Writing Difficulties of Students with Learning Disability:

A Meta-Synthesis

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Abstract

This meta-synthesis of the literature of special education students with handwriting difficulties analyzed factors that affect handwriting. A number of students with learning disabilities have handwriting difficulties. Legible handwriting continues to be an important skill for children to develop in elementary school and difficulty with this area can affect any child's proficiency at school work. Many factors affect handwriting proficiency. Many areas of the brain are accessed when handwriting activities take place. With purposeful and sequential handwriting instruction including occupational therapy as well as evidence-based practices was the key areas that helped students improve their handwriting skills in addition to on-task behavior. This meta-synthesis of the literature on special education students with handwriting difficulties investigates the challenges of handwriting.

1. Introduction

a. Background

Many of my students with special needs have writing difficulties. There are a variety of causes for the difficulties when it comes to writing. Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect writing (Cornhill & Case-Smith, 1996). When working with primary students, the teacher needs to understand and know how the student is developing in these areas. Many adaptions and modifications can be made to curriculum to ensure that students with writing difficulties are able to access the curriculum.

Kinesthesia is the awareness of weight of an object and the directionality of joint and limb movement (Cornhill & Case-Smith, 1996). Studies have been completed using kinesthetic training with children. The results are not conclusive and more research needs to be completed in this area. Some of the limitations were convenient sample, the examiner was not blind to the subject's handwriting classification during testing, and there are other variables that influence handwriting. Students, who are not aware of the weight of an object or the amount of pressure the object has in the hand, may struggle with handwriting. Occupational therapy may be recommended and positive results could occur with the student's ability to write. Teachers can provide weighted pencils or heavier pencils to help the child. These adaptive tools may help the student put more pressure on the paper and position the pencil in an appropriate grip to improve handwriting.

Motor planning is the ability to plan and direct sequences of hand movements. For many students with Autism Spectrum Disorder and other developmental disabilities, intellectual or

cognitive processing takes a backseat to the effort involved in the motor planning that must go on in order to put pencil to paper (Broun, 2009). Students put so much effort into the motor planning that the other areas decrease in quality. Teachers should break larger tasks into smaller steps to allow the student to focus on one or two cognitive processes. According to Naus (2000), there are a variety of strategies that will help with motor planning such as matching, sorting, and sequencing small objects, completing puzzles, cutting, and stringing beads.

The quality of eye-hand coordination also effects handwriting. The alignment of letters within the well-defined parameters of the writing lines requires the guidance of the visual system (Cornhill & Case-Smith, 1996). When the visual system is not functioning accurately, then the accuracy of writing (handwriting efficiency) decreases. Our eyes help us to be able to perform many different tasks. According to Naus (2000), the eyes provide pertinent information to guide hand and finger movements. Small muscle control enables the hand to accomplish what the eye desires to see (Naus, 2000). There are many fun and engaging activities that can strengthen eye-hand coordination that will improve letter formation.

When a child copies a letter, he or she is using visuomotor integration to perform the task. Visuomotor takes place when an individual visualizes a form, assigns a meaning to the form, and then manipulates a writing tool to reproduce the same form (Cornhill & Case-Smith, 1996). Children are expected to be able to copy many different forms during their educational experience. This is a sensorimotor component that is moderately to strongly related to handwriting (Denton, Cope, & Moser, 2006). Children, who can copy a form, have better handwriting skills.

Writing is expressive language that requires a high degree of integration of several areas of the brain. In-hand manipulation of a writing tool is one of the key skills. Movement of the pencil on the paper requires the ability to isolate and grade individual finger and thumb movements (Cornhill & Case-Smith, 1996). In-hand manipulation requires fine motor ability. These muscles can be strengthened with fun activities such as play dough, picking up small objects using a pincher grasp, coloring, typing letters using a keyboard, playing with a Lite Brite, completing puzzles, and many other activities. Writing is a skill that is essential for student success.

1.2 Author's beliefs and experiences

My experience with writing began before I entered elementary school. Being able to hold a pencil and show my thoughts as well as my ideas in a tangible way was and still is very empowering. Before I started preschool, my brothers would head off to school. I was at home by myself with my mother. There were many hours to fill by myself. I always had some kind of writing utensil and paper. I would draw and create my own form of words. I think writing and drawing were important to me because I saw everyone around me modeling different types of writing. My aunt is an artist by trade. She created so many different types of drawings that inspired me to express my own form of art on paper. I would spend many hours watching my mother write fancy letters on documents for different people. I learned that this form of writing was called calligraphy. She tried to teach it to me at one point; however, it was challenging since I was right-handed and she was left-handed.

