

The relationship between handwriting, reading, fine motor and visual-motor skills in
kindergarteners

by

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ABSTRACT

Little is known about handwriting development in kindergarten. A vast number of studies can be found on reading, but few include writing skills and even fewer include handwriting skills in kindergarteners. This study examined the relationship between handwriting and reading measures at the kindergarten mid-year using the Alphabet Writing Test (Clark, 2010), Name Writing Test (Clark, 2010), and the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminiski, 2002). The 48 participating students ranged in ages from 68 to 82 months, with boys making up 53.8% of the study. Significant correlations were found between handwriting measures and DIBELS measures. Students who scored lower on DIBELS measures also scored lower on handwriting measures. The study also found a significant difference between the student's legibility in writing upper case letters compared to lower case letters; however, the speed of writing these letters was not significantly different. Variables that predicted alphabet writing included the student's age, ability to write first and last name, and the score on the DIBELS Initial Sound Fluency. Variables that predicted name writing were the student's age, writing the upper and lower case alphabet, the BeeryTM Visual Motor Integration (Beery & Berry, 2006), and Motor Coordination test (Beery & Beery, 2006). The implications for kindergartener's handwriting skills and future research are discussed.

CHAPTER 1. GENERAL INTRODUCTION

Introduction

Writing allows individuals to communicate knowledge and engage in life activities, including education and work (Graham, Struck, Santoro, & Berninger, 2006; McHale & Cermak, 1992). Although writing is considered one of the basic R's in education (e.g., reading, writing and arithmetic), little is known about handwriting development. Compared to the vast number of studies on reading, few studies exist on early writing skills and even fewer include handwriting skills in kindergarten.

In recent years, there has been a considerable amount of research on the process of writing (MacArthur, Graham, & Fitzgerald, 2006), but this study investigates the act of writing, or as it is known in the educational field, "handwriting." These descriptions are used to distinguish between writing and handwriting for this study. Writing enables individuals to express their knowledge and thoughts (Berninger, 1994; McHale & Cermak, 1992; Parush, Lifshitz, Yochman, & Weintraub, 2010); handwriting, e.g., using the hand to form letters on a page, is essential in the writing process and can predict the amount and quality of children's written ideas (Edwards, 2003; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Graham, Harris, & Fink, 2000; Jones & Christensen, 1999). Even though Graham, Harris and Fink (2000) found handwriting was causally related to writing, little attention has been focused on the instruction of writing mechanics (e.g., letter formation, size, spacing); as a result, students are struggling with foundational handwriting skills that affect legibility and, ultimately writing performance. Persky, Daane, and Jin (2003) found that approximately 70-75 % of American students in grades 4 to 12 were writing below grade level on a national writing exam. The American College Testing Program (ACT, 2005) reported that approximately one-third of

students entering college were unprepared to write at the college-level, indicating they will have difficulty achieving even a “C” in these courses. American employers consider writing to be an essential skill (National Commission on Writing, 2004), yet employees are often not prepared when they enter the work force. Casner-Lotto and Barrington (2006) found that 81% of surveyed employers reported recent high school graduates were deficient in written communications, including memos, letters, and technical reports. An estimated \$3.1 million per year is spent by private businesses to instruct their employees in writing skills and \$200 million is spent by state governments to teach writing skills to their employees (National Commission on Writing, 2004; 2005). The value of writing has been highlighted by the World Health Organization’s (2002) inclusion of writing difficulties as an impediment to school participation. Handwriting skills are critical for future success; schools need to prepare better writers.

Effective handwriting skills begin in kindergarten with instruction focusing on forming upper and lower case letters, understanding sound letter associations, and combining letters into words. Yet, instruction in handwriting has been practically ignored by educators (Asher, 2006; Graham et al., 2008). A survey of teachers randomly selected from across the United States (first through third grade) indicated that only 12% had college-level courses that prepared them to teach handwriting (Graham, et al. 2008). If teachers do not consistently receive effective instruction on what and how to teach, they are unable to provide effective instruction to students and will have difficulty providing supplemental or targeted interventions for students who are at-risk for handwriting problems.

When students do not have effective instruction in handwriting, they frequently struggle with writing and lack the skills necessary for legible and fluent writing. Marr and

Cermak (2002) studied the consistency of student's handwriting performance from the beginning of kindergarten through the middle of first grade. They established three groups, based on the group mean and standard deviation scores from the mean (i.e., the low group were children performing less than 1 standard deviation from the group mean, the high group were the children performing greater than 1 standard deviation above the group mean). They found that 42% of the kindergarteners who were in the low handwriting group were still performing in the low group in the first grade, 70% of the kindergarteners who were performing in the middle group were still in the middle group, and only 38% of the kindergarteners performing in the upper group were still in the upper group. These results highlight the probability that without early intervention, students who are struggling early in kindergarten will continue to struggle.

Writing skills are critical life skills. A strong relationship between kindergarten performance and performance in later academic years (Baydar, Brooke-Gunn & Furstenberg, 1993; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Marr & Cermak, 2002; Molfese, Beswick, Molnar, & Jacobi-Vessels, 2006; Stevenson & Newman, 1986) demonstrates the important roles early childhood teachers and related service staff have in affecting writing performance in later years. Their roles become even more challenging considering the diversity of experience of today's students. The National Association for the Education of Young Children (1998) reported that a five-year range in literacy-related skills were common in a kindergarten classroom. For example, one kindergartener may be unable to identify any letters of the alphabet while another kindergarten student may enter school with the ability to write simple words.

Expectations for students have increased significantly in the last few years. Bridge, Compton-Hall, and Cantrell (1997) found that in 1995 children were engaged in writing 2-3 times as often as they were in 1982. They also found that first graders were expected to compose their own stories, generating ideas and using their own words (e.g., finish story starters, personal journals). In addition, students were expected to read and discuss their writings with classmates. These high expectations were also noted in a Snow, Burns and Griffin (1998) report where they stated that at the end of kindergarten students should be able to complete the following skills:

1. Independently write many uppercase and lowercase letters.
2. Use phonemic awareness and letter knowledge to spell independently (invented or creative).
3. Write (unconventionally) to express own meaning.
4. Build a repertoire of some conventionally spelled words.
5. Show awareness of distinction between “kid writing” and conventional orthography (i.e., writing words with proper letters and spelling).
6. Write own name (first and last) and the first names of some friends of classmates.
7. Write most letters and some words when they are dictated (Snow et al., p. 80).

Many school districts use assessment measures to identify kindergarteners who are at risk for reading problems. Measures such as the Dynamic Indicator of Basic Early Literacy Skills (DIBELS; Good & Kaminiski, 2002) are often based on the essential early literacy domains (e.g., alphabet knowledge and phonological awareness) outlined in the National Reading Panel report (NICHHD, 2000) and National Research Council (1998). Examiners assess a kindergartener’s performance on various indicators and identify the students that

need extra help in the areas of phonological awareness and alphabetic principle. While writing skills, such as writing alphabet letters or their name, also require phonological awareness and alphabetic principle skills, seldom are these included in the district-wide screening process.

The ability to write one's name is an important indicator of early literacy. The National Early Literacy Panel (NELP; 2008) identified name writing as an indicator related to later reading ability, even after controlling for IQ and socioeconomic status. Name writing appears to be based on the alphabetic principle (i.e., specific letters correspond to specific letter sounds). Weinberger (1996) found children's skills in naming letters and writing their name at five years was linked with their reading skills at age seven years.

Students with problems in handwriting are frequently referred to occupational therapists (Weil & Amundson, 1994; Dennis & Swinth, 2001) for evaluation and intervention. Research by occupational therapists focuses on the underlying components such as visual-motor skills, patterns of pencil grasp, perceptual-motor skills, legibility, and fine motor skills, including manipulation of objects in the palm (Case-Smith, 1995; Cornill & Case-Smith, 1996; Dennis & Swinth, 2001; Schneck, 1991; Weil & Amundson, 1994; Ziviani & Elkins, 1986). Studies in these skill areas include students with and without handwriting difficulties, but have not combined the early literacy skills of reading and handwriting with underlying motor and visual-motor development.

Little is known about handwriting development in kindergarten, yet it is a critical life skill. As a result, there is little known about the early handwriting skills of kindergartners and the relationship among early reading skills, early handwriting skills, visual-motor skills and fine motor skills. Knowing the variables that predict writing performance is essential to allow

educators and occupational therapists to screen students early to identify those at-risk for writing delays, provide skill-building interventions, and monitor their performance.

Research Questions

This study is designed to study handwriting skills in kindergarteners by addressing the following research questions:

1. What is the relationship between reading and handwriting skills among kindergarteners during their second semester?
2. By second semester, are students in kindergarten more accurate and fluent in writing upper or lower case letters?
3. Are there differences in performance between students in Group 1 (At Risk) and Group 2 (At Grade Level) on handwriting, fine motor, and visual-motor measures?
4. Which pre-reading, visual-motor, and fine motor skills predict name writing and letter writing for students in kindergarten?

CHAPTER 2. REVIEW OF LITERATURE

Literature Review

The literature review begins by establishing the link between reading and handwriting for young children. It explores the literature on the alphabetic principle and its relationship to writing and the link between understanding the sound of letters and writing letters. The importance of name and letter writing are examined as well as the influence of fine motor and visual skills on handwriting skills. Little empirical evidence exists on kindergarten handwriting skills so this literature review includes research from preschool and early elementary years.

Links Between Reading and Handwriting

As beginning readers and writers, students in kindergarten must learn the names of the letters, the sounds of the letters, and how to write the letters. Phonemic awareness, defined as “conscious attention to phonemes” (Richgels, 2003, p. 144), which includes understanding and manipulating speech sounds, is critical to both the reading and writing processes. A phone is an individual speech sound; phonemes are the smallest units of sounds that can differentiate meaning. Similar words may have different sounds (phonemes) due to one letter (phone) difference (e.g., cat, hat). If students do not develop phonemic awareness, they may have difficulty learning the phoneme-spelling correspondences required to spell and write (Berninger, 2000).

Students’ ability to read words is interwoven with their ability to write letters and words (Domico, 1993; Richgels, 1995). Reading and writing are highly similar but they are not identical cognitive processes. Reading words is much easier than the process of selecting words and then writing them on paper (Fitzgerald & Shanahan, 2000). Many school districts provide only reading instruction and assume that students will be able to learn everything

needed for handwriting from the reading instruction or simply writing. Yet, handwriting is a learned process and requires instruction for true skill development. The literature supports separate instruction in both reading and handwriting with activities to reinforce and support each other (Glazer & Burke, 1994; Miller, 2000; Stellakis & Kondyli, 2004; Tierney & Pearson, 1983). While the research on the relationship between phonemic awareness and reading is abundant, there are markedly fewer studies on the relationship between writing and phonemic awareness, especially regarding students in kindergarten who are just learning both skills.

The alphabetic principle and letter writing. The alphabetic principle focuses on the letter-sound correspondence and word blending (e.g., using letters to make certain sounds), and links the phonemes (sounds) and graphemes (e.g., letters of the alphabet) to the spelling of words (Ehri, Nunes, Stahl & Willows, 2001). Understanding the alphabetic principle is necessary in both reading (Adams, 1990; Honig, 2001) and writing (Berninger et al., 2006; Stevenson & Newman, 1986; Treiman, 1993). This relationship is easy to understand when one realizes that a symbol such as “G” has meaning both as a specific sound and as a specific mark (which can vary depending upon the culture). In order to master reading and writing, individuals must integrate both of these meanings.

Sulzby and colleagues (Bus et al., 2001; Sulzby, Barnhardt, & Hieshima, 1989) studied the relationship between letter knowledge and writing in preschoolers and found a significant correlation between 4- and 5-year-old children’s letter naming and invented spelling in their written work. Recently, Molfese, Beswick, Molnar and Jacobi-Vessels (2006) expanded on Sulzby’s earlier work by examining preschool children’s skills in alphabetic knowledge, e.g. naming and writing. Using three different writing tasks, Molfese

and colleagues studied name writing, letter writing from dictation, number writing from dictation, letters copied, and numbers copied. The measures were administered in the fall of the preschool year and at the start of the kindergarten year. They found that letter naming was significantly related to handwriting letters and numbers. Significant correlations were also found between letters and numbers that were handwritten from dictation or copied; however, the correlations between naming the letter and handwriting the letter were stronger in the dictation condition. Since dictation requires that the writer to visualize the appropriate letter in order to then write it, the writer would have to know the name and the visual representation of the letter as opposed to being presented with a model to copy the letter.

Knowledge of letter sounds and letter writing. Educators agree that readers must learn letter names and letter sounds (phonemes), but writers must also learn these concepts in order to write or spell correctly (Fitzgerald & Shannon, 2000). Phonological awareness is defined as the ability to discriminate and manipulate the sound structure (e.g., auditory, orally) of language (Adams, 1990; Burke, Crowder, Hagan-Burke, & Zou, 2009; Ehri et al., 2001) while phonemic awareness is the understanding of a sound, such as the initial sound of a word. Students struggling with knowledge of letter names, letter sounds, and phonemic awareness may have difficulty learning reading and writing skills (Berninger et al., 2006; Fischel et al., 2007). Denton and West (2002) examined students in grades kindergarten through fifth grade and found that students who were proficient at identifying letters and recognizing letter sounds at kindergarten entry had higher skills on measures of phonological processing and word reading in first grade. Handwriting words assists students in learning about print and increases the number of words they can vocalize (Berninger, 1999; O'Connor & Jenkins, 1995; Treiman, 1998; Vernon & Ferreiro, 1999). Kindergarten students who were

more proficient at understanding the correspondence between letter sounds and letter names produced a higher level of writing (Cain, 2007).

Ritchey (2006) investigated the relationship between the DIBELS (Good & Kaminiski, 2002) and writing measures she developed. Using letter writing and spelling measures, Ritchey found handwriting upper and lower case letters from dictation correlated significantly with DIBELS measures Letter Naming Fluency and Letter Sound Fluency. Ritchey (2008) used these data to determine which beginning skills in reading, phonological awareness, and writing would predict letter writing and spelling for students in kindergarten. Findings indicated 52.5% of the variance in the performance on Letter Writing could be accounted for by three DIBELS measures: Letter Naming Fluency (identification of alphabet letters), Letter Sound Fluency (identification of the sounds of letters), Phoneme Segmentation Fluency (identification of sounds in a word), and two other measures, the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999), and the Test of Early Reading Ability (Reid, Hresko, & Hammill, 2001).

