TEACHING HANDWRITING IN THE CLASSROOM: RESEARCH-BASED RECOMMENDATIONS AND COMMERCIALLY AVAILABLE PROGRAMS

by

Stephanie LeBlanc Penny

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Abstract

Despite ever-evolving technological advances, writing in many settings, including school, still involves paper and pencil or pen. Writing skills have been positively linked to academic achievement at school, especially reading. Therefore, how students are taught handwriting is important, but in Nova Scotia, guidelines for this are not in the curriculum. The Handwriting Without Tears (HWT) Program and the Center on Accelerating Student Learning (CASL) Handwriting Program are two handwriting programs that have been shown to be effective. These programs were compared on five important elements (four founded in research, one of importance to teachers and school boards) of handwriting programs. It was concluded that to teach according to the most effective elements, the CASL Program, which is available for free on the internet, would be recommended to teachers as it better addressed more of the key elements. Limitations of the study are discussed as well as suggestions for teachers, school boards, and school psychologists.

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Definitions

According to research, handwriting is the process in written expression that allows an individual to turn their internal thoughts into written symbols (letters) to express ideas in written language and involves speed and the formation and orientation of letters (Medwell & Wray, 2014). Handwriting is the creation of letters, and therefore language, by hand. It requires skill in fine-motor movement and proficient alphabetic knowledge, which includes knowing letter names, shapes, and sequence quite automatically. There are multiple related processes that contribute to handwriting such as fine-motor movement, visual-motor coordination, and knowledge of letters and letter formation (Datchuk, 2015). Fine-motor movements are small changes made to the positioning of the fingers, hands, and arms during handwriting. Visual-motor coordination is the use of eyesight to help guide these fine-motor movements of a pen or pencil. Without sufficient knowledge of the alphabet, students may omit letters when they write the alphabet or struggle with more complex writing activities (Datchuk, 2015).

There are two main scripts (types of handwriting) that students learn in elementary school, printing and cursive. Printing is usually introduced in grade primary or grade one and cursive in grade two or three. Printing is handwriting in which the letters are formed separately and not joined together. The printed alphabet is characterized by round upright letters that look like type (Graham, 2010). Cursive is handwriting in which the letters are joined. When using cursive, each letter must contain a leader that could connect to a previous letter and a trailing part that could connect to the next (Berninger et al., 2006). When using either printing or cursive on lined paper, stems should come close to the top line and tails should extend low enough that to

clearly indicate they are tails (Berninger, Abbott, Jones, Wolf, Gould, Anderson-Youngstrom, Shimada & Apel, 2006).

Movements used for printing and cursive are, for the most part, classified as either discontinuous or continuous patterns. Discontinuous patterns involve an explicit start and stop point for printed letters, whereas continuous patterns do not require an explicit goal of when to start and stop cursive letters (Jin, Barta, Ferencak, Comstock, Riley & Krueger, 2014). The more complex sequential motor movements needed to form the loops and connections of cursive writing place more demand on the writer, which is why cursive is often taught after printing has been mastered (Berninger, Abbott, Augsburger & Garcia, 2009). If something is said to be handwritten, for the purposes of this thesis, it refers to printing and cursive. Also, handwriting will from now on refer to both printing and cursive.

The terms writing and handwriting are words that are often used interchangeably when used colloquially and even within research. Writing is often used to refer to any act of putting pen-to-paper. Herein, the word writing will be used to refer to a broader idea than handwriting. Writing will be used to refer to any activity of putting words on paper and composing text, as opposed to the creation of letters alone. Writing is a complex process and translating, reviewing, and planning have been identified as underlying processes (Medwell & Wray, 2014). Writing and cursive are terms that are sometimes used interchangeably but for the purposes of this thesis, we will use the definitions specified above.

Written expression is one of the most complex writing that people of all ages perform, which includes the important and necessary component of handwriting. Completing a piece of writing involves the coordination of multiple abilities such as cognitive, linguistic, and physical operations. These tasks include, but are not limited to, planning, generating text, transcribing,

reviewing, and revising (Hayes, 2012). Written expression involves generating ideas, constructing meaningful sentences, sequencing and organizing ideas into paragraphs (or other form), and using appropriate grammar.

Importance of Handwriting

Despite the ever-evolving technological advances, which include popular digital writing tools like word processing and speech synthesis applications, writing in many settings still involves paper and pencil or pen (Santangelo & Graham, 2016). The use of paper and pencil is still prominent in the school setting, as much of the work students complete is handwritten (Santangelo & Graham, 2016). Classic pen-to-paper handwriting remains an inexpensive, important, and convenient way for students to engage in writing in the classroom and at home. Handwriting plays a foundational role in writing as well as promotes continued growth of related writing abilities like spelling and sentence construction (Datchuk, 2015). Therefore, problems with handwriting can obviously negatively affect the writing of students. Slow, illegible handwriting can decrease the amount of writing output an individual creates and readers can struggle to interpret the message as intended. Handwriting instruction can help students with illegible handwriting, especially in early elementary school. (Datchuk, 2015).

Handwriting Difficulties

Misinterpretations of a composition are not the only consequence of handwriting difficulties. Poor handwriting can influence perceptions about someone's ability as a writer (Dinehart, 2015). Neatly written papers, that differ only in handwriting quality are often assigned a higher grade for writing quality than papers of poorer legibility. It has been found that more positive evaluations of nicely handwritten pieces were not associated with how nice the writing looked per se, but rather the fluency associated with processing legible versus illegible

handwriting. In other words, teachers are more likely to give higher grades to work they find easier to read (Dinehart, 2015).

Problems handwriting can also hinder composing processes during the act of writing. Having to intentionally attend to handwriting processes while writing may put stress on the writer's memory, interfering with other writing processes, such as creating content and planning ahead (Graham and Harris, 2000). For instance, having to switch attention during composing to mechanical demands, such as having to think about how to form a certain letter, may make the writer to forget ideas held in memory. Finally, handwriting difficulties may limit a child's development as a writer. Problems in mastering handwriting skills may lead children to avoid writing and develop the attitude that they cannot write, resulting in less writing development. Children may begin to feel frustration, decreased self-efficacy, and poor motivation (Dinehart, 2015). Handwriting may require so much effort for some students that they develop an approach to composing that minimizes the use of other writing processes, such as planning and revising, because they exert considerable processing demands as well (Graham and Harris, 2000).

Handwriting Benefits and Technology

Despite a shift away from classic paper-and-pen handwriting towards typing on a keyboard, writing skills have been positively linked to academic achievement at school. These skills include the production of letters, shapes, and numbers to complete written expression pieces (Dinehart, 2015). In early childhood, the development of early handwriting skills may be beneficial for two main reasons. First, research suggests that writing by hand in the early years, even before school age, supports the development of reading skills (Dinehart, 2015). Using functional magnetic resonance imaging technology with four- and five-year-old children, it has been found that writing letters by hand activated areas of the brain known as the reading circuit.