While in elementary school, I learned the correct way to write letters through direct instruction. My teachers would use a chalk holder to make straight lines on the board and then

put a dashed line in the middle. These lines matched our paper. We had large, black pencils without erasers. I always wondered why we could not have erasers on our pencils at school because all of my pencils at home had an eraser. Coles and Yetta (1980) state that children who have already been exposed to number two pencils with erasers are relegated to using a specified kind of writing implement. The teacher modeled each stroke on the board then walked around to see that everyone was writing correctly. If we did not do the stroke correctly, we had to put an X through it and try again until we wrote it correct. The whole class could not go on until everyone had completed that step correctly. The teacher would show us the next stroke and we would continue.

During second grade handwriting, I usually had to wait for a long time for the rest of the class to finish. My teacher arranged to have me work as a peer helper in a kindergarten class. After the teacher modeled the writing on the board, it was my job to walk around the room and help the kindergarten students write their letters. The kindergarten teacher once told me that my handwriting was very beautiful. This praise has remained with me for many years. At the end of second grade, my handwriting drastically changed. I broke my right arm. I could not write at all. Throughout that summer, I started practicing my letters with my left hand. Since my mother was left handed, she was able to show me the correct way to hold a pencil. The cast remained on my arm until Christmas of my third grade year. In third grade, we learned cursive. I was not very excited because writing took more time and it wasn't easy anymore. I had to put a lot of effort into all of my assignments. By the time my cast was removed, my left hand penmanship was very similar to my second grade right hand penmanship. Even though my right hand is dominant, I have been able to retain the muscle memory in my left hand. As a general education

teacher of primary students, I would challenge my students to write better than I could with my left hand. Many of the students thought this was a fun way to be better than the teacher. I found that they enjoyed this game we played and writing became more fun.

There are many different tools that we can use to write. Some of the traditional tools are crayons, pencils, markers, paints, and pens. In the past couple of decades, computers have become writing tools. Most classrooms and homes have at least one computer. There are a variety of word processing programs that allow the writer to express his/her thoughts on the screen by typing on the keyboard. There are also voice activated programs that allow individuals to vocalize their thoughts and the program transcribes the words. iPads have become more available. Individuals can use a stylus or a finger to write. The text can be highlighted and transferred into type written words. With all of the technology available some students refuse to pick up a writing utensil and put it to paper.

This year, as I began to work with my students, I discovered that two students refused to pick up a writing utensil and put it to paper. I started thinking about writing and where this skill is used throughout our life. Should I fight the battle over the pencil? Should I teach my students other ways to write using technology that they prefer? What type of research is out there to support writing with a pencil versus a technology device? As I work through this research project, I am hoping that I will be able to find ways to encourage my students to pick up a pencil and write every day for at least 15 minutes. Writing is a lifelong skill that is important for all students to learn. The ability to write provides important advantages for a child (Naus, 2000).

1.3 The purpose of the meta-synthesis

This meta-synthesis, which focused on students with writing difficulties, had multiple purposes. The first purpose was to locate and identify journal articles that identified different types of writing difficulties. The second purpose was to locate and identify journal articles that identified different strategies that would help students improve their writing. The third purpose was to increase the amount of time that a student would use a writing utensil to complete seatwork. My final purpose was to identify significant themes in the literature and connect these themes to my students with writing difficulties.

2. Methods

2.1. Selection criteria

The journal articles included in this meta-synthesis met the following selection criteria.

1. The articles explored issues related to handwriting difficulties for primary students with special needs.
2. The articles explored issues related to different strategies that would help students improve their writing.
3. The articles were published in peer reviewed journals related to the field of education.
4. The articles were published between 1980 and 2011.

2.2. Search procedures

Database searches and ancestral searches were conducted to locate articles for this metasynthesis.