Importance of Name Writing

Learning to recognize the letters in their name and to write their name provides children with a personal connection to writing. Within everyday routines, children are frequently exposed to their written name, providing them with multiple learning opportunities to connect with their name. Having children write their name is an important step toward literacy (Clay, 1975). The National Early Literacy Panel (2008) found that one of the top six variables that correlated with later literacy and predicted literacy development, even when IQ and socioeconomic status (SES) were accounted for, was “the ability to write letters in isolation on request or to write one’s own name” (p. 3).

Riley (1995) identified both letter naming and name writing as strong predictors of reading, accounting for 31% and 45% respectively, of the variance found. A study by Weinberger (1996) supports this finding. Weinberger found letter naming and name writing skills in children at age five were linked to their reading skills at age seven years. Bloodgood (1999) studied name writing with preschoolers to learn how the written name mirrors a child's literacy acquisition. Forty percent of the writing samples from 4- and 5-year old children were found to include the letters of their name. The ability to write their name correlated with alphabet knowledge (.39 to .66) for 4- and 5-year olds. This was supported by a study of preschoolers' name writing skills completed by Molfese, Beswick, Molnar, and Jacobi-Vessels (2006). They found name writing and letter naming were significantly correlated, but also found that children's scores on name writing were significantly better than scores on writing dictated letters or copying letters. Children most easily identified the letters of their name. Being able to write one's name automatically appears to indicate emerging knowledge of the alphabet, recognition of sight words, and visual tracking skills (Bloodgood, 1999).

Automatic Letter Writing and Legibility

Legibility and automaticity were found to be important to handwriting (Berninger & Rutberg, 1992). Legibility of letters refers to the quality or readability of the letter. Berninger, Nielsen, Abbott, Wijsman and Raskind (2008) defined automaticity as "effortless and fast retrieval and production of legible letters" (p. 3). A study of students in the first through sixth grades found that the single best predictor of the length and quality of written composition in elementary grades was automatic letter writing (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). This finding was consistent at each grade level for handwriting

automaticity. Automatic letter writing was also supported in studies in high school and college years (Connolly, Campbell, MacLean, & Barnes, 2006; Peverley, 2006).

One method of measuring handwriting legibility and automaticity is to have the student print the lowercase letters in alphabetical order from memory. Berninger and Rutberg (1992) developed norms for grades 1-9 using a scoring system that counts legibility and order for the letters written during the first 15 seconds. McClutchen and colleagues (2002) used the Berninger and Rutberg's alphabet writing task but provided the first grade students with a 60 second time frame instead. They found that 60-seconds was too long to reliably discriminate between levels of skills among first grade students.

Using lowercase letters only during a handwriting task may not be appropriate for emerging writers such as kindergarteners. Research has shown that children recognize upper case letters before lower case letters (Adams, 1990). The National Association for the Education of Young Children (1998) stated that upper case letters are visualized more easily and should be used first, followed by lower case letters.

Fine Motor Influence on Handwriting Demands

Hand use is critical to daily life functions, including writing, dressing, and playing. An observation of 10 Head Start and 10 kindergarten classrooms found that kindergarten students spent almost one-half (46%) of their day engaged in fine motor activities while children in Head Start spent over one-third of their day (37%) in fine motor activities (Marr, Cermak, Cohn, & Henderson, 2003). Self-care activities represented 45% of the total fine motor time in Head Start (e.g., opening milk carton, dressing, eating). Manipulating objects represented 44-46% of the total fine motor time in kindergarten and Head Start (e.g., cutting, finger plays, using play dough,). Paper and pencil tasks (e.g., writing, coloring, or painting)

represented 42% of the total fine motor time in kindergarten, but only 10% in Head Start. Children spend almost half of their day engaged in fine motor activities, yet little attention is paid to these tasks in research and teacher training.

The link between fine motor skills and handwriting is obvious, but researchers have struggled to identify the motor components that play a crucial role. For example, the method of holding a pencil (pencil grasp) was assumed to be linked to the quality of handwriting, but has only been supported in one study of first graders (Schneck, 1991). Other studies have found that the pattern of grasp does not have a significant effect on handwriting legibility (Bergmann, 1990; Burton & Dancisak, 2000; Dennis & Swinth, 1999; Roston, Hinojosa, & Kaplan, 2008; Ziviani & Wallen, 2006; Ziviani & Wilkins, 1986).

Research on handwriting skills, especially factors that predict legibility, appears frequently in the literature for students in primary grades (grades 1-3). Simner (1982) studied printing errors by kindergarteners. Students were shown flashcards of alphabet letters and numbers and were asked to print, from memory, the letter or number immediately after seeing the flashcard. The student's performance was compared with teacher rank-ordering for each student's readiness on reading, phonics, language, and math skills. Findings indicated that the occurrence of form errors in students entering kindergarten related to academic performance at the end of kindergarten and throughout first grade. Graham, Struck, Santoro, and Berninger (2006) analyzed legibility based on handwriting lower-case alphabet letters from memory, copying letters from a passage, and composing text on topics that were provided. Using students in first and second grade, Graham and colleagues found motor program variables (e.g., adding extra strokes or missing strokes on letters) were a statistically significant contributor to predicting handwriting performance for copying tasks and

composing tasks. Students in the poor handwriting group were found to be more than twice as likely to produce letters that had extra strokes. Also their letters were smaller and had more variability in spacing within words and placing letters on a line when compared to students in the good handwriting group. Poor handwriters have difficulty automatically producing legible letters and words that can be read by the teacher, resulting in lower grades and poorer academic performance.

In-hand manipulation skills. The term “in-hand manipulation” entered into the literature based on research by Exner (1989), who used this term to define the movement of an object within a person’s hand. Exner outlined three different types of in-hand manipulation skills essential to refined, skilled fine motor tasks: *translation* (moving object from palm to finger); *shift* (moving objects along the surface of the fingers or among the fingers); and *rotation* (turning objects around). When people use one hand to pick up several coins from the table and move the coins into their palm, they are using finger-to-palm translation skills. When they move the coins to their fingertips to place the coins in a vending machine, they are using palm-to-finger translation skills. Shift skills are movements that occur at the fingertips such as turning the pages in a book or readjusting the pencil for a better grip. Flipping a pencil over to use the eraser is an example of rotation skills. If an object is already in a person’s hand, then that object has to be stabilized for the other movements to occur (stabilization). Development of these skills occurs during early childhood. Generally, the in-hand manipulation skills of translation and rotation can be observed in children before 4 years of age as they perform fine motor tasks with smooth dexterity and make small adjustments in their hands to enhance their performance. This is observed as preschoolers use one hand to rotate a pencil to use the eraser or make fine

adjustments to their crayon grasp in order to trace along a line or form a letter. These in-hand manipulation skills should be present and observable in kindergarteners.

Comparing preschool children who were typically developing with a matched sample of children with fine motor delays, Case-Smith (1993) found that children with fine motor delays were slower and less efficient at in-hand manipulation skills than typically developing children. Children with fine motor delays needed more time, dropped the objects more frequently, and required external stability (e.g., surface of table) to complete the task of placing the pegs into the pegboard. This lack of dexterity interferes with writing or drawing tasks, controlling the pencil when writing, rotating the pencil to erase, and performing smoothly (Case-Smith, 1993; Exner, 2005). Pehoski, Henderson, and Tickle-Degnen, (1997) found no significant difference between boys and girls on their performance on in-hand manipulation tests.

Cornhill and Case-Smith (1996) investigated translation skills and the rotation skills of first graders that were separated into poor and good handwriters based on teacher identification. Findings indicated that the relationships between in-hand manipulation (e.g., rotation skills and translation skills) and the writing test were statistically significant. Translation skills explained most of the variance in children's handwriting scores, compared to other handwriting skills. Precise control of fingers and hand (e.g., in-hand manipulation) appears to be highly associated with letter formation. A predictive relationship between fine motor deficits and poor in-hand manipulation was found in young children (Breslin & Exner, 1999).

Visual-Motor and Visual Perceptual Skills

Studies have found that elementary students spend 30-60% of the school day engaged in reading, writing, and other tasks requiring near-point vision (McHale & Cermak, 1992; Ritty, Solan, & Cool, 1993). Visual-motor and visual-perceptual skills are used in nearly all aspects of daily life. Visual-motor integration is an individual's motor ability to reproduce symbols, such as copying geometric shapes, alphabet letters, or numbers. Visual perception is a non-motor process of organizing and interpreting visual information, such as noticing the differences between similar forms or identifying a form from a busy background.

Visual-motor skills. Integration of motor and visual skills is critical for performing complex tasks such as copying letters, symbols or geometric shapes. The student must be able to use visual and motor skills to reconstruct letters to form his name or a word. The *BeeryTM Visual Motor Integration* (VMI; Beery & Beery, 2006) is one of the most commonly used tests for visual-motor skills. Regression models have shown that scores on the VMI significantly correlated with legibility and speed in students in grades 1 through 9 (Cornhill & Case-Smith, 1996; Maeland, 1992; Tseng & Murray, 1994; Weintraub & Graham, 2000) and copying alphabet letters (Weil & Amundson, 1994). Other studies have indicated that the ability to copy the first nine forms of the VMI indicates readiness for formal writing instruction (Benbow, Hanft, & Marsh, 1992; Oliver, 1990; Weil & Amundson, 1994). The first nine forms of the VMI include a vertical line, a horizontal line, a circle, a cross, a square, a left diagonal line, a right diagonal line, a triangle, and an oblique cross (e.g., X).

Visual perceptual skills. Being able to process visual stimuli is also important in writing. A "b" and a "d" are visually different and require individuals to process this

difference before writing or reading the letter. A study of first and second graders' writing identified visual-spatial elements of writing as space between words, space within words (e.g., space between the letters in a word), and alignment of the letters to the baseline. The study found that poor handwriters had more variability with these visual-spatial aspects of writing than did the good handwriters (Graham, Struck, Santoro & Berninger, 2006).

A variety of tests have been used to measure visual-perceptual skills. Tseng and Murray (1994) used the VMI, the Test of Visual Perceptual Skills (TVPS; Gardner, 1982), and a writing measure (e.g., copying a paragraph from their textbook) in a study of students in the third, fourth and fifth grades. A significant difference was found between students who had been identified by their teachers as good handwriters and those that were identified as poor handwriters. When comparing the difference in mean scores for poor and good handwriters, their performance on the VMI and TVPS was very significant. Tseng and Murray found that the VMI and the TVPS correlated significantly with handwriting legibility. The step-wise multiple regression of the total sample indicated that the VMI accounted for 30.5% of the variance. Step-wise multiple regression using scores from the group of good handwriters indicated that the best and only significant predictor of legibility scores was visual perception (TVPS measure).

Summary

Few studies have been conducted to investigate kindergarten handwriting and the relationship with early reading measures. Phonological awareness, phonemic awareness and alphabetic principle have been linked to reading skills in children of various ages, from preschool to middle school; however, few studies included the link to handwriting skills among kindergartners. Cain (2007) found kindergartners who were more proficient in

phoneme/grapheme correspondence skills were more likely to write at a higher developmental level (as measured during independent writing time). Ritchey (2006, 2008) found a significant correlation between kindergarten alphabet writing and spelling on a piloted writing measure and DIBELS.

For this study, DIBELS was chosen as the measure of reading skills since it is standardized and widely used. While instruction in letter or name writing may not be provided consistently in kindergarten classrooms across the United States, students are expected to be able to write their name, alphabet letters, and compose simple sentences. Dictation was chosen over copying because dictation requires the student to recall the form and the steps to write the form from memory. Studies found correlations to be stronger with letter naming and writing letters when dictation rather than copying was used (Molfese, Beswick, Molnar, & Jacobi-Vessels, 2006; Ritchey, 2006). To gather data on isolated letter formation, legibility and speed, dictation was chosen instead of sequential alphabet writing since sequential would allow the student could use the alphabet song to help with letter memory. Since name writing had been identified as an indicator of early literacy (NELP, 2008) and is a kindergarten expectation (Snow, Burns, & Griffin, 1998), a name writing measure of first and last name was also included. Research indicated that poor in-hand manipulation skills impede writing tasks and were predictive in fine motor delays (Case-Smith, 1993; Cornhill & Case-Smith, 1996; Exner, 2005). The Test of In-Hand Manipulation-Revised (TIHM-R; Pont, Wallen, Bundy, & Case-Smith, 2008) is the only published test that provides information specifically on in-hand manipulation. The VMI (Beery and Berry, 2006) is a standardized test with two supplemental standardized tests, Visual Perception and Motor Coordination. The VMI was chosen because it was found to significantly correlate

with legibility in students in grades 1-9 (Cornhill & Case-Smith, 1996; Maeland, 1992; Tseng & Murray, 1994; Weintraub & Graham, 2000) and indicate a readiness for formal handwriting instruction (Benbow, Hanft, & Marsh, 1992; Weil & Amundson, 1994).

CHAPTER 3. METHODS AND PROCEDURES

Method

Participants

The study sample consisted of 48 kindergarten students recruited from a public school district in central Iowa. This school district was chosen to control for variables that have been shown to be predictive of poor literacy skills, such as low socio-economic status and mother's educational level (Baydar, Brooke-Gunn, & Furstenberg, 1993). Data gathered through correspondence with the school administrators (personal communication, 2010) indicates this school district has 2.4% of students enrolled in free lunch program and 12.4% English Language Learners (ELL). In addition, the graduation rate for this district is approximately 99%, indicating a strong education and community partnership. This district also collected district-wide reading data on kindergarteners three times a year using the Dynamic Indicators for Basic Early Literacy Skills (DIBELS; Good & Kaminiski, 2002). The mid-year DIBELS scores were provided by the school district after the testing was completed in January. Student names had been removed by the school district; for identifying purposes, codes were listed next to the individual's tests scores. The DIBELS software program generates a recommendation based on the student's score on three measures (i.e., Letter Naming Fluency, Initial Sound Fluency, and Phoneme Segmentation Fluency). The DIBELS' mid-year instructional recommendation was used to recruit kindergarten students rather the score from an individual test since the DIBELS' recommendation used multiple scores.