Writing letters activated specific areas more than either tracing or typing letters. Due to this activation, it was concluded that handwriting appears to support to the development of reading in young children. Also, although all fine-motor skills in preschool predicted later achievement, fine-motor writing skills were consistently stronger predictors of reading and mathematics achievement than fine-motor manipulation tasks (Dinehart, 2015). Second, given the positive connection between handwriting and academic achievement (Feder & Majnemer, 2007; Grissmer, Grimm, Aiyer, Murrah & Steele, 2010; Roberts, Derkach-Ferguson, Siever & Rose, 2014), the development of early handwriting readiness skills may increase the likelihood of academic achievement in an individual's later school years (Dinehart, 2015). Effective early handwriting instruction improves students' writing. Both legibility and the quantity and quality of the written expression piece are enhanced (Graham, 2010). Gains from handwriting instruction include an improvement in handwriting, sentence-writing skills, the amount students write, and the quality of their writing (Graham, 2010).

As students get older, they often begin using a laptop to take notes in class; however, laptop use has been proven to be inferior to classic paper-to-pen note taking (Mueller & Oppenheimer, 2014). Mueller & Oppenheimer, 2014 performed three experiments (one described below) to come to this conclusion. In one study, five TED Talks were selected to serve as the lecture. The room was set up with either laptops (disconnected from the Internet) or paper. Participants were instructed to use their normal classroom note taking strategy, to mimic class lectures. After watching the lecture, participants were taken to a lab where they completed two distracter tasks and engaged in a working memory task. Participants then responded to both factual-recall questions (e.g., “Approximately how many years ago did the Indus civilization exist?”) and conceptual-application questions (e.g., “How do Japan and Sweden differ in their

approaches to equality within their societies?") about the lecture. On factual-recall questions, participants performed equally well across conditions. On the other hand, on conceptual-application questions, laptop participants performed significantly less well than those who took notes by hand on paper. Participants using laptops were more likely to take longer transcription-like notes with more verbatim overlap with the lecture compared to those who took notes by hand. Although taking more notes and having more information could be beneficial, this transcription-style of note taking seemed to offset this benefit (Mueller & Oppenheimer, 2014).

Note taking by hand has been linked to positive test performance. Research in the area of effectiveness of note taking has focused on two ways in which note taking by hand can affect learning; encoding and external storage. The encoding hypothesis suggests that the processing that occurs during classic note taking improves the learning and retention of the taught material. The external storage hypothesis highlights the benefits of the ability to review material. Note taking saves the taught information so it is available later from the task environment. These two theories are often assessed together as students who both take *and* review their handwritten notes likely benefit the most (Benton & Kiewra, 1993; Mueller & Oppenheimer, 2014).

In studies exploring the encoding benefit, students listened to a lecture and were randomly assigned to groups which either took notes during the lecture or only listened. In order to isolate the encoding benefit, students in these studies were not allowed to review their notes before a test. A majority of such studies has found a beneficial effect of note taking (Bui and Myerson, 2014). Annis (1981) separated students into three conditions: students who took their own personal notes during a lecture, those who received a partial set of notes, and those who received a set of full notes with instructions not to write any of their own notes. Two weeks after attending a lecture and being assigned to one of the three groups, an exam was given. It was

found that those given partial notes and those who took their own notes performed significantly better than students who were given full notes, with personal note takers performing the best of all groups (Annis, 1981).

Larwin (2012) conducted an investigation to examine the impact of student prepared testing aids on student performance. The students were instructed to prepare one-side of a piece of paper to create a sheet of notes which they could use during the final assessment. Students were not given any other instructions as to how to prepare their aid. The results of this study support the encoding hypothesis in that students who hand-generated testing aids performed significantly better than students who computer-generated their testing aids (Larwin, 2012).

Best Practices in Handwriting Instruction

Generally, according to research, the best practices in handwriting instruction should include teaching children specifically how to form each letter, helping children become more fluent, promoting handwriting development, and provision of additional support to students experiencing difficulty (Graham, 2010). More specifically, during the beginning stages of teaching students handwriting, the teacher provides the most amount of support, with teachers delivering less feedback with time and correct student responses. It is important for the teacher to model multiple correct responses of the letters being taught. The teacher should provide frequent feedback to the students (Arslan, 2012), addressing each letter individually in the beginning, with the amount of feedback lessening with time. The feedback should include immediate correction of errors and praise for correct letters. Students should then complete more items correctly on their own before receiving teacher feedback (Datchuk, 2015).

When determining which letters of the alphabet to start with, it is important to pay particular attention to the number of letters in each lesson and the similarity in shape between

letters (Graham, Harris & Fink, 2000). It is suggested that the number of newly introduced or reviewed letters per lesson be kept to two to three letters, to ensure students have the chance to become familiar with each letter and to build accuracy and speed. Some research recommends teaching letters with similar shapes (e.g., b and d, u and n) during different lessons to try and reduce possible confusion and letter formation errors, like reversals (Datchuk, 2015). Others suggest that letters formed in similar ways or sharing characteristics should be grouped together, like the letters v, w, y because they have slanting lines, so students can note similarities (Graham et al., 2000). Letters occurring more frequently in students' writing should be introduced first as well as letters that are easier for young children to produce, for example l and i (Graham et al., 2000).

When teaching students handwriting, it is the goal to have students write letters accurately and fluently, eventually moving on to words and sentences (Graham et al., 2000). Graham suggests that during grades primary through three handwriting should be taught in short sessions several times a week (or daily), totalling 50 to 100 minutes per week of instruction time, resulting in substantial gains made by students for such a small amount of time devoted to teaching handwriting (Graham, 2010). Regardless of whether or not teachers follow this method of teaching handwriting, there will be some students who struggle. Potential areas for handwriting intervention include letter formation (legible letters with correct strokes and shapes), alphabetic knowledge (identification of letters of the alphabet by correct name and sequence), and handwriting speed, which is the quick writing of legible letters (Datchuk, 2015).

An area of disagreement among researchers involves the usefulness of teaching motor skills. It is generally assumed that fine-motor skills are critical to developing handwriting, as writing involves a specific sequence of movements involving the fingers and hand. Some

research points to the idea that fine-motor skills are an important component in the early stages of learning handwriting (e.g., Vries, Hartingsveldt, Cup, Nijhuis-van der Sanden & Groot, 2015). This has led to the development of instruction that addresses fine-motor skills either before, during, or instead of, handwriting instruction. However, the value of such approaches is not clear, as students' fine-motor skills are not a good predictor of their proficiency in handwriting (Santangelo & Graham, 2016). Something that is agreed upon is that it is important that students get off to a good start in writing. There is much agreement that waiting until later grades to address writing challenges that began at the primary level is not very effective (Cutler & Graham, 2008).

Specific Key Elements of Effective Printing Instruction

Four key elements of effective printing instruction have been identified by research. First, during the beginning stages of teaching students printing, the teacher provides the most amount of support. It is important for the teacher to model multiple correct responses of the letters being taught (Arslan, 2012). Second, during the beginning stages of teaching students printing, the teacher provides the most amount of feedback, with teachers delivering less feedback with time and correct student responses. The teacher should provide frequent feedback to the students (Arslan, 2012), addressing each letter individually in the beginning, lessening with time. The feedback should include immediate correction of errors and praise for correct letters. Students should then complete more items correctly on their own before receiving teacher feedback (Datchuk, 2015). Third, that the number of newly introduced or reviewed letters per lesson be kept to two to three letters, as to ensure students have the chance to become familiar with each letter and to build accuracy and speed (Datchuk, 2015). Connected with this, letters formed in similar ways or sharing characteristics should be grouped together, like the letters v, w, y

because they have slanting lines (Graham et al., 2000). Fourth, handwriting should be taught in short sessions several times a week (or daily), totalling 50 to 100 minutes per week of instruction time (Graham, 2010).