2.2.1 Database searches

In the fall of 2012 and spring of 2013, I conducted systematic searches of two databases that index articles related to the disciplines of education, special education, occupational therapy,

and the brain. These two databases were Education Resources Information Center (ERIC, Ebscohost) and Education Journals (ProQuest). I used the following search combinations to conduct Boolean searches of this database:

1. (“handwriting”) AND (“stamina”).
2. (“handwriting”) AND (“difficulties”).
3. (“handwriting difficulties”).
4. (“writing”) AND (“difficulties”).
5. (“motor planning”) AND (“Greenspan”).
6. (“visumotor integration”).
7. (“handwriting”) AND (“students with disabilities”).
8. (“special education students with writing difficulties”).
9. (“integration theory”) AND (“special education”).
10. (“integration theory“) AND (“handwriting”).
11. (“vision”) AND (“handwriting”) AND (“special education”).
12. (“handwriting”) AND (“brain research”).
13. (“handwriting difficulties”) AND (“special education”) AND (“brain”).
14. (“handwriting and the brain”).

These searches yielded a total of 21 articles that met my selection criteria Allen, & Courchesne, 2003; Bonggat & Hall, 2010; Broun, 2009; Coles & Goodman, 1980; Cornhill & Case-Smith, 1996; Denton, Cope, & Moser, 2006; Erhardt & Meade, 2005; Graham, 1999; Jasmin, Couture, McKinley, Reid, Fmbonne, & Gisel, 2009; Jongmans, Linthorst-Bakker, Westernberg, & Smits-Engelsman, 2003; Keller, 2001; Kushki, Chau, & Anagnostou, 2011;

Levy, 1982; Li, 2004; Murray, Baker, Murray-Slutsky, & Pais, 2009; Naus, 2000; Nayate, Bradshaw, & Rinehart, 2005; Thompson, 2011; Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010; Weintraub, Yinon, Hirsch, & Parush, 2009; Zwicker & Hadwin, 2009).

2.3. Coding procedures

I developed a coding form to categorize the information presented in each of the 21 articles. This coding form was based on: (a) publication type; (b) research design; (c) participants; (d) data sources; and (e) findings of the studies.

2.3.1 Publication types

I evaluated and classified each article according to publication type (e.g., research study, descriptive article, guide, opinion piece/position paper, annotated bibliography, review of the literature). *Research studies* employ systematic methods to gather and/or analyze quantitative and/or qualitative data. *Descriptive articles* describe experiences and phenomena but do not employ systematic methods to gather and analyze data. *Guides* recommend specific strategies and/or explain how practitioners might implement particular programs, policies, or curricula. *Opinion pieces/position papers* explain an author's opinion about a particular issue; these articles may support or advocate for particular educational objectives, political views, policy positions, or philosophical ideas. *Annotated bibliographies* include a list of articles on a given topic with a brief summary of each piece of work. *Reviews of the literature* summarize and synthesize the essential themes of previously published works on a particular topic (Table 1).

2.3.2 Research design

I classified each empirical study by research design (i.e., quantitative research, qualitative research, mixed methods research). *Quantitative* researchers collect and analyze numerical data.

Qualitative researchers use language (as opposed to numbers) to describe experiences and phenomena, and to tell people's stories. *Mixed methods* research combines quantitative (i.e., numerical) and qualitative (i.e., non-numerical) research methods within a single study (Table 2).

3. Results

3.1. Publication type

I located 23 articles that met my selection criteria. The publication type of each article is located in Table 1. Eleven of the 23 articles (49%) included in this meta synthesis were research studies (Allen & Courchesne, 2003; Bonggat & Hall, 2010; Cornhill & Case-Smith, 1996; Denton, Cope, & Moser, 2006; Erhardt & Meade, 2005; Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003; Thompson, 2011; Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010; Weintraub, Yinon, Hirsch, & Parush, 2009; Zwicker & Hadwin, 2009). Six of the articles (26%) were guides (Graham, 1999; Keller, 2001; Li, 2004; Naus, 2000; Polloway, Miller, & Smith, 2004; Ratey, 2001). One of the articles (4%) was a descriptive work (Nayate, Bradshaw, & Rinehart, 2005). Two of the articles (9%) were Opinion piece/Position papers (Broun, 2009; Coles, & Goodman, 1980). Two of the articles (9%) were theoretical works (Kushki, Chau, & Anagnostou, 2011; Levy, 1982).