All 87 kindergarteners recommended for further intervention (e.g., strategic and intensive instruction) were included in the recruitment for Group 1 (At-Risk) (see Figure 1).

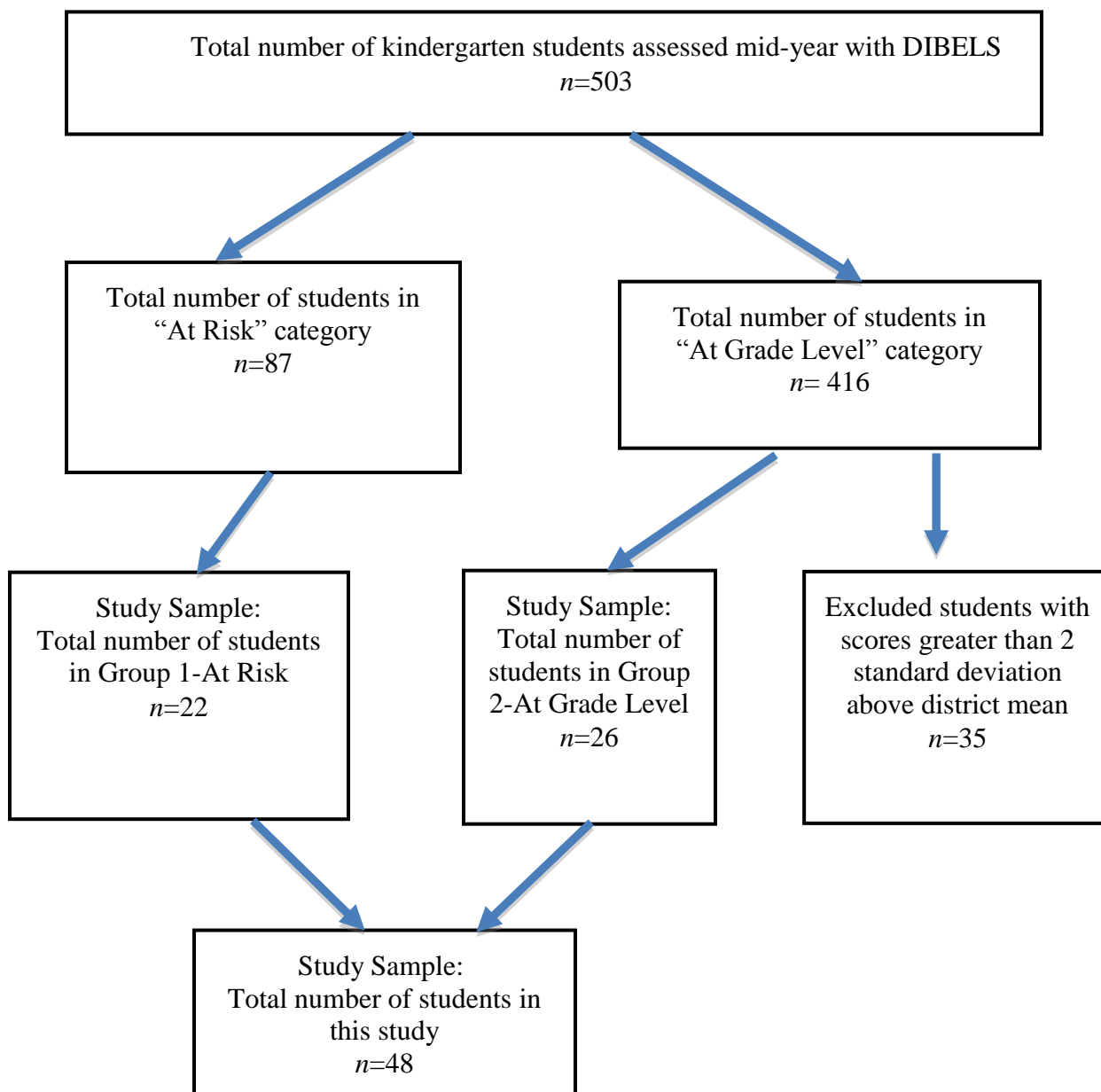


Figure 1. Flow Chart of the Participants Chosen During Recruitment Process. The kindergarteners' scores on the DIBELS determined their instructional recommendation category. Participants for this study were recruited from these two categories, excluding students considered outliers (e.g., scores greater than 2 standard deviations above the district mean).

Eighty students were included in the recruitment for Group 2 (At Grade Level) from the remaining almost five hundred students, matching for gender, elementary building, and, when possible, by school kindergarten teachers. Recruitment began in February and continued through April due to low responses. Students were excluded from the study if a known physical disability prevented them from effectively holding a pencil to write, a known cognitive disability affected their ability to complete reading or writing tasks, or they were unable to follow commands in the English language. Students were excluded from Group 2 if their score on any individual test was below the district's kindergarten mean score for that test or if their score was at or greater than 2 standard deviations above the district's kindergarten mean score for that test (considered to be an outlier).

There were 28 male kindergarteners and 20 female kindergarteners participating in the study. Students were between 68 months and 82 months at the time of the study with an average age of 74.23 months. Student demographics were gathered through a parent survey. Parents completed a one-page questionnaire (see Appendix A for a copy of the survey) and returned the form by mail (96 % return). Two forms were not returned, one from a student in Group 1, the second was from a student in Group 2, so the birthdates for these students were obtained from the school personnel. Results are presented on Table 1. Data from the surveys returned indicated almost 92% of the kindergarten students lived with their biological mothers while 85% of the mothers indicated having some college experience or a college degree. Forty-two students (87.5%) had a preschool or childcare experience prior to attending kindergarten, 27 students (56.2%) had been in pre-kindergarten (e.g., a full-day school district program for children who are kindergarten-age but not developmentally ready for

Table 1

Means, Standard Deviations, and Percents for Child Demographic Variables from the Parent Survey

Variables	<i>n</i>	%	<i>M</i>	<i>SD</i>
Age (months)	48		74.23	4.23
Gender				
Male	28	58.3		
Female	20	41.7		
Lives with biological mother				
Yes	44	91.6		
No	2	4.2		
Missing	2	4.2		
Mothers' highest level of education				
Less than high school	2	4.2		
High school/GED	2	4.2		
Some college/college degree	41	85.4		
Missing/unknown	3	6.2		
Lived in district for at least two years				
Yes	40	83.3		
No	6	12.5		
Missing	2	4.2		
Attended preschool/childcare for at least one school year				
Yes	42	87.5		
No	4	8.3		
Missing	2	4.2		

Table 1. (continued)

Variables	<i>n</i>	%	<i>M</i>	<i>SD</i>
Attended Pre-kindergarten in previous year				
Yes	27	56.2		
No	19	39.6		
Missing	2	4.2		
Attended kindergarten before this year				
Yes	3	6.2		
No	43	89.6		
Missing	2	4.2		
Had vision tested by optometrist or physician				
Yes	39	81.2		
No	7	14.6		
Missing	2	4.2		
Has known vision or hearing concerns				
Yes	4	8.3		
No	42	87.5		
Missing	2	4.2		

kindergarten) and three students were repeating kindergarten (6.2%). Data collected indicated four students had known vision or hearing concerns (8.3%). Boys comprised 58.3 % of the study, 72.7 % of Group 1 and 46.2% of Group 2. All five of the community school district's elementary schools were represented with kindergarteners from 17 of the 24 kindergarten classrooms (70%) included in this study.

The kindergarten teacher for each student in the study was recruited to provide information about the class size, teaching history and experience, classroom writing instruction and writing time, and student information. A total of 17 teachers (100%) completed a one-page questionnaire (Appendix B). Data presented in Table 2 indicated the

Table 2

Means, Standard Deviations, and Percents for Variables from the Teacher Survey

Variable	<i>n</i>	%	<i>M</i>	<i>SD</i>
Class size	17		24.6	1.0
Years as a licensed teacher				
0-3 years	2	11.8		
4-10 years	7	41.2		
10+ years	8	47.0		
Years as a kindergarten teacher				
0-3 years	5	29.4		
4-10 years	7	41.2		
10+ years	5	29.4		
Educational degree				
Bachelors	13	76.5		
Masters	4	23.5		
Additional Teaching Endorsements				
None	2	11.8		
One	6	35.3		
Two	6	35.3		
Three	3	17.6		

Table 2 (continued)

Variable	<i>n</i>	%	<i>M</i>	<i>SD</i>
Formal training in handwriting				
Yes	8	47.1		
No	9	52.9		
Handwriting as a separate subject				
Yes	16	94.1		
No	1	5.9		
Writing Instruction (minutes/week) for First Semester				
0-20 minutes	7	41.1		
21-49 minutes	10	58.8		
Writing Instruction (minutes/week) for Second Semester				
0-20 minutes	11	64.7		
21-49 minutes	6	35.3		
Time spent in writing (minutes/week) for First Semester				
0-20 minutes	1	5.9		
21-49 minutes	4	23.5		
50+ minutes	12	70.6		
Time spent in writing (minutes/week) for Second Semester				
0-20 minutes	0	0.0		
21-49 minutes	4	23.5		
50+ minutes	13	76.5		

class mean was 24.6 students, which was similar across the district. Most teachers had a bachelor's degree (76.5%), taught kindergarten for 4-10 years (41.2%) and worked as a teacher for over 10 years (47%). While teachers stated handwriting was taught as a separate subject in 16 of the 17 classrooms (94.1%), over half of the teachers did not have formal training in handwriting (52.9%). This school district used the Zaner-Bloser Handwriting curriculum (Zaner-Bloser, 2008) that teaches upper and lower case letters together in each lesson. During the first semester 59% of the teachers provided 21-49 minutes per week of handwriting instruction while 41% of the teachers provided 0-20 minutes of handwriting instruction. Teachers completed the instruction of upper and lower case letters by mid-November. The number of students participating in the study per teacher ranged from one to six students with 60% of the teachers having two or three students from their class who participated since recruitment attempts were made to match students from each group by teachers, when possible.

Design and Procedure

Informed consent was obtained from the parents during the recruitment phase; informed consent from the teachers was obtained during the student evaluation phase. Child assent was obtained before measures were administered. The Iowa State University Institutional Review Board approved all materials and procedures for this study. The school district participating in this study also approved the materials and procedures for this study. Each student was seen once at his or her elementary school for a battery of tests. The principal investigator collected all data during three weeks in April and scored all assessments. Evaluations were scheduled during the school day. The students were evaluated outside of the classroom at a hallway table typically used as a student or volunteer work area.

Measures

Parent demographic survey. After the informed consents were collected from the parents and student data were collected, a one-page survey of demographic questions was sent home to parents (see Appendix A). These data were used to identify differences between the groups of students in terms of family or education characteristics. Questions included if the child lived with biological mother, the mother's education level, child's preschool history, known vision or hearing concerns, and child's birthdate. These data were reported in an earlier section and presented in Table 1.

Teacher demographic survey. Teachers were asked to complete a one-page survey of demographic questions (see Appendix B for the complete survey). These data were used to identify differences between the teachers and to compare teacher knowledge of the child with student data. The three sections of the Teacher Survey included: (1) information about degree, endorsements, teaching experience, (2) knowledge about instruction and curriculum, (3) information about the student (e.g., receives writing assistance, rating of student's writing). These data were reported in an earlier section and presented in Table 2.

DIBELS measures. The purpose of the Dynamic Indicators of Basic Early Literacy (DIBELS; Good & Kaminiski, 2002), a standardized and individually administered measure, is to assess the early literacy foundational skills related to reading outcomes identified from the National Reading Panel report (National Institute of Child Health and Human Development, 2000) and the National Research Council (1998). The DIBELS focuses on three of these foundational skills: phonological awareness, alphabetic principle, and fluency with connected text. The DIBELS is norm-referenced and used nation-wide to screen students at risk for developing these early literacy foundational skills.

Classroom teachers administered four measures from the DIBELS during January 2010. These measures included: Letter Naming Fluency-LNF, Initial Sounds Fluency (ISF), Phoneme Segmentation Fluency (PSF), and Nonsense Word Fluency (NWF). LNF measures the number of upper and lower case alphabet letters that the student verbally identifies correctly in one minute. ISF measures phonological awareness, the student's skill at identifying and orally producing the initial sounds of a presented word. PSF measures the phonological awareness, the student's ability to segment three and four phoneme words. NWF assess the alphabetic principle of letter-sound correspondence.

Measures Used to Assess Student Handwriting Performance

Each student was given six measures by this examiner. Measures were administered to every student in the following order: Alphabet Writing Test, Name Writing Test, Test of In-Hand Manipulation-Revised, BeeryTM Visual-Motor Integration, Visual Perceptual Test, and Motor Coordination Test. Testing lasted approximately 20-30 minutes. Detailed descriptions of each of these measures are included in this section.

Alphabet writing test. For this writing task, each student was given a new short pencil (approximately 4" pencil) and a piece of paper. Directions were standardized to increase consistency (see Appendix C for complete directions). To prevent bias, random sampling was used to determine the sequence of the upper and lower case letters. Twenty-six slips of paper, each with one alphabet letter on it, were placed in a box and then randomly drawn from the container. The sequence that the letters were drawn was recorded. The process was repeated for lower case letters. Alphabet letters were dictated to each student and the speed of writing was recorded on the data sheet (see Appendix D for the data collection form).

There is little information in the literature about the type of paper that is better for handwriting. Different handwriting curricula use different size lines or boxes and a different number of lines for their paper. Waggoner, LaNunzia, Hill, and Cooper (1981) found suburban kindergarten and first-grade students produced more accurate letter strokes on large-spaced paper (2.2cm; 0.86 inches) as compared to normal-space paper (1.1 cm; 0.43 inches). Writing paper found commercially for kindergarten students was oriented horizontally (landscape) with top and bottom lines that were 1" apart or $\frac{3}{4}$ " apart and a $\frac{1}{2}$ " space between the sets of writing lines (making it 1.25" apart). The Print Tool (Olsen, 2006) used five lines spaced 1.5" apart for kindergarten to second grade writers. To avoid line confusion with the various curricula, paper was designed for this study that only used a bottom line. Distance between the lines was set at 1.25" since this seemed more consistent with various writing paper used in kindergarten programs (see Appendix E for sample of the writing paper). The paper was printed double-sided for this study.