The four above mentioned key elements will be used to compare two printing instruction programs. The factors are: (1) level of teacher support throughout each stage and modeling multiple correct responses, (2) level of teacher feedback throughout each stage with the inclusion of immediate correction of errors and praise for correctness, (3) how new information is introduced with new letters per lesson kept to two or three that show similarities, and (4) organization of instruction time using short and frequent sessions. A fifth factor cost and ease of access, will also be examined. The cost and ease of access of both programs are factors not mentioned in research. However, this is an important and relevant factor when considering teachers and school boards, as they would likely value this information as much as the evidence behind the programs.

Handwriting Programs

There are numerous programs available to assist teachers with organizing handwriting instruction. The Center on Accelerating Student Learning (CASL) Handwriting Program and Handwriting Without Tears (HWT) Program were chosen to be included in this study because of evidence-based roots, ease of access, and popularity. The CASL Program focuses solely on teaching printing. The HWT Program is available for students from kindergarten through grade five and is available for teaching both printing and cursive. The focus of this thesis will be the printing portion of the HWT Program.

Handwriting Without Tears. Handwriting Without Tears is a commercially available program that is often used to teach early elementary students to handwrite in Nova Scotia. The

program was developed by occupational therapist, Jan Olsen. According to an article on HWT's website, Handwriting Without Tears Delivers Success (2014), the Handwriting Without Tears curriculum is based on years of research to provide developmentally appropriate, multisensory tools and strategies to teach students handwriting. The article states that the curriculum is easy to teach and easy to learn, which makes handwriting mastery joyful for students and teachers.

The program is said to promote developmentally appropriate learning by using stages from imitation to copying to independent writing, which is achieved by grouping letters of similar difficulty and using a letter style that uses simple vertical lines. The HWT Program uses a multisensory approach through the use of teacher modeling of letter formations, use of verbal descriptions of the strokes that create letters, finger tracing of letters, drawing letters in the air, and using various materials to teach the correct letter formations. The approach is reported to follow research that demonstrates children learn more effectively by being hands-on with materials that address multiple styles of learning. Some of the available materials include small chalkboards, gray block paper, and small pencils or chalk bits. The HWT program is based on three principles. First, materials used should be intuitive, engaging, and developmentally progressive. Second, instruction should engage children as active participants as they move, sing, talk, and experience the lessons. Finally, there should be support for expansion of teacher knowledge. The main aim of the curriculum is for students to develop good, consistent handwriting size, formation, and placement of the letters on the lines (Olsen, 2009).

A search using the term *Handwriting Without Tears* was completed using three different databases (Academic Search Premier, ERIC, and PsycINFO). When using Academic Search Premier, four articles were found. Upon review of these four articles, one will be reviewed below. One excluded article's focus was on the cursive portion of the HWT Program. A second

does not mention the program at all. The third excluded article only mentions a HWT app and its cost. These three articles will not be reviewed as they do not study the effectiveness of the printing portion of the HWT Program. A search of the database ERIC revealed six articles. Upon further review of these six articles, five of them will be discussed below in greater detail as one excluded article's focus was on the cursive portion of the HWT Program (the same article found through Academic Search Premier and excluded from review). The database PsycINFO offered four initial results. Of these four articles, three will be reviewed further. One article was excluded as it overlapped with the database ERIC (the 2009 study by Carlson, McLaughlin, Derby and Blecher appeared in both searches). The nine included articles are indicated with an asterisk in the reference section.

Four of these studies used a case study design. Meyers, McLaughlin, Derby, Weber and Robison (2015) examined the effect of the HWT Program on teaching a four-year-old male preschooler with developmental delays in areas such as cognition, fine motor skills, and communication, how to properly size and form the letters in his first name. The student was familiar with the letters of his first name but was unable to correctly print them. The study took place in a special education preschool and the intervention lasted for 15 minutes in the afternoon for four days a week for a total of 15 sessions. The first author worked with the participant in his classroom. They were seated at a table by themselves in an area of the room that was away from any distractions. Following each HWT session the participant was given a strip of paper and asked to "Write name". For the purposes of the study, the student earned one point each for suitable size, form, and tool (pencil) per letter. The participant made considerable gains in correctly printing the letters in his first name. Prior to the study, the participant was only able to

recognize the first letter of his name and at the end of the study, he was able to earn two to three points per letter printed (Meyers et al., 2015).

Steele, McLaughlin, Derby, Weber, Donica and McKenzie (2015) evaluated the effectiveness of the HWT Program. This was done through the examination of the progress of a participant with printing his first name independently, using letters with suitable size, shape, and form. The participant was a four-year-old boy with diagnosed developmental delays in pre-academic skills, communication, fine motor, and adaptive areas. The study occurred during the regular preschool classroom routine and sessions took place during free play time and center activity time. The participant was instructed one-on-one and most of the 20 sessions occurred at a table outside of the classroom in order to reduce distractions. As in the previous study, following each HWT session a blank piece of paper was given to the student to print the letters of his first name. For the purposes of the study, the letters were scored using a point system with three possible points awarded per letter of his name. On the last day of instruction, the participant reached 88% accuracy in writing his name with the appropriate size, shape, and form of each letter. Prior to the intervention, the participant was only able to recognize the first letter of his name. Session 19 took place on the day that the participant returned from a two week school break and had not had a session for two weeks. The authors concluded that learning had actually occurred because the student showed maintenance of gains of information taught prior to the break. This was seen in his ability to correctly size, shape, and form the letters by himself (Steel et al., 2015).

Griffith, McLaughlin, Neyman, Donica and Robison (2013) measured the effectiveness of HWT on letter writing with two preschool students diagnosed with developmental delays. The two students were selected by the classroom teacher from a special education preschool

classroom. The two participants were not able to print their name and needed to acquire this skill before beginning kindergarten. The program was used to teach both students how print the letters in their first names. In the baseline trial, both students were asked to, "Write the letters of your name." During this trial, the two participants were able to print some of the letters in their names. However, both students did so unreliably, as many letters had inconsistencies over the five baseline trials. The participants were worked with one-on-one at a table within the classroom, which was placed specifically to prevent distractions. The study took place over nine weeks, with a total of 16 sessions, lasting 10 to 20 minutes for one participant and 18 sessions, lasting 15 to 40 minutes for the second student. Both students showed improvement in their ability to print the letters of their name. The authors noted that the program was inexpensive and easy to implement, making it possible for most teachers to use it in the classroom (Griffith et al., 2013).

The participants in Carlson et al.'s (2009) study were two preschool age children with developmental disabilities. The goal of this study was to test the HWT Program and its ability to help increase the legibility of chosen letters using tracing. Participant one was a four-year-old boy diagnosed with autism. Participant two was a four-year-old girl diagnosed with developmental delays. The participants were chosen for the study because neither student could legibly print any letters other than those in their first name. A multiple baseline design was used to test the effects of the HWT-Get Set for School (HWT-GSS) curriculum. The study was carried out in a special education preschool classroom. The curriculum was used for 14, 15-minute sessions for participant one and 9 sessions, each lasting 15 minutes, for participant two. During baseline, neither participant could legibly print the letters chosen for the study (T, H, D, and F). The number of legible letters were scored after each session to measure improvement. The results of this study indicated that the use of the HWT Program can increase a student's ability to

print specified letters because the quality of the printed letters increased for each participant by the end of the study (Carlson et al., 2009).