Table 1

Author(s) & Year of Publication	Publication Type
Allen, G. & Courchesne, E. (2003, February).	Research Study
Bonggat, P. W, & Hall, L. J. (2010).	Research Study
Broun, L. (2009, September).	Opinion piece/Position paper
Coles, R. E. & Goodman, Y. (1980, June 1).	Opinion piece/Position paper
Cornhill, H. & Case-Smith, J. (1996, October).	Research Study
Denton, P.L., Cope, S., & Moser C. (2006, January).	Research Study
Erhardt, R. P. & Meade, V. (2005).	Research Study
Graham, S. (1999).	Guide
Jasmin, E., Couture, M., McKinley, P., Reid, G., Fombonne, E., & Gisel, E. (2009).	Research Study
Jongmans, M. J., Linthorst-Bakker, E., Westenberg, Y., & Smits-Engelsman, B. (2003, September).	Research Study
Keller, M. (2001, September).	Guide
Kushki, A., Chau, T., & Anagnostou, E. (2011, December).	Theoretical Work
Levy, J. (1982).	Theoretical Work
Li, A. (2004).	Guide
Murray, M., Baker, P. H., Murray-Slutsky, C., & Paris, B. (2009).	Opinion piece/Position paper
Naus, J. M. (2000, March).	Guide
Nayate, A., Bradshaw, J. L., & Rinehart, N. J. (2005, July).	Descriptive Work
Polloway, E. A., Miller, L., & Smith, T. (2004).	Guide

Ratey, J. J. (2001).	Guide
Thompson, C. J. (2011).	Research Study
Van Hoorn, J. F., Maathuis, C. G., Peters, L. H., & Hadders-Algra, M. (2010, June 15).	Research Study
Weintraub, N., Yinon, M., Hirsch, I., & Parush, S. (2009, Summer).	Research Study
Zwicker, J. G. & Hadwin, A. F. (2009).	Research Study

3.2. Research design, participants, data sources, and findings of the studies

As stated previously, I located 11 research studies that met my selection criteria (Allen & Courchesne, 2003; Bonggat & Hall, 2010; Cornhill & Case-Smith, 1996; Denton, Cope, & Moser, 2006; Erhardt & Meade, 2005; Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003; Thompson, 2011; Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010; Weintraub, Yinon, Hirsch, & Parush, 2009; Zwicker & Hadwin, 2009).

Table 2

Authors	Research Design	Participants	Data Sources	Findings
Allen & Courchesne, 2003	Qualitative	8 patients with autism ages 14-38 years old and 8 healthy comparison subjects ages 13-39 years old	Functional Magnetic Resonance Imaging (fMRIs), WISC-R or WAIS-R IQ tests, Wechsler Block Design and Object Assembly subtests	While performing tasks, individuals with autism showed significantly greater motor activation in the cerebellum region and significantly less cerebellar attention activation. Motor activation was localized to the anterior cerebellar hemisphere. Cerebellar pathology can affect a variety of non-motor functional deficits. Patients with autism showed minimal activation during the attention task. The size of cerebellar hemisphere lobule VIIa is strongly correlated with the amount of attention activation in that same region provides even further support for cerebellar involvement in attention operations.
Bonggat & Hall, 2010	Mixed Methods-Case study	3 preschool boys. Two boys with developmental delays and one	Observations	Most reviewers of sensory integration believe there is a lack of relationship between any changes in behavior with proposed dysfunctional

		boy with autism. Preschool teacher with TEEACH, discrete trial, ABA, Pivotal Response training.		sensory or motor system; however, sensory integration-based activities continue to be recommended by OTs and used by educators. Children were more engaged when seated on a therapy ball than other seating. Data indicated that there was not a change as a result of the treatment; however, participants maintained a higher level of on task behavior when working on a one-on-one activity using sound teaching strategies along with motivating materials to maintain on task behavior than an independent activity.
Cornhill & Case-Smith, 1996	Quantitative Research Study	48 typically developing first grade children attending schools in one county of central Ohio. In the poor handwriting group there were 9 girls and 14 boys. In the good handwriting	Teacher analysis of handwriting from predetermined criteria. Minnesota Handwriting Test (MHT). Developmental Test of Visual Motor Integration (VMI)	Handwriting is required in testing situations for most academic subjects. Students with handwriting problems are often referred to an occupational therapist. Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect handwriting.

		group there were 19 girls and 6 boys.	Motor Accuracy Test (MAC)	After writing is learned, it relies less on visual input and more on kinesthetic input. Eye-hand coordination skill is a fundamental component of handwriting and should be evaluated when handwriting legibility is low. Visual Motor Integration is a strong predictor of handwriting skill at a variety of ages. Precise control of fingers and thumb is highly associated with letter formation. The moderate correlations suggest that the relationships among variables are complex and that they contributing factors to handwriting performance vary among individual children.
Denton, Cope, & Moser, 2006	Quantitative Research Study	38 (12 girls and 26 boys) children 6 to 12 years of age with handwriting dysfunction from six private schools in two cities in the Midwest.	Pre- and post-intervention, Gardner's Test of Handwriting skills. Developmental Test of Visual Perception-2	Legible handwriting continues to be an important skill for children to develop in elementary school and difficulty with this area can affect any child's proficiency at school work. Children receiving therapeutic practice