As an occupational therapist, this author was involved in the development of a state-wide screening tool for handwriting (Clark, 2005). The Alphabet Writing measure uses similar scoring criteria. In addition, this author obtained HWT Level I Certification (offered by Handwriting Without Tears, Inc.) by completing a multiple choice test about handwriting, scoring two *The Print Tool*TM student packets, completing remediation worksheets, and writing a report on these case studies. This process was completed to enhance systematic scoring of the writing measures used in this study.

Each upper or lower case letter was scored either a 0 or 1 for accuracy. To obtain a score of 1, a letter met all five of the following criteria: (a) letter written matches the letter dictated (no substitutions for upper and lower case forms except letters c, o, s, u, v, w, x, and

z); (b) lower case letters g, j, p, q, y, must extend below the bottom line; (c) letter does not have any over-tracing or gaps larger than $1/16''$; (d) letter is oriented in the correct direction (no reversals); and (e) letter is recognizable out of context. Students receive an upper case accuracy score, a lower case accuracy score and a total accuracy score (sum of upper and lower case accuracy scores).

The speed score was collected as the student wrote the letter. Timing began after the examiner said the letter and stopped when the student finished writing the letter. Initially scoring was going to be completed by adding the amount of time each student required to complete each letter; however, a score of 0 seconds for letters skipped would have provided students who frequently skipped letters a better score than students who wrote each letter. A scoring rubric was developed to systematically score all letters (e.g., skipping a letter would result in a 0 score rather than 0 seconds). The scoring rubric ranged from 0 to 4 based on the number of seconds a student requires for writing. Scores include: (0) letter was skipped or omitted; (1) more than 10 seconds needed to write the letter; (2) letter written between 6-10 seconds; (3) letter written between 3-5 seconds; and (4) letter written between 1-2 seconds. Students received an upper case speed score, a lower case speed score and a total score for speed (see Appendix C for scoring directions).

Name writing test. The purpose of this test was to assess the students' skill at writing their first and last name. Paper with only a bottom line was used since students typically write their name on the top line of their paper, which provides them with a baseline. The paper that was used in Alphabet Writing Test was also used here. Sulzby, Barnhart, and Hieshima (1989) developed a scoring measure for kindergarten writing that was modified and used by Molfese, Beswick, Molnar and Jacobi-Vessels (2006) for a preschool study. This

scale was reviewed; however, the scale appeared more appropriate for preschoolers than kindergarteners. A new scoring rubric was designed based on the constructs of the above studies, e.g., the number of letters written and formation of letters, and was reviewed by several kindergarten teachers for face validity (see Appendix C for the scoring rubric). The scoring rubric included three items that were scored as follows:

- Number of letters written: (0) refused, (1) wrote first letter of name; (2) wrote more than the first letter of name; (3) wrote all letters of name.
- Formation of letters: (0) did not form all letters of name —score as a 0 for this item; (1) Poor formation. Letters could be mistaken for another letter or number, mark-overs, reversals or gaps greater than $1/16$ "; (2) Fair formation. At least 50% of letters formed similar to curriculum, may have some gaps or over-strokes greater than $1/16$ "; (3) Good formation. 100% of letters were formed according to curriculum with no over-tracing or gaps larger than $1/16$ ". If lower case letters (g, j, p, q, y) are used, there must be a tail below the baseline.
- Recognizable out of context: (0) did not form all letters of name in sequential order—score as a 0 for this item; (1) less than 50% of all letters are recognizable out of context; (2) at least 50% of the letters are recognizable out of context; (3) all letters are clearly recognizable out of context. If lower case letters (g, j, p, q, y) are used, there must be a tail below the baseline.

Students received three scores, first name score (ranging 0-9), last name score (ranging 0-9), and a total name score (ranging 0-18). The total name score was used in this study.

Test of in-hand manipulation-revised. The Test of In-Hand Manipulation-Revised (TIHM-R; Pont, Wallen, Bundy and Case-Smith, 2008) was used to assess each student's fine motor dexterity, specifically the ability to manipulate objects within the dominant hand (in-hand manipulation). The TIHM-R measures two types of in-hand manipulation skills, *translation with stabilization* (e.g., picking up objects, holding them in the palm, then replacing them) and *rotation* (e.g., picking up objects, turning them over, then replacing them). The use of the non-dominant hand or external surface support (considered a stabilization) are considered errors and points are deducted. The student's dominant hand was determined by observation during the preceding writing tasks. Results include scores for performance, pegs dropped and the number of times a student uses external stabilization. The examiner was trained in the administration and scoring of this test by the primary test developer and achieved interrater reliability of 98%.

BeeryTM Visual-Motor Integration and supplemental tests. The VMI (Beery & Beery, 2006) requires students to copy geometric designs from models presented in the booklet. The supplemental tests, Visual Perception and the Motor Coordination, contain the same geometric forms using in the VMI and assess the students' visual and motor performance. The Visual Perception test requires the student to point to the form that is the same as the form in the stimulus box. The Motor Coordination test requires the student to draw a line around a geometric shape, staying within the boundary lines. The VMI short form (15 geometric forms) was used for this study since it was designed for children ages 2-7 years. Scoring criteria is provided for each of the items. The VMI has a maximum of 21 points. The supplemental tests each contain 30 items (maximum 30 points each).

Summary

Students for this study were recruited based on their scores on the DIBELS kindergarten reading measures administered mid-year by the school district. This study includes survey measures for parents and teachers as well as specific measures for kindergarteners to assess skills of writing, fine motor coordination (e.g., in-hand manipulation) skills, visual-motor and visual perception skills. The writing measures included alphabet letter (upper and lower case) and name writing (first and last name). The relationships among these variables were analyzed and reported in the next section.

CHAPTER 4. RESULTS

Results

This study investigated relationships between reading and writing skills among kindergarten children. SPSS 18.0 (SPSS, 2009) was used for all statistical analysis. This study included students whose performance on the Dynamic Indicator of Basic Early Literacy Skills (DIBELS; Good and Kaminiski, 2002) ranged from very low to average. Excluding the above average students from the study controlled for outliers in kindergarteners who performed at least two standard deviations above district average; therefore, this sample was not expected to fall within a normal distribution. As predicted, skewness and kurtosis values for student demographics were outside of the expected distribution range. Skewness values ranged from -3 to 4 (values between ± 2.0 are acceptable for most purposes); kurtosis values were especially high on three demographic questions where the student's backgrounds were nearly identical. These values ranged from 2 to 11 (values between ± 2.0 are acceptable for most purposes). Descriptive statistical tests were employed to examine the differences between student demographics of Group 1 (At Risk) and Group 2 (At Grade Level) and are presented in Table 3. Independent *t tests* were used for scale or ordinal variables; Chi-square statistics were used for nominal variables (e.g., gender, lives with biological mother, passed school's vision screening). To test for association of these variables during chi-square statistics, the Cramer's V (Cramer, 1999) and Fisher's Exact Test (Fisher, 1954) were run. Cramer's V measures the strength of association and falls between 0 and 1. None of the measures were significant, indicating the variables were independent. Since some of the counts in the cells were small, the Fisher's Exact Test

Table 3

Means, Standard Deviations, and Percents for Child Demographic Variables from the Parent Survey for Group 1 and Group 2

Variable	Group 1-At Risk (n = 21)				Group 2- At Grade Level (n = 25)				Test Statistic
	n	%	M	SD	n	%	M	SD	
Age (months)	22		74.3	4.5	26		74.19	4.07	$t(46) = 0.07$
Gender									$\chi^2(1) = 3.46$
Males	16	72.7			12	46.2			
Females	6	27.3			14	53.8			
Lives with biological mother									$\chi^2(1) = 2.49$
Yes	19	90.5			25	100.0			
No	2	9.5			0	0.0			
Mothers highest level of education									$\chi^2(3) = 6.68$
Less than high school	2	9.5			0	0.0			
High school/GED	2	9.5			0	0.0			
Some college/college degree	16	76.2			25	100.0			
Unknown	1	4.8			0	0.0			
Lived in district for at least two years									$\chi^2(1) = 1.23$
Yes	17	81.0			23	92.0			
No	4	19.0			2	8.0			

Table 3 (continued)

Variable	Group 1-At Risk (<i>n</i> = 21)				Group 2- At Grade Level (<i>n</i> = 25)			Test Statistic
	<i>n</i>	%	<i>M</i>	<i>SD</i>	<i>n</i>	%	<i>M</i>	<i>SD</i>
Attended preschool or childcare for at least a year								$\chi^2(1) = 0.03$
Yes	19	90.5			23	92.0		
No	2	9.5			2	8.0		
Attended Pre-kindergarten in previous year								$\chi^2(1) = 0.04$
Yes	12	57.1			15	60.0		
No	9	42.9			10	40.0		
Attended kindergarten before this year								$\chi^2(41) = 0.57$
Yes	2	9.5			1	4.0		
No	19	90.5			24	96.0		
Had vision tested by optometrist or physician								$\chi^2(1) = 0.03$
Yes	18	85.7			21	84.0		
No	3	14.3			4	16.0		
Has known vision or hearing concerns								$\chi^2(1) = 1.52$
Yes	3	14.3			1	4.0		
No	18	85.7			24	90.0		

Note. **p* < .05. ***p* < .01.

□

was used to look at difference in association. Small p values indicated the variables were different. Data provided by the teachers were not found to be statistically significant. Results indicate students in Group 1 received significantly more assistance in writing than students in Group 2, $\chi^2(1) = 12.13, p < .001$. Teacher's rating of difference was found between the groups indicating students had similar backgrounds. Table 4 presents descriptive statistics

Table 4

Means, Percentiles, and Tests Statistics from the Teacher Survey for Group 1 and Group 2

Variable	Group 1		Group 2		Test Statistic
	At Risk		At Grade Level		
	(n = 22)		(n = 26)		
	n	%	n	%	
Passed school’s vision screening					$\chi^2(2) = 1.23$
Not screened	1	4.5	1	3.8	
Passed	20	90.9	25	96.2	
Failed	1	4.6	0	0.0	
Received extra help in writing					$\chi^2(1) = 12.13^{***}$
Yes	13	59.1	3	11.5	
No	9	40.9	23	88.5	
Teacher’s rating of writing					$t(46) = -7.70^{***}$
1-performs much below peers	10	45.5	0	0.0	
2-performs somewhat below	7	31.8	2	7.7	
Peers					
3-performs similar to peers	5	22.7	12	46.2	
4-performs above most peers	0	0.0	12	46.2	

Note. * $p < .05$. ** $p < .01$. *** $p < .001$

and statistical tests for student writing skills which were significantly lower for students in Group 1 than students in Group 2, $t(46) = -7.701, p < .001$.

Relationship Between Reading and Handwriting Skills

Research Question 1. What is the relationship between reading and handwriting skills in kindergarteners during their second semester? Correlational analyses were used to examine relationships among the measures and data are presented in Table 5. Results show that there are significant correlations between writing scores (e.g., letters and name writing) and reading scores on the DIBELS. The Alphabet Writing Test (accuracy score) correlated positively and significantly with DIBELS Initial Sound Fluency-ISF ($r = .726, p < .01$), Letter Naming Fluency-LNF ($r = .676, p < .01$), Phoneme Segmentation Fluency-PSF ($r = .600, p < .01$), and Nonsense Word Fluency-NWF ($r = .633, p < .01$). The ability to accurately write letters of the alphabet was significantly correlated to all four mid-year kindergarten DIBELS measures. The high significant positive correlations suggest that if students score poorly on the DIBELS, they tend to score poorly on the writing measures.

Significant relationships were found between Name Writing (first and last name score) and ISF ($r = .638, p < .01$), LNF ($r = .638, p < .01$), PSF ($r = .505, p < .01$) and NWF ($r = .570, p < .01$). The ability to write the first and last name appears to be highly correlated with LNF and ISF, which assess knowing letter names and sounds. Students who knew the alphabet letters and initial word sounds performed better on name writing tasks.

The relationship between DIBELS scores and writing the alphabet letters quickly was statistically significant. The speed of writing the letters was not significantly correlated with name writing, fine motor, VMI, or any supplemental tests. Alphabet Writing speed score

Table 5

Correlations among Writing, Visual-Motor, Fine Motor, and Reading Performance

	1	2	3	4	5	6	7	8	9	10	11
DIBELS Measures											
1. Initial sound fluency	1.0										
2. Letter naming fluency	.842**	1.0									
3. Phoneme segmentation fluency	.845**	.797**	1.0								
4. Nonsense word fluency	.811**	.872**	.807**	1.0							
Writing Measures											
5. Alphabet Writing Test- Total accuracy score	.726**	.676**	.600**	.633**	1.0						
6. Alphabet Writing Test- Total speed score	.357*	.510**	.386**	.495**	.310*	1.0					
7. Name Writing Test- Total name score	.638**	.638**	.505**	.570**	.764**	.215	1.0				
Fine -Motor Measure											
8. THM-R ¹	.329*	.410**	.458**	.329*	.425**	.219	.454**	1.0			
Visual Motor Measures											
9. Beery TM VMI ²	.465**	.529**	.465**	.453**	.534**	.164	.561**	.346*	1.0		
10. Visual Perception	.387**	.292*	.385**	.373**	.263	.240	.171	.322*	.089	1.0	
11. Motor Coordination	.361*	.353*	.357*	.374**	.514**	.066	.608**	.586**	.435**	.274	1.0

Note. ¹T-IHM = Test of In-Hand Manipulation; ²Beery VMI = Beery Visual Motor Integration Test* $p < .05$. ** $p < .01$.