In study by Patton and Hutton (2016), perspectives of parents on a three-way collaboration between teachers, parents, and occupational therapists in the use of the HWT Program with children with Down Syndrome were of interest. All children in the study were between the ages of five and ten and were experiencing challenges in printing based on a parent or teacher report. Forty-six children with this diagnosis who were attending mainstream schools (along with their parents and teachers) were recruited for the study. Using a mixed methods design, 46 parents completed pre-intervention questionnaires and 44 completed post-intervention questionnaires regarding their children. Six parents attended a post-intervention focus group to gather their perspectives. The study included both parent and teacher education in the use of HWT, goal setting, child/parent participation in group intervention (7 sessions), and support during the program at home and school over an eight month period. The authors did not set out to study how effective the HWT Program was at improving printing ability but wanted to gain insight into parent's perspectives of the program. The authors determined that the HWT Program was a useful teaching method for parents. The program promoted active parent-child engagement while learning printing skills. The three-way collaboration was important to allow parent-child involvement in using the program at home, as was the inclusion of group intervention (Patton & Hutton, 2016).

In a second study conducted by Patton and Hutton (2017), the same group of individuals with Down Syndrome were of focus. Children with Down Syndrome often have difficulty maintaining their engagement with academic tasks. This study set out to evaluate the HWT Program as a way to encourage motivation to printing and improve such skills among children

with this diagnosis. A HWT group task participation scale and pre- and post-intervention teacher and parent questionnaires were created by the authors and used to explore the participation of the participating children in HWT activities. A collaborative approach was used and the first author trained parents and teachers in the HWT Program. Parents and teachers then were able to teach the program at home or school, with support provided from the first author, over the eight-month period of the study. Children and parents also attended seven HWT group intervention sessions. Positive changes in participation in HWT activities were recorded in group data and in teacher and parent reports. Post-intervention, it was found that 82% of parents and 79% of teachers reported that the child had more interest in printing. Approximately 75% of teachers and parents strongly agreed or agreed that the student showed more enjoyment of writing activities after the completion of the study. Findings suggest that hands-on multisensory programs such as HWT may encourage children with Down Syndrome to take part in activities that promote handwriting skills (Patton & Hutton, 2017).

Roberts et al. (2014) examined the effectiveness of HWT on grade one students' printing skills. This study included 83 boys and 66 girls with an average age of six years and two months. A cross-over design was used with repeated measures and included the Minnesota Handwriting Assessment (MHA) and performance rating scales. Students were asked to copy the sentence "The brown jumped lazy fox quick dogs over", at three points throughout the study. This sentence contains all the letters of the alphabet but was not in its regular form to account for factors such as memory and reading level. The printing sample was assessed for rate of completion and five components considered important for good quality printed letters. The components were legibility, form, alignment, size, and spacing. Students receiving HWT achieved significantly greater improvements compared to students with teacher-designed

instruction in MHA Total Test Score and in four of the five (not legibility) MHA components mentioned above. The authors concluded that instruction using HWT was shown to improve students' skill in printing (Roberts et al., 2014).

Dolin (2017) investigated the effect of printing instruction, using the HWT curriculum, on student handwriting ability. This study included 789 primary and first grade students attending elementary school with a random sample of 320 students chosen for final data analysis. Students from two types of classrooms were included in the study. The first group included classes who had a teacher that was not trained in and did not use the HWT curriculum. The second group included classes who had a teacher that was trained in and did use the HWT curriculum to teach handwriting. The two groups were compared on measures of legibility, written literacy, and basic literacy skills. Those students who received the HWT curriculum instruction scored better in areas of written literacy, number of words written, number of properly spelled words, and number of ideas expressed in writing compared to students who did not receive HWT instruction (Dolin, 2017).

Lust and Donica (2011) investigated whether HWT-GSS was differently effective than traditional Head Start curriculum for teaching handwriting readiness skills. All students were four to five years of age and intervention sessions occurred three times a week from October to March. Two groups were included in the study, one that received HWT instruction and one that received the Head Start curriculum. Their handwriting readiness was measured before and after the intervention. On post-testing, both groups made significant improvements between pretesting and post-testing in prewriting, printing their first name, handwriting readiness, and school readiness but the HWT group made greater improvements compared to the control group in prewriting, primary readiness, and fine motor skills. This suggests that Head Start programs are

effective in improving handwriting readiness, but supplementing with HWT significantly improves handwriting readiness beyond what is accomplished by the Head Start curriculum alone (Lust & Donica, 2011).

Center on Accelerating Student Learning Handwriting Program. The second program of interest was developed by respected handwriting researchers, Steve Graham and Karen Harris. This program was based on research Graham and Harris have conducted since the 1980s (e.g., Graham, 2010; Graham & Harris, 2000; Graham & Weintraub, 1996) and is called the Center on Accelerating Student Learning (CASL) Handwriting Program. More specifically, the development and testing of the program was conducted over a five-year period (1999-2004) as part of a larger effort involving three research sites. The sites were Vanderbilt University, Columbia University, and the University of Maryland, and the effort was funded as the Center on Accelerating Student Learning by the Office of Special Education Programs in the U.S. Department of Education. The CASL researchers worked to develop and test the effectiveness of instructional procedures in writing, reading, and mathematics for primary through grade three students (Graham & Harris, 2005). The handwriting portion of the program was developed to accelerate the handwriting development of slow handwriters, including children with and without disabilities.

The program's 27 lessons take 15 minutes each, focus only on printing, and can be used with a whole class or with individual kindergarten (primary) or first grade students. The program can also be used or as a method of intervention for second grade students who struggle with printing and may produce written work too slowly or have writing that is illegible (Graham, 2010). Each lesson has four parts: (1) alphabet warm-up, (2) alphabet practice, (3) alphabet rockets, and (4) alphabet fun. Alphabet warm-up is to help students learn the letters of the

alphabet and to gain quick access to them. This is a pre-writing activity that does not involve the student printing. Alphabet practice helps students learn how to properly form letters and speed is not emphasized. Alphabet rockets help the student to increase the speed of handwriting but accuracy is not emphasized. Alphabet fun is exactly what it sounds like, extra time for students to have some fun with letters.

A search of the term *Center on Accelerating Student Learning Handwriting Program*, using PsychINFO, Academic Search Premier, and ERIC yielded no results but a large number (771 in PsycInfo, 1 in Academic Search Premier, and 640 in ERIC) of articles were identified using Smart Text Searching. The titles of these articles were reviewed to determine whether they included the words writing or *handwriting* or referenced the CASL Program specifically. If the titles contained these terms, the abstracts were reviewed to determine whether the article referenced the CASL Program specifically. One article was were found using PsycINFO, the same article was found using ERIC, and two additional articles were found using Academic Search Premier. The three articles are indicated with a double asterisk in the reference section.