		4 registered occupational therapists and one licensed physical therapist provided the intervention.	Test of Manual Pointing In-Hand Manipulation	moderately improved handwriting whereas children receiving sensorimotor intervention declined in handwriting performance. Sensorimotor impairment was noted at pretest in three or four components and selected sensorimotor component function improved with intervention. Therapeutic practice (intervention using current motor-learning strategies to promote long-term learning of the handwriting skill) was more effective at improving handwriting performance. Handwriting is necessary for assignments, homework, and many tests including standardized test for the majority of children.
Erhardt & Meade, 2005	Qualitative Case study	A 13 year old boy with learning problems, occupational therapist, and physiotherapist	Baseline and reevaluation testing. Developmenta l Test of Visual Motor Integration. Weschsler Intelligence Scale for	This case study described an intervention process and a relationship between an occupational therapist and physiotherapist as they helped meet the needs of an adolescent with handwriting problems.

			Children 3rd edition (WISC-III). Children's Depression Inventory. Purdue Perceptual-Motor Survey.	The foundational prerequisites for efficient, legible handwriting are generally assumed to be gross motor, fine motor, and oculomotor skills. Many authors believe that mastering basic shapes should take place before writing. Emphasis on foundational components and performance components should be within relevant performance contexts. When the subject understands the purpose of the activity and its connection to the functional goal, he or she is more likely to comply and complete the task. Careful sequencing and adaptation of activities ensure a higher success. Integrate treatment principles into daily living activities provides practice and repetition for successful motor learning.
Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009	Quantitative Research Study	35 children with ASD, ages 3 to 4 years old from the Montreal	Autism Diagnostic Interview, Autism Diagnostic Observation	Some children with Autism Spectrum Disorder (ASD) have difficulty mastering daily living skills (DLS) to care for themselves.

		Children's Hospital.	Schedule-Generic, Preschool Language Scale 4th edition, Peabody Picture Vocabulary Test 3rd edition, Caregiver Questionnaire, Functional Independence Measure for Children, Vineland Adaptive Behavior Scales	Atypical sensory responses may interfere with self-care skills. Preschool children with ASD revealed very poor performance in gross motor, fine motor, and self-care. Individual assessments need to be completed to determine specific areas of treatment.
Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003	Mixed methods	Study 1-14 children attending regular schools who were referred by their teacher as having significant handwriting difficulties 12 boys & 2 girls Study 2-24 children in grades 2-6 attending	Concise Assessment Scale for Children's Handwriting (BHK) Pretest and post test 18 lessons over three months with one-to-one instruction	Two studies were conducted to investigate the effect of task-specific self-instruction intervention to improve handwriting ability of children in regular education. Study 1 showed that children with poor handwriting quality who received regular intervention on an individual basis for three months improved than the group who did not receive intervention.

		schools for special education in The Netherlands 17 boys and 19 girls		Study 2 showed that after six months of intervention in a group setting children with poor handwriting quality improved their quality of writing more so than the children without intervention. Handwriting requires a high level of fine motor coordination and high-precision force regulation, and also perceptual, cognitive and language abilities. Few studies have reported prevalence of handwriting problems among children with developmental problems. The task-oriented self-instruction method applied in both studies has shown a positive effect on the quality of handwriting of children with poor handwriting quality.
Thompson, 2011	Quantitative	A stratified random sample of 50 students with severe developmental disabilities ages eight to eighteen was selected for	Observations of facial expressions, body language, and vocal cues Using a Likert Scale in three settings:	An observational research study based on sensory integration theory was conducted. The purpose was to observe students selecting multi-sensory experiences within a multi-sensory