(upper and lower case) significantly correlated with ISF ($r = .357, p < .05$), LNF ($r = .510, p < .01$), PSF ($r = .386, p < .01$) and NWF ($r = .495, p < .01$). The relationship between writing speed and the ISF was less than LNF, suggesting the name of the letter may be more important than the initial sound when kindergarteners are writing letters from dictation.

The fine motor and visual-motor measures were significantly correlated with the writing measures and all of the DIBELS reading measures. The Test of In-Hand Manipulation-Revised (TIHM-R), a measure of dexterity and coordination, was significantly correlated with Alphabet Writing accuracy ($r = .425, p < .01$) and Name Writing ($r = .454, p < .01$). A significant relationship was evident between Motor Coordination test, a paper-pencil measure of visual-motor coordination, and Name Writing ($r = .608, p < .01$), TIHM-R ($r = .586, p < .01$), Alphabet Writing (accuracy score) ($r = .514, p < .01$), and the BeeryTM Visual Motor Integration Test ($r = .435, p < .01$). The results indicate there are positive and significant correlation among writing, reading, fine motor and some visual-motor measures in kindergarten students by mid-year.

Writing Upper and Lower Case Letters

Research Question 2. By second semester, are students in kindergarten more accurate and faster when writing upper or lower case letters? Paired-sample t tests were run to examine student's scores on writing upper case letters and scores on writing lower case scores. Paired-sample t test results show Alphabet Writing Test accuracy score (e.g., number of letters scored as correct) for upper case letters was significant as compared to lower case letters, $t(47) = 8.69, p < .001$ (see Table 6). This suggests that kindergarteners at mid-year are significantly more skilled at writing upper case letters of the alphabet than lower case letters. A second paired-sample t test compared writing speed for upper case and lower case letters.

There was no significant difference, $t(47) = -1.739$, $p = .089$ between students' speed in writing upper and lower case letters.

Table 6

Statistical Tests Comparing Alphabet Writing Test's Upper and Lower Case Letters

Variables	M	SD	Test Statistic
Upper case accuracy-lower case accuracy	4.40	3.51	$t(47) = 8.69^{***}$
Upper case speed-lower case speed	-2.06	8.22	$t(47) = -1.74$

Note. $***p < .001$

Performance by Students in Group 1 (At Risk) and Group 2 (At Grade Level)

Research Question 3. Are there differences in performance between students in Group 1 (At Risk) and Group 2 (At Grade Level) on writing, fine motor, and visual-motor measures? Based on their performance on the district's mid-year kindergarten DIBELS reading measures, students who were recommended for strategic or intensive intervention were placed in Group 1 (At Risk) while students who were at grade-level were placed in Group 2 (At Grade Level). Independent t tests were run to compare the means of students in Group 1 with students in Group 2 on writing, fine motor and visual-motor measures (see Table 7). Levene's test of Equality of Variances was significant for some results, indicating the variances differed significantly from each other, so the unequal variance t test was used. The equal-variance t test is statistically stronger and used whenever possible. Students in

Table 7

Means, Standard Deviations, and t tests for Measures

Variable	Full Sample (<i>n</i> = 48)		Group 1 At Risk (<i>n</i> = 22)		Group 2 At Grade Level (<i>n</i> = 26)		Test Statistic
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
DIBELS							
Initial Sound Fluency	28.44	14.56	14.91	8.66	39.88	6.20	<i>t</i> (37.3) = -11.30***
Letter Naming Fluency	39.13	20.47	19.73	11.23	55.54	8.41	<i>t</i> (46) = -12.62***
Phoneme Segmentation Fluency	33.02	19.65	15.00	12.65	48.27	7.98	<i>t</i> (34.3) = -10.67***
Nonsense Word Fluency	29.02	18.40	12.32	8.97	43.15	10.77	<i>t</i> (46) = -10.66***
Writing Measures							
Alphabet Writing Test (total accuracy)	35.35	10.04	28.64	9.64	41.04	6.18	<i>t</i> (34.6) = - 5.20***
Alphabet Writing Test (upper case accuracy)	20.00	5.49	17.00	6.30	22.54	2.96	<i>t</i> (28.7) = - 3.79***
Alphabet Writing Test (lower case accuracy)	15.60	5.06	12.09	4.23	18.58	3.60	<i>t</i> (46) = -5.74***
Alphabet Writing Test (total speed)	161.98	23.83	152.09	27.49	170.35	16.56	<i>t</i> (46) = -2.84**
Alphabet Writing Test (upper case speed)	79.87	10.93	76.45	13.14	82.77	7.79	<i>t</i> (46) = -2.06*

Table 7 (continued)

Variable	Full Sample (<i>n</i> = 48)		Group 1 At Risk (<i>n</i> = 22)		Group 2 At Grade Level (<i>n</i> = 26)		Test Statistic
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Alphabet Writing Test (lower case speed)	81.98	14.04	75.64	15.06	87.27	10.37	$t(46) = -3.16^{**}$
Name Writing Test (total score)	14.15	3.31	12.14	3.54	15.85	1.89	$t(30.87) = -4.42^{***}$
Name Writing Test (first name score)	7.52	1.38	6.86	1.52	8.08	0.98	$t(46) = -3.34^{**}$
Name Writing Test (last name score)	6.63	2.56	5.27	2.91	7.77	1.48	$t(29.9) = -3.64^{***}$
Fine-motor Measure							
Test of In-Hand Manipulation-Revised	51.88	8.24	48.64	8.80	54.62	6.75	$t(46) = -2.662^{*}$
Visual-Motor Measures							
Beery™ Visual Motor Integration (raw)	15.92	2.00	14.86	1.64	16.81	1.85	$t(46) = -3.811^{***}$
Visual Perception (raw)	19.21	3.21	18.27	3.18	20.00	3.09	$t(46) = -1.906$
Motor Coordination (raw)	14.96	2.52	14.05	3.11	15.73	1.56	$t(46) = -2.428^{*}$

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

□

Group 1 performed significantly lower than students in Group 2 on all measures, except the Visual Perception test. This test required students to identify the picture that matched the stimulus picture, requiring no fine motor or writing skills. Statistical differences between students in Group 1 and Group 2 on several measures, specifically DIBELS measures, Alphabet Writing accuracy, Name Writing Test, and VMI, was significant at $p < .001$. Since the groups were designed around the DIBELS measures, the difference between Group 1 and Group 2 performance on the DIBELS was expected. The significant difference between these two groups on the alphabet and name writing measures indicates a relationship between reading and writing skills. Students at risk for reading delays also scored low on the writing measures: Alphabet Writing Test (total accuracy score), $t(34.6) = -5.20, p < .001$; Alphabet Writing Test (total speed score), $t(46) = -2.84, p < .001$; and Name Writing Test, $t(30.87) = -4.42, p < .001$.

Performance on the Test of In-Hand Manipulation-Revised was significantly different between students in Group 1 and Group 2, $t(46) = -2.662, p = .011$. Students with reading delays (e.g., Groups 1) also demonstrated significantly lower fine motor coordination performance. Results found the two groups have a statistically significantly different score on the VMI, $t(46) = -3.811, p = .063$, than either of the supplemental tests, Visual Perception, $t(46) = -1.906, p < .01$, or Motor Coordination, $t(46) = -2.428, p = .010$.

Variables that Predict Name Writing and Letter Writing Skills

Research Question 4. Which pre-reading and visual-motor, and fine-motor skills predict name writing and letter writing skills for kindergarteners during their second semester? To answer this question, two multiple regression analyses were conducted to show the influence of several independent variables on the dependent variable letter writing and

the dependent variable name writing. Predictors for alphabet writing were investigated first. Minimal literature exists on predictors for kindergarten letter or name writing so formulating a theoretical model was not attempted; rather, age and the independent variables from this study's measures that were highly correlated with alphabet writing were used (e.g., all four DIBELS measures, name writing, in-hand manipulation skills, VMI, and the supplemental test, Motor Coordination. Based on the number of variables (11 test scores) and a limited sample size of only 48 students, choosing a limited number of independent variables was necessary. The Backward procedure (SPSS, 2009) was used because the program considers the nine variables entered (see Model 1 in Table 8) and removes one variable at a time. The program automatically removes independent variables that are significant at .10 or less (e.g., $p \leq .10$). Model 1, with all nine variables, significantly predicted alphabet writing performance, $R^2 = .74$, $F(9, 47) = 10.94$, $p < .001$. The subsequent models had one less variable but each was significant at $p < .001$. Variables were excluded in this order: VMI, DIBELS-Letter Naming Fluency, Motor Coordination, DIBELS-Phoneme Segmentation Fluency, DIBELS-Nonsense Word Fluency, and Test of In-Hand Manipulation. Model 7 was composed of the remaining three variables and was statistically significant. This model was the most parsimonious (i.e., had the least number of variables) for predicting alphabet writing, $R^2 = .71$, $F(3, 47) = 35.80$, $p < .001$. Name Writing Test (first and last name), Initial Sound Fluency, and age were significant predictors, accounting for 70.9% of the variance in student performance on the Alphabet Writing Test. The other models were significant but included additional variables without much additional explanation of variance.

Table 8

Predictors of Writing Alphabet Letters

Variable	Model 1 B	Model 2 B	Model 3 B	Model 4 B	Model 5 B	Model 6 B	Model 7 B
Constant	-35.266	-33.487	-30.929	-29.205	-27.327	-27.154	-24.887
Age	.471	.488*	.455*	.422*	.408*	.401*	.410*
Name Writing Test	1.429**	1.489***	1.429***	1.367***	1.434***	1.447***	1.530***
DIBELS-Initial Sound Fluency	.329*	.323*	.301*	.303*	.251*	.284***	.287***
Test of In-Hand Manipulation	.155	.153	.133	.110	.077	.081	
DIBELS-Nonsense Word Fluency	.098	.095	.063	.058	.035		
DIBELS-Phoneme Segmentation	-.073	-.067	-.067	-.063			
Fluency							
Motor Coordination	-.294	-.273	-.184				
DIBELS-Letter Naming Fluency	-.060	-.052					
Beery™ Visual Motor Integration	.272						
R^2	.721	.720	.718	.717	.714	.713	.709
F	10.938***	12.519***	14.556***	17.331***	20.994***	26.689***	35.803***
Adjusted R^2	.656	.662	.669	.676	.680	.686	.690
ΔR^2	.721	-.002	-.002	-.001	-.003	-.001	-.003
ΔF	10.938	.239	.229	.125	.433	.200	.520

Note. * $p < .05$. ** $p < .01$. *** $p < .001$

Since the independent variables were correlated with each other, indicators were used to check for multicollinearity. Multicollinearity occurs when independent variables become increasingly correlated with each other, thus the regression equation has less unique information to use in the prediction of the dependent variable (Cohen, Cohen, West, & Aiken, 2003). The variance inflation factor (VIF) of 10 or greater is commonly used as an indicator of serious multicollinearity. VIF scores for each of the variables used in this regression analysis indicate all scores were under 10. In Model 7, VIF scores ranged from 1.0 to 1.7. Tolerance is another measure of multicollinearity and scores of .10 or less indicate multicollinearity problems. Tolerance values for all independent variables were greater than .10, indicating multicollinearity was not a problem. Model 7 had tolerance scores of .6 to 1.0, which were within the expected range.

Multiple regression analysis was used to predict Name Writing (first and last name) for kindergarteners. Using a similar process to alphabet writing, age and measures that were correlated with name writing were used in the regression analysis, including all four DIBELS measures, alphabet writing, VMI, Motor Coordination. The Backward procedure was used for the regression analysis and is outlined in Table 9. Model 1, which included all eight variables, was a significant predictor of name writing, $R^2 = .74$, $F(8, 47) = 13.69$, $p < .001$. The subsequent models had one less variable but each was significant at $p < .001$. Variables were excluded in this order: DIBELS-Initial Sound Fluency, DIBELS-Nonsense Word Fluency, DIBELS-Phoneme Segmentation Fluency, and DIBELS-Letter Naming Fluency. Results indicate Model 5 significantly predicted Name Writing using only four variables, $R^2 = .71$, $F(4, 47) = 26.20$, $p < .001$. Age, Alphabet Writing Test (accuracy score), BeeryTM

Table 9

Predictors of Writing First and Last Name

Variable	Model 1	Model 2 B	Model 3	Model 4	Model 5
	B		B	B	B
Constant	-10.394	11.013*	10.243*	10.123*	10.108*
Age	-.174*	-.182*	-.169*	-.163**	-.176*
Alphabet Writing Test	.145**	.156***	.154***	.150***	.176***
Motor Coordination	.466***	.463***	.446**	.430**	.427**
Beery TM Visual Motor Integration	.227	.218	.229	.221	.281
DIBELS-Letter Naming Fluency	.052	.052	.052	.023	
DIBELS-Phoneme Segmentation Fluency	-.032	-.023	-.030		
DIBELS-Nonsense Word Fluency	-.027	-.026			
DIBELS-Initial Sound Fluency	.029				
R^2	.737	.735	.731	.719	.709
F	13.688***	15.819***	18.536***	21.524***	26.204***
Adjusted R^2	.684	.688	.691	.686	.682
ΔR^2	.737	-.003	-.004	-.011	-.010
ΔF	13.688	.408	.601	1.729	1.525

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Visual Motor Integration, and Motor Coordination test accounted for 70.9% of the variance in the Name Writing Test.

Tests for multicollinearity were also considered to be within the normal range. VIF scores ranged from 1.2 - 6.0 in Model 1 to 1.0 – 1.6 in Model 5. Tolerance scores in Model 5 ranged from .62 to .91. Multicollinearity was not considered to be a problem among these variables.

CHAPTER 5. SUMMARY AND DISCUSSION

Discussion

Understanding the relationship between reading and writing is critical to handwriting instruction and identification of students who are at risk for problems in these skill areas. The majority of literacy studies focus on reading and the foundational skills of reading, e.g., phonological awareness and alphabetic principle. Few studies include handwriting skills and their relationship with foundational reading skills. The primary purpose of this study was to investigate the relationship between reading and handwriting measures among kindergarteners. Significant positive relationships were found between early writing measures and the Dynamic Indicator of Basic Early Literacy Skills (DIBELS; Good & Kaminiski, 2002). This study found Name Writing and the Alphabet Writing Tests were significantly and positively correlated with all of the DIBELS measures in mid-year kindergarten. Knowing letter names, hearing and manipulating letter sounds (phonological awareness), and knowing the letter-sounds correspondence (alphabetic principle) are critical, not just for reading, but also for writing skills. If a student scores low on the DIBELS, he or she is also significantly more likely to score low on these handwriting measures.