In a review of the CASL Handwriting Program, Oxaal (2005) describes the years of research conducted and provides an introduction to key aspects of the work of the researchers. The CASL researchers designed a systematic program of large-scale classroom research studies using multiple methods. They asked related questions, designed to further practice and research, that required qualitative or case study designs. The researchers also carefully monitored treatment fidelity. The CASL Program had a broad focus and its goal was to provide guidance about explicit and comprehensive instruction in mathematics, reading, and writing for children in grades primary through three. Oxaal noted that the handwriting program was designed especially

for individuals identified as having disabilities and/or as being at risk for disabilities and in recognition of the need for early intervention research and classroom use (Oxaal, 2005).

Graham, Harris, and Fink (2000) tested the effectiveness of the CASL Handwriting Program in grade one classrooms in four schools. Three hundred and ten grade one students were administered a timed printing screening measure that measured fluency. The printing screening task was used to identify children struggling with printing. The average age of participants was six years and nine months old. Twenty-six of the children were boys and 12 were girls. All of the participating students were experiencing difficulties learning to write and each child's printing fluency was below what would be expected for their age. None of the children were able to copy more than sixteen letters correctly in one minute. Close to 40% of these students had been identified as having a disability (e.g., learning disability, attention deficit hyperactivity disorder, developmental disability) and 55% had previously participated in the Reading Recovery program. The CASL Program was provided as a supplement to the printing instruction already provided by the classroom teachers. In comparison to grade one students who received phonological awareness instruction to control for extra instructional time, students with and without disabilities in the CASL Handwriting Program made more gains in printing than students in the control group immediately following instruction and these gains were maintained at six month follow-up (Graham, Harris & Fink, 2000). Improvements included faster printing, a larger number of properly formed letters, greater ability to write sentences, and better output when writing a story. The authors concluded that early, supplemental printing instruction can enhance the writing performance of children with disabilities and that this instruction is an important in preventing challenges in writing (Graham, Harris & Fink, 2000).

Graham and Harris (2006) tested the effectiveness of the CASL Handwriting Program with 30 grade one students who were experiencing difficulties with handwriting. One third of the children were identified as having special needs, with diagnoses that included attention deficit/hyperactivity disorder (ADHD) and learning disabilities. The researchers randomly selected half of the students for the CASL Handwriting Program and the other half received instruction designed to improve phonological awareness to control for instructional time. Both groups had average word-recognition skills and presented with average intelligence. In comparison with children in the phonological awareness program, students who received the CASL Handwriting Program made greater gains in handwriting legibility, fluency, sentence writing, and vocabulary in their written pieces immediately after instruction. This demonstrates that the CASL Program improved the student's handwriting, as well as two other aspects of writing that the program did not explicitly target, sentence construction and vocabulary (Graham, 2006).

Both the HWT Program and CASL Handwriting Program have been shown to be effective ways of teaching students handwriting. The next section will compare these two programs based on the key elements of effective handwriting instruction which have been identified in research. These are (1) level of teacher support throughout each stage and use of modeling multiple correct responses, (2) level of teacher feedback throughout each stage with the inclusion of immediate correction of errors and praise for correctness, (3) how new information is introduced with new letters per lesson kept to two or three that show similarities, and (4) instruction time using short and frequent sessions. Because cost and ease of availability of the program will also, logically, be important to teachers and school boards, they will be an additional point of comparison.

Handwriting Without Tears (HWT) Program and Center on Accelerating Student Learning (CASL) Handwriting Program Comparison

Teacher support and use of modeling. According to Olsen and Knapton (2008) in the HWT teacher's guide, printing instruction is completed in three steps: imitation, copying, and independent writing. Imitation is defined as when the child watches the teacher as they write and then the student imitates the teacher. It is said to have two advantages. First, it gives the student the best chance to write the letter and second, it teaches the student correct motor habits. When introducing a new letter, teachers are instructed to say each letter and to name each stroke or step in making the letter as the letter is demonstrated using words like big line, little line, big curve, and little curve. Teachers are instructed to model letters step-by-step and to be consistent with words used to describe letter strokes. When teaching students to print their names, it is suggested that teachers demonstrate how to form letters on one blank strip of paper and have the child imitate the letter formation on a second strip. It is also recommended that each stroke/step is said aloud as the student prints a letter, encouraging the child to say the stroke/steps aloud as well. The program also notes that it is important for the instructor to model correct grip when doing demonstrations with the students as they tend to do what the teacher does. However, the program guide does not indicate how to phase out this teacher support as the students become more capable of printing letters and words independently (Olsen & Knapton, 2008).

According to Graham and Harris (n. d.), during all letter activities in the CASL Program, the teacher should model how to form each letter as the students watch. The teacher must be sure to model the letter correctly and describe the process at the same time. When the student takes their turn, the teacher is to ensure that the letter has been formed correctly, whether just tracing a letter with a finger or actually printing the letter. Before students get to print a letter, teachers are

asked to check their pencil grip. Then the teacher supports them through the use of questions used to have to students think about the letters. They are asked how letters in a particular group are similar and how they are different. The child is then asked to work on one letter at a time independently and encouraged to say the letters aloud as they move through the program (Graham & Harris, n. d.).

Both the HWT and the CASL programs include information regarding teacher support and/or modeling of letters as essential components of the program; however, the HWT Program is superior to the CASL Program with respect to part of this necessary element for effective handwriting instruction. It gives clearer instructions for teachers about how to model letters and what language to use when doing so. Handwriting Without Tears lacks specific information regarding how to reduce teacher support through the course of the program. CASL provides better information regarding teacher support as children become able to complete handwriting tasks on their own.

Level of teacher feedback. The idea of correction and praise is briefly mentioned twice in the HWT teacher's guide (Olsen & Knapton, 2008). It is first mentioned in the section on remediating handwriting difficulties. The guide mentions that recognition of what a student gets correct is encouraging and should come before any suggestions or corrections that are required. Second, the guide suggests that a small reward can be offered to the child as motivation to use the proper pencil grip. Level of feedback is mentioned on a parent handout page. The handout indicates that if a child has difficulty imitating a letter, parents can assist by using a gray crayon to pre-write that letter on the child's paper for them to trace. It is suggested that the gray letters become progressively lighter and that pre-writing should be stopped once the child learns the letter. The only other mention of feedback is when the guide instructs the teacher to help children

check their letters for proper start, steps, and bumps. No specific instructions about how to do this are provided (Olsen & Knapton, 2008).

During the alphabet song pre-writing activity in the CASL Program, the teacher must make sure to correct mistakes and offer feedback but to also let students do it independently as soon as they are able (Graham and Harris, n. d.). Teachers are instructed to always be positive when teaching printing and to reinforce and provide feedback to students as necessary during all activities. On a fluency activity, the idea of positivity is mentioned more specifically. During the activity, the teacher should ask their student if the goal was met. If the student met their goal, the teacher gives them a big star. If the goal was not met, the student is encouraged by the teacher who is instructed to let tell the child that they worked hard and will be able to meet the goal next time. A yellow highlighter is used to point out areas needing improvement with letters a student has printed. The guide provide teachers with information about specific aspects of letters that they should correct (e.g., letter formation and slant), and about specific ways of correcting each using the highlighter. The student then is asked to correct the highlighted sections (Graham and Harris, n. d.).