		observation within a public school environment representing four classifications of students: Trainable Mentally Handicapped (TMH), Profoundly Mentally Handicapped (PMH), students with Autism, and students with Multiple Disabilities	regular classroom, in the multisensory center, and in the regular classroom after the multisensory center.	intervention center. The researchers observed the sustained focus levels of students with special needs during the multi-sensory experiences. Significant increase in sustained focus (14%), self-injurious behaviors decreased (98%), Student happiness increased (16%), student relaxation increased (17%), student engagement increased (13%) when students returned to the regular classroom after experiencing the multi-sensory center.
Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010	Quantitative	200 children ages 8 to 13. 118 students were general education students and 82 were special education students. 131 boys and 69 girls	Four assessments were administered: a neurological examination Movement Assessment Battery for Children, Concise Assessment Method for Children's Handwriting, and Developmenta	The study investigated the relationships between handwriting, visuomotor integration, and neurological condition between general education students and students with special needs. Children needs to know how to understand directional terms, recognize similarities and differences in forms, have a functional pencil grasp, and the ability to

			l Test of Visual Motor Integration.	copy lines and shapes before learning to write. The quality of handwriting and speed was clearly related to the presence and severity of neurological dysfunction. The study indicates that writing problems are related to the presence and severity of minor neurological dysfunction (MND) and the more complex tasks of visuomotor integration are impacted by various MND. When a neurological profile is available it may help guide the choice of intervention and when not available children with any type of MND writing may improve through practice and appropriate seating.
Weintraub, Yinon, Hirsch, & Parush, 2009	Quantitativ e	Stage 1-55 general education students in 2-4 grade and had handwriting difficulties Stage 2- each intervention group (sensorimotor and	Brief Assessment Tool for Handwriting (BATH) questionnaire, Motor Accuracy Test (MAC), Developmenta l Test of Visual	Both intervention programs (task-oriented approach and a sensorimotor approach combined with a task-oriented approach) required higher-level functions to control for their contribution to the handwriting process. Spatial organization significantly improved 4

		task-oriented) had 13 students.	Perception-Second Edition (DTVP-2), Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), Pediatric Examination of Educational Readiness at Middle Childhood (PEERAMID), Hebrew Handwriting Evaluation (HHE)	months after the intervention with both groups. Both groups improved their handwriting performance. There wasn't significant data to determine if one program showed an advantage over another.
Zwicker & Hadwin, 2009	Qualitative	72 students in 1st and 2nd grade who had been referred to school-based occupational therapy for handwriting difficulties. 51 boys and 21 girls	Beery-Buktenica Developmental Test of Visual Motor Integration, Evaluation Tool for Children's Handwriting (ETCH) for pretesting and post-testing.	Handwriting problems are one of the most common reasons for referral to school-based occupational therapy. Three interventions were compared: cognitive intervention, multisensory intervention, and no intervention. Both treatment groups involved some modeling, imitation, tracing, and copying. The testing scores indicated there was no significant difference between 1st and 2nd grade

				students. 1st grade students achieved similar results regardless of intervention, with slightly more positive results with the multisensory intervention. 2nd grade students showed little improvement with the multisensory intervention while the cognitive group showed a greater improvement.

3.2.1. Research design

Six of the 11 studies (35.2%) used a quantitative research design (Cornhill & Case-Smith, 1996; Denton, Cope, & Moser, 2006; Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009; Thompson, 2011; Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010; Weintraub, Yinon, Hirsch, & Parush, 2009). Two of the studies (18.1%) utilized a mixed methods research design (Bonggat & Hall, 2010; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003). Three of the studies (27.2%) used a qualitative research design (Allen & Courchesne, 2003; Erhardt & Meade, 2005; Zwicker & Hadwin, 2009).

3.2.2. Participants and data sources

The majority of the 11 research studies included in this meta-synthesis analyzed data from elementary school students with disabilities and special services professionals. Three of the studies (27.2%) analyzed data collected from students with autism (Allen & Courchesne, 2003; Bonggat & Hall, 2010; Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009). Five of the studies (45.5%) analyzed data collected from students with learning problems (Denton, Cope, & Moser, 2006; Erhardt & Meade, 2005; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003 Thompson, 2011; Zwicker & Hadwin, 2009). One of the studies (9.1%) analyzed data collected from only general education students (Cornhill & Case-Smith, 1996). Two of the studies (18.2%) analyzed data collected from students with learning problems and general education students (Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010; Weintraub, Yinon, Hirsch, & Parush, 2009).

Educational assessments provided the main data sources used in the research studies. Seven of the studies (63.6%) collected data from educational assessments which included a

questionnaire and survey (Cornhill & Case-Smith, 1996; Denton, Cope, & Moser, 2006; Erhardt & Meade, 2005; Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003; Weintraub, Yinon, Hirsch, & Parush, 2009; Zwicker & Hadwin, 2009). Two of the studies (18.2%) collected data from educational assessments and medical testing (Allen & Courchesne, 2003; Van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010). Two of the studies (18.2%) collected data from observations (Bonggat & Hall, 2010; Thompson, 2011).

