shown me that once students with learning challenges reach this adolescent stage, they have developed many coping and protective measures in order to
survive. If positive change is possible for teenagers, then it could indicate that a handwriting intervention is an effective way of impacting literacy rates.

**Research Questions**

This research project proposes to answer the following questions:

- Does the direct instruction of handwriting skills impact specific core aspects of overall academic achievement, and more specifically does it impact the reading and writing skills of struggling high school students?
- Does practice of handwriting and its’ underlying skills lead to improvements in graphomotor and visual-motor integration skills (i.e. eye-hand coordination, letter formation, speed, legibility)?
- Following a handwriting intervention do the participants’ self-perceptions and self-descriptions around cursive writing enjoyment, competence, effort, and performance change?
CHAPTER TWO: REVIEW OF THE LITERATURE

The main purpose of the following literature review is to determine what the current research findings show in connection to the impact handwriting has on an individual’s writing and reading abilities. Further to this, studies that have focused on handwriting instruction and intervention will be highlighted to illustrate the great importance handwriting should hold within the educational system.

Background

Handwriting is still an essential skill, despite modern technology. People present themselves to the world through their handwriting, and are inevitably judged by it. From our earliest school days, success and failure are often measured in terms of neat handwriting. …The constant visible reminder of failure can affect the writer’s self-image in a subtle and destructive way. Handwriting problems can lead to underachievement in all written work and influence children’s attitudes and behaviour throughout the school. (Sassoon, 1990, p. 1)

Handwriting is a functional task that is used to communicate thoughts using a written code. It is a skill that is required for full participation in school activities since children spend up to half of their classroom time engaged in paper and pencil tasks daily (Kushki, Schwellnus, Ilyas & Chau, 2011). Therefore, handwriting difficulties can have a profound impact on a student’s academic success and self-esteem (Feder & Majnemer, 2007). Handwriting is not just important for school children; it is an important activity for people of all ages and across many cultures. Adults still report using handwriting to “record factual information and ideas, to communicate with others, and for creative
expression”, despite the advances that have been made in technology (VanDrempt, McCluskey, & Lannin, 2011, p. 321).

Given the evident practical importance of handwriting it might be assumed to be an area of research focus. However, as Miller and McCardle (2011) point out, writing research has been neglected relative to reading and oral language in recent decades. Handwriting is a component of the writing process, and so if writing has been overlooked it is not surprising that there has been little educational research into handwriting and its impact on students’ academic achievement in North America. Even in the United Kingdom, the methods used to teach handwriting in English mainstream schooling is based on studies conducted in the mid-1980s and early 1990s (Medwell & Wray, 2007). There is a sense of urgency in the current literature to see this change. “A focused scientific research effort on writing research and its relationship to language development and reading is needed to address the writing and broader literacy needs of today’s and tomorrow’s learners and workers” (Miller & McCardle, 2011, p. 121). It should also be noted that the majority of the recent research findings on writing view the role of handwriting in the writing process as peripheral and instead place great importance on written composition (Medwell & Wray, 2007). This emphasis on composing has drawn attention away from handwriting and the role that it plays in the overall writing process. Research in the areas of neuroscience, cognitive psychology and special education points to the necessity of examining how handwriting impacts the ability to write, as well as read (Cahill, 2009; Medwell & Wray, 2007).
Handwriting: Related to Learning to Write

A considerable amount of the cognitive psychological research that has been done on the writing process has focused on the role of working memory in writing (Medwell & Wray, 2007). As Baddeley (2003) states, “working memory involves the temporary storage and manipulation of information that is assumed to be necessary for a wide range of complex cognitive activities” (p. 189). Working memory can only temporarily hold a few items of information necessary for carrying out tasks at any given point in time. As mentioned already in Chapter One (Introduction), the Simple View of Writing places working memory in a central role and therefore, it is necessary to understand how its limited resources are used when writing. As studies have shown, the capacity of working memory is closely associated with the literacy skills of younger children (Gathercole, Pickering, Knight, & Stegmann, 2004). Thus, students who are learning to write and must devote large amounts of working memory to the control of the lower-level processes such as handwriting, will have little left over for the higher-level cognitive processes of executive functioning and text generation (Berninger, 1999; Olive, 2012). In this way it can be seen that handwriting affects composition (Berninger, 1999; Graham, Harris, & Fink, 2000; Medwell, Strand, & Wray, 2009).

Sweller and Chandler (1994), have found that, since individuals can generally only attend to one cognitive task at a time, automaticity allows for cognitive processes to occur quickly, accurately and without conscious control. They further state that with time and practice, all cognitive processes can be carried out automatically. Thus, the solution to the problem of limited working memory capacity, when applied to the task of writing, is to make handwriting an automatic process to allow the cognitive resources to be used
to generate ideas, plan and revise what is composed, and all of the many higher-level processes that go into writing (Christensen, 2005; Medwell & Wray, 2007).

Nevertheless, the quality of the written production (i.e. legibility, neatness, uniform size and spacing) is more commonly measured in studies on writing as opposed to measuring handwriting automaticity and fluency, which incorporate speed and accuracy (Abbott & Berninger, 1993; Tucha, Tucha, & Lange, 2008). A paradigm shift in research from looking at the writing product in a quantitative way to looking at the writing process in a qualitative and theoretical way started in the 1990s (Abbott & Berninger, 1993). The resulting research indicates that the mechanics of writing or, in other words, the lower-level skills of getting language on paper, can interfere with both the quality and quantity of written composition (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Graham, et al., 2000). In fact, some studies have suggested that automatic letter writing is the single best predictor of length and quality of written composition in younger students (Graham et al., 1997).

Current theory, practice and policy in handwriting is founded on the assumption that it becomes an automatic skill relatively early on in a writer’s development; but support for this huge assumption is not evident in the literature (Medwell et al., 2009). As Medwell and Wray (2008) point out, handwriting does not appear as an objective in the UK’s National Literacy Strategy after the age of nine since it is assumed that handwriting will have been mastered by this time. It is time for practical application and educational policies to catch-up with the new evidence based research findings.

Over the last fifteen to twenty years a group of researchers in the United States have investigated the role of handwriting in writing (Berninger et al, 1997; Graham et al.,
2000). Interestingly, they have established that handwriting is not purely a motor act but rather it is “language by hand” (Berninger et al., 2006). By conducting cross-sectional, longitudinal, and instructional studies these researchers examined how language works with sensory and motor systems to produce and receive language (Berninger, 1999; Berninger & Abbott, 2010; Berninger, Abbott, Abbott, Graham, & Richards, 2002). A considerable amount of time has been spent examining the four separate and interacting functional language systems: language by ear (listening comprehension), language by mouth (oral expression), language by eye (reading comprehension), and language by hand (written expression). Of significance for the purpose of the present discussion, handwriting has been shown to be an integration of orthographic codes (letter forms), phonological codes (letter names and sounds), and graphomotor codes (written shapes) and this is why it is referred to as language by hand (Berninger et al., 2006).

The concept that handwriting is not merely a mechanical or motor skill is further supported by Richards et al. (2011) who claim that it is rather a “brain-based skill that facilitates meaning-making as writers externalize their cognitions through letter forms, the building blocks of written words and text” (p. 512). Similarly, Christensen (2005) suggests that handwriting is not just about training the hand (motor skills); but it is about how memory and orthographic processes must work together to be able to recall the letter shapes and translate these patterns onto the page automatically. This skill is called orthographic-motor integration and it has been shown to contribute more to handwriting than to motor skills (Berninger & Amtmann, 2003). Thus, handwriting as a language act is an important part of writing and not just a motor act that is used to record writing (Medwell et al., 2009).
Graham et al. (1997) have suggested that handwriting contributes directly to compositional fluency and quality for both beginning (primary Grades 1 to 3) and developing (intermediate Grades 4 to 6) writers. This group of researchers used multiple-group structural equation modeling to analyze the relationships between transcription (handwriting and spelling) and composition in 600 students, Grades 1 to 6, who were virtually all general education students (N = 599) and right-handed (90%). After implementing two, timed handwriting fluency measures (alphabet and copy task), three spelling measures (dictation and assessment of spelling in separate writing samples), and two composition measures (narrative and expository) the researchers developed two structural models. The results of the model of compositional fluency showed that the paths from both handwriting and spelling were significant in the primary grades but in the intermediate grades only the path from handwriting was significant. In the second model, a model of compositional quality, only the path from handwriting was significant for all six grade levels. Spelling only contributed to compositional quality indirectly through its correlation with handwriting. Overall, the study showed that, due to the large proportion of variance that was accounted for by a combination of handwriting and spelling in compositional fluency (41% in primary grades to 66% in intermediate grades) and in compositional quality (25% to 42%), the transcription skills necessary for writing, affect students written composition throughout elementary school. Their research is supported by others and suggests that orthographic-motor integration accounts for more than 50 percent of the variance in written language performance in individuals from primary through to secondary school and even into adulthood (Bourdin & Fayol, 2002; Graham et al., 1997; Jones & Christensen, 1999).
Handwriting: Related to Learning to Read

At least in the Western world, 40% of a child’s life is spent in school (O’Hare, 2010). Children who have difficulty with learning how to read will be at greater risk of academic failure. Learning to read is critical for academic and vocational success. Graham and Hebert (2011) claim that one way to improve students’ reading is through writing. Many of the instructional practices that have resulted in improved writing (and handwriting as a component of the writing process) have not been studied to determine if they also enhance reading ability (Graham & Hebert, 2011). To effectively address the national illiteracy challenges, it is imperative that research on the impact writing has on reading is promoted.

In viewing literacy through the lens of developmental psychology, many researchers have focused on studying the potential cognitive factors that contribute to an individual’s ability to learn how to read and write. In so doing, they look at the cortical functions of the brain in both typically developing and atypically developing populations. Researchers who study the subcortical functions of the cerebellum, however, have come to conclude that motor development is interrelated with cognitive development and argue that it should also be taken into account when analyzing the possible causes of illiteracy (Diamond, 2000).

James (2009), a researcher at Indiana University, has framed this connection between motor and cognitive function by explaining that in order to perceive something we need to act on it. For example, we need to move our eyes (action) in order to see objects in our environment (perception). She is involved in conducting functional magnetic resonance imaging (fMRI) studies that look at the fine motor skill of printing
(the action component) with reading and letter identification (the perception component) and has found that both of these components are linked in behaviour and in the neural systems that underlie those behaviours. In one study James (2009) recruited twelve healthy participants (ages 4 years 3 months to 5 years 4 months) who were all native English speakers and right-handed. There were seven females and five males and each child was randomly assigned to either the experimental or control group. After time to be familiarized and become comfortable with the MRI environment the children were initially scanned while viewing the visual stimuli passively. The stimuli presented were letter forms, isolated false fonts (have same features of letters but are not real letters) and simple shapes. Neural activation was measured by the blood-oxygen-level-dependent (BOLD) signal in the entire brain. A week later the participants returned once a week for four weeks of training. The experimental group used a sensorimotor training protocol where they were encouraged to learn to print letters and words by copying from a story. Those in the control group were asked to name the same letters and words aloud as part of a visual training protocol. One week following the final training session a post-scan was performed and increases in BOLD responses to letters were seen in the brain regions associated with recognizing letters of the experimental group participants. No changes were seen in the same brain areas within those in the control group. James (2009) concluded that, “sensori-motor experience (printing) augments processing in the visual system of pre-school children. The change of activation in these neural circuits provides important evidence that ‘learning-by-doing’ can lay the foundation for, and potentially strengthen, the neural systems used for visual letter recognition” (p. 1). Therefore, it may well be that handwriting directly impacts the development of reading.
This connection between handwriting and reading is also discussed in the reviews by Richey (2008) and Vander Hart, Fitzpatrick, and Cortesa (2010), where they point out that learning how to write individual letters and spell words has been shown to reinforce the skills of letter naming, phonemic awareness and word reading. Interestingly writing and reading appear to share a close and reciprocal relationship (Graham & Hebert, 2011). This is seen in Abbott and Berninger’s (1993) structural equation modeling approach to analyzing writing skills when they found that oral language and reading contribute uniquely to written composition in early primary school years. In addition, others have found that practicing handwriting is important for the development of early reading abilities because early print exposure is an important component of learning language code (Levy, Gong, Hessels, Evans, & Jared, 2006).

**Handwriting: Development and Performance**

Typically, handwriting development begins at an early age. Between the ages of three and four the underlying features of handwriting, like directionality and linearity, begin to appear in the scribbles, wavy lines, pseudo-letters, and pictorial representations produced (Beery & Beery, 2010; Graham & Weintraub, 1996). By four to five years of age, letters are beginning to become part of children’s writing, although they often happen along with pictures during the kindergarten years. A child’s ability to copy geometric shapes, specifically the oblique cross, is seen as an indication that the child is ready to write (Beery & Beery, 2010; Feder & Majnemer, 2007). Dramatic changes occur in the early elementary grades with handwriting progressing from irregular to smooth and consistent output, indicating improvement in legibility. The speed at which children write
steadily increases from year to year throughout the primary and intermediate grades (Feder & Majnemer, 2007). Little is empirically known about handwriting development beyond elementary school and more research with older students is necessary to link what is known about the developing capabilities of children to the skilled handwriting of adults (Graham & Weintraub, 1996).

Competence in handwriting is usually described in terms of legibility and speed. Legibility refers to the readability of the written text (taking into account elements such as letter formation, size, alignment, and spacing) and is often what is judged and seen as a reflection of the writer’s intelligence or capabilities (Feder & Majnemer, 2007). It has been illustrated that, despite similar written content, lower marks were consistently assigned to students with poor handwriting in comparison to those with neater handwriting (Connelly et al., 2006). As Sassoon (2006) points out, poor handwriting is a demoralizing and constant reminder of failure at any age but especially to those in secondary school and on into adulthood. Handwriting speed (typically measured as the average number of letters or words written per minute) is another essential measure of handwriting performance since writing needs to be completed within a reasonable span of time to be functional (VanDrempt et al., 2011).

Individual differences must be considered when looking at handwriting development. Gender differences do exist and studies have shown that by the age of seven, males have a significantly lower quality of handwriting and are slower in their production than females of the same age (Graham & Weintraub, 1996). Overall, girls are better handwriters than boys and boys are more likely to be identified as having handwriting problems (Medwell & Wray, 2007). Research into the question of whether
handedness impacts the legibility and speed of writing has generally supported the view that left and right-handers are similar on both measures (Graham & Weintraub, 1996). Intelligence and fine motor skills in the general population appear to only account for a small proportion of the variance in handwriting scores (Abbott & Berninger, 1993; Graham & Weintraub, 1996).