Alphabet and name writing share many of the same components as reading. This study found knowing letter names and letter sounds were significantly correlated to a kindergartener's writing skills and supports previous research that found understanding the alphabetic principle and letter sounds important for both reading and writing (Adams, 1990; Berninger et al. 2006; Edwards, 2003; Fischel et al, 2007; Fitzgerald & Shannon, 2000; Honig, 2001; Stevenson & Newman, 1986, Treiman, 1993). This study's findings that the DIBELS measures of letter names, phonological awareness, and alphabetic principle were

highly correlated with writing measures supports previous research that found kindergarteners with higher phonological awareness skills performed higher in handwriting skills (Cain, 2007; Edwards, 2003; Ritchey, 2006, 2008). The speed of letter writing was correlated with the DIBELS measures and letter writing but not other measures.

This study also found significant correlations among reading, writing, visual-motor, and fine motor skills for kindergarteners, which has not been investigated previously. Results showed that name writing and alphabet writing skills were significantly correlated, indicating a positive relationship between these writing skills. Both writing measures should be closely observed in emerging writers. If students continue to have difficulty with writing, additional instruction or intervention should be considered by teachers or special education related service staff (e.g., occupational therapy). Statistically significant positive relationships were found among in-hand manipulation, visual-motor, reading, and writing measures. In-hand manipulation was significantly related to handwriting skills, which supports previous studies (Case-Smith, 1993; Cornhill & Case-Smith, 1996; Exner, 2005) where the lack of in-hand manipulation skills was found to interfere with pencil control during writing. Visual-motor skills, but not visual perceptual skills, were significantly correlated to handwriting measures. The visual perceptual measure used in this study only focused on one aspect of visual perception: the identification of forms that were the same. Results may have been different with a measure that included several different subtests. The motor aspect appears to be critical for writing; however, visual perception was correlated with the in-hand manipulation test of putting the pegs into the holes of the pegboard. These findings suggest relationships among reading, writing, visual-motor and fine motor skills in kindergarteners' early literacy skills.

A second purpose of this study was to investigate differences between writing upper and lower case alphabet letters by students in second semester kindergarten. Writing alphabet letters is one of the earliest writing skills. Adams (1990) found that students recognize uppercase letters before lower case letters. This study found students master *writing* upper case letters before lower case letters, even when instruction was provided simultaneously for upper and lower case letters. This is expected since upper case (capital) letters typically have the same height, all start at the top, occupy the same vertical space and are easy to recognize (Olsen, 2003). Kindergarteners were found to be significantly more accurate at writing upper case letters than lower case letters; however, many kindergarteners in this study had not mastered writing all upper or lower case letters. The group mean score for writing upper case letters was 20, lower case letter mean score was 15.6, and total accuracy (complete alphabet) mean score was 35.35 letters. By the third semester of kindergarten, students had not yet mastered writing these letters from dictation. This supports research by Ritchey (2008) that found kindergarteners during April and May could not write all upper and lower case letters (group mean 45.32). The mean score in Ritchey's study may have been higher due to scoring differences, i.e., most reversals were scored as correct. In a study of first graders, Graham, Weintraub, and Berninger (2001) found 5.5% of the letters tested were not written at all and approximately 5% of the responses were substituted with upper and/or lower case letters. These findings suggest that kindergarteners master upper case letters before lower case letters but still struggle with writing letters without a model. Districts should consider these findings when setting writing expectations for kindergarten students.

The Alphabet Writing Test total speed score was significantly correlated to the total accuracy score and to the DIBELS measures, but no other measures. Kindergarteners were

still working to master letter writing. The automaticity of letter writing may not have developed until the student is proficient at letter formation.

A third purpose of this study was to examine the difference between students in Group 1 (At Risk) and Group 2 (At Grade Level) on handwriting, fine motor and visual-motor measures. Significant differences in handwriting, reading, fine-motor and visual-motor skills were found between student performance in these groups. Group 1 consisted of students who scored at risk on the mid-year kindergarten DIBELS. Their performance on the DIBELS would suggest these students had difficulty with phonological awareness (Initial Sounds Fluency and Phoneme Segmentation Fluency) and alphabetic principle skills (Nonsense Word Fluency). Students in Group 2 had scored at grade level on the DIBELS measure and were considered to be typical kindergarteners in the area of pre-reading skills. Results indicated Group 1 (At-risk) readers had more difficulty writing alphabet letters, writing their first and last names, performing in-hand manipulation skills, and completing visual-motor copying tests. These measures appear to indicate students who are at risk for reading are also at risk for handwriting difficulties. Poor performance on underlying skills such as in-hand manipulation and visual motor skills supported previous studies that found children with poor in-hand manipulation skills to have difficulty with handwriting tasks (Case-Smith, 1993; Cornhill & Case-Smith, 1996). Breslin and Exner (1999) found in-hand manipulation highly associated with letter formation. Visual Motor Integration (VMI) was found to indicate readiness of formal handwriting instruction (Benbow, Hanft, & Marsh, 1992; Oliver, 1990; Weil & Amundson, 1994).

A fourth purpose to this study was to examine which pre-reading, visual-motor, and fine motor skills predict name and letter writing for students in kindergarten. There are

multiple studies that investigated letter naming or name writing skills as reading predictors; however this study investigated reading, visual-motor, and fine motor skills as predictors of writing. Results found a significant predictive relationship between handwriting the alphabet letters and three variables: student age, writing the first and last name, and the DIBELS Initial Sound Fluency (ISF) measure. This may indicate that knowing the initial letter sounds are critical for letter writing as well as name writing and age. These three independent variables were able to predict 70.1 % of the variance in the kindergartener's ability to write alphabet letters. Age has not been investigated in kindergarten as a possible predictor for writing. Few empirical studies using fine motor, visual motor and reading variables to predict writing in kindergarten are found. Ritchey (2008) used only reading measures with kindergarteners and found five reading variables were predictive of letter writing.

Name Writing performance was significantly predicted by four variables: student's age, Alphabet Writing Test, the Motor Coordination test, and BeeryTM Visual-Motor Integration Test (VMI). DIBELS measures were not significant in predicting name writing, possibly because the student memorizes their name as a series of letters/symbols, rather than based on the sounds of the letters. Age was a significant predictor for both writing measures but was not investigated further in this study. As expected since they share many of the same foundations, Alphabet Writing and Name Writing were significant predictors of each other.

Limitations

Students in this study were chosen by convenience sample from one suburban school district in the Midwest. The initial plan was to recruit students for Group 2 (At Grade Level) that were matched to students in Group 1 (At Risk) by gender, school and school kindergarten teachers so specific comparisons could be made between the groups. This could

not be investigated due to low recruitment numbers. The sample size was small and limited to parents who agreed to have their child involved in the study. This could have biased the sample since parent choice determined the students in the study.

Students in this study were homogeneous. They had similar preschool experiences and over 85% students had parents with college experience/degrees. Their full-day kindergarten program provided specific handwriting instruction using a published curriculum. While the study participants were not all Caucasian, no effort was made to recruit by ethnic diversity. This district had few students (5.9%) enrolled in the free and reduced lunch program, indicating few families with poor socio-economic status (SES) The sample does not reflect the full range of students. Students with DIBELS scores in the low and mid range were included in the study while students with high scores (e.g., 2 standard deviations above the district's mean test scores) were excluded as outliers in order to maintain an "average" kindergarten group.

Writing samples were gathered during a testing situation rather than authentic writing in the classroom (e.g., journals, sentences). A student's performance on these tests may not be an accurate representation of the student's handwriting skills in the classroom. These results may not be generalizable to all kindergarteners.

Implications

People master the ability to compose and to handwrite by mastering early skills in fine motor (e.g., hold and manipulate pencil with smooth coordination); visual motor (copying shapes, letters, or symbols); and understanding phonological awareness, alphabetic principle, and phonemic awareness (concepts of letter sounds and names). Teachers, related

service staff, school administrators, teaching institutions, and policy makers must understand these foundations for early handwriting.

Instruction in handwriting must no longer be neglected or ignored. Reading and writing share critical literacy concepts that are important for effective and efficient instruction. Identifying which concepts need to be taught separately as well as how the concepts should be taught is important. Phonological awareness, letter naming, and alphabetic principle skills are critical in both reading and handwriting performance. These skills should be screened in all students, especially kindergarteners who are struggling with writing letters, to identify if they have the foundation for understanding and producing print. Instruction in handwriting is critical and should be integrated into States' core curriculum instruction and district practices. Instruction should include letter formation and letter sounds and monitor mastery of letters before increased writing demands are made (e.g., journal or story writing).

Instruction for teachers must also occur. Only 12% of the teachers in the study by Graham and colleagues (2006) have any college-level classes on handwriting. Instruction in handwriting should be a component of literacy coursework and required for all teachers, including early childhood teachers. Teachers need to be instructed in simple but effective remediation strategies for students who struggle with letter formation, legibility, and fluency. As related service professionals, occupational therapists should also have coursework that includes literacy skills such as phonological awareness, phonemic awareness, and alphabetic principle in addition to fine motor and visual motor skills. Professionals working in early childhood or early elementary programs should have knowledge and skills to teach and remediate these foundational components of handwriting.

Research studies indicate by the third quarter of kindergarten, students cannot form all of the letters of the alphabet legibly and automatically. Upper case letters were easier to master than lower case, which supports that these letters are easier and should be taught first (Olsen, 2003). Teaching the easier letters first allows the students to practice handwriting; lower case letters can be introduced later. More emphasis should be placed on supplemental instruction (e.g., basic instruction plus additional strategies such as re-teaching, additional practice) to learn letter formations before emphasis on writing words and sentences occur. Teaching students a specific sequence for forming each letter increases automaticity as the student masters this sequence and it become more automatic. Expecting students to handwrite without the appropriate skills encourages ineffective skills and creates bad habits. The letters that are most difficult should be re-taught using several different strategies.

This study used writing paper with only a bottom line, but the kindergarten students had difficulty placing the letters on this baseline. Ritchey (2008) found kindergarteners had difficulty placing letters on paper that used top, middle and bottom lines. Using paper without lines increased the legibility of beginning writers since they did not have to attend to the lines (Lindsay & McLennan, 1983; Weil & Amundson, 1994). The type of paper being used for beginning writers who have not mastered letter formation should initially use no lines or a single baseline. Asher (2006) suggests that teachers minimize the variations of writing paper used throughout the day for beginning or struggling writers.

Proficient handwriting is critical for education and life tasks. Some people argue that technology is decreasing the importance of handwriting with a pencil; however, two research studies using first and second graders indicate that during spelling instruction on predictable words, students who used a pencil scored higher than students using a computer on posttest

spelling tests (Berninger, et al., 1998; Cunningham & Stanovich, 1990). Handwriting is the primary method of communication and knowledge assessment for students (Peverly, 2006). Previous research findings that approximately 70-75% of American students in grades 4-12 were writing below grade level on national writing exam (Perksy, Daane, & Jin, 2003), and 42% of kindergarteners performing in a low handwriting group were still in the low group by first grade (Marr & Cermak, 2002). A strong relationship between kindergarten performance and later academic years (Baydar, Brooke-Gunn & Furstenberg, 1993; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Marr & Cermak, 2002; Molfese, Beswick, Molnar, & Jacobi-Vessels, 2006; Stevenson & Newman, 1986) suggests a need to become more serious about universal screening for writing skills. Universal screening of all students to identify those at risk is being implemented across the nation (NASDSE, 2006). Universal screening to identify students, especially in kindergarten and early elementary grades, who are struggling with automatic formation of alphabet letters should be completed each semester until mastery is complete for at least two consecutive semesters. Supplemental practice and instruction on letter formation should be provided so students can produce these letters automatically during classroom work. Students who score low on the DIBELS, especially the Initial Sound Fluency measure, should be closely monitored for difficulty in alphabet writing. If fine motor problems appear to interfere, the Test of In-Hand Manipulation could be used to identify students with poor in-hand manipulation skills interfering with the dexterity and smooth movements needed for handwriting.

Formal handwriting instruction is necessary for learning the alphabet letters and should focus on writing upper case letters first since those are easier for kindergarteners to master. When students lack the skills to automatically form letters during text production,

they either struggle to remember or avoid writing, thus losing what they are attempting to communicate (Graham & Harris, 2000). Failure to write letters automatically and legibly interferes with future writing ability (Berninger & Rutberg, 1992; Graham, Struck, Santoro, & Berninger, 2006; Richey, 2008).

Future Research

Few studies have included handwriting skills in the investigation of literacy skills; fewer studies included kindergarten students. The findings of this study suggest strong relationships between reading and handwriting measures in kindergarteners. Further research is needed to learn more about the relationship between handwriting and reading measures at the beginning, middle and end of kindergarten and first grades when students are beginning writers. A larger sample with more diversity should investigate if the DIBELS measures could be used as an indicator of students at risk in writing. Using other published kindergarten reading measures would strengthen research between reading and handwriting relationships. Age, as a predictor for writing performance, should be further investigated to identify the age range that is potentially at-risk in kindergarten. Identification of the upper and lower case letters that are most problematic for kindergarten or first grade would allow more focused instruction and monitoring to occur when these letters are introduced. Replication of the scoring procedures used in this study to determine their usefulness for teachers and occupational therapists should be considered. This preliminary study provides a research base for further research in this area.

Conclusion

Kindergarteners are expected to write their first and last name, first name of their friends, write some letters and words from dictation, write words to express meaning, and use

phonemic awareness and letter knowledge to spell independently (Snow, Burns, & Griffin, 1998). This study highlights the importance of handwriting in kindergarten and the strong relationship between reading and handwriting skills. Descriptive analysis, statistical tests, correlations, and multiple regression support the belief that handwriting skills are related to a student's understanding of basic literacy concepts of phonological awareness and alphabetic principles. Limited attention has been focused on early handwriting development, especially in kindergarten. While reading and writing are separate skills, during the early years there is a strong need for instruction to understand letter names and letter sounds to form words and to read. Separate handwriting instruction is necessary to form the letters correctly, position them on a line, space between the letters, etc.