Both the CASL Program and HWT Program addresses the idea of teacher feedback, correction, and praise but CASL does so in a more detailed way. Therefore, the CASL Program is superior to the HWT Program in this important aspect of handwriting instruction.

Introduction of new information. The HWT Program states that it follows a developmental teaching order where instruction is planned to help students learn handwriting in the easiest and most efficient way (Olsen & Knapton, 2008). It begins by instructing teachers to teach students the easier letters, the capitals, which are all formed by starting at the top of the letter. The capitals should be taught in three groups that share similar characteristics. The groups

are the Frog Jump Capitals (F, E, D, P, B, R, N, M), the Starting Corner Capitals (H, K, L, U, V, W, X, Y, Z), and the Center Starters (C, O, Q, G, S, A, I, T, J). The Frog Jump Capitals all start at the top left corner with a big line, the next part is on the right side. This is said to prevent reversals and teaches good stroke habits. The Starting Corner Capitals ensures that letters begin at the top left and use the left-to-right habit. This group promotes the habit of top-to-bottom as well. The Center Starters group includes the letters C, O, Q, and G, which all start with a Magic C stroke. The strokes and steps that students learn with C, O, S, T, and J will make learning their lowercase counterparts much easier and there will not be problems with stroke direction or reversals. The lowercase letters are introduced in a different order and within different groups. First, students should first be taught c, o, s, v, w, and t because they are so similar to their capital counterparts. Next teach a, d, and g because these high frequency letters begin with the previously learned Magic c. The next group of letters include u, i, e, l, k, y, and j to introduce the rest of the vowels and the others are familiar from capitals. The second last group includes p, r, n, m, h, and b because they start with the same pattern (dive down, swim up, swim over) and the b-d confusion is said to be avoided by separating the letters and teaching them in different groups. Finally, teach students the letters f, q, x, and z as the letter f has a challenging start. The letter q is to be taught separately from g to avoid confusion. The letters x and z are familiar but are not used often. Vertical print uses four shapes, including vertical and horizontal lines, circles and curves, and diagonal lines. The teaching guidelines lay out a structured approach to using the curriculum, although it is mentioned that HWT is adaptable and can be used in numerous ways. The structured approach in the guide suggests teachers teach one letter at a time over the span of two days, using multiple short activities from the guide to do so with reviews after each group of letters has been taught. If the curriculum was followed in this way, it would be accomplished in

29 weeks, with a few weeks following set aside for review if desired (Olsen & Knapton, 2008).

In each unit of the CASL Program, three lowercase letters are introduced except in the final unit where just two letters are introduced (Graham and Harris, n. d.). All letters introduced to students in each unit share common formational characteristics. In unit one, the straight line letters are taught (l, i, t), in unit two, the backward curved letters are taught (o, e, a), and in unit three, the curved letters are introduced (n, s, r). In the fourth unit, students learn two tall and one tailed letter (p, h, f). In the fifth, the backward circle letters are taught (c, d, g), and in the sixth unit, curved and one tall letter are introduced (b, u, m). In the seventh unit, the slant letters are taught (v, w, y). During the eighth unit, students learn more slant letters (x, k, z), and in the final unit, tailed letters are introduced (j, q). The letters in the nine units are taught in order from more to less frequently used and from easier to more difficult to form. There are two exceptions to this. Firstly, the letters in the second unit are more frequently used than in the first, but those in the first are easier to print. Secondly, the letters in the seventh and eighth units are easier than those in the fifth and sixth units. The letters in each unit were also put together because they are not easily confused or reversed with one another (Graham and Harris, n. d.).

Both the CASL Program and HWT Program include specific information about how to introduce letter formation to students, but the CASL Program is superior in this area of effective handwriting instruction. Research indicates letters should be introduced in groups of two or three similar letters. The CASL Program introduces letters two to three at a time and they are grouped with other similarly formed letters. Despite teachers being instructed to teach the letters in three groups that share similar characteristics, the HWT Program guide contradicts itself. It does so as the guide also instructs teachers to teach one letter over the span of two days. Letters are not taught in these three groups that show formation similarities as letters are taught one at a time on

separate days. The HWT Program first introduces each individual letter from a specific group and then, after all have been taught, the whole group of letters is shown to the students.

Organization of instruction time. As previously noted, research has found that handwriting instruction that uses short, frequent sessions is most effective. The HWT guide mentions this idea when laying out the structured approach to using the HWT curriculum. HWT indicates that handwriting should be taught every day and notes that this only requires a short period of time because the students complete just one or two activities on one specific letter. In the section of the teacher's guide addressing remediating handwriting difficulties, it is recommended that practice sessions are short (ten to fifteen minutes) to keep children's attention and full effort. The lesson should end while it is still going well or as soon as a child's interest has been lost. Also, once students have completed their workbooks, teachers can continue with short lessons to maintain and improve upon handwriting skills but nothing more specific regarding what these lessons would look like is offered in the guide (Olsen & Knapton, 2008).

There is little focus on the specifics of instruction time in the CASL Program. Each of the nine units in the CASL Program consists of three, 15 minute lessons, with four short activities per lesson. However, there is no specific mention of how frequently these lessons should occur (Graham and Harris, n. d.).

Both the CASL Program and HWT Program address the organization of instruction time and suggest short, frequent lessons. However, the HWT Program has a more structured approach which lays out lessons day-by-day, than the CASL Program. The HWT Program is specific about completing one lesson per day, whereas the CASL Program is not specific about this.

Cost and ease of access. To purchase the essential components to each the HWT Program, a teacher would need to have the Teacher's Guide for the student workbook, which

costs $11.25 USD. Student Workbooks, titled Letters and Numbers for Me, which costs $10.15 USD per book would also be needed. If a primary class consisted of twenty students and one teacher, the total cost would be $214.25 USD plus taxes and shipping. These essential components plus many other additional components are available for purchase at http://shopping.lwtears.com and shipping time would vary depending on one's specific location. There are HWT programs specifically geared toward each grade from primary to five. The program for grades primary through two focus on learning to print and grades three through five focus on learning cursive.

The CASL Program is available from https://peabody.vanderbilt.edu/departments/sped /research/casl_-_center_on_accelerating_student_learning.php. This link will provide access to a free PDF download of the entire program designed for grade one students to learn how to print. The program requires external materials that a teacher would already have in their classroom or could easily gain access to such as a yellow highlighter, extra lined paper, and jumbo alphabet cards.

It is clear that the CASL Program is easier to access and is the more cost effective option of the two, especially for teachers who must often buy supplies out of pocket. In terms of cost and ease of access, the CASL Program would be recommended over HWT in all circumstances.

Discussion

Despite ever-evolving technological advances, writing in many settings, including school, still involves paper and pencil or pen (Santangelo & Graham, 2016). Classic pen-to-paper handwriting remains an inexpensive, important, and convenient way for students to engage in writing. Handwriting skills have been positively linked to academic achievement broadly. Handwriting also plays a specific role in the development of writing skills and promotes the

growth of related writing abilities like spelling, and sentence construction (Datchuk, 2015). Poor handwriting can influence perceptions about someone's ability as a writer and teachers are more likely to give higher grades to work that is more legible and, therefore, that they find easier to read (Dinehart, 2015). Slow, illegible handwriting can decrease the amount of writing output and readers can struggle to interpret the message as intended. Handwriting instruction can help students with illegible handwriting, especially in early elementary school (Datchuk, 2015).