Like other complex motor skills, handwriting is a learned skill that requires time to develop a high level of proficiency (Smits-Engelsman & Van Galen, 1997). It also requires spatial and temporal abilities along with coordination of diverse muscle groups, as is seen in the common task of tying a shoelace; it is not just about how the task is completed but also about how long it takes (Ben-Pazi, Kukke, and Sanger, 2007). Timing is crucial for one to be proficient on a motor task and so it is important to examine the temporal impairment of motor activity when looking at penmanship (Ben-Pazi et al., 2007). “Penmanship is one of the most complex rhythmic tasks: it requires motor control, visuospatial coordination, visuomotor coordination, sensory feedback, adequate pen grip, and manipulation as well as other acquired skills” (Ben-Pazi et al., 2007, p. 543). Children who fail to integrate all of these skills will develop problems with handwriting. However, it must again be emphasized here that handwriting is much more than a motor act.

A study by Abbott and Berninger (1993) analyzed the structural relationship between fine motor functioning and handwriting fluency in 600 Grade 1 to 6 students and found that fine motor skills only contributed to the prediction of handwriting performance indirectly through orthographic coding. They stated that, “Handwriting is fundamentally a linguistic act – producing alphabet symbols on the motor output channel” (p. 503).
Therefore, it follows that the linguistic skill of rapidly coding letters in written words (orthographic coding) has a more significant relationship with handwriting than did fine motor skills.

Proficient handwriting is significantly correlated with academic achievement and is a predictor of general learning abilities (Kushki et al., 2011). Approximately 10 to 30% of children have difficulty mastering the skill of handwriting and problems are most common among children with various disorders, such as ADHD, learning disabilities, and speech and language difficulties (Graham & Harris, 2005). Dysgraphia is a disorder of written expression that can be defined as “difficulties in handwriting control” (Nicolson & Fawcett, 2011, p. 117). Even when provided with an appropriate amount of instruction and practice, children with dysgraphia fail to progress typically in the acquisition of handwriting (Smits-Engelsman & Van Galen, 1997). Dysgraphic handwriting lacks consistency and is variable in size, form and orientation across several trials. Nicolson and Fawcett (2011) have demonstrated, through extensive research, that dysgraphia reflects a lack of automaticity at the cognitive level.

There are very few studies of dysgraphia. One conducted by Smits-Engelsman and Van Galen (1997) in the Netherlands investigated the quality of motor control in a group of 24 children with dysgraphia compared to an equally sized control group. They designed a longitudinal research project based on a preliminary cross-sectional study that matched 7 to 12 year olds who were proficient handwriters with children who scored as low performers on writing tasks. The participants were tested individually and the handwriting experiment lasted about 30 minutes. Differences in handwriting performance were demonstrated in a repeated measures design one year later. By using a digitizer
tablet and a special pen the researchers were able to measure the force exerted on the pen point, as well as the position of the pen during the writing task. The children were given a variety of target writing samples consisting of short strings of connected script. They were required to copy the scripts onto the digitized tablet and were scored on the following variables: “overshoots, undershoots, movement time, writing dysfluencies, stroke curvature, and the relative amount of noise in the velocity signals of the writing tasks” (p. 172). The results of this study were that overall, without extra help, dysgraphic children persisted in their poor psychomotor skill over a one year time frame and that dysgraphia was associated with poor motor control. It is noteworthy that the researchers suggested that poor handwriting ability may be a persistent trait when untreated but it may also be sensitive to training. Further study in the role of handwriting intervention was recommended.

The relationship between handwriting style and handwriting speed and legibility has been a topic of debate in research and in educational circles. Graham, Weintraub and Berninger (1998) investigated this relationship with a group of 600 children in Grades 4 to 9. The sample represented those within a normal range of achievement, with only 8 to 10% of the students being left-handed. Each student was asked to provide three samples of handwriting. Completing a timed copying test that gave the participants 1.5 minutes to copy a short paragraph as quickly and accurately as possible produced the first writing sample. The other two handwriting samples were obtained during two 5-minute, free-writing tasks that required the students to write one narrative composition and one expository composition about a familiar topic. The researchers noted that even though the tasks were timed the children never seemed anxious, but instead seemed to enjoy the
activities. Handwriting speed was measured in number of letters copied correctly in one minute using the copy task samples. Handwriting legibility was measured using all three handwriting samples by comparing them to a set of graded specimens, available from the Test of Legible Handwriting, with a score range from 1 to 9. The two independent raters were trained prior to scoring the samples collected during the study and interobserver reliability during training was .92. The raters were told that the various individual aspects of legibility (i.e. slant, size, letter formation, spacing) were only important if they distracted from the overall legibility of the handwriting. Four classifications of handwriting style were used to sort the samples collected: manuscript (all letters printed); cursive (all letters in cursive); mixed-mostly manuscript (50% or more printed); and mixed-mostly cursive (50% or more in cursive). The overall results indicated that there were no differences between manuscript and cursive in terms of legibility or speed. The findings also suggest that the students who used a mixed style wrote faster than those who used manuscript or cursive exclusively and, handwriting samples written in a mixed-mostly cursive writing style received higher legibility ratings than those in which the other three styles were used. This evidence does not support the previously made claims that manuscript tends to be more legible than cursive and that cursive writing is faster than manuscript (Graham et al., 1998). The researchers recommended continued study of handwriting fluency and its impact on written composition with the interesting focus on how handwriting style might impact the fluency of handwriting.

In Australia, a study that examined the cursive writing speed and legibility of 7 to 14 year olds was conducted with a sample of 372 students (Ziviani & Watson-Will, 1998). As the investigators explained, printing was initially taught with a transition to
cursive writing later on in primary school. However, in the mid-1980s the curriculum was revised and now “modern cursive script” is the established style of handwriting taught throughout Australia. Even though modern cursive script has been adopted by the school system there is still much controversy about whether it is superior over the previous printing and cursive styles. In their research project, Ziviani and Watson-Will (1998) sought to document the handwriting speed and legibility of students who used modern cursive script. To determine handwriting speed (number of letters written per minute) the students were told to write “cat and dog” as many times as they could in a 2-minute period as quickly and accurately as they could without stopping to make corrections. These samples were then used, by two trained teachers, to rate legibility using a seven-point scale where 1 corresponded to poor legibility and 7 corresponded to good legibility. An interobserver reliability coefficient of .79 was produced for the legibility ratings. The data collected showed that there was not a significant difference between the handwriting speed of the girls and boys; a finding which contradicts earlier studies that have found girls write faster (Graham & Weintraub, 1996). On the other hand, legibility was significantly better for girls than boys. A low correlation between speed and legibility was found ($r = .23, p > .05$).

In a more recent review of the research, Berninger and Amtmann (2003) found that writing is the most common problem in 9 to 14 year old students with learning disabilities. The hypothesis that the developmental origin of these written expression problems could be found in impaired transcription abilities (handwriting and spelling) has been confirmed (Graham et al., 1997). They further explain that students with severe motor problems are likely to have handwriting problems, but students with typical motor
development could also have handwriting difficulties that are more directly related to orthographic processing than motor processing skills.

As has already been discussed, automaticity contributes to individual differences in beginning writing; the more automatic low-level handwriting and spelling are, the more spatial and temporal resources of working memory are available for higher-level cognitive tasks of planning, composing and revising the generated text. In addition, it was suggested that early intervention aimed at increasing automaticity of letter production in children may have long term effects on the written expression of students in their high school years and beyond.

**Handwriting: Instruction and Intervention**

There is evidence to indicate that handwriting difficulties do not resolve without intervention and affect between 10 and 30% of school-age children. Despite the widespread use of computers, legible handwriting remains an important life skill that deserves greater attention from educators and health practitioners. (Feder & Majnemer, 2007, p. 312)

Recently an in-depth analysis of handwriting curriculum and instruction in four American kindergarten classrooms was carried out using both quantitative and qualitative methods (Vander Hart et al., 2010). They stated that, “educational practices that emphasize process writing and whole language or personal communication coupled with the heightened focus on reading and mathematics as a result of the No Child Left Behind Act of 2001 have resulted in a de-emphasis on the direct instruction of mechanical skills in handwriting” (p. 674). What they found in their study was that daily, explicit
handwriting instruction is not receiving as much classroom time as is needed to promote efficient and automatic handwriting. Teachers were not implementing many of the effective strategies that have been recommended in the literature (Berninger et al., 1997). Namely, letters were not consistently introduced in an order to avoid confusion; writing for fluency was not emphasized; writing from memory was not employed; and the use of student self-evaluation of their handwriting samples are some of the neglected strategies. They suggest that this may be because there is not a general understanding among teachers about the impact of handwriting on literacy learning. In fact, research findings have demonstrated that 50 to 100 minutes of handwriting instruction per week with daily practice is optimal (Graham & Miller, 1980). As well, it appears that teachers believe that handwriting should not be given as much importance as in the past, due to the extensive use of computers and other technology in our society today (Berninger & Amtmann, 2003).

Berninger and Amtmann (2003) support the claim that handwriting must be explicitly taught. They stress the importance of having learning environments that allow students with transcription problems to think of themselves as writers and they encourage daily writing. They argue that if the students are permitted to avoid handwriting then a self-perpetuating cycle is created in which poor handwriting breeds poor handwriting through lack of practice. Berninger and Amtmann (2003) do not recommend the use of alternative computer-based technologies commonly used to bypass handwriting challenges (keyboarding, voice recognition programs, word prediction software) since these technologies create new tasks for the individual who may or may not be able to handle the varied processing requirements. Berninger et al. (2006) proposed that typing
and handwriting are only moderately correlated and use separate neuropsychological processing systems. Surprisingly there has not been a lot of research to support educational applications of technology-based accommodations on the writing process and it was recommended that they should only be used after explicit handwriting intervention has been implemented and writing challenges are still evident (Berinder & Amtmann, 2003). These studies support the notion that once students have adequate transcription skills or, in cases where this is not possible, an appropriate computer-based compensatory tool for handwriting, they should be encouraged to progress and to gain experience in expressing their ideas through writing.

Occupational therapists, Bartorowicz, Missiuna, and Pollock (2012), from McMaster University in Ontario, Canada were the first to critically review the use of technology for children with learning disabilities who required support in written performance. After conducting a systematic electronic literature search only 28 peer-reviewed studies of the initial 864 met their selection criteria that included learning disabled children in Grades 1 to 12 who used technology for writing. In general, this review indicated that evidence is moderately low to support the use of technology and that a direct link between writing difficulties and the usefulness of a computer-based technology to solve these difficulties cannot be made based on the available research.

The majority of handwriting remediation studies focus on children between five to ten years of age (Feder & Majnemer, 2007; Yancosek & Howell, 2011). One such pediatric-based study was conducted by Ratzon, Efraim and Bart (2007) and looked at 52 first-graders with low scores (below the 21st percentile) on the Beery Visual-Motor Integration test. The total sample was randomly divided into a treatment group (N = 24)
and a control \((N = 28)\) group. A short-term graphomotor program was developed by a graduate student at Tel Aviv University in Israel and specified 45 minutes of intervention once per week for 12 weeks. For the first 10 to 15 minutes of each session fine-motor activities (i.e. threading beads, inserting pegs, etc.) were implemented as a warm-up to the pencil and paper tasks that occurred in the remaining 30 to 35 minutes. These writing activities included having the students complete worksheet tasks like connecting numbers, dots or arrows; colouring by numbers; and tracing mazes. Two pretest-posttest measures were conducted to evaluate graphomotor and fine-motor proficiency. It was concluded that a significant positive difference between the control and treatment groups was seen in copying, eye-hand coordination, spatial relationship and visual perception. Furthermore, this study differed from other studies since it was a short-term intervention rather than lasting seven or more months and illustrated the possibility of implementing a handwriting intervention while maximizing resources of time and expense.

Christensen has undertaken two studies to investigate the role of orthographic-motor integration in the production of written text (Christensen, 2005; Jones & Christensen, 1999). One study measured the orthographic-motor integration, reading and written expression of Grade 1 students \((N = 114)\) (Jones & Christensen, 1999). Orthographic-motor integration refers to the process of recalling letter forms from memory and then producing them in a written form and in this study it was measured with a Writing Speed and Accuracy measure (Jones & Christensen, 1999). The children were asked to write the lowercase alphabet letters in order for one minute and if they completed the whole alphabet then they were instructed to begin writing the uppercase alphabet until the minute was up. The number of letters that were formed correctly and in
the proper order were counted. Since the researchers felt that it was unlikely for these Grade 1 students to score above 35 they developed the following rating scale: scores below 8 were *poor*; scores between 9 to 14 were *low average*; scores between 15 to 24 were considered *average*; scores between 25 to 30 were *good*; and scores falling above 30 were rated as *very good*. Interrater reliability was reported as .99. Even when reading scores were controlled, 67% of the variance in written expression was accounted for by orthographic-motor integration.

The second major study by Christensen (2005) dealt with 50 secondary school students with an average age of 13 years 6.5 months all of whom had low levels of orthographic-motor integration. The participants were matched on gender and handwriting ability and were randomly assigned to either a control or experimental group. The same Writing Speed and Accuracy test described above was used as well as a test that measured the quality of written expression. Both of these measures were conducted before and after an intensive, small group handwriting intervention that lasted for 20 minutes per day for eight weeks. Students met with a tutor during regular class time, but times varied from day to day so that the students did not miss the same subject regularly. The control group completed journal writing for the same amount of time as those who participated in the intervention group. The experimental group completed a handwriting program that was developed specially for the study. Practice in writing letters, words and sentences was the focus of the program. Letters were grouped according to shape and were practiced in isolation and then were combined until the student was comfortable with tackling words, phrases and short sentences. A criterion of 60 letters per minute on the mastery test allowed the student to move on to the next level.
in the sequence. Impressively, although these secondary school students started with very low orthographic-motor integration abilities (a definite lack of handwriting automaticity) and had experienced many years of failure when it came to writing, this study showed they improved. Those in the intervention group obtained scores at posttesting that were 70% higher in orthographic-motor integration and 46% higher in quality of written text than those in the control group. The handwriting group also wrote approximately twice as much text.

In conclusion, these two studies present convincing evidence that handwriting intervention can improve the writing abilities of children who are struggling with difficulties in handwriting in mainstream classes (Christensen, 2005; Jones & Christensen, 1999). These findings also support what other researchers have suggested; that automatic letter writing is the single best predictor of length and quality of written composition at all ages (Connelly et al., 2006; Graham et al., 1997; Medwell & Wray, 2007; Peverley, 2006).