Alphabet Writing and Name Writing were found to have a strong relationship with reading measures. Upper case letters are easier to form by students in mid-year kindergarten and their use should be encouraged for emerging writers. Predictive relationships were found between several reading, writing, visual-motor and fine-motor variables that can be used to support future research. Fine motor and visual motor skills have an important relationship with handwriting that must not be overlooked. Students with delays in handwriting should be screened for fine motor delays as well as their ability to understand the letter names and sounds. Educators should consider effective handwriting instruction for all students, monitor emerging handwriters, and provide further interventions for struggling handwriters.

BIBLIOGRAPHY

- Adams, M. (1990). *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.
- American College Testing (ACT). (2005). *Crisis at the core: Preparing all students for college and work*. Iowa City, IA: Author.
- Asher, A. (2006). Handwriting instruction in elementary schools. *American Journal of Occupational Therapy*, 60, 461-471.
- Baydar, N., Brooke-Gunn, J., & Furstenberg, F. (1993). Early warning signs of functional literacy: Predictors in childhood and adolescence. *Child Development*, 64, 815-829.
- Beery, K., & Beery, N. (2006). *BeeryTM VMI: Administration, scoring and teaching manual* (5th ed.). Minneapolis, MN: NCS Pearson, Inc.
- Benbow, M., Hanft, B., & Marsh, D. (1992). Lesson 5 Handwriting in the classroom: Improving written communication. In C. Royeen (Ed.), *AOTA self-study series: Classroom applications for school-based practice*. Rockville, MD: American Occupational Therapy Association.
- Bergmann, K. (1990). Incidence of atypical pencil grasps among nondysfunctional adults. *American Journal of Occupational Therapy*, 44, 736-740.
- Berninger, V. (1994). Future directions for research on writing disabilities: Integrating endogenous and exogenous variables. In G. R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities: New views on measurement* (pp. 419-439). Baltimore: Paul H. Brookes.

- Berninger, V. (1999). Coordinating transcription and text generation in working memory during composing: Automatic and constructive processes. *Learning Disability Quarterly*, 22(2), 99-112.
- Berninger, V. (2000). Development of language by hand and its connections with language by ear, mouth, and eye. *Topics in Language Disorders*, 20(4), 65-84.
- Berninger, V., Abbott, R., Jones, J., Wolf, B., Gould, L., Anderson-Youngstrom, M., Shimand, S., & Apel, K. (2006). Early development of language by hand: Composing reading, listening, and speaking connections; three letter-writing modes; and fast mapping in spelling. *Developmental Neuropsychology*, 29(1), 61-92.
- Berninger, V., Abbott, R., Rogan, L., Reed, E., Abbott, S., Brooks, S., et al. (1998). Teaching spelling to children with specific learning disabilities: The mind's ear and eye beat the computer or pencil. *Learning Disability Quarterly*, 21, 1-17.
- Berninger, V., Nielsen, K., Abbott, R., Wijsman, W., & Raskind, W. (2008). Writing problems in developmental dyslexia: Under-recognized and under-treated. *Journal of School Psychology*, 46, 1-21.
- Berninger, V., & Rutberg, J. (1992). Relationship of finger function to beginning writing: Application to diagnosis of writing disabilities. *Developmental Medicine and Child Neurology*, 34, 155-172.
- Bloodgood, J. (1999). What's in a name? Children's name writing and literacy acquisition. *Reading Research Quarterly*, 34, 342-367.
- Breslin, D., & Exner, C. (1999). Construct validity of the in-hand manipulation test: A discriminant analysis with children without disability and children with spastic diplegia. *American Journal of Occupational Therapy*, 53(4), 381-386.

- Bridge, C., Compton-Hall, M., & Cantrell, S. (1997). Classroom writing practices revisited: The effects of statewide reform on writing instruction. *The Elementary School Journal*, 98(2), 151-170.
- Burke, M., Crowder, W., Hagan-Burke, S & Zou, Y. (2009). A comparison of two path models for predicting reading fluency. *Remedial and Special Education*, 30, 84-95.
- Burton, W., & Dancisak, J. (2000). Grip form and graphomotor control in preschool children. *American Journal of Occupational Therapy*, 54(1), 9-17.
- Bus, A., Both-de Vries, A., de Jong, M., Sulzby, E., de Jong, W., & de Jong, E. (2001). *Conceptualizations underlying prereaders' story writing* (CIERA Report No. 2-015). Ann Arbor: University of Michigan, School of Education, Center for Improvement of Early Reading Achievement.
- Cain, H. (2007). *The relationship between phoneme/grapheme correspondence and level of writing and spontaneity of writing in kindergarten students*. (Unpublished doctoral dissertation). Walden University, Georgia.
- Case-Smith, J. (1993). Comparison of in-hand manipulation skills in children with and without fine motor delays. *Occupational Therapy Journal of Research*, 13(2), 87-100.
- Case-Smith, J. (1995). The relationships among sensorimotor components, fine motor skill, and functional performance in preschool children. *American Journal of Occupational Therapy*, 49, 645-652.
- Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work?* New York: The Conference Board.

- Clark, G. F. (2010). The relationship between handwriting, reading, fine-motor and visual-motor skills in kindergarteners (Unpublished doctoral dissertation). Iowa State University, Ames, Iowa.
- Clark, G. F. (2005). *IOWAN: Iowa Writing Assessment and Norms*. Des Moines, IA: Iowa Department of Education.
- Clay, M. (1975). *What did I write?* Portsmouth, NH: Heinemann.
- Cohen, J., Cohen, P., West, S., & Aiken, L. (2003). *Applied multiple regression/correlation analysis for behavioral sciences (3rd ed.)*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Connolly, V., Campbell, S., MacLean, M., & Barnes, J. (2006). Contribution of lower-order skills to the written composition of college students with and without dyslexia. *Developmental Neuropsychology*, 29, 175-196.
- Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy*, 50(9), 732-739.
- Cramér, H. (1999). *Mathematical methods of statistics*. Princeton, NJ: Princeton University Press.
- Cunningham, A., & Stanovich, K. (1990). Early spelling acquisition: Writing beats the computer. *Journal of Educational Psychology*, 82, 159-162.
- Dennis, J., & Swinth, Y. (2001). Pencil grasp and children's handwriting legibility during different-length writing tasks. *American Journal of Occupational Therapy*, 55(2), 175-183.

- Denton, K., and West, J. (2002). *Children's reading and mathematics achievement in kindergarten and first grade*. Washington, DC: U.S. Department of Education, National Center for Education Statistics.
- Domico, M. (1993). Patterns of development in narrative stories of emergent writers. In C. Kinzer & D. Leu (Eds.), *Examining central issues in literacy research, theory, and practice* (pp 391-404). Chicago: National Reading Conference.
- Edwards, L. (2003). Writing instruction in kindergarten: Examining an emerging area of research for children with writing and reading difficulties. *Journal of Learning Disabilities*, 36(2), 136-148.
- Ehri, L., Nunes, S., Stahl, S., & Willows, D. (2001). Systematic phonics instruction helps students learn to read: Evidence from the national reading panel's meta-analysis. *Review of Educational Research*, 71, 393-447.
- Exner, C. (1989). Development of hand functions. In P. N. Pratt & A. S. Allen (Eds.), *Occupational therapy for children* (pp. 235-259). St. Louis, MO: Mosby.
- Exner, C. (2005). Development of hand skills. In J. Case-Smith (Ed.), *Occupational therapy for children* (5th ed.) (pp. 304-355). St. Louis, MO: Mosby.
- Fischel, J., Bracken, S., Fuchs-Eisenberg, A., Spira, E., Katz, S., & Shaller, G. (2007). Evaluation of curricular approaches to enhance preschool early literacy skills. *Journal of Literacy Research*, 39(4), 471-501.
- Fisher, R.A. (1954). [*Statistical methods for research workers*](#). Edinburgh, Scotland: Oliver and Boyd.
- Fitzgerald, J., & Shanahan, T. (2000). Reading and writing relations and their development. *Educational Psychologist*, 35(1), 39-50.

- Gardner, M. (1982). *Test of Visual Perceptual Skills*. Seattle: Special Child Publications.
- Glazer, E., & Burke, E. (1994). *An integrated approach to early literacy*. Boston, MA: Allyn and Bacon.
- Good, R., & Kaminiski, R. (Eds.) (2002). *Dynamic Indicators of Basic Early Literacy Skills* (6th ed.). Eugene, OR: Institute for the Development of Educational Achievement.
- Graham, S., Berninger, V., Abbott, R., Abbott, S., & Whitaker, D. (1997). The role of mechanics in composing of elementary school students: A new methodological approach. *Journal of Educational Psychology*, 89(1), 170-182.
- Graham, S., & Harris, K. (2000). The role of self-regulation and transcription skills in writing and writing development. *Education Psychologist*, 35, 3-12.
- Graham, S., Harris, K., & Fink, B. (2000). Is handwriting causally related to learning to write? Treatment of handwriting problems in beginning writers. *Journal of Educational Psychology*, 92, 620-633.
- Graham, S., Harris, K., Mason, L., Fink-Chorzempa, B., Moran, S., & Saddler, B. (2008). How do primary grade teachers teach handwriting? A national survey. *Reading and Writing*, 21, 49-69.
- Graham, S., Struck, M., Santoro, J., & Berninger, V. (2006). Dimensions of good and poor handwriting legibility in first and second graders: Motor programs, visual-spatial arrangement, and letter formation parameter setting. *Developmental Neuropsychology*, 29, 43-60.
- Graham, S., Weintraub, N., and Berninger, V., (2001). Which manuscript letters do primary children write legibly? *Journal of Educational Psychology*, 93, 488-497.
- Honig, A. (2001). *Teaching our children to read*. Thousand Oaks, CA: Corwin Press.

- Jones, D., & Christensen, C. (1999). The relationship between automaticity in handwriting and students' ability to generate written text. *Journal of Educational Psychology, 91*, 44-49.
- Lindsay, G., & McLennan, D. (1983). Lined paper: Its effects on the legibility and creativity of young children's writing. *British Journal of Educational Psychology, 53*, 364-368.
- MacArthur, C., Graham, S., & Fitzgerald, J. (2006). *Handbook of writing research*. New York: Guilford Press.
- Maeland, A. (1992). Handwriting and perceptual-motor skills in clumsy, dysgraphic, and 'normal' children. *Perceptual and Motor Skills, 75*, 1207-1217.
- Marr, D., & Cermak, S. (2002). Consistency of handwriting in early elementary students. *American Journal of Occupational Therapy, 56*(2), 161-167.
- Marr, D., Cermak, S., Cohn, E., & Henderson, A. (2003). Fine motor activities in head start and kindergarten classrooms. *American Journal of Occupational Therapy, 57*(5), 550-557.
- McCutchen, D., Abbott, R., Green, L., Beretvas, N., Cox, S., Potter, N., Quiroga, T., & Gray, A. (2002). Beginning literacy: Links among teacher knowledge, teacher practice, and student learning. *Journal of Learning Disabilities, 35*(1), 69-86.
- McHale, K., & Cermak, S. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy, 46*, 898-903.
- Miller, W. (2000). *Strategies for developing emergent literacy*. Boston: McGraw Hill.

- Molfese, V., Beswick, J., Molnar, A., & Jacobi-Vessels, J. (2006). Alphabetic skills in preschool: A preliminary study of letter naming and letter writing. *Developmental Neuropsychology*, 29, 5-19.
- National Association for the Education of Young Children. (1998). Learning to read and write: Developmentally appropriate practices for young children. *Young Children*, 53(4), 30-46.
- National Association of State Directors of Special Education. (2006). *Response to intervention: Policy considerations and implementation*. Alexandria, VA: Author
- National Commission on Writing for America's Families, Schools, and Colleges. (2004). *Writing: A ticket to work...Or a ticket out: A survey of business leaders*. New York: The College Board.
- National Commission on Writing for America's Families, Schools, and Colleges. (2005). *Writing: A powerful message from state government*. New York: The College Board.
- National Early Literacy Panel. (2008). *Developing early literacy: A scientific synthesis of early literacy development and implications for intervention*. Jessup, Maryland: National Institute for Literacy.
- National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel. Teaching children to read: an evidence-based assessment of the scientific research literature on reading and its implications for reading instruction*. Retrieved from <http://www.nichd.nih.gov/publications/nrp/smallbook.htm>
- National Research Council (1998). Preventing reading difficulties in young children. Washington, DC: National Academy Press.

- O'Connor, R., & Jenkins, J. (1995). Improving the generalization of sound/symbol knowledge: Teaching spelling to kindergarten children with disabilities. *The Journal of Special Education, 29*, 255-275.
- Oliver, C. (1990). A sensorimotor program for improving writing readiness skills in elementary-age children. *American Journal of Occupational Therapy, 44*, 111-116.
- Olsen, J. (2003). *Handwriting without Tears® kindergarten teacher's guide*. Cabin John, MD: Handwriting Without Tears.
- Olsen, J., & Knapton, E., (2006). *The Print Tool (2nd ed.)*. Cabin John, MD: Handwriting Without Tears.
- Parush, S., Lifshitz, N., Yochman, A., & Weintraub, N. (2010). Relationships between handwriting components and underling perceptual-motor functions among students during copying and dictation tasks. *Occupational Therapy Journal of Research, 30*, 39-48.
- Pehoski, C., Henderson, A., & Tickle-Degnen, L. (1997). In-hand manipulation in young children: Translation movements. *American Journal of Occupational Therapy, 51*, 719-728.
- Persky, H., Daane, M., & Jin, Y. (2003). *The nation's report card: Writing 2002*. (NCES 2003-529). U.S. Department of Education. Institute of Education Sciences. National Center for Educational Statistics. Washington, DC: Government Printing Office.
- Peverley, S. (2006). The importance of handwriting speed in adult writing. Implications for automaticity and working memory. *Developmental Neuropsychology, 29*, 197-216.