Laptop use has been proven to be inferior to classic paper-to-pen note taking. In a study completed by Mueller and Oppenheimer (2014), participants using laptops were more likely to take longer transcription-like notes. Although taking more notes and having more information could be beneficial, this transcription-style of note taking seemed to offset this benefit as it resulted in shallower information processing. Participants who took notes using paper and pen/pencil provided better answers to conceptual questions than those who took notes using a computer. Note taking using paper and pen/pencil has been linked to positive test performance. The encoding hypothesis suggests that the processing that occurs during classic note taking improves the learning and retention of the taught material. Therefore, taking notes using paper and pen/pencil can give students an advantage during test taking (Benton & Kiewra, 1993; Mueller & Oppenheimer, 2014).

Effective elements of handwriting instruction. Four key elements of effective printing instruction have been identified. First, during the beginning stages of teaching students printing, the teacher provides the most amount of support. It is important for the teacher to model multiple correct responses of the letters being taught (Arslan, 2012). Second, during the beginning stages of teaching students printing, the teacher provides the most amount of feedback, with teachers delivering less feedback with time and correct student responses (Arslan, 2012). The feedback

should include immediate correction of errors and praise for correct letters (Datchuk, 2015). Third, number of newly introduced or reviewed letters per lesson should be kept to two to three letters (Datchuk, 2015). Connected with this, letters formed in similar ways or sharing characteristics should be grouped together (Graham et al., 2000). Fourth, handwriting should be taught in short sessions several times a day or week (Graham, 2010). The cost and ease of access of programs are factors not typically considered in research about program effectiveness. However, they are two important and relevant factors for those using and purchasing handwriting programs. This would include teachers and school boards and they would likely consider this information as well as the evidence behind the programs. Therefore, cost and ease of access served as the fifth comparison factor.

Programs of focus. The HWT Program was chosen for comparison because it is a commercially available program that is often used to teach early elementary students to handwrite in Nova Scotia. Handwriting Without Tears is a commercially available program that is often used to teach early elementary students to handwrite. The program was developed by occupational therapist, Jan Olsen. According to an article on HWT's website, Handwriting Without Tears Delivers Success (2014), the curriculum is based on years of research. It provides developmentally appropriate, multisensory tools and strategies to teach students handwriting. The program is said to promote developmentally appropriate learning by using stages from imitation to copying to independent handwriting.

The CASL Program was chosen for comparison because it was developed by respected handwriting researchers, Steve Graham and Karen Harris, is easily accessible, and is free. This program was based on research Graham and Harris have conducted since the 1980s (e.g., Graham, 2010; Graham & Harris, 2000; Graham & Weintraub, 1996). The development and

testing of the program was conducted over a five-year period (1999-2004) as part of a larger effort. The handwriting program was developed to accelerate the handwriting development of slow handwriters, including children with and without disabilities (Graham & Harris, 2005).

Final Program Recommendation. An examination of both programs to see if they included the important components of effective handwriting instruction found that both the CASL and HWT programs had strengths in terms of teacher support and use of modeling (factor one), but the CASL program was concluded to be better than HWT in addressing the level of teacher support throughout the learning process. The HWT Program did a more thorough job explaining the other aspect of this key element, modeling correct responses. Level of teacher feedback (factor two) was better addressed in the CASL Program as was introduction of new information (factor three). It was concluded that the HWT Program better addressed the organization of instruction time using short and frequent sessions (factor four). With respect to cost and ease of access (factor five), the CASL Program is better because it free and easily accessible online, whereas the HWT Program would cost a minimum of $214.25 USD plus taxes and shipping. To summarize, the CASL Program is better in 3.5/5 components and the HWT Program is better in 1.5/5 components. As the CASL Program was concluded to better address the majority of the important components of effective handwriting, it would be the better choice.

Research has found both the CASL and HWT programs to be effective. Therefore, an individual could successfully teach students handwriting using either format. However, if a teacher is concerned with teaching according to the most effective elements, the CASL Program would be a better choice. Another major factor in the decision to recommend the CASL Program was the cost and ease of access of the full program. The program is completely free and downloaded easily from the internet. In consideration of teachers and schools boards, free is

always preferable, especially when the free and easily accessible option is backed by research and has been proven effective. As many teachers may already own the necessary materials for implementing the HWT curriculum and want to get use out of them, they can rest assured that the program does address the important elements in effective handwriting instruction. The CASL Program would be recommended in all circumstances.

Limitations. One limitation of this study was the small sample size, in this case, comparing just two of the many available programs to teach handwriting. Therefore, it is important not to take this conclusion as an absolute endorsement of the CASL Program over every other available handwriting program. Another limitation is the use of five specific comparison features. Even though these key features were deemed most important, there may be other factors that would have been seen as important for individuals who are looking to find a good program to guide their teaching of handwriting.

Suggestions for school boards, teachers, and school psychologists. School boards and teachers should be aware of the programs used in their schools to teach all subjects. It is important to have an understanding of the research, if any, that was used in the creation of specific programs. Using programs that have been created and tested with research based principles are more likely to be effective and produce the best outcomes. This benefits all involved from students to teachers and school boards, as school boards are often concerned with student performance rate and improving upon the student body's grades as a whole.

School psychologists have a duty to be aware of what programs are being used in their school board, including what the research indicates regarding the effectiveness of these programs. Without this knowledge, it would be difficult to recommend research based programs to teachers and school boards who may inquire about such information. It could even be helpful

if this information has not been specifically sought after but may need to be offered. For instance, if a teacher has a classroom of students with the majority performing below where expected in a particular subject, the issue may not be the students or teacher, but the program being used to teach the subject. This could be a helpful recommendation for a school psychologist to offer to help both the teacher and students. It is also important for school psychologists to be aware of the way students they are working with have been taught. This can greatly affect diagnoses, specifically of a Learning Disability (LD). If a student who has been referred for school psychology services has not received good quality, research based instruction, it may difficult, or even impossible, to determine why the individual is having difficulty with handwriting or a with other academic skills. It would be challenging to determine if a diagnosis of LD would be fitting for a student or whether or not they have been given the opportunity for proper intervention and learning.

References

Annis, L. F. (1981). Effect of preference for assigned lecture notes on student achievement. *Journal Of Educational Research, 74*(3), 179-182. doi:10.1080/00220671.1981.10885306

Arslan, D. (2012). Examining first grade teachers' handwriting instruction. *Educational Sciences: Theory & Practice, 12*(4), 2839-2846.