3.2.3. Findings of the studies

The findings of the 11 research studies included in this meta-synthesis can be summarized as follows.

1. The education of children with developmental disabilities will face a number of challenges that impact their learning. Cognitive brain functioning as well as Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect handwriting.

2. Handwriting strategies can be taught with evidence-based practices which may improve student's skills. With purposeful and sequential handwriting instruction including occupational therapy and therapeutic practice, students with learning difficulties are more likely to improve in the area of handwriting.

3.3. Emergent themes

Seven themes emerged from my analysis of the 11 articles included in this metasynthesis. These emergent themes, or theme clusters, include: (a) brain research; (b) evidence-based practices; (c) improving on-task behavior; (d) developmental disabilities impact the ability to

learn to write; (e) motor planning; (f) importance of handwriting; (g) handwriting skills. These seven theme clusters and their formulated meanings are represented in Table 3.

Table 3

Theme Clusters	Formulated Meanings
Brain Research	● Motor activities increase brain activity. ● Brain abnormalities affect cognitive and motor function. ● Many cortical and sub-cortical regions of the brain are important for motor learning. ● Many areas of the brain are accessed when handwriting activities take place. ● The quality of handwriting and speed was clearly related to the presence and severity of neurological dysfunction. ● After writing is learned, it relies less on visual input and more on kinesthetic input. ● The size of cerebellar hemisphere lobule VIIa is strongly correlated with the amount of attention activation in that same region provides even further support for cerebellar involvement in attention operations. ● Motor activation was localized to the anterior cerebellar hemisphere.
Evidence-based practices	● Sound teaching (research-based) methods should take place in educational settings. ● Data is used to guide treatment and interventions in both educational and therapy sessions. ● Discrete trial teaching methods, structured TEACCH activities, and independent work stations provide predictable experiences for children in the classroom. ● Children should be assessed using a variety of research based assessments such as the Minnesota Handwriting Test (MHT), Developmental Test of Visual Motor Integration (VMI), and Motor Accuracy Test (MAC). ● Students with handwriting problems are often referred to an occupational therapist. ● Therapeutic practice (intervention using current motor-learning strategies to promote long-term learning of the handwriting skill) was one of the more effective methods that improved handwriting performance. ● The development of positive relationships and communication between family and professionals resulted in a true commitment to the programs. ● Many authors believe that mastering basic shapes should take place before writing.

	● Careful sequencing and adaptation of activities should take place to ensure more success. ● Children with poor handwriting quality who received regular intervention on an individual basis for three months improved their handwriting skills. ● Task-oriented self-instruction method has shown a positive effect on the quality of handwriting of children with poor handwriting quality. ● Task-oriented approach and a sensorimotor approach combined with a task-oriented approach significantly improved spatial organization 3 months after the intervention took place.
Improving on-task behavior	● Sensory integration increased on-task behavior in primary students in one study. ● Children with autism were more engaged when seated on a therapy ball than other seating choices. ● Higher level of on-task behavior was observed when working in a one-on-one activity. ● Sound teaching methods along with motivating materials maintained on-task behavior. ● Multisensory activities that students selected improved sustained focus decreased self-injurious behaviors, increased student happiness, relaxation, and engagement of many students.
Developmental disabilities impact the ability to learn to write	● Tactile defensiveness and low muscle tone effect learning. ● Cognitive brain functioning impacts learning. ● The moderate correlations suggest that the relationships among many variables are complex and that they are contributing factors to handwriting performance vary among individual children. ● Eye-hand coordination skill is a fundamental component of handwriting and should be evaluated when handwriting legibility is low. ● Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect handwriting. ● Writing problems are related to the presence and severity of minor neurological dysfunction (MND) and the more complex tasks of visuomotor integration are impacted by various MND. ● Handwriting problems are one of the most common reasons for referral to school-based occupational therapy.
Motor planning	● Motor planning is the ability of the brain to conceive, organize, and carry out a sequence of unfamiliar actions. ● Precise control of fingers and the thumb is highly associated with letter formation. ● The foundational prerequisites for efficient, legible handwriting are generally assumed to be gross motor, fine motor, and oculomotor skills. ● Integration of treatment principles into daily living activities provides