Handwriting instructional or remedial programs are available for purchase by educators in North America and include Callirobics, Handwriting Without Tears, Big Strokes for Little Folks, Sensible Pencil and Loops and Other Groups. Cahill (2009) provides a brief description of each of these programs including website addresses for further information. Although these programs may incorporate strategies that are grounded in theory or evidence, an online literature search did not reveal any of these programs named in the titles or abstracts of studies on teaching handwriting (Cahill, 2009). Continued research is definitely needed to determine if one program is more effective than another.
The handwriting program implemented in the current research project is called *ez Write* and is marketed as an “easy, effective and affordable handwriting program that bridges writing to reading” (Beckman, 2010). The *ez Write* program is both practically and theoretically motivated. Recognizing the great need of an effective program that teachers could use to teach their students how to print and write in cursive, Beckman, an Early Childhood Special Education Teacher, and Thoreson, an Occupational Therapist, partnered together to develop a handwriting program that incorporates the following unique features: muscle memory, transcriptional automaticity, letters taught in groupings (8 basic strokes), a strong language arts connection through the use of high frequency words, and many other features. They based their program and its’ various features on the evidence-based research findings in current literature, much of which has been discussed above. To date, two unpublished Master’s level dissertations have been conducted to examine the effectiveness of *ez Write* on handwriting and it has recently been adopted by the public school system in Minnesota, USA as part of the language arts curriculum.

Hohlen (2010) conducted a ten-week pretest-posttest handwriting intervention using the *ez Write* program. She provided 24 first-graders with brief, daily fine-motor practice and handwriting instruction and measured the time it took the students to print the whole alphabet before and after the ten-week program. The findings suggest that there was a 34% improvement overall in handwriting speed and automaticity. Furthermore, the transcriptional errors made by the students lessened in number by 67% overall.

Similarly, Anderson (2010) implemented a ten-week pretest-posttest research project with a class of 26 Grade 2 students. The intervention was comprised of 30 group lessons of 30 minutes each with three lessons being taught each week. The first two
lessons each week focused on improving neatness and automaticity using the second grade ez Write curriculum. The third lesson began with the “alphabet race” that was used to monitor the students’ progress in automaticity. This task measured the amount of time it took to print the entire uppercase and lowercase alphabet (Aa, Bb, Cc, …) and was considered the score of transcriptional automaticity. A weekly written composition activity (narrative or procedural paragraph), which allowed for prewriting strategy instruction, was also completed during the third weekly lesson. Her findings show that after ten weeks of explicit printing instruction, the students had gains in transcriptional automaticity, wrote longer compositions, spent more time creating their compositions and wrote their thoughts down much faster than before the ez Write intervention. The findings also suggested that transcriptional automaticity could aid in producing positive changes in reading fluency and computational math.

**Summary**

In conclusion, based on this review of the current literature, it can be strongly argued that handwriting is an important, even vital skill for individuals of all ages and in various settings. Research findings have indicated that handwriting is causally related to both learning to read and learning to write. In fact, handwriting has been classified as “language by hand” which separates it from being solely considered a motor act (Berninger et al., 2006). Studies have shown that handwriting contributes directly to compositional fluency and quality for beginning and developing writers and that automatic letter writing is the single best predictor of length and quality of written composition in younger students (Graham et al., 1997; Graham et al., 2000). Brain-based
and applied research evidence lends support to the concept that reading and handwriting are closely linked (James, 2009; Levy et al., 2006; Richey, 2008; Vander Hart et al., 2010). Thus, it is of utmost importance that educators and therapists who work with those struggling to gain competency in their literacy skills, not make assumptions. Ultimately, one should not assume that handwriting instruction is unnecessary or less valuable than reading and writing instruction (Medwell et al., 2009). As the studies outlined in this review have illustrated, even when handwriting is directly taught within short periods of time with little cost or added effort on the part of the instructor, it can lead to great gains in many aspects of academic achievement. The ez Write program is an example of an effective handwriting program that is currently being implemented in a public school board and was developed on the basis that by improving handwriting skills, improvements in writing and reading abilities would follow (Beckman, 2010). Schools need to prepare students to be better handwriters. The emerging literature suggests that the contribution of handwriting to academic achievement and vocational success must be considered. The current study will examine the impact of a cursive handwriting intervention on the reading, writing and graphomotor skills of a small group of high school students.
CHAPTER THREE: METHODS AND PROCEDURES

Single-Subject Research Design

This quantitative research project was a single-subject (AB), multiple-baseline research design with multiple subjects in multiple locations. Single-subject research designs (SSD; also referred to as a single-case, single-system or time-series designs) are useful when doing research in a clinical or educational setting as well as when evaluating practices and monitoring client progress (Engel & Schutt, 2007; Gay, Mills, & Airasian, 2009; Hayes, Barlow, & Nelson-Gray, 1999; Horner et al., 2005). Time-series methodology allows the researcher to formalize the measurement relevant to the behaviour under question and to repeat the assessment of the behaviour over-time (Hayes et al., 1999). The single-subject, multiple-baseline design is the design of choice when academic learning is involved and is ideal in situations when the behaviour being studied is not likely to be reversed (Hartnedy, Mozzoni, & Fahoum, 2005). Single-subject research projects are comprised of three main components: repeated measures, a baseline phase (A), and a treatment phase (B) (Engel & Schutt, 2007; Gay et al., 2009). In this project a pretest-posttest component was added to allow for further evaluation of the effectiveness of the handwriting intervention.

To begin, a brief overview of the research design will be outlined here but will be described in more detail in the following sections. Initially, the Pretest Measures were performed (Beery VMI, DASH, WJ-III ACH, CTOPP, and SWAN) and then the Intervention began (baseline and treatment phases). After a maximum of 15 hours of direct handwriting instruction was completed by each of the participants the Posttesting
Measures were implemented (Beery VMI, DASH, WJ-III ACH, CTOPP, and IMI). In total, the whole research project finished within a four-month time frame including time for school trips, holidays and exams.

The handwriting intervention was the independent variable that was actively manipulated during the treatment phase. The targets or dependent variables that I measured were overall reading ability (while considering the sub-skills of reading such as phonological awareness), written composition (including writing fluency and expression), visual-motor integration, and handwriting skill (i.e. speed and legibility).

A single-subject design was chosen because it is the design that can clearly demonstrate the functional relationship between my dependent and independent variables. Based on my years of experience, I have come to learn that when working with struggling learners, a one-to-one instructor-student model provides a safer, more effective learning environment. In applying this design with the four participants in this study, I was able to draw comparisons between and within-subjects. Single-subject designs are used to explore the nature of behaviour and use the collected information to develop hypotheses and robust explanations (Kennedy, 2005). The current exploratory, hypothesis-generating study used a SSD to provide an opportunity to look at several outcomes in a detailed, sensitive way over time, and the opportunity to directly match the outcomes to the intervention.

Participants and Locations

The study sample consisted of four high school students recruited from two different schools in Southern Ontario. The youth participating in this study \(N = 4\) had an
age range of 13 years 6 months to 17 years 10 months ($M = 15$ years 1 month; $SD = 23.87$) at the commencement of the project. All four participants were male and were chosen by their teachers due to their struggles with handwriting tasks and overall low academic achievement. To my knowledge, none of the boys had been formally diagnosed as having any specific learning or behavioural disorders. For the sake of simplicity and to maintain confidentiality Participant A will be referred to as Abe, Participant B as Bemus, Participant C as Cecil and Participant D as Dedrick. Table 1 provides the ages, grades and handedness of the four participants.

Table 1

<table>
<thead>
<tr>
<th>Demographic Variables</th>
<th>Participants</th>
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<tbody>
<tr>
<td></td>
<td>Abe</td>
</tr>
<tr>
<td>Age (year/Month)</td>
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<tr>
<td>Pretest</td>
<td>13/6</td>
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<tr>
<td>Posttest</td>
<td>13/9</td>
</tr>
<tr>
<td>Grade (year)</td>
<td>9</td>
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<tr>
<td>Handedness</td>
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Note. --- = not applicable since participant did not do posttesting.

Abe, Bemus and Cecil were all students at a private boarding school for high school students that offers structured and individual educational programming to target adolescents who are not motivated to achieve in the traditional public school environments. They were all in the same Basic Language Arts and Basic Math classes, which allowed for consistency in the scheduling as well as increased internal validity by
controlling for historical and maturational effects. A classroom was provided for me to set up and work individually with the students three times per week.

I had previously met with the director of the private school to learn more about his school’s educational programming. In the spring of 2012, I approached him directly to determine if he would be interested in allowing me to implement the cursive handwriting intervention with some of his students. He was very supportive of my project and its importance in educational research and welcomed me into his school.

Dedrick was a student in a public high school in the same neighbourhood as the private school attended by the other three participants. He had experienced fine-motor and graphomotor challenges from a young age. Dedrick came with a private referral to Dr. Jan Frijter’s Motivation, Instruction and Reading Lab, located at Brock University, to participate in my research project twice a week.

**Handwriting Intervention (ez Write)**

The handwriting program that fit within the context of my research project is called *ez Write*. The following section is taken directly from the *ez Write* website:

*eZ Write* is a research-based, developmentally appropriate handwriting program that engages all learning styles. *ez Write* was developed by Mary Beckman, an early childhood special education teacher, and Tami Thoreson, an occupational therapist, to improve handwriting in the early years. Research has shown that improved handwriting skills translate to improved learning in other subject areas. (Beckman, 2010)
This handwriting program can be purchased directly from Mary Beckman or from the American Pearson Assessments website (www.pearsonassessments.com) and is comprised of classroom kits for pre-kindergarten to fifth grade, as well as those that can be used in a Special Education, Occupational Therapy or home-based setting. Manuscript (printing) is instructed from pre-school to Grade 2, with cursive handwriting instruction commencing in Grade 3 and continuing to Grade 5.

After being in direct contact with Mary Beckman via phone and email in July 2012, she, being the sole owner of the program, graciously granted me permission to use her program and agreed to modify it somewhat so that it is more age-appropriate for my older participants. Subsequently, the grade level subtitles and labels were eliminated from the worksheets. The Grade 3 cursive handwriting curriculum and parts of the Grade 4 and Grade 5 curriculums were incorporated to formulate a cursive writing intervention that was appropriate for high school age students. Mary Beckman sent me all of the modified materials that I needed to use her program. Please see Appendix A to view samples of the worksheets used during the intervention.

The pre-writing warm-ups used in the current study were also modified from the primary level curriculum and more age-appropriate activities were developed. The warm-ups included finger dexterity activities, writing posture steps review, an alphabetical order memory task, basic English sound code review, directional arrows chart task, and a pattern trace, copy, and reproduce activity. Sassoon (2012) who has spent years conducting studies on handwriting instruction, has recently developed software that I downloaded and used to create warm-up patterns as part of the pre-writing sessions.
Please refer to the Table B.1 in Appendix B for a detailed description of these warm-up activities.

I chose to implement a cursive handwriting intervention because it is more age appropriate for older students. All four participants explicitly expressed their interest and motivation for learning to write in cursive since it was more adult-like. The ezWrite cursive handwriting program organizes the letters of the alphabet into six groups based on their beginning strokes. The complete lowercase cursive alphabet was directly instructed as were 12 uppercase letters that closely resemble their lowercase counterparts (A, C, E, M, N, O, P, U, V, W, X, and Y).

**Procedure**

Informed consent was obtained from the acting legal guardians of all four participants. Each participant also provided informed assent before commencing the project. The assent form was read aloud by the examiner, while the participant followed along, and it outlined the purpose, procedure, and potential benefits and risks of the study. Most importantly, it was made clear to the students that if at any time they had questions or did not want to continue to participate, they needed to make it known and there would be no negative repercussions. The Brock University Social Science Research Ethics Board reviewed all aspects of the research study and provided a Certificate of Ethics Clearance in September 2012.

Beginning October 1st, 2012, the weekly schedule at the private school allowed for me to work with Abe, Bemus and Cecil three afternoons a week for 30 minutes each session. Dedrick came to the lab at the university twice a week for 45 minutes each
session. Therefore, each student had the equivalent of 90 minutes of one-on-one time with me weekly. The research project wrapped up four months later on January 31, 2013.

Although they were not randomly selected for inclusion in my study the participants were; however, randomly assigned to one of the four possible treatment start dates. Abe, Bemus and Cecil completed all of the pretest measures during the first five sessions (equivalent of 150 minutes total) and Dedrick finished the pretest measures in his first four sessions (equivalent of 180 minutes). The repeated measures were also started simultaneously with the pretesting sessions and were the first tasks completed at the start of almost each session throughout the whole project.

Immediately following the pretest sessions both Abe and Dedrick began the cursive handwriting treatment phase (B). The decision to start the intervention after a few baseline data points were collected was made based on the assumption that these students had had years of using (or not using) cursive writing and so their baseline abilities would be stable from the outset. Bemus continued to provide baseline scores on handwriting speed and legibility until beginning the treatment phase during his tenth session. The final participant to start the treatment phase was Cecil and he continued in the baseline phase until starting the instruction component during his fifteenth session. Again, the decision of when Bemus and Cecil started the intervention was made prior to beginning the study and was influenced by the assumption that they would both be stable in their handwriting skills as older students. While the participants were in the baseline phase they completed the five-minute repeated measures of handwriting speed and legibility. Then they returned to the classroom for the remaining 25 minutes of the session, so the control became the regular class instruction during the same time period.
Once the treatment phase was started the intervention material was presented in a preset order, but the participants progressed at their own speed through the work. The total number of sessions was left open-ended to ensure that each student had the opportunity to complete the intervention sessions and most of the review sessions too. Table B.1 in Appendix B outlines the order in which the subsections of the cursive handwriting intervention component of the study were performed.

Unfortunately, due to unforeseen personal reasons, Bemus did not return to school after the holiday in December-January and so he did not complete his last six scheduled intervention sessions or the posttesting phase. I will report on the results obtained by working with Bemus up until he stopped, but will not be able to draw any overall conclusions about his improvements in relation to the main research questions since the pretest-posttest comparison was not possible. In total, he received 10.5 hours of direct cursive handwriting intervention.

At the end of the study, each of the remaining three participants underwent a posttesting phase that was basically a repeat of the pretest phase. Abe, Cecil, and Dedrick received a total of 15.5, 11, and 15 hours respectively of direct cursive handwriting intervention. Abe and Cecil both had a total of 39 sessions, eight of which were in the pretesting and posttesting phases. Bemus completed 30 sessions that included five pretesting sessions, and Dedrick participated in 28 sessions of which eight were pretesting and posttesting sessions.
Measures

Pretest and posttest outcome measures.

Woodcock-Johnson Tests of Achievement—3rd Edition. Participants’ reading and writing abilities were assessed using the Woodcock-Johnson Tests of Achievement (WJ-III ACH; Woodcock, McGrew, & Mather, 2001). It is an assessment that is norm-referenced and measures academic achievement for individuals ages 2 to 90 years of age. In total it contains 22 tests measuring five main areas (reading, mathematics, written language, oral language, and academic knowledge). Scores from individual subtests, as well as combinations of scores that form cluster scores, are used for interpretation. In this current study the following seven of the 22 subtests were used to obtain ten overall scores per participant: Letter-Word Identification, Reading Fluency, Word Attack, Spelling, Writing Fluency, Writing Samples and Handwriting Legibility. No accommodations were provided in the current study. The following detailed descriptions of the WJ-III ACH subtests were paraphrased from the manual (Woodcock et al., 2001):

Test 1: Letter-Word Identification. This test measures the participant’s word identification/reading decoding skills. He/she must pronounce the words correctly. He/she does not need to know the meaning of the words.