- Pont, K., Wallen, M., Bundy, A., & Case-Smith, J. (2008). Reliability and validity of the test of in-hand manipulation in children ages 5 to 6 years. *American Occupational Therapy Association*, 62(4), 384-392.
- Reid, K., Hresko, W., & Hammill, D. (2001). *The test of early reading ability* (3rd ed.). Circle Pines, MN: American Guidance Service.
- Richgels, D. (1995). Invented spelling ability and printed word learning in kindergarten. *Reading Research Quarterly*, 30, 96-109.
- Richgels, D. (2003). Invented spelling, phonemic awareness, and reading and writing instruction. In C. MacArthur, S. Graham, & J. Fitzgerald (Eds.), *The handbook of writing research* (pp. 142-155). New York: The Guilford Press.
- Riley, J. (1995). The relationship between adjustment to school and success in reading by the end of the reception year. *Early Child Development and Care*, 114, 25-38.
- Ritchey, K. (2006). Learning to write. *TEACHING Exceptional Children*, 39(2), 22-26.
- Ritchey, K. (2008). The building blocks of writing: Learning to write letters and spell words. *Reading & Writing*, 21, 27-47.
- Ritty, M., Solan, H., & Cool, S. (1993). Visual and sensory-motor functioning in the classroom: A preliminary report of ergonomic demands. *Journal of the American Optometric Association*, 64, 238-244.
- Roston, K., Hinojosa, J., & Kaplan, H. (2008). Using the Minnesota Handwriting Assessment and the handwriting checklist in screening first and second graders' handwriting legibility. *Journal of Occupational Therapy, Schools & Early Intervention*, 1, 100-115.

- Schneck, C. (1991). Comparison of pencil-grip patterns in first graders with good and poor writing skills. *American Journal of Occupational Therapy*, 45, 701-706.
- Simner, M. (1982). Printing errors in kindergarten and the prediction of academic performance. *Journal of Learning Disabilities*, 15(3), 155-159.
- Snow, C., Burns, S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.
- SPSS (2009). *PASW Statistics GradPack version 18*. Chicago, IL: Author.
- Stellakis, N., & Kondyli, M. (2004). The emergence of writing: Children's writing during the pre-alphabetic spelling phase. *Educational Studies in Language and Literature*, 4, 129-150.
- Stevenson, H., & Newman, R. (1986). Long-term prediction of achievement and attitudes in mathematics and reading. *Child Development*, 57, 646-659.
- Sulzby, E., Barnhardt, J., & Hieshima, J. (1989). Forms of writing and rereading from writing: A preliminary report. In J. Mason (Ed.), *Reading and writing connections* (pp. 31-63). Needham Heights, MA: Allyn & Bacon.
- Tierney, R., & Pearson, P. (1983). Toward a composing model of reading. *Language Arts*, 60, 568-580.
- Tseng, M., & Murray, E. (1994). Differences in perceptual-motor measures in children with good and poor handwriting. *Occupational Therapy Journal of Research*, 14, 19-34.
- Trieman, R. (1993). *Beginning to spell*. New York: Oxford University Press.
- Trieman, R. (1998). Why spelling? The benefits of incorporating spelling into beginning reading instruction. In J. L. Metsala & L. C. Ehri (Eds.), *Word recognition in beginning literacy* (pp. 289-313). Mahwah, NJ: Erlbaum.

- Vernon, S., & Ferreiro, E. (1999). Writing development: A neglected variable in the consideration of phonological awareness. *Harvard Educational Review*, 69, 395-414.
- Waggoner, J., LaNunzia, L., Hill, D., & Cooper, J. (1981). Space size and accuracy of kindergarten and first grade students' manuscript handwriting. *Journal of Educational Research*, 74, 182-184.
- Wagner, R., Torgesen, J., & Rashotte, C. (1999). *Comprehensive test of phonological processing*. Austin, TX: ProEd.
- Weil, M., & Amundson, S. (1994). Relationship between visuomotor and handwriting skills of children in kindergarten. *American Journal of Occupational Therapy*, 48, 982-988.
- Weinberger, J. (1996). A longitudinal study of children's early literacy experiences at home and later literacy development at home and school. *Journal of Research in Reading*, 19, 14-24.
- Weintraub, N., & Graham, S. (2000). The contribution of gender, orthographic, finger function, and visual-motor processes to the prediction of handwriting status. *The Occupational Therapy Journal of Research*, 20, 121-141.
- World Health Organization. (2002). *International checklist of functioning, disability and health: ICF (Version 2.1a)*. Geneva, Switzerland: Author.
- Zaner-Bloser (2008). *Zaner-Bloser Handwriting for Kindergarten*. Columbus, OH: Author.
- Ziviani, J., & Wallen, M. (2006). The development of graphomotor skills. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child: Foundations for remediation* (2nd ed.) (pp. 217-236). St. Louis, MO: Mosby.
- Ziviani, J., & Wilkins, J. (1986). Effects of pencil grip on handwriting speed and legibility. *Education Review*, 38, 247-257.

Appendix A. Parent Survey

Directions: Please take 2 minutes to complete this short survey about your child. Based on the correct answer for your family, please indicate your response by marking either YES or NO for each question. You may skip any questions that you do not wish to answer or that makes you feel uncomfortable.

Section 1: Family Information

1. Does child live with his or her biological mother? YES NO
If NO—go to Section 2: Child Information
2. What is the highest level of education the child's mother has obtained?
 _____ Less than High School
 _____ High school/GED
 _____ Some college or college degree

Section 2: Child Information

3. Has your child lived in this district for at least 2 years? YES NO
4. Did your child attend preschool/childcare for at least one school year? YES NO
5. Did your child attend Pre-Kindergarten in the previous year? YES NO
6. Did your child attend Kindergarten before this current year? YES NO
7. Was your child's vision tested by an optometrist or physician? YES NO
8. Does your child have any known vision or hearing concerns? YES NO
9. What is your child's gender? Boy Girl
10. Child's birthdate (please print) ____/____/____

Thank you. Please use the self-addressed stamped envelope to return this survey.

To protect confidentiality, no names are listed. Data are being tracked using a code system.

Appendix B. Teacher Survey

Directions: Please take about 3 minutes to complete this short survey about your student. You may skip any questions that you do not wish to answer or that makes you feel uncomfortable. Indicate your response by circling the best choice or writing in the answer.

Section 1: Teacher Information

1. How many years have you been a licensed teacher? 0-3 years 4-10 years 10+ yrs
2. How many years have you have taught kindergarten? 0-3 years 4-10 years 10+ yrs
3. What is your current educational degree? Bachelors Masters Ph.D.
4. List the teaching endorcements you currently have. _____

Section 2: Classroom Instruction and Curriculum

5. How many students are in your class? _____
6. Is handwriting taught as a separate subject? YES NO
7. Have you had formal training in teaching handwriting? YES NO

For questions 8-11: What is the average number of *minutes per week* that students:

- 8received formal instruction in handwriting during 0-20 min. 21-49 min. 50+ min.
the 1st semester?
9.receive formal instruction in handwriting during 0-20 min. 21-49 min. 50+ min.
the 2nd semester?
10. ...spend in writing during the 1st semester? 0-20 min. 21-49 min. 50+ min.
11. ...spend in writing during the 2nd semester? 0-20 min. 21-49 min. 50+ min.

Section 3: Information about the Student

12. Did this child pass the school's vision screening? YES NO
13. Does this child receive any extra help in the area of writing? YES NO
14. Rate this child's writing skills on scale of 1-4.
1-performs much below peers, 2-performs somewhat below peers, 3-perfoms similar to peers, 4-performs above most peers. 1 2 3 4

Thank you. Please return this survey in the accompanying envelope.

Appendix C. Writing Measures: Directions for Administering and Scoring

Prior to testing: Find out which term the child's teacher uses to label letters (e.g., upper case, capital letters, lower case). The room needs seating for two people and a flat, even table or desk surface for writing. The chair should allow the child's feet to rest on the floor and the table surface should be 2" above the child's bent elbow. There should be no visual model of the alphabet in child's view.

Materials: Sharpened golf-sized pencil-no eraser, 2 sheets of paper designed for this study, Data Collection Form for Writing Measures, stopwatch, pen or pencil for examiner.

Set-up: Center the paper in front of the child, approximately 1" from the bottom edge of the table. Place the pencil in the center of the paper, with the lead pointing towards the top of the paper. (It is acceptable for the child to reposition the paper once he or she begins to write. However, if the child tries to turn the paper back and forth while writing, move the paper back to this starting position).

1. Writing alphabet from dictation (upper case first, then lower case).

Directions: *With this pencil write the Capital Letters that I say. Make your letters sit on this line* (Point to the left side of top line). *If you want to change what you wrote, (pause) cross out the letter and write the other letter. Sometimes I will make a mark on your paper. Do not pay any attention to this. Keep going. Work as quickly as you can **with good writing*** (emphasize). *Remember to print the letter I tell you. Do you understand these directions?* (Wait for response. Give directions again, if needed). *You may pick up the pencil* (wait until child has pencil ready). *Ready? Write Capital Letter L (Upper Case Letter L).*

Discretely start stopwatch and mark on the recording form the length of time to complete the form (time lapsed from the end of the verbal request to the completion of the letter). Let the stopwatch run as you administer and score the remaining items from the first column (set #1) of the Data Collection Form for Writing Measures. Then go to the next column of letters (set #2).

Note: If the child does not begin writing within 3 seconds, appears distracted, or asks you to repeat the letter, repeat the alphabet letter once. If the child does not begin writing within 3 seconds or refuses, do not repeat. Go to the next alphabet letter.

When student is finished or refuses to finish, turn paper over. Give the next set of directions.

Directions: *Now I will ask you to write the lower case letters. Make your letters sit on this line* (Point to line). *Remember, if you want to change what you wrote, (pause) cross out the letter and write the other letter. Work as quickly as you can **with good writing*** (emphasize). *Remember to print the letter I tell you. Ready? Write lower case c.*

2. Writing first and last name (not timed)

Directions: *Use the pencil to write your name on this paper. Write your first name **and** (emphasize) your last name on this line* (point to first line on a clean sheet of the lined paper).

If child doesn't begin writing within 3 seconds, repeat directions. If child does not respond after 10 seconds or refuses, stop the testing.

If child only writes his or her first name, give a reminder to write the last name.

Writing Measures: Directions for Scoring

1. Writing alphabet from dictation

Scoring: Upper case and lower case writing will each have two scores:

1. Time/Fluency: For each letter written or attempted, use the scoring table below for the time score. Time includes the duration from when the examiner says the letter to when the child quits writing. For instance, if the child used 8 seconds to write a letter, the score would be 2.

Score 0	Score 1	Score 2	Score 3	Score 4
Letter was skipped or omitted	More than 10 seconds	6-10 seconds	3-5 seconds	1-2 seconds

2. Accuracy: Letters will be given a score of 0 or 1. Must meet all 5 criteria for a score of 1.

- Letter written matches the letter dictated (no substitutions for upper and lower case forms). Letters c, o, s, u, v, w, x, and z may be difficult to judge for this criteria.
- Lower case letters g, j, p, q, y, must extend below the bottom line.
- Letter does not have any over-tracing or gaps larger than 1/16"
- Letter is oriented in the correct direction (no reversals)
- Letter is recognizable out of context

2. Writing first and last name (not timed)

Name Scoring: Two scores are given. First name will have a score 0 - 9; Last name will have a score 0 – 9. Scores will be based on the following criteria:

Item	0	1	2	3
Number of Letters written	Refused	First letter of name	More than first letter of name written	All letters of name written
Formation of letters	Did not form all letters of name—score as a 0 for this	<u>Poor formation.</u> Letters could be mistaken for another letter or	<u>Fair formation.</u> At least 50% of letters formed similar to	<u>Good formation.</u> 100% of letters were formed according to curriculum with no

	item.	number, mark-overs, reversals, or gaps greater than 1/16"	curriculum, may have some gaps or over-strokes greater than 1/16"	over-tracing or gaps larger than 1/16". If lower case letters g, j, p, q, y are used—there must be a tail below the baseline.
Recognizable out of context	Did not form all letters of name—score as a 0 for this item.	Less than 50% of the letters are recognizable out of context	At least 50% of the letters are recognizable out of context	All letters are clearly recognizable out of context. If lower case letters g, j, p, q, y are used—there must be a tail below the baseline.

DATA COLLECTION FORM FOR WRITING MEASURES

§1. CAPITAL LETTERS: Writing from Dictation

1 ST SET	TIME	ACCURACY	NOTES	2 ND SET	TIME	ACCURACY	NOTES
L				A			
U				G			
E				Z			
H				I			
K				M			
J				O			
Y				V			
D				X			
R				P			
C				W			
F				N			
Q				B			
T				S			
SCORE:				SCORE:			

2. | LOWER CASE LETTERS: Writing from Dictation

1 ST SET	TIME	ACCURACY	NOTES	2 ND SET	TIME	ACCURACY	NOTES
s				l			
b				v			
x				s			
i				d			
r				f			
g				g			
h				t			
a				k			
z				v			
i				q			
n				m			
u				p			
g				w			
SCORE:				SCORE:			

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Clark, G.F., Polichino, J., Swinth, Y., & Muhlenhaupt, M. (2007). Evaluating occupational performance in schools and early childhood settings (pp23-58). In L. Jackson (Ed), Occupational therapy services for children and youth under IDEA (3rd ed). Bethesda, MD: AOTA Press.

Clark, G.F. (2008). The infants and toddlers' with disabilities program (Part C of IDEA). OT Practice, January, 2008, CE1-CE8.

Clark, G.F. (2008). Getting into a collaborative school routine. In Hanft, B. & Shepherd, J. (Eds.), Collaboration and Teamwork: Essential to School-Based Practice (p. 105-138). Bethesda, MD: AOTA Press.

Clark, G.F. (in press). Evaluation, assessment, and early childhood outcomes. In B. Chandler (Ed), Early childhood occupational therapy: Services for children birth

to five. Bethesda, MD: AOTA Press.