Benton, S. L., & Kiewra, K. A. (1993). Encoding and external-storage effects on writing processes. *Journal of Educational Psychology, 85*(2), 267. doi:10.1037/0022-0663.85.2.267

Berninger, V. W., Abbott, R. D., Augsburger, A., & Garcia, N. (2009). Comparison of pen and keyboard transcription modes in children with and without learning disabilities. *Learning Disability Quarterly, 32*(3), 123-141. doi:10.2307/27740364

Berninger, V. W., Abbott, R. D., Jones, J., Wolf, B. J., Gould, L., Anderson-Youngstrom, M., Shimada, 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. doi:10.1207/s15326942dn2901_5

Bui, D. C., & Myerson, J. (2014). The role of working memory abilities in lecture note-taking. *Learning & Individual Differences, 33,* 12-22. doi:10.1016/j.lindif.2014.05.002

*Carlson, B., McLaughlin, T. F., Derby, K. M., & Blecher, J. (2009). Teaching preschool children with autism and developmental delays to write. *Electronic Journal Of Research In Educational Psychology, 7*(1), 225-238

Cutler, L., & Graham, S. (2008). Primary grade writing instruction: A national survey. *Journal Of Educational Psychology*, *100*(4), 907-919. doi:10.1037/a0012656

Datchuk, S. (2015). Teaching handwriting to elementary students with learning disabilities. *Teaching Exceptional Children*, *48*(1), 19-27. doi:10.1177/0040059915594782

Dinehart, L. H. (2015). Handwriting in early childhood education: Current research and future implications. *Journal of Early Childhood Literacy*, *15*(1), 97-118. doi:10.1177/1468798414522825

*Dolin, E. T. (2017). An analysis of the effectiveness of curriculum embedded handwriting instruction and its impact on student learning. *Dissertation Abstracts International Section A,* 78, 1-182.

Feder, K. P., & Majnemer, A. (2007). Handwriting development, competency, and intervention. *Developmental Medicine & Child Neurology*, *49*(4), 312-317. doi:10.1111/j.1469-8749.2007.00312.x

Graham, S., & Harris, K. R. (n. d.). *CASL Handwriting Program (Grade 1).* Retrieved from https://peabody.vanderbilt.edu/departments/sped/research/casl_-_center_on_accelerating_student_learning.php

**Graham, S., & Harris, K. R. (2000). Is handwriting causally related to learning to write? treatment of handwriting problems in beginning writers. *Journal Of Educational Psychology*, *92*(4), 620-633. doi: 10.1057//0022-0663.92.4.620

Graham, S., & Harris, K. R. (2005). Improving the writing performance of young struggling writers: Theoretical and programmatic research from the center on accelerating student learning. *Journal Of Special Education, 39*(1), 19-33. doi:10.1177/00224669050390010301

**Graham, S., & Harris, K. R. (2006). Preventing writing difficulties: Providing additional handwriting and spelling instruction to at-risk children in first grade. *Teaching Exceptional Children, 38*(5), 64-66.

Graham, S., Harris, K. R., & Fink, B. (2000). Extra handwriting instruction: Prevent writing difficulties right from the start. *Teaching Exceptional Children, 33*(2), 88-91.

Graham, S., & Weintraub, N. (1996). A review of handwriting research: Progress and prospects from 1980 to 1994. *Educational Psychology Review, 8*(1), 7-87. doi:10.1007/BF01761831

Graham, S. (2010). Want to improve children's writing? Don't neglect their handwriting. *Education Digest: Essential Readings Condensed For Quick Review, 76*(1), 49-55.

*Griffith, J., McLaughlin, T. F., Neyman, J., Donica, D. K., & Robison, M. (2013). The differential effects of the use of Handwriting Without Tears® modified gray block paper to teach two preschool students with developmental delays capital letter writing skills. *Journal On Educational Psychology, 7*(1), 13-22.

Grissmer, D., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world: Two new school readiness indicators. *Developmental Psychology, 46*(5), 1008-1017. doi:10.1037/a0020104

Handwriting without tears delivers success. (2014). Retrieved July 17, 2017, from https://www.hwtears.com/files/HWT_Screener_Efficacy.pdf

Hayes, J. R. (2012). Modeling and remodeling writing. *Written Communication, 29*(3), 369-388. doi:10.1177/0741088312451260

Jin, B., Barta, J., Ferencak, H., Comstock, S., Riley, V., & Krueger, J. (2014). Developmental characteristics in cursive and printed letter-writing for school-age children. *Journal Of Motor Learning & Development, 2*(1), 1-8. doi:10.1123/jmld.2012-0001

Larwin, K. (2012). Student prepared testing aids: A low-tech method of encouraging student engagement. *Journal Of Instructional Psychology, 39*(2), 105-111.

*Lust, C. A., & Donica, D. K. (2011). Effectiveness of a handwriting readiness program in Head Start: A two-group controlled trial. *American Journal Of Occupational Therapy, 65*(5), 560-568. doi:10.5014/ajot.2011.000612

Medwell, J., & Wray, D. (2014). Handwriting automaticity: The search for performance thresholds. *Language and Education, 28*(1), 34–51. doi:10.1080/09500782.2013.763819

Mueller, P. A., & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: advantages of longhand over laptop note taking. *Psychological Science (0956-7976), 25*(6), 1159-1168. doi:10.1177/0956797614524581

*Meyers, C., McLaughlin, T. F., Derby, M., Weber, K. P., & Robison, M. (2015). The effects of "Handwriting Without Tears®" on the handwriting skills of appropriate size, form, and tool for a four year-old boy with a developmental delay. *Journal Of Special Education Apprenticeship, 4*(2), 1-12.

Olsen, J. (2009). Handwriting Without Tears: Research report. Retrieved August 16, 2017, from http://www.hwtears.com/hwt

Olsen, J. Z., & Knapton, E. F. (2008). *Handwriting Without Tears® Kindergarten Teacher's Guide.* Cabin John, MD: Handwriting Without Tears.

**Oxaal, I. (2005). Accelerating student learning in kindergarten through grade 3: Five years of OSEP-sponsored intervention research. *Journal Of Special Education, 39*(1), 2-5. doi:10.1177/00224669050390010101

*Patton, S., & Hutton, E. (2016). Parents' perspectives on a collaborative approach to the application of the Handwriting Without Tears® programme with children with Down Syndrome. *Australian Occupational Therapy Journal, 63*(4), 266-276. doi:10.1111/1440-1630.12301

*Patton, S., & Hutton, E. (2017). Exploring the participation of children with Down Syndrome in Handwriting Without Tears. *Journal Of Occupational Therapy, Schools & Early Intervention, 10*(2), 171-184. doi: 10.1080/19411243.2017.1292485

*Roberts, G. I., Derkach-Ferguson, A. F., Siever, J. E., & Rose, M. S. (2014). An examination of the effectiveness of Handwriting Without Tears® instruction. *Canadian Journal Of Occupational Therapy / Revue Canadienne D'ergothérapie, 81*(2), 102-113. doi:10.1177/0008417414527065

Santangelo, T., & Graham, S. (2016). A comprehensive meta-analysis of handwriting instruction. *Educational Psychology Review*, *28*(2), 225-265. doi:10.1007/s10648-015-9335-1

*Steele, E. C., McLaughlin, T., Derby, K. M., Weber, K. P., Donica, D. K., & McKenzie, M. (2015). Employing Handwriting Without Tears® to teach a 4-year-old preschool student to write his name with the appropriate size, shape, and form combined with an imitate/trace/copy/memory procedure. *Journal On Educational Psychology, 8*(4), 16-24.

Vries, L., Hartingsveldt, M. J., Cup, E. C., Nijhuis-van der Sanden, M. G., & Groot, I. M. (2015). Evaluating fine motor coordination in children who are not ready for handwriting: Which test should we take?. *Occupational Therapy International, 22*(2), 61-70. doi:10.1002/oti.1385