Test 2: Reading Fluency. This test measures the participant’s ability to read simple sentences and decide if the statements are true, and then indicate Yes or No by circling his/her answer in the response booklet. As many items as possible must be completed within three minutes. It is a measure of reading speed and rate.

Test 7: Spelling. This test measures the participant’s ability to write down/spell orally presented words correctly. Performance on this test may be related to several
factors including handwriting, muscular control, or visual motor skill needed in beginning handwriting.

*Test 8: Writing Fluency.* This test measures skill in formulating and writing simple sentences quickly/automatically. There is a seven-minute time limit for the participant to write a sentence relating to a given stimulus picture in the response booklet and it must include a given set of three words. Minimal attention and problem solving is necessary and this subtest can be related to several factors including muscular or motor control, response style, ability to sustain concentration and reading or spelling skills.

*Test 11: Writing Samples.* This test measures skill in writing responses given a variety of demands. The participant is not penalized for errors in basic writing skills (i.e. spelling or punctuation), but must produce written sentences that are evaluated with respect to the quality to expression. The difficulty of the items increases by increasing passage length, level of vocabulary, grammatical complexities, and level of concept abstraction. It can be related to a participant’s attitude toward writing, oral language performance, vocabulary, and organization ability.

*Test 13: Word Attack.* This test measures the participant’s skill in applying phonic and structural analysis skills to the pronunciation of unfamiliar printed words. He/she must read aloud letter combinations that are phonically consistent and have regular patterns in English orthography but are non-words or are low-frequency words. If a participant has poor performance on this task then he/she has not mastered phonetic decoding skills.

*Handwriting Subtests.* These two tests are different in several ways from other handwriting scales. The subject is not instructed to use his/her best handwriting; in fact
he/she is not even informed that his/her handwriting will be evaluated. Therefore, this evaluation is based on the participant’s typical handwriting. Poor performance may result from a visual-motor integration problem, impulsivity or a lack of instruction and practice. (Woodcock et al., 2001, p. 87)

a) WJ-III ACH Handwriting Legibility Scale: This is a standardized evaluation of the general appearance of the handwriting produced on the Test 11-Writing Samples. Writing samples are matched with samples on the norm-based scale. Both legibility and general appearance are considered. The standardized samples are arranged along a 100-point scale and go from 0 (illegible) to 100 (artistic) in ten-point increments. Printing/manuscript or cursive handwriting are both considered equal and will not affect the scoring for legibility and general appearance. Two raters could rate the handwriting and should match within a ten-point range.

b) Handwriting Elements Checklist: An informal evaluation of six handwriting elements: slant, spacing, size, horizontal alignment, letter formation, line quality. Using the Handwriting Elements Checklist in the Test Record Booklet, the participant’s handwriting from the Test 11-Writing Samples is analyzed. This checklist provides a three-point rating scale of excellent, satisfactory, or needs improvement.

Reading Cluster: Basic Reading Skills. This cluster score is a combination of Test 1 and Test 13 and provides a measure of basic reading skills. It is an aggregate measure of sight vocabulary, phonics, and structural analysis.
*Written Language Cluster: Broad Written Language.* This cluster score is a combination of Tests 7, 8, and 11 that provides a comprehensive measure of written language achievement including spelling of single-word responses, fluency of production, and quality of expression.

*Written Language Cluster: Written Expression.* This cluster score is a combination of Tests 8 and 11 that provides an aggregate of meaningful written expression and fluency providing a measure of written expression skills.

*Comprehensive Test of Phonological Processing.* The Comprehensive Test of Phonological Processing (CTOPP) is a standardized measure that is appropriate for ages 5 to 24 (Wagner, Torgesen, & Rashotte, 1999). There are a total of six core subtests, six supplemental subtests and five composite scores on the CTOPP that all measure some aspect of phonological processing. The core subtests used in the current study were Rapid Automatic Letter Naming, Elision, and Blending Words. Rapid Automatic Colour Naming and Phoneme Reversal were the two supplemental tests also implemented in this study. The following detailed descriptions of the CTOPP subtests were paraphrased from the manual (Wagner et al., 1999):

*Elision.* A 20-item subtest that measures the participant’s ability to say a word and then say what is left after dropping out a designated sound. For example, the examinee is instructed, “Say *told.*” After repeating ‘told’, the examinee is told, “Now say *told* without saying /t/.” The correct response is ‘old’.

*Blending Words.* A 20-item subtest that measures the participant’s ability to combine sounds to form words. The stimuli are presented via audio recording. For
example, the examinee is asked, “What word do these sounds make: b-oi?” The correct response is the word ‘boy’.

Rapid Letter Naming. A 72-item subtest that measures the speed at which the participant can name the six letters (i.e. a, c, k, n, s, t) randomly arranged on two pages. The score is the total number of seconds it took to name all of the letters on both pages.

Rapid Colour Naming. A 72-item subtest that measures the speed at which the participant can name the colours of a series of six randomly arranged coloured blocks (i.e. blue, red, black, green, yellow, brown) printed on two pages. The score is the total number of seconds it took to name all of the colours on both pages.

Phoneme Reversal. An 18-item subtest that measures the participant’s ability to reorder speech sounds to form words. The stimuli are presented via audio recording. For example, after listening to the sounds ‘oot,’ the examinee is instructed to repeat ‘oot’ and then to say ‘oot’ backwards. The correct response is ‘to’.

Phonological Awareness Composite Score. A combination score that takes into account the scores on the Elision and Blending Words subtests.

Beery-Buktenica Developmental Test of Visual-Motor Integration and Supplemental Tests. The Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery-VMI), Motor Coordination (MC) and Visual Perception (VP) are all appropriate for ages 2 to 18 years of age (Beery & Beery, 2010). This standardized test is commonly used for screening and assessment purposes and requires that the participants copy a developmental sequence of geometric forms using pencil and paper.

Detailed Assessment of Speed of Handwriting. The Detailed Assessment of Speed of Handwriting (DASH) is a measure of handwriting speed (Barnett, Henderson,
Scheib, & Schulz, 2007 & 2010). There are two levels of this measure, one for ages 9 to 16 and one for adults (ages 17 years and above). It is comprised of five subtests that can be done in printing or cursive depending on personal choice. The following descriptions of the DASH subtests were taken directly from an article written by the authors of the DASH (Barnett, Henderson, Scheib, & Schulz, 2011, p. 116):

**Copy Best.** The student is required to repeatedly copy the sentence “The quick brown fox jumps over the lazy dog.” for two minutes in their best handwriting. The number of words produced is recorded and divided by two to give a word per minute score.

**Copy Fast.** As above, the student is required to repeatedly copy the sentence “The quick brown fox jumps over the lazy dog.” for two minutes, but here they are instructed to write as quickly as possible but make sure that every word is readable. The number of words produced is recorded and divided by two to give a word per minute score.

**Alphabet Writing.** The student is required to repeatedly write out the letters of the alphabet from memory for one minute, using lowercase (not capital letters). The number of correctly sequenced lowercase letters is recorded.

**Free Writing.** Following a short period of thinking and planning time, the student is required to write on the topic of My Life for ten minutes, marking their script every two minutes. A prompt sheet is available throughout, listing suggested topics for writing. The total number of legible words produced is recorded and divided by ten to give a word per minute score.

**Graphic Speed.** The student is required to draw X shapes for one minute in a series of printed circles, following guidelines for accurate production (in terms of the size
and orientation of the lines). The number of correctly produced Xs is recorded.

**SWAN Rating Scale.** The SWAN Rating Scale is a 30-item rating scale that was completed by the student’s guardian/teacher at the start of the intervention phase and it gave a score on the participant’s ability to attend, control activity and inhibit impulses (Swanson et al., 2001). The SWAN items used in this study are dimensional scale versions of the Diagnostic and Statistical Manuals-IV (DSM-IV) criteria for Attention Deficit Hyperactive Disorder (ADHD) including the two subtypes of Inattention (items 1 to 9) and Hyperactivity/Impulsivity (items 10 to 18), as well as Oppositional Defiant Disorder (ODD; items 19 to 27). If a participant scores greater than or equal to a score of 2 or 3 on 6 or more of the nine items in a given category then this is considered to be one piece of evidence toward a diagnosis as per the DSM-IV. Refer to Appendix C for a copy of this scale.

**Intrinsic Motivation Inventory.** The participants completed the Intrinsic Motivation Inventory (IMI) questionnaire during the post-intervention stage. The IMI items used pertain to the five subsections of Interest/Enjoyment, Perceived Competence, Effort/Importance, Pressure/Tension, and Values/Usefulness (Ryan, 1982). The questionnaire was revised to relate to learning cursive handwriting and the participants were asked to provide self-reported truthfulness rating of the statements on a scale from 1 (not at all true) to 5 (very true). Each item was read out loud by the researcher to ensure that potential reading challenges would not interfere with the task. Refer to Appendix C to view the full version of the IMI that was used in this research study.
Repeated measures.

At the start of each session the participants completed a five-minute repeated measures activity that consisted of four separate handwriting tasks resulting in eight outcome measures. The four tasks were always completed in the same order as follows. The first task was to print the lowercase alphabet in sequence as many times as was possible in one minute (Printed Lowercase). The second task was to print the uppercase alphabet in sequence as many times as was possible in one minute (Printed Uppercase). Similarly, the third repeated measure task was timed for one minute and the students were required to write as many lower or uppercase letters as they could in cursive writing (Cursive Writing). All three of these tasks were modeled after the DASH alphabet writing subtest and produced a score indicating the number of letters written correctly per minute (Barnett et al., 2007). Using the first three tasks the number of errors (both in alphabetical order and in letter formation) that were made in a minute were also calculated (Error Score-Printed Lowercase, Error Score-Printed Uppercase, Error Score-Cursive Writing). The fourth task was an open-ended, timed copy task and they were asked to copy a selected poem (or part of the poem) as quickly and accurately as possible (Copy Task). The score calculated for this task was the number of words written per minute. Please refer to Appendix C for a copy of the poem that was used in the copy task.

Two blind raters were recruited to score the fourth repeated measure for handwriting legibility (Legibility Ratings). The raters were only provided with de-identified student information and did not have access to any confidential information. They were trained to score the collected handwriting samples using a standardized rating scale taken from the WJ-III ACH (Woodcock et al., 2001). This handwriting scale ranges
from zero (illegible) to 100 (artistic). Training occurred until a criterion of 90% agreement was reached. Data derived from the primary rater was used for all legibility data analysis. The inter-rater reliability ranged from .90 to .97 for the ratings on the four participants’ written outputs from the copy task, showing agreement between the raters’ ideas of what was considered legible. All tests of difference in mean level were non-significant, indicating that overall quality of each written output was considered equivalent across raters of that output. Taken together, these two lines of evidence suggest that the legibility rating measure used in the current study was reliable.

Statistical Analysis

Prior to discussing the specific results it is necessary to explain two calculations that were done during the data analysis to determine if the differences between pretest and posttest standard scores were statistically significant and were not just due to unreliability of the measurement. First, the Standard Error of Measurement (SEM) is a statistical estimate made of the amount of error inherent in a score and provides a more accurate representation of the obtained score (Woodcock et al., 2001). Since statistics are based on mathematical probabilities and are not perfectly precise, a standard score of 75 on the WJ-III ACH measure, for example, is actually an estimate of the participant’s true test performance (Beery & Beery, 2010). By adding or subtracting the SEM (provided by the authors of the measure) provides a range of possible true scores about two-thirds (68% confidence interval) of the time. It is reasonable to assume that the scores collected in this study that equaled or exceeded the delineated SEM ranges indicated that real
change had occurred. However, the SEM consideration is not enough to determine statistical or clinical significance.

Second, in order to report statistical significance, the *Reliable Change Index* (RCI) was developed in 1991 by Jacobson and Truax and can be used to assess the effectiveness of an intervention (Zahra & Hedge, 2010). The RCI demonstrates the direction (positive RCIs are increases and negative RCIs are decreases) and amount of change that an individual has undergone and whether the noted change is reliable (Zahra & Hedge, 2010). An RCI value that is equal to or greater than 1.96 (in either direction) is statistically reliable at the \( p < .05 \) level and indicates change that exceeds the unreliability of the measure in question (Jacobson & Truax, 1991). An online RCI calculator was used to calculate the RCI values reported in this study (Evans, 1998).

There are many different metrics that can be applied to measure individual effect size but when dealing with SSDs it is important to consider the requirements and limitations of the specific metric chosen. Since there is currently no general consensus as to which metric is the best for summarizing the results of a single-subject research design it is important to visual inspect the graphed data and pick the one that best fits the characteristics of the data (Manolov, Solanas, Sierra, & Evans, 2011). The PEM, or *Percentage of Data Points Exceeding the Median*, is the effect size metric that I decided to apply to my data (Ma, 2006). It was first introduced as an alternative to the more commonly used PND, or *Percentage of Non-overlapping Data* between baseline and treatment phases, statistic (Scruggs & Mastropieri, 1998). Both the PEM and PND are non-parametric statistics that are easy to interpret once the data is presented in graph form. Due to the exploratory nature of my research questions I felt that it would be better
to use the PEM scores, which are less effected by outliers since they are based on the
to use the PEM scores, which are less effected by outliers since they are based on the
median. The PND scores are obtained by identifying the highest data point in the baseline
phase and determining what percentage of data points during the intervention phase
exceed this level; the higher the percentage of non-overlap the more effective the
intervention (Scruggs & Mastropieri, 1998). However, this PND method of calculating
effect size ignores all but one baseline data point and so, in order not to lose potentially
valuable information, the median point in the baseline data was determined for each
participant on each of the eight dependent variables. The percentage of treatment phase
data points that fall above (if behaviour is expected to increase) or below (if the
behaviour is expected to decrease) this median level represents the PEM score. PEM
scores range from 0 to 1 where .9 to 1 shows highly effective treatment, .7 to .89 shows
moderately effective treatment, .5 to .69 shows questionably effective treatment, and
scores less than .5 reflect ineffective treatment (Lenz, 2013; Scruggs & Mastropieri,
1998). A couple of limitations of PEM are that it is insensitive to the magnitude of the
data points that fall above the median and it does not consider variability or trend in the
treatment phase’s data points (Wendt, 2009). Notwithstanding, I feel that based on the
data collected the PEM effect size calculation was the most appropriate choice.

The overall group effect size, which is an approximation to Hedges G for single-
subject designs (hereafter referred to as $G'$), was calculated using IBM SPSS Statistics
(2010). $G'$ estimates a standardized mean difference statistic ($d$) for SSDs in the same
metric as those used in between-subject designs (i.e. randomized experiments) and was
recently developed by Hedges, Pustejovsky, and Shadish (2012). Currently, this SSD $d$
effect size requires a multiple baseline SSD study with at least three independent cases
and a macro add-on to the IBM SPSS Statistics computer software application allows for straightforward calculations of $G'$ (Shadish, Hedges, & Pustejovsky, 2013). The $G'$ values can be interpreted using the standard interpretation of effect size for Cohen’s $d$: .2 represents small/insignificant effect size; .5 represents a medium effect size; and .8 represents a large effect size (Cohen, 1988; Cohen, 1992).

For the purposes of the current data analysis, the more conservative $G'$-detrended group effect size was reported as opposed to the normal $G'$ since this research study is exploratory in nature and there is little background information to aid in determining if a trend could potentially exist. The $G'$ effect size measures if there is a difference between the average scores in the baseline phase compared to the average scores in the treatment phase (Hedges et al., 2012). Since the detrended option eliminates any effect that a linear trend (i.e. an increase in ability over time) may have between the baseline and treatment phases it downgrades or adjusts high effect sizes and the resulting effect size is smaller. It must be noted that in the current study with a sample size of four participants, there were not enough observations per case to detect an effect size of 0.5 with at least 80% power (Shadish et al., 2013). In future, an SSD study that incorporated larger numbers of observations per case is highly recommended.
CHAPTER FOUR: RESULTS

In this single-subject (AB), multiple-baseline research study three quantitative methods of analyzing the data were used: visual inspection/analysis (graphs), a nonparametric statistical test (PEM), and parametric statistical tests of significance (SEM, RCI, $G^\prime$). The five main outcome variables that were repeatedly measured throughout the intervention were Printed Lowercase, Printed Uppercase, Cursive Writing, a Copy Task and Legibility Ratings. As well, three Error Score outcomes were collected for the Printed (Uppercase and Lowercase) and Cursive Writing alphabet tasks. In addition to these repeated measures a pretest-posttest comparison was performed using the Woodcock-Johnson Tests of Achievement-III (WJ-III ACH), the Comprehensive Test of Phonological Processing (CTOPP), the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery-VMI), and the Detailed Assessment of Speed of Handwriting (DASH). Two questionnaires, the SWAN Rating Scale and the Intrinsic Motivation Inventory, were conducted once each during the intervention phase to provide feedback from the students and teachers/guardians. Please refer to Tables 2 to 6 and Figures 1 to 5 below as well as Appendix D to review the data collected.

The analysis of the dataset focused on the following main areas of inquiry which correspond to the three guiding research questions of the study: reading and writing abilities, graphomotor/visual-motor integration skills, and self-perceptions/self-descriptions by the participants’ of their experience in learning cursive handwriting.
Aim 1: The handwriting intervention improved reading and writing skills

The results obtained by comparing the pretest-posttest standard scores on the WJ-III ACH and the CTOPP measures were examined when looking at this first aim (see Table 2 below). The complete comparison was only possible with Abe, Cecil, and Dedrick since Bemus did not finish the intervention or go through the posttesting phase. As well, please note that, unless otherwise mentioned, statistically significant change was change in a positive direction (i.e. improvement). It is also important to note that though a range change might appear to be a significant improvement, the scores reported for this first aim (see Table 2 below) show small increments of change that then resulted in the overall range change.

Abe improved on all the subtests of the WJ-III ACH. Even though all changes in standard scores (excluding the Reading Fluency score) exceeded the *Standard Error of Measurement* (SEM), only the subtest scores for Writing Fluency and Writing Samples had significant *Reliable Change Indexes* (RCIs: 2.55 and 2.63 respectively). He also significantly improved on the three WJ-III ACH cluster tests. At pretesting, when compared to others at his age level his standard score for Written Expression was *very low*; his standard score for Broad Written Language was *low*; and his standard score for Basic Reading Skills was *average*. At posttesting, Abe’s standard scores had improved to *low* on Written Expression, to *low average* on Broad Written Language, and with Basic Reading Skills remaining at *average* levels. The RCIs for Abe’s scores on the three WJ-III ACH cluster tests were all statistically significant and ranged from 2.28 to 7.60. On the CTOPP the Reliable Change Index (RCI) showed that his scores on the Rapid Letter Naming (RCI = -4.65) significantly worsened but Abe’s ability on the Phoneme Reversal...
test (RCI = 5.05) significantly improved. The pretest-posttest standard score difference comparison when considering the Rapid Colour Naming subtest showed that it equaled the expected SEM, but it did not have a significant RCI. The composite score of Phonological Awareness that combines the Elision and Blending Words subtests went down from superior at pretesting to the above average range at posttesting but was not considered a statistically reliable change.

Cecil’s standard difference scores between pretest and posttest fell above the expected median SEM range on the WJ-III ACH subtests of Letter-Word Identification, Writing Fluency, and Writing Samples, as well as the three cluster tests (see Table 2). Like Abe, Cecil’s improvements on the Writing Fluency and Writing Samples subtests had statistically significant RCIs of 4.25 and 3.01 respectively. When compared to other students at his age level his standard score was low in Basic Reading Skills and his standard scores on the remaining two cluster scores were very low at pretesting. After completing the intervention, his posttesting standard scores had increased to low average in Basic Reading Skills and Written Expression and low in Broad Written Language. All three of these WJ-III ACH cluster tests showed significant changes: Broad Written Language (RCI = 4.85), Written Expression (RCI = 10.53) and Basic Reading Skills (RCI = 2.03). Cecil obtained difference scores greater than or equal to the SEM on the Elision, Blending Words, Phoneme Reversal and Phonological Awareness sections of the CTOPP, but notably less than the SEM on Rapid Letter Naming and Rapid Colour Naming. The RCI statistical test showed only a significant regression on the Rapid Letter Naming subtest with a RCI of -2.33.
Dedrick made improvements above the expected variability on WJ-III ACH subtests of Letter-Word Identification, Reading Fluency and Writing Fluency. The two subtests of the WJ-III ACH that resulted in statistically significant RCIs for Dedrick were Reading Fluency (RCI = 3.30) and Writing Fluency (RCI = 2.55). He also improved significantly on the Basic Reading Skills cluster test, going from a low average to an average range when his standard scores were compared between pretesting and posttesting (RCI = 2.03). The changes seen on the other two cluster tests were not considered significant, and when compared to others at his age level Dedrick’s abilities remained at the very low range for Broad Written Language and the low range for Written Expression. Dedrick’s standard difference scores were greater than the SEM on the Blending Words, Rapid Letter Naming, Rapid Color Naming, and Phoneme Reversal subtests of the CTOPP. But, statistically significant change was only seen on the Rapid Letter Naming (RCI = 2.33) and Phoneme Reversal (RCI = 3.03) subtests.

Although he did not complete the study, Bemus’ pretest standard scores for the WJ-III ACH and the CTOPP are found in Table 2 and when compared to others at his age level his standard score for Basic Reading Skills was average; for Broad Written Language was low; and for Written Expression was very low.

Overall, on the WJ-III ACH, Abe, Cecil and Dedrick improved above the SEM range on the Letter-Word Identification, Writing Fluency, and Basic Reading Skills tests; of these only the Writing Fluency subtest and the Basic Reading Skills composite test showed statistically significant change across all participants. Figures 1 to 3 provide a graphic presentation of the results on the three WJ-III ACH cluster tests. On the CTOPP,
Rapid Letter Naming was the only subtest on which all three boys made statistically significant change; however, two had a decrease in performance and one had an increase.

Table 2
*Standard Scores on Tests of Reading and Writing Skills*

<table>
<thead>
<tr>
<th></th>
<th>Abe</th>
<th>Bemus</th>
<th>Cecil</th>
<th>Dedrick</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
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<tr>
<td><strong>WJ-III ACH</strong></td>
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<td>Identification</td>
<td>102</td>
<td>113*</td>
<td>111</td>
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<td>Reading Fluency</td>
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<td>86</td>
<td>97</td>
<td>--</td>
</tr>
<tr>
<td>Word Attack</td>
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<td>100*</td>
<td>73</td>
<td>--</td>
</tr>
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<td>Spelling</td>
<td>89</td>
<td>97*</td>
<td>99</td>
<td>--</td>
</tr>
<tr>
<td>Writing Fluency</td>
<td>59</td>
<td>68**</td>
<td>65</td>
<td>--</td>
</tr>
<tr>
<td>Writing Samples</td>
<td>81</td>
<td>95**</td>
<td>69</td>
<td>--</td>
</tr>
<tr>
<td>Basic Reading Skills</td>
<td>98</td>
<td>107**</td>
<td>92</td>
<td>--</td>
</tr>
<tr>
<td>Broad Written Language</td>
<td>73</td>
<td>84**</td>
<td>75</td>
<td>--</td>
</tr>
<tr>
<td>Written Expression</td>
<td>64</td>
<td>77**</td>
<td>63</td>
<td>--</td>
</tr>
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<td>13</td>
<td>--</td>
</tr>
<tr>
<td>Rapid Letter Naming</td>
<td>7</td>
<td>5**</td>
<td>10</td>
<td>--</td>
</tr>
<tr>
<td>Rapid Colour Naming</td>
<td>3</td>
<td>4*</td>
<td>11</td>
<td>--</td>
</tr>
<tr>
<td>Phoneme Reversal</td>
<td>8</td>
<td>13**</td>
<td>9</td>
<td>--</td>
</tr>
<tr>
<td>Phonological Awareness</td>
<td>121</td>
<td>118</td>
<td>112</td>
<td>--</td>
</tr>
</tbody>
</table>

*Note.* * > or = SEM; ** > or = SEM and RCI statistically significant at *p < .05; WJ-III ACH = Woodcock-Johnson Tests of Achievement-III; CTOPP = Comprehensive Test of Phonological Processing; -- = not applicable.
**Figure 1.** Pretest-posttest comparison of standard scores on the WJ-III ACH **Basic Reading Skills** cluster test for Abe (A), Cecil (C) and Dedrick (D).

**Figure 2.** Pretest-posttest comparison of standard scores on the WJ-III ACH **Broad Written Language** cluster test for Abe (A), Cecil (C) and Dedrick (D).
Aim 2: The handwriting intervention improved graphomotor and visual-motor integration skills

There were two separate components used in this research project to address this second aim: the repeated measures (see results outlined in Tables 3 and 4, Figure 4 and Appendix D) and the standardized measures (see results outlined in Table 5 and Figure 5).

On the repeated measures subsection of this second aim, all four participants were considered for the data analysis. The most significant result on any of the repeated measures was on the Cursive Writing dependent variable and was the focus of the following analysis and discussion. (Figure 4 shows the graphed results of this measure and graphs for the other repeated measures are found in Appendix D.) Each of the boys increased in the number of cursive letters they wrote in one minute after the treatment phase commenced compared to the baseline phase of the study. Scores on Cursive
Writing increased for each participant anywhere from three to seven letters per minute (Table 3). The *Percentage of Data Points Exceeding the Median* (PEM) individual effect sizes for this variable ranged from .7 to 1, showing *moderately to highly effective ratings* (refer to Table 4). The overall group effect size (G’) for the Cursive Writing measure was 0.98.

Upon visual inspection of the multiple baseline graph for the Cursive Writing outcome measure (Figure 4) the following points should be noted. Abe and Dedrick, who were at different locations, were both transitioned from the baseline to treatment phases immediately following the completion of their pretesting measures. Then Bemus and Cecil began the treatment phase in staggered start times. The number of letters written per minute for Abe, Dedrick and Bemus all increased throughout the baseline phase. The treatment phase scores also showed an increasing trend for these three participants. Cecil was not able to produce any cursive letters at all until five sessions into his treatment phase. His results show a definite increasing trend throughout the intervention.

For three of four participants, Legibility Ratings decreased. Legibility ratings increased marginally for Abe, but Bemus, Cecil and Dedrick all received average legibility ratings during the treatment phase that had decreased, compared to their baseline ratings, by 3.4 to 10 points on the scale. Individual PEM effect size ratings fell in the *not effective range* of 0 to .4 for all four boys and the overall G’ effect size for the Legibility Ratings measure was -0.32.

Dedrick was the only one who improved in his handwriting speed during the treatment phase of the intervention. His Copy Task scores improved and this was further illustrated by his individual effect size (PEM) being a value of .8 showing a *moderate*
level of effect. Since the other three participants did not show improvement in their Copy Task speed the overall $G'$ effect size for the Copy Task was -0.22.

Bemus improved the most on the Printed Uppercase measure. His average number of letters prior to the treatment phase was 41 letters printed in one minute. However, after starting the intervention the average number of letters that he could print in uppercase was 49. His individual PEM effect size was .9, which is representative of a *highly effective* intervention. The overall or group $G'$ effect size for Printed Uppercase was 0.12.

The average number of lowercase letters printed in one minute increased for Abe, Bemus and Dedrick. Cecil did not improve his treatment phase score on the Printed Lowercase variable like the others. Even though there was positive improvement for three of the participants, PEM effect sizes for all four students ranged from .4 to .6 which all fell in the *questionably effective intervention* range. The $G'$ group effect size for Printed Lowercase was 0.02.

The Error Variables for Printed Lowercase, Printed Uppercase, and Cursive Writing all have varied yet small changes. Error corrections include retouching, overwriting, crossing out and letters written in the incorrect sequence. Tables 3 and 4 and Appendix D outline the results obtained for these three variables. Note that Abe had the largest effect sizes in his error outcome variables that fell in the *moderately effective* range.
Table 3
Repeated Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Abe</th>
<th>Bemus</th>
<th>Cecil</th>
<th>Dedrick</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Treatment</td>
<td>Baseline</td>
<td>Treatment</td>
</tr>
<tr>
<td>Printed Lowercase (#letters/min)</td>
<td>26.67</td>
<td>31</td>
<td>68.86</td>
<td>70.56</td>
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<tr>
<td>Printed Uppercase (#letters/min)</td>
<td>25</td>
<td>26.31</td>
<td>41.17</td>
<td>48.59</td>
</tr>
<tr>
<td>Cursive Writing (#letters/min)</td>
<td>10.5</td>
<td>13.48</td>
<td>8.33</td>
<td>13.41</td>
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<tr>
<td>Copy Task (#words/min)</td>
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<td>8.85</td>
<td>18.79</td>
<td>16.23</td>
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<tr>
<td>Legibility Ratings (scale 0-100)</td>
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<td>24.81</td>
<td>50</td>
<td>44.12</td>
</tr>
<tr>
<td>Error Score-Printed Lowercase</td>
<td>4.33</td>
<td>3.85</td>
<td>0.43</td>
<td>1.31</td>
</tr>
<tr>
<td>Error Score-Printed Uppercase</td>
<td>1.5</td>
<td>1.85</td>
<td>0</td>
<td>0.65</td>
</tr>
<tr>
<td>Error Score-Cursive Writing</td>
<td>1.5</td>
<td>2.07</td>
<td>4</td>
<td>4.12</td>
</tr>
</tbody>
</table>

*Note.* The scores reported in this table are average scores.
Figure 4: Cursive Writing measure with baseline (A) and treatment (B) phases.
Table 4
Percentage of Data Points Exceeding the Mean (PEM): Individual Effect Sizes

<table>
<thead>
<tr>
<th>Participants</th>
<th>Printed Lowercase</th>
<th>Printed Uppercase</th>
<th>Cursive Writing</th>
<th>Copy Task</th>
<th>Legibility Ratings</th>
<th>Error Score-Printed</th>
<th>Error Score-Printed Uppercase</th>
<th>Error Score-Cursive Writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abe</td>
<td>.6</td>
<td>.5</td>
<td>.7</td>
<td>.5</td>
<td>.4</td>
<td>.9</td>
<td>.7</td>
<td>.7</td>
</tr>
<tr>
<td>Bemus</td>
<td>.5</td>
<td>.9</td>
<td>1</td>
<td>.2</td>
<td>.3</td>
<td>.3</td>
<td>0</td>
<td>.4</td>
</tr>
<tr>
<td>Cecil</td>
<td>.4</td>
<td>.5</td>
<td>.7</td>
<td>.4</td>
<td>.06</td>
<td>.6</td>
<td>.6</td>
<td>.0</td>
</tr>
<tr>
<td>Dedrick</td>
<td>.5</td>
<td>.4</td>
<td>1</td>
<td>.8</td>
<td>0</td>
<td>.5</td>
<td>.4</td>
<td>.6</td>
</tr>
</tbody>
</table>

*Note. .9-1 = highly effective intervention; .7-.89 = moderately effective; less than .7 = questionable/not effective*

On the standardized measures subsection of this aim’s focus only the three participants who completed both pretesting and posttesting (Abe, Cecil and Dedrick) were included in the data analysis. Bemus’ pretesting scores are included in Table 5 for reference. On the WJ-III ACH Handwriting Legibility Scale two of three students showed improvement. Abe had a difference in standard score of 16 on his overall legibility rating and improved on his spacing, size, horizontal alignment and letter formation. On the overall legibility rating Dedrick had a difference in standard score of 4. He showed improvement in letter formation but declined from a satisfactory rating on spacing and size to a needs improvement for both of these handwriting elements. Cecil had a difference in standard score of -5 indicating that his overall legibility decreased throughout the intervention. He also decreased in his ability to have consistent slant when writing and remained as needing improvement in spacing, size, letter formation and line quality.

Abe and Dedrick improved on the overall Beery-VMI test but did not significantly improve on Visual Processing (VP) or Motor Coordination (MC) subtests. Abe obtained a VMI difference in standard score of 19 (SEM +/-5) and Dedrick’s VMI
difference in standard score was 38 (SEM +/-6). It is important to note that the positive advances that both Abe and Dedrick made on the Beery-VMI test (refer to Figure 5) moved them from below to well above the average ability of the general population. Cecil improved on the VP test with a difference in standard score of 21 (SEM of +/-6) but did not significantly improve on VMI or MC tests. The above changes were all reliable based on the RCIs calculated. Abe’s VMI results had a RCI of 2.31 and interestingly his MC results had a RCI of -3.16, indicating a reliable decrease in his motor coordination skills over time. The other reliable changes on the VMI were seen on Dedrick’s outcome score with a RCI of 4.0 and on Cecil’s VP outcome score with 2.67.

On the DASH, the first four subtests are the core tasks used to calculate a total composite score of handwriting speed, while the fifth Graphic Speed task provides a separate measure of perceptual motor performance (Barnett et al., 2007). Scores are transferred into an overall percentile; at or below the 5th percentile indicates slow handwriting requiring intervention, 6th to 15th percentile indicates moderately slow handwriting requiring monitoring and some intervention, at or above the 16th percentile indicates no difficulty with speed of output. All participants have scores that indicate slow handwriting and problematic copy speed abilities at the completion of the handwriting intervention.

Abe’s DASH scores decreased on all five subtests from pretesting to posttesting. He had no change in total score and his pretest and posttest Copy Speed Differences were problematic. Abe’s percentile ranking on both pretest and posttest was 15th percentile or below for his age. Like his MC scores on the Beery-VMI, his scores on the Graphic Speed measure of perceptual motor performance also decreased from a raw score of 42 at
pretesting to a raw score of 38 at posttesting. In all, these results on the DASH showed that Abe required handwriting intervention and instruction to improve his handwriting speed.

Cecil’s abilities stayed the same on three DASH subtests and decreased on two as illustrated in Table 5. He had a reduced total score of 67 to 54 at posttesting, both of which fall into the 15th percentile or below for his age. This drop in total score was considered a reliable regression (RCI = -3.69). Cecil’s pretest Copy Speed Difference score was not considered problematic but his posttesting Copy Speed Difference was problematic. Overall, Cecil’s results indicated a definite need for intervention to improve his handwriting speed.

Dedrick had no change in his total DASH score and his scores remained the same except for a small improvement on two subtests (see Table 5). His pretest Copy Speed Difference was not problematic; however, at posttesting it became problematic. His pretest and posttest overall rankings both fell in the 15th percentile or below for his age.

![Graph](image)

*Figure 5.* Pretest-posttest comparison of standard scores on the Beery-Visual Motor Integration test for Abe (A), Cecil (C) and Dedrick (D).
Table 5

Visual-Motor Integration & Graphomotor Skills: Standard Scores

<table>
<thead>
<tr>
<th>Measures</th>
<th>Abe</th>
<th>Bemus</th>
<th>Cecil</th>
<th>Dedrick</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>WJ-III Handwriting Legibility</td>
<td>70</td>
<td>86</td>
<td>--</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>73</td>
<td>71</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Beery-VMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMI</td>
<td>82</td>
<td>101**</td>
<td>72</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>97</td>
<td>98</td>
<td>67</td>
<td>105**</td>
</tr>
<tr>
<td>Visual Perception</td>
<td>101</td>
<td>105</td>
<td>94</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>97**</td>
<td>93</td>
<td>98</td>
</tr>
<tr>
<td>Motor Coordination</td>
<td>89</td>
<td>73**</td>
<td>52</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>73</td>
<td>72</td>
<td>78*</td>
</tr>
<tr>
<td>DASH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copy Best</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Alphabet writing</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Copy Fast</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Free Writing</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Graphic Speed</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total Standard Score</td>
<td>54</td>
<td>54</td>
<td>75</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>54**</td>
<td>54</td>
<td>54</td>
</tr>
</tbody>
</table>

Note. * > or = SEM; ** > or = SEM and RCI statistically significant at $p < .05$; WJ-III ACH= Woodcock-Johnson Tests of Achievement-III; Beery VMI= Beery-Buktenica Developmental Test of Visual-Motor Integration; DASH= Detailed Assessment of Speed of Handwriting; -- = not applicable.

Aim 3: The handwriting intervention increased the participants’ self-perceptions and self-descriptions around cursive writing enjoyment, competence, effort and performance change

Intrinsic Motivation Inventory.

The Intrinsic Motivation Inventory (IMI) was completed only once at the end of the intervention by Abe, Cecil and Dedrick. This inventory required each participant to indicate how true each of the statements was based on a five-point Likert scale where 1 was the lowest rating and represented not at all true, 2 represented just a little true, 3 represented somewhat true, 4 represented true, and 5 was the highest rating and
represented very true. An average rating from each of the five subsections (Interest/Enjoyment, Perceived Competence, Effort/Importance, Pressure/Tension, Value/Usefulness) on the IMI was calculated and are reported in Table 6. Abe felt that he had become more competent and that the value/usefulness of the cursive intervention was high. He had self-reported ratings out of 5 of 4.1 and 4.6 respectively on the two categories mentioned. Cecil reported a high level of interest/enjoyment, he felt more competent, and rated the value/usefulness of the cursive writing intervention as high. His IMI ratings out of 5 were 4.2, 4.9, and 4.5 respectively. Dedrick did not rate any of the IMI categories very high but his highest rating was on effort/importance of learning cursive with an average score of 3.2 out of 5. All three participants agreed that they did not feel pressure/tension during this intervention but rather reported feeling relaxed and admitted to enjoying the time spent learning cursive.

Table 6
Post-Intervention Self- Perception Ratings: Intrinsic Motivation Inventory

<table>
<thead>
<tr>
<th>Categories</th>
<th>Abe</th>
<th>Cecil</th>
<th>Dedrick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/Enjoyment</td>
<td>3.7*</td>
<td>4.2*</td>
<td>2</td>
</tr>
<tr>
<td>Perceived Competence</td>
<td>4.1*</td>
<td>4.9*</td>
<td>1.5</td>
</tr>
<tr>
<td>Effort/Importance</td>
<td>4*</td>
<td>3.5*</td>
<td>3.2*</td>
</tr>
<tr>
<td>Pressure/Tension</td>
<td>1.4*</td>
<td>2.1*</td>
<td>1.8*</td>
</tr>
<tr>
<td>Value/Usefulness</td>
<td>4.6*</td>
<td>4.5*</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Note. * = positive motivation or perception.
The classroom teacher completed the SWAN Rating Scale for Abe, Bemus and Cecil once towards the commencement of the intervention. Dedrick’s legal guardian provided feedback about his ability to focus attention, control activity, and inhibit impulses on the SWAN Rating Scale as well. Abe showed evidence toward ADHD-Hyperactivity/Impulsivity and ODD diagnoses but not ADHD-Inattention. This is based on the DSM-IV criterion that the SWAN Rating Scale is derived from (Swanson et al., 2001). Abe had scores greater than or equal to a severity score of 2 (below average) or 3 (far below average) on 6 or more of the 9 items on the scale for each of these two sections. Bemus also showed evidence toward an ODD diagnosis. He had scores greater than or equal to a severity score of 2 (below average) or 3 (far below average) on 8 of the 9 items on the scale for this section. On the other hand, Cecil and Dedrick did not show evidence toward an ADHD-Inattention, ADHD-Hyperactivity/Impulsivity, or ODD diagnoses.
CHAPTER FIVE: DISCUSSION AND SUMMARY

Review of Study

The main purposes of this research project were to determine if a cursive handwriting intervention would improve abilities in three areas: reading and writing skills, graphomotor/visual-motor integration skills, and the participants’ self-perceptions and self-descriptions around handwriting enjoyment, competence, and effort. A single-subject research design was implemented with four, struggling, male high school students who each received 10.5 to 15.5 hours of cursive handwriting intervention. The following section will discuss the findings, implications, recommendations and limitations of this study.

Single-subject designs (SSDs) examine pretest versus posttest treatment performance within a small sample size (Kennedy, 2005). The purpose is to reveal a causal or functional relationship between the independent and dependent variables. This type of experimental research design allows for repeated and reliable measurement, within and between-subject comparisons to control for major threats to internal validity, and requires systematic replication to enhance external validity. All of these factors are the basis on which treatment efficacy can be determined and are used to establish evidence-based practice (Horner et al., 2005).

In the current study, a single-subject (AB), multiple-baseline research design with multiple subjects in multiple locations, four participants had staggered start times for the treatment phase. This allowed for a demonstration of experimental effect within each participant’s outcomes before and after treatment commencement. The best example of experimental control was seen for Cecil in Figure 4 where he showed no cursive writing
ability until completing five sessions of the intervention. Since Abe, Bemus and Dedrick all had rising baseline trends it did not allow for as much control and could be indicative of increasing familiarity over time with the task. The study’s design also showed experimental control across individuals by allowing for a comparison between the change in handwriting skills and the introduction of the ez Write cursive writing intervention within four different data series at four different points in time and in two different locations. Horner and his colleagues (2005) strongly argue that SSD research is experimental and not correlational or descriptive in nature and they advocate that multiple-baseline designs, unlike studies that have only a baseline followed by an intervention, provide “experimental documentation of unequivocal relationships between manipulation of independent variables and change in dependent variables” (p. 169). It is also important to note that this design increases the external validity of the study due to its’ inherent replicative nature, which will in turn allow for greater generalizability of the findings. As it was in this study, when the same procedures are repeated by the same researcher and in the same setting with different clients who have similar characteristics, this is referred to as direct replication (Engel & Schutt, 2009). If all participants have positive outcomes then this enhances the strength of the findings; however, if the results are varied between participants then the factors that lead to success or failure can be examined further.

During the baseline phase (A), five main dependent variables were repeatedly measured prior to the handwriting intervention treatment phase. This provided two aspects of control that are similar to a control group in a between-group design (Engel & Schutt, 2009). First, the participant served as his own control since the baseline measures
established a pattern of scores that were then expected to change once the intervention was introduced. Second, most threats to the internal validity of the design could be overruled due to the repeated baseline measurements. As has already been mentioned, the commencement of the treatment phase for each participant was predetermined, and so the results of the current study do not show as much control as they might have if a stable trend in the baseline had been observed. It is recommended that in future the decision to move the next participant into the treatment phase be guided by a demonstration of a stable trend line in his baseline and a noted treatment effect in the previous participant’s results. This will strengthen the experimental control of the study.

Another aspect, the use of multiple dependent variables as opposed to just one, allowed for a more in-depth evaluation of various components of handwriting (i.e. speed and legibility). The repeated measures of the same baseline dependent variables were collected during the treatment phase (B), while at the same time the implementation of the cursive handwriting intervention (actively manipulated independent variable) was also carried out. The results reported in Chapter Four detail changes in the scores on the outcome measures that were observed after the intervention began.

Kazdin (2011) refers to SSD research as an intensive, applied, systematic study of the individual in context. The purpose of SSD research is to test the effectiveness of a particular intervention while monitoring a participant’s progress and to enhance knowledge about what works and what does not (Engel & Schutt, 2009). The following discussion will focus on analyzing the efficacy of the ez Write cursive handwriting intervention utilized in this study.
Findings

In summary, answers to the three main research questions were found by analyzing the data collected. First, the three students who completed posttesting showed significant improvements in various aspects of reading and writing; lending support to the hypotheses that handwriting is related to learning to read and write. Second, all four participants improved significantly in their cursive writing abilities, demonstrating the effectiveness of direct cursive writing instruction using the ez Write program. Third, the participants’ self-perceptions concerning their handwriting experience and competence indicated positive change over the course of the study.

Handwriting performance: Academic achievement.

The three participants who completed the pretest-posttest comparison (Abe, Cecil and Dedrick) all showed statistically significant improvement on various measures on the WJ-III ACH test that target writing skills. The Writing Fluency subtest was the only one that all three boys improved on. However, the fact that there was significant improvement in an academic area that was not explicitly taught lends support to the research findings that handwriting is linked directly to compositional fluency and quality (Graham et al., 1997; Jones & Christensen, 1999). Abe and Cecil outperformed Dedrick in their abilities to express themselves in writing following the handwriting intervention and this may have been because they, unlike Dedrick, were enrolled in a Language Arts class during the same semester as the research was taking place. Composing book reports, writing poetry, and formulating other written assignments may have reinforced the positive impact that the intervention was having on their writing skills. One of the primary focuses of the study was to develop automatic cursive handwriting. As many studies have
shown, by making the lower-level processes (forming letters on paper) automatic, the higher-level processes (planning, generating ideas, revising what is composed) can then be the focus cognitively (Christensen, 2005; Medwell & Wray, 2007). Although, given the short time frame of the study, it is not possible to claim that the participants reached a level of automaticity with their handwriting, it is possible to strongly suggest that their increased writing fluency scores were at least in part due to the handwriting process becoming easier with practice. These results are consistent with Christensen’s (2005) findings that a systematic handwriting program can also be effective in remediating older students’ problems in orthographic-motor integration leading to improvement of their written language skills.

The findings of this study showed that both reading and writing were impacted positively by the implementation of the handwriting intervention. In comparing the results of the WJ-III ACH and the CTOPP, both of which provide measures of reading ability, three interesting patterns emerged. First, the CTOPP is a measure of phonological processing. Phonological processing refers to the “use of phonological information, especially the sound structure of one’s oral language, in processing written language (i.e. reading, writing) and oral language (i.e. listening, speaking)” (Wagner et al., 1999, p. 2). Deficits in phonological awareness are common in those with reading disabilities. Abe, Cecil and Dedrick all fell in the average to above average range for phonological awareness, which would indicate that their reading challenges are not primarily phonological in nature. In fact, none of the students showed statistically significant improvement in their scores on Phonological Awareness, yet their Basic Reading Skills test results at posttesting far exceeded their initial scores. I hypothesize that the
improvement in reading abilities was linked to the orthography component of language and not phonology. Orthographic-motor integration was the direct focus of the intervention and so it follows that the improvements seen in reading were as a result of the proposed connections between these two skills. These findings provided evidence to support the hypothesis put forth by other researchers that handwriting is related to reading (Graham & Hebert, 2011; Levy et al., 2006; Richey, 2008; Vander Hart et al., 2010).

Second, rapid naming is one of the skills that have been found to be a root cause of decoding difficulties and when an individual does poorly on the Rapid Naming tasks it can indicate difficulty with reading fluency (Wagner et al., 1999). The Reading Fluency subtest on the WJ-III ACH test indicated no significant change for Abe and Cecil. However, the decrease in their CTOPP Rapid Letter Naming (RLN) scores over the course of the intervention was found to be significant. One possible reason for this decrease could be because all of the focus of the intervention was on letters presented and written in cursive whereas the RLN test uses printed letters. The possibility that the students’ naming abilities were hampered by what they had recently been focusing on is further supported by the fact that their scores on the Rapid Colour Naming (RCN) were not as drastically effected by the intervention. Dedrick, on the other hand, showed great improvement in Reading Fluency and in Rapid Letter Naming tasks, which reinforces that rapid naming, and reading fluency are related.

Third, although transcription skills include both handwriting and spelling, this study targeted handwriting in isolation. This might explain why the participants’ spelling abilities did not show statistically significant improvement over the course of the
intervention. Of important note is that all three students demonstrated phonological strategies (sounding out the words and when the word was spelled incorrectly it could still be recognized phonetically) when attempting to spell unfamiliar words and this again supports the supposition that the phonological component to language was not what was primarily holding these students back in their reading. This requires further investigation.

**Handwriting performance: Graphomotor skills.**

The repeated measures data collected during a single-subject research project is traditionally evaluated by visual analysis of the graphed data. However, as Wendt (2009) emphasized, it is important in evidence-based practice to obtain more objective outcome measures such as effect sizes or other indices of magnitude of effect. Whether visual inspection or the use of statistical approaches is used the question being addressed concerns the practical or clinical significance of the findings (Engel & Schutt, 2009).

As was outlined in Chapter Four (Results) and Table 4, the most significant effect sizes were seen when considering the Cursive Writing variable. A PEM value of 1 indicates that the intervention was highly effective. Interestingly both Bemus and Dedrick obtained this maximum PEM effect size of 1. Dedrick, who had 15 hours of intervention during the treatment phase and did not show evidence of an ADHD-Inattention, ADHD-Hyperactivity/Impulsivity or ODD diagnoses, improved significantly in his ability to write in cursive. Bemus, on the other hand, had the shortest amount of intervention (10.5 hours) due to his untimely departure from school and he did show evidence toward ODD type behaviour. Even so, he made substantial gains in his cursive writing ability. Abe and Cecil both obtained an individual effect size of .7, which corresponds to the intervention being moderately effective. Cecil only received 11 hours of intervention since he was
randomly chosen to be the last participant to start the treatment phase and he did not have any reported behaviours that would indicate challenges in attention or control. Overall the four participants’ group effect size $G^*$ was 0.98, showing tremendously significant change on this Cursive Writing outcome variable and indicating that the current intervention was effective.

Writing is one of the later language skills to develop following comprehension and oral language (Sandler et al., 1992). Studies have supported the connection between the mechanics of writing or, in other words, the lower-level skills of getting language on paper, and the quality and quantity of written composition (Graham et al., 1997; Graham et al., 2000). It is for this reason that both handwriting legibility (quality) and handwriting speed (quantity) were examined in the current study. I felt that it was important to incorporate both aspects into my project in order to have a more global view of the handwriting skills of my participants and measures were used that allowed me to obtain scores of legibility and speed. This differs from some researchers who have chosen to study the effect of an intervention on only one handwriting component (Zwicker & Hadwin, 2009).

There are some discrepancies in the results obtained on the legibility outcome measures. In an attempt to explain these inconsistencies I need to point out that legibility was rated on writing samples that were done in printing. The repeated measures Legibility Ratings score were based on the writing samples produced during the Copy Task. The students were asked to copy a poem but they were able to choose the handwriting style (printing or cursive) that they used. Printing was the style of choice for all samples produced by the four participants (with one exception discussed below).
Direct instruction and practice in handwriting skills has been promoted to help develop fluency with the retrieval and legible production of the alphabet symbols (Abbott & Berninger, 1993; Kaiser, Albaret, & Doudin, 2011; Weintraub, Drory-Asayag, Dekel, Jokobovits, & Parush, 2007; Yancosek & Howell, 2011). Support for this is seen in the current research findings where the overall legibility scores showed no significant change since the measures used in this study rated the legibility of printed writing samples and not the legibility of samples written in cursive.

While the overall legibility ratings for the whole sample did not improve, there were two instances where this was not the case. When completing the Copy Task during sessions 21 to 26, Abe spontaneously chose to write in cursive rather than his regular choice of printing. Consequently, his legibility scores increased during this time. Refer to Figures D.3 and D.4 in Appendix D to view the increase in legibility and subsequent decrease in speed that resulted from Abe’s choice to write in cursive. As well, on the WJ-III ACH Handwriting Legibility Scale Abe’s difference in standard score of 16 between pretest and posttesting represented a difference greater than one standard deviation (SD = 15), indicating a change that showed clinical significance. These results provide support the suggestion that directly teaching students to improve their letter formation could lead to better overall legibility (Kaiser et al., 2011; Weintraub et al., 2007). Zwicker and Hadwin (2009) obtained results similar to the current study and found that contrary to what they hypothesized, there was no significant difference in improvement of handwriting legibility with or without intervention for a group of first and second grade students. Nevertheless, these results differ from those of Roberts, Siever, and Mair (2010) who conducted a seven-week, cursive handwriting intervention for Grade 4 to 6 students.
and found a significant increase in ratings of global legibility (more than one-third of the students improved in cursive handwritten samples). Hereafter, it is recommended that the writing samples be produced in the handwriting style (printing or cursive) that is being measured for legibility and that comparison research on specific age groups from primary to secondary levels be conducted.

The global measures of handwriting speed (DASH and Copy Task) found handwriting to be slow and problematic for all participants and, even following the handwriting intervention, demonstrated no significant increases in writing speed. Nonetheless, as with the legibility measures, the written outputs on these measures were done in printing. Despite the fact that the measures were not specific to cursive writing, these results are in keeping with findings from other studies that found handwriting speed did not significantly improve after interventions were implemented (Lockart & Law, 1994; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003). In analyzing the results of the specific tests that were also used to measure handwriting speed in this study (Printed Lowercase, Printed Uppercase, and Cursive Writing outcomes), it is evident that speed (number of letters written per minute) did improve somewhat, although not to the point where the change could be deemed highly significant.

Visual-motor integration is “the degree to which visual perception and finger-hand movements are well coordinated” (Beery & Beery, 2010, p. 13). The Beery-VMI is used to assess the extent to which individuals can integrate their visual and motor abilities and is related to academic achievement (Beery & Beery, 2010). Volman, VanSchendel, and Jongmans (2006) found that visual-motor integration was a significant predictor of
handwriting speed and quality in second and third grade children who were experiencing handwriting challenges. Fascinatingly, Abe and Dedrick significantly improved in their VMI scores following intervention and went from below average to well above average in their standard score outcomes. It appears that the handwriting intervention positively impacted these two students’ ability to integrate their visual perceptual and motor skills. Additional investigation is necessary to determine what component(s) of the intervention would have led to this drastic advancement.

Two other overall findings on the Beery-VMI that should be addressed concern Abe’s motor coordination challenges and Cecil’s visual perception strengths. Abe did not significantly improve on the VP subtest, but intriguingly, he regressed significantly on his MC abilities. The order of the test presentation, VMI then VP and then MC, offers a possible justification for this seemingly contradictory outcome. It was observed that Abe completed the VMI with great care and effort given to copying the shapes as accurately as he could. Therefore, by the time he got to the MC subtest he was fatigued and did not perform up to his potential. Cecil only demonstrated significant improvement on the VP subtest, with no marked difference occurring on the VMI or MC tests. Even though his visual-motor integration skills remained in the average range for his age, his VP and MC skills were in the poor range prior to the intervention with his VP abilities improving to average level post-intervention. These results, paired with the fact that Cecil received the least amount of time during the treatment phase, could illustrate the need for a longer intervention in order to see gains in motor coordination and overall visual-motor integration.
Handwriting performance: Self-reports.

In order for handwriting to be functional and effective, it must be legible and automatic (Christensen, 2005; Weintraub et al., 2007). Studies have shown that due to the complexity of the handwriting task, difficulties in learning how to form letters on the page can lead to various problems, including illegible and slow handwriting, that only worsen as the demands for written work increase in the later school years (Sandler et al., 1992; Weintraub et al., 2007). These students are most likely to be vulnerable to frustration, disappointment, and under-achievement (Sandler et al., 1992).

We present ourselves to the world through our handwriting and are judged by others by it (Sassoon, 1990). This fact can serve as an explanation for why students who have difficulty with handwriting and focusing on an academic task may feel anxious or insecure when required to write. All four participants had received various accommodations (including scribes, computers, and modified assignments) at school to help them get around their graphomotor challenges and they avoided writing whenever possible. To ease their possible anxiety and frustration as positive and non-threatening a work environment as possible was created. For example, I worked one-on-one with the students in a separate space, away from their teachers and classmates. In addition, I provided a selection of writing utensils (different style of pencils and pens) and allowed them to choose the one they felt most comfortable to use. Given that the participants’ motivation to write was low at the start, the intervention sessions were designed to have a number of short tasks. This helped to maintain the boys’ attention all the while switching from activity to activity to avoid them becoming disinterested or frustrated.
At the end of the intervention I asked the participants to rate their experience and found that their self-reports matched my own observations and perceptions of their motivation, attitudes, and feelings in regards to handwriting. Abe and Cecil both reported positive motivation or perception in all five subcategories of the Intrinsic Motivation Inventory. What was even more telling than their responses on the IMI however, was the fact that they both started to use their newly developed cursive writing skills in the classroom, of their own volition, surprising their teacher immensely. Dedrick was much more conservative on his self-reported IMI ratings and did not feel very competent in his cursive writing abilities after participating in the study. It must be noted here that even though Dedrick improved significantly in his cursive writing abilities, he began the study with an extremely limited knowledge of the cursive alphabet and was not able to complete the full set of *ez Write* instructional and review worksheets before the study came to an end. He may have felt that since he did not finish the program he lacked competence. Nevertheless, he did feel that he had tried hard to learn cursive and that it had been an important skill for him to learn. Since all three boys reported not feeling pressured, nervous, tense, or anxious while participating in this study, my goal of making the learning environment friendly and safe was shown to be a success. These findings are similar to the increased personal satisfaction and self-reported improvements in attitudes toward handwriting that Roberts and her colleagues (2010) noted.

**Limitations**

Several limitations to the current study exist and may have affected the results of this study. For one, the small number of participants the results may not be representative
of the general population; therefore, limiting the study’s power and generalizability. As well, all four participants were struggling high school level, male students who were not randomly selected. This sample was possibly biased by teacher and legal guardian interest in the research project and because it is not representative of students of all ages or abilities. However, since positive improvement in the skills targeted in this study was evident, even though these four boys were at a more advanced stage in their academic journeys and brain development, then it can be reasonably hypothesized that a similar intervention with younger children could result in equally positive and possibly even more significant improvements. Data were incomplete due to one of the participants leaving school unannounced and before finishing the treatment and posttesting phases of the study. Another limitation was the limited length of time spent in the treatment phase of the intervention due to the school schedules and research timeline. Given more time to learn, assimilate, and practice cursive handwriting, may have allowed the students to continue to improve their handwriting automaticity skills and potentially reach a point of mastery where they would be more comfortable to use handwriting in their daily communications. Finally, the handwriting style used in the measures (printing) did not correspond to the handwriting style used in the intervention (cursive) and in the future this mismatch needs to be addressed. Further study is required to confirm these results and caution needs to be taken when interpreting the results.

**Implications and Recommendations**

Within educational research, the need to document the impact that various socially important interventions have is high. Social validity, or the practicality of the
research procedures and findings, was one of the research goals of this study (Horner et al., 2005). The cursive handwriting intervention was chosen as the independent variable because of its’ high social relevance. By taking a cursory glance at the intervention, it can be argued that the social validity of the *ez Write* cursive handwriting program is quite high. I can answer the three questions, outlined by Kazdin (2011), about interventions that encompass social validity, affirmatively. For one, the goals of the intervention are relevant to everyday life. Not only has it been shown that handwriting directly impacts overall literacy skills, but currently in North America it is a newsworthy topic of debate as to whether or not handwriting should be taught in our public schools. Two, the intervention procedures are acceptable to consumers (teachers, parents, clients). The results of this study and the other two projects that implemented the *ez Write* program all show that it is effective, easy and inexpensive to use. Three, the outcomes of the intervention are important and make a difference in the everyday lives of the individuals. This is by far the most important of the three in my opinion and in the current research findings did show that there were differences made for each participant and that the participants themselves described the intervention as being important and useful. It is recommended that in future research a longitudinal approach to looking at the students’ retention of what they have gained during the intervention be applied.

There is a recognized need for more attention to be directed at handwriting development and remediation during adolescence (Graham & Weintraub, 1996). In this study I did the cursive writing intervention with older students and found an increase in their abilities in basic reading skills and written expression. The literature has focused on early intervention and has shown that by targeting the handwriting skills of young
children it will have a long-term effect on written expression in the middle school years (Berninger & Amtmann, 2003). But, by the time students reach secondary school handwriting problems are seldom straightforward as no two problems are the same (Sassoon, 2006). The four students in the current study had varied etiologies of academic and handwriting problems. By implementing this same intervention with students who have less varied underlying reasons for their handwriting challenges it is possible that the outcomes would differ. As Graham and Miller (1980) point out, poor penmanship has at least two possible causes: “a learner may bring to the task certain predilections that impede effective instruction …[or] that most handwriting difficulties are the result of inadequate instruction” (p.1). Whatever the case, more research is needed to explore the effect of handwriting instruction and intervention in middle school and beyond and to produce unique research findings that will fill a gap in the current literature while building on past studies with younger children.

The strong gender effect is an important detail in the current study since, if boys are more prone to not developing automatic handwriting at the expected age, then this could very well interfere with their ability to compose (Medwell & Wray, 2007). Reasons most often reported by boys for disliking and underperforming in written composition tasks are due to technical challenges with handwriting and spelling (Medwell & Wray, 2007). Interestingly, the students chosen by their teachers to participate in my study, due to their struggles in handwriting, were all boys. This supports the findings by Weintraub (2007) and her fellow researchers who found that boys in middle school (mean age = 13.5 years) continued to be more at risk for having handwriting difficulties compared to girls. Further research is required to address boys’ underperformance in writing skills.
There is some variability in the literature when measuring handwriting speed and legibility. Handwriting speed was measured as words per minute in this study, whereas others have measured it as letters per minute (Graham et al., 1998; VanDrempt et al., 2011; Weintraub et al., 2007). Some researchers have taken it even further and only score the number of letters produced in the first 15 seconds of the measure (Berninger et al., 2006). When conducting further research, using a score of letters per minute would provide more accurate data on handwriting speed since the length of the words written would be taken into account.

No gold standard for assessing handwriting legibility in older individuals has yet been identified (VanDrempt et al., 2011). Digitized tablets are one possible way to make it possible to score handwriting samples and the movements one makes while writing with increased precision, reliability, and objectivity (Graham & Weintraub, 1996; Rosenblum, Weiss, & Parush, 2004). A digitizer was not used in the current project; however, in the future the use of a digitizer would make scoring legibility much more straightforward and objective than the rating methods employed in the current data analysis. Other handwriting components could also be measured quantitatively such as speed, size, slant, and writing pressure, using this technology.

Several studies have been conducted to examine handwriting and determine what remedial methods are the most effective for addressing challenges in handwriting; however, little consensus has been reached (Edwards, 2003; Feder, Majnemer, & Synnes, 2000; Roberts et al., 2010; Zwicker & Hadwin, 2009). Similarly, many handwriting instructional programs and practices that have resulted in improved written output have not been empirically tested to determine if they enhance students’ reading and writing.
New research is needed to determine the role that handwriting plays in literacy learning and future studies are recommended to delineate which instructional approaches and which interventions are most powerful.

**Conclusion**

The results of this single-subject study indicated the importance of cursive handwriting instruction and intervention for improved academic achievement, graphomotor abilities, and students’ self-perceptions. It is imperative to bridge the praxis gap and combine theory and application for best practice (Hayes, 2012). By presenting these exploratory research findings, one of the primary goals was to inspire researchers to continue to explore the questions I have raised and to provide evidence-based findings that will illustrate the importance of handwriting instruction in school. The contribution of handwriting to academic achievement and vocational success can no longer be neglected. Medwell and Wray (2007) make this argument very clear when they stated that:

> Handwriting has not been an important aspect of literacy for teachers in the last decade, but it has been the subject of important research. It is time for the research in this area to be made more accessible to educators and for it to be considered in the planning of pedagogies for struggling writers. (p. 14)

Further investigation, both experimentally and clinically, is needed to impact positive and effective change, at the applied educational level, through improved teaching and intervention measures.


Graham (Eds.), *Handbook of learning disabilities*. New York: Guilford.


Statistics Canada and the Organization for Economic Co-operation and Development.


Appendix A: *ez Write* Handwriting Program

Monday August 26, 2013

To Whom It May Concern,

I, Mary Beckman, granted Tamara McEachern permission to use my *ez Write* handwriting program during our initial communications beginning in July 2012. I subsequently provided her with the materials she needed to implement the *ez Write* cursive handwriting program with her high school research participants as part of her Master’s thesis research project at Brock University. Before providing the program materials to Tamara, I made changes to the worksheets to eliminate grade level designations that were not appropriate for the older students. Being the author and owner of the *ez Write* handwriting program I have the ability to grant this permission.

Sincerely,

Mary Beckman

*Figure A.1: ez Write Letter of Permission*
Handwriting Intervention Worksheets:

Figure A.2: ez Write Lowercase Cursive Alphabet (© ez Write, LLC, 2010)
Up the Steps Letter

- Put your pencil on the dot and write the letter as the instructions are read.
  - go Up the Steps to the "middle line"
  - make a small ez Across line
  - go Down the Steps to the "writing line"
  - add a small end tail

The letter “r” in cursive is another Up the Steps letter. It is a little tricky to make, but you should be able to do it if you follow the instructions carefully. Be sure the Up the Steps and Down the Steps lines run parallel to each other.

Fill in the “r’s”, trying to copy the model given.

Write a line of “r’s” connected in 2’s.

Write the word “sir”. Practice spacing and circle your best word.

Write the word “stir”. Practice spacing and circle your best word.

Practice the words “sir” and “stir” at home.

© ez Write, LLC (2010)
Figure A.4: Sample ez Write Cursive Review Worksheet
Appendix B: Overview of Handwriting Intervention

Table B.1
Overview of Handwriting Intervention

<table>
<thead>
<tr>
<th>Baseline Phase: A</th>
<th>Handwriting Speed and Legibility ratings obtained each session throughout the project.</th>
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<tbody>
<tr>
<td>Measures:</td>
<td>1. Printed Lowercase Alphabet – 1 minute timed</td>
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<tr>
<td></td>
<td>2. Printed Uppercase Alphabet – 1 minute timed</td>
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<tr>
<td></td>
<td>3. Cursive Letters (lower and/or uppercase) – 1 minute timed</td>
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<tr>
<td></td>
<td>4. Copy Task - timed</td>
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<tr>
<td></td>
<td>5. Legibility Ratings – scored using ‘copy task’ written output</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervention Phase: B</th>
<th>Warm-ups*:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ez Write program:</td>
<td>Basic Stroke &amp; Letter Placement Instruction (House Diagram)</td>
</tr>
<tr>
<td></td>
<td>Up the Steps Letters (i, t, s, r) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>Up the Steps Loop Letters (e, l, b, f, j) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>Down the Steps Letters (Pp, h, k) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>C Stroke Letters (Cc, Oo, Aa, d, g, q, E) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>U Turn Letters (Uu, Yy, Ww) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>Rainbow Curve (Nn, Mm, Vv, Xx, z) Instruction &amp; Review</td>
</tr>
<tr>
<td></td>
<td>Overall Lowercase Alphabet Review – 26 worksheets</td>
</tr>
<tr>
<td>Wrap-up</td>
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</table>

*Explanation of Warm-ups:

Finger Warm-up Activities: Basic finger movements used to have participants practice eye-finger coordination. For instance, touching each fingertip to the thumb in sequence forward and then backward, one hand at a time and then with both hands simultaneously.

Writing Posture Steps: Reviewed the following five steps until the participant automatically positioned himself with the correct writing posture most of the time. The researcher developed these five steps after observing numerous sessions conducted by occupational therapists.
1. Sit with both feet flat on the floor
2. Back is straight
3. Paper is on the desk centred on student’s midline
4. Non-writing hand anchors page
5. Efficient pencil grip

Alphabetical Order Memory Task: Spent time memorizing the order of the alphabet.
Rehearsed alphabet in smaller chunks both forward and backward and with and without looking at a visually represented copy of the ‘alpha chunks’.

abcd
efgh
ijkl
mnop
qrst
uvwxy

The researcher and her colleagues developed this method of learning the alphabet. It is important to discuss the placement of the vowels (all start their chunk except the ‘o’) and the number of chunks and number of letters in each chunk in order to aid in the memorizing process. This was important since some of the participants did not know how to write the alphabet in order during the baseline phase.

Basic English Sound Code Review: The 26 letters of the alphabet were categorized as vowels and consonants and then the sounds that are represented by each of these 26 letters were reviewed. For example, ‘a’ = /a/ as in ‘apple’, ‘b’ = /b/ as in ‘ball’ and so on. Very little time and focus was given to this task during this project.

Directional Arrows Chart (Lane, 1991): Using a worksheet that has arrows pointing in four directions (left, right, up and down) the participant names the direction of each arrow out loud, tracking each line on the page from left to right. This was a warm-up chosen to prepare the participants to recognize the various directions that letter forms use.

Patterns (Sassoon, 2012): Patterns are a precursor to writing. The Sassoon® Patterns were downloaded and used as warm-ups at the beginning of each session until all 15 patterns were completed. The patterns start as simple scribbles and they gradually become more precise and progressively more difficult. Using blank paper a three-step process was used. First, the participant traced the pattern a few times. Second, the participant copied the pattern he had just traced while referring to the pattern. Third, he reproduced the pattern without looking at the pattern or, in other words, from memory. Once the participant could reproduce the pattern in question with approximately 80% accuracy he was considered to have mastered that pattern and progressed to the next one.
## Appendix C: Measures - Examples

<table>
<thead>
<tr>
<th>SWAN RATING SCALE</th>
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<tbody>
<tr>
<td>Participant:</td>
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</tr>
<tr>
<td>Gender:</td>
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<td></td>
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<tr>
<td>Age:</td>
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<td></td>
</tr>
<tr>
<td>Grade:</td>
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<td></td>
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<tr>
<td>Completed By:</td>
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<tr>
<td>Date Completed:</td>
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</table>

<table>
<thead>
<tr>
<th>Far Below</th>
<th>Below</th>
<th>Slightly Below</th>
<th>Average</th>
<th>Slightly Above</th>
<th>Above</th>
<th>Far Above</th>
</tr>
</thead>
</table>

1. Give close attention to detail and avoid careless mistakes
2. Sustain attention on tasks or play activities
3. Listen when spoken to directly
4. Follow through on instructions & finish school work/chores
5. Organize tasks and activities
6. Engage in tasks that require sustained mental effort
7. Keep track of things necessary for activities
8. Ignore extraneous stimuli
9. Remember daily activities
10. Sit still (control movement of hands/feet or control squirming)
11. Stay seated (when required by class rules/social conventions)
12. Modulate motor activity (inhibit inappropriate running/climbing)
13. Play quietly (keep noise level reasonable)
14. Settle down and rest (control constant activity)
15. Modulate verbal activity (control excess talking)
16. Reflect on questions (control blurtng out answers)
17. Await turn (stand in line and take turns)
18. Enter into conversations & games (control interrupting)
19. Control temper
20. Avoid arguing with adults
21. Follow adult requests or rules (follow directions)
22. Avoid deliberately doing things that annoy others
23. Assume responsibility for mistakes or misbehavior
24. Ignore annoyances of others
25. Control anger and resentment
26. Control spitefulness or vindictiveness
27. Avoid quarreling
28. Remain focused on task (does not stare into space/daydream)
29. Maintains appropriate energy level (not sluggish or drowsy)
30. Engage in goal directed activity (not apathetic or unmotivated)

*Figure C.1: SWAN Rating Scale (Swanson et al., 2012)*
### Intrinsic Motivation Inventory

For each of the following statements, please indicate how true it is for you, using the following scale:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>not at all true</td>
<td>somewhat true</td>
<td>very true</td>
<td></td>
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</table>

**Interest/Enjoyment**
- I enjoyed learning cursive very much.
- Cursive writing was fun to do.
- I thought learning cursive was a boring activity. (R)
- Learning cursive writing did not hold my attention at all. (R)
- I would describe learning cursive as very interesting.
- I thought learning cursive was quite enjoyable.
- While I was doing the cursive writing program, I was thinking about how much I enjoyed it.

**Perceived Competence**
- I think I am pretty good at cursive writing.
- I think I did pretty well at cursive handwriting, compared to other students.
- After working at learning cursive for a while, I felt pretty competent.
- I am satisfied with my performance at this task.
- I was pretty skilled at writing in cursive.
- This was an activity that I couldn’t do very well. (R)

**Effort/Importance**
- I put a lot of effort into this.
- I didn’t try very hard to do well at learning cursive writing. (R)
- I tried very hard to learn cursive.
- It was important to me to do well at this task.
- I didn’t put much energy into this. (R)

**Pressure/Tension**
- I did not feel nervous at all while doing the handwriting program. (R)
- I felt very tense while doing this cursive writing program.
- I was very relaxed in doing the cursive writing program. (R)
- I was anxious while working on this task.
- I felt pressured while doing the cursive writing program.

**Value/Usefulness**
- I believe that learning cursive writing could be of some value to me.
- I think that doing this activity is useful for my schoolwork.
- I think this is important to do because it can help me in class.
- I would be willing to do this again because it has some value to me.
- I think doing this activity could help me to write faster and neater.
- I believe that learning cursive could be beneficial to me.
- I think that cursive handwriting is an important activity.

*Figure C.2: Intrinsic Motivation Inventory - Post-Intervention (Ryan, 1982)*
It Makes A Difference

As the old man walked the beach at dawn, he noticed a young man ahead of him picking up starfish and flinging them back into the sea. Finally catching up with the youth, he asked him why he was doing this. The answer was that the stranded starfish would die if left until the morning sun. “But the beach goes on for miles and there are millions of starfish,” countered the old man. “How can your effort make any difference?” The young man looked at the starfish in his hand and then threw it to safety in the waves. “It makes a difference to this one,” he said.

Author Unknown

Figure C.3: Repeated Measure - Copy Task
Figure D.1: Multiple Baseline Graph - 
**Printed Lowercase** outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.2: Multiple Baseline Graph - Printed Uppercase outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.3: Multiple Baseline Graph - Copy Task outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.4: Multiple Baseline Graph - Legibility Ratings outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.5: Multiple Baseline Graph - Error Score-Printed Lowercase outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.6: Multiple Baseline Graph - Error Score-Printed Uppercase outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.
Figure D.7: Multiple Baseline Graph - Error Score-Cursive Writing outcome measure for Abe, Dedrick, Bemus and Cecil at baseline (A) and treatment (B) phases.