	practice and repetition for successful motor learning.
Importance of handwriting	● Handwriting is required in testing situations for most academic subjects. ● Handwriting is necessary for assignments, homework, and many tests including standardized test for the majority of children. ● Legible handwriting continues to be an important skill for children to develop in elementary school and difficulty with this area can affect any child's proficiency at school work.
Handwriting skills	● Handwriting requires a high level of fine motor coordination and high-precision force regulation, and also perceptual, cognitive and language abilities. ● Student need to know directional terms such as left, right, up, down, slant, and curve. ● Student need to be able to recognize similarities and differences in forms. ● Student need to have a functional pencil grasp. ● Student need to have the ability to copy lines and shapes.
Handwriting skills	● Handwriting requires a high level of fine motor coordination and high-precision force regulation, and also perceptual, cognitive and language abilities. ● Student need to know directional terms such as left, right, up, down, slant, and curve. ● Student need to be able to recognize similarities and differences in forms. ● Student need to have a functional pencil grasp. ● Student need to have the ability to copy lines and shapes.

4. Discussion

In this section I have summarized the emergent themes from my analysis of the 11 articles included in this meta-synthesis. These emergent themes were then connected to my own practices as a special education teacher.

4.1. Brain research

Educators have a better understanding of learning by reading brain research. Students with a learning disability often have brain abnormalities that affect cognitive and motor function. The research has shown that motor activities increase brain activity. Many of the cortical and sub-cortical regions of the brain are important for motor learning. Many areas of the brain are assessed when a student writes. Motor activation is localized to the anterior cerebellar hemisphere. The size of cerebellar hemisphere lobule VIIa is strongly correlated with the amount of attention activation in that same region provides even further support for cerebellar involvement in attention operations. After writing is learned, the process relies less on visual input and more on kinesthetic input. The quality of handwriting and speed has been clearly related to the presence and severity of neurological dysfunction.

When educators understand the background behind handwriting dysfunction, they can make decisions based on research. This research helps us to understand best practice. When we have clear research based methods to teach with we can compare our results with other groups of students. The research helps guide us and gives a clearer understanding behind the methods that are used in the classroom. Our brains are capable of many different functions. When teachers understand which part of the brain is accessed during an activity, we can plan and adapt lessons to better fit the needs of our students. Handwriting activates many areas of the brain.

4.2. Evidence-based practices

Educators have a duty to use sound teaching (research-based) methods when instructing students. A few of these methods relating to handwriting include but are not limited to therapeutic practice, task-oriented self-instruction, task-oriented self-instruction with a sensorimotor approach, discrete trial teaching methods, structured TEACCH activities, and independent work stations. Data must be used to guide treatment and interventions. Children should be assessed using a variety of research based assessments such as the Minnesota Handwriting Test (MHT), Developmental Test of Visual Motor Integration (VMI), and Motor Accuracy Test (MAC). Students with handwriting problems are often referred to an occupational therapist (OT). The OT and teacher need to carefully sequence activities and adapt the activities to ensure a higher success for the students. Many authors believe that mastering basic shapes should take place before handwriting instruction begins. The research stated that children with poor handwriting quality who received regular intervention on an individual basis for three months improved their handwriting skills.

My students all receive occupational therapy. Each student has instruction tailored to his or her level and learning style. Our team meets weekly to discuss how instruction and therapy are progressing. We then make adjustments based on the data that has been collected. A few of my students are more focused when they participate in sensory activities before an academic activity. The data we have collected has helped us to formulate Individual Education Plan (IEP) goals and make sound decisions. We use discrete trial teaching methods, structured TEACCH activities, and independent work stations with therapeutic practice. Each child receives occupational therapy with a sensorimotor approach. While researching the topic of handwriting

difficulties, I taught handwriting with a structured well planned out process. The students were taught the three areas in sequence. Over a four week period, their handwriting improved. This was determined using pre-test and post-test handwriting samples. While analyzing the tests, there was significant improvement in the formation of letters on the post-test.

4.3. Improving on-task behavior

Improving on-task behavior has been a challenge for many special education teachers. When sound teaching methods along with motivating materials were paired, more on-task behavior has been observed during handwriting instruction. Children with autism were more engaged when seated on a therapy ball than other seating in one study. In other studies, sensory integration increased on-task behavior in primary students and higher levels of on-task behavior took place during one-to-one instruction. Multisensory activities that students selected improved sustained focus decreased self-injurious behaviors, increased student happiness, relaxation, and engagement of many students.

To improve on-task behavior, I created a choice board. The main board contains a number of different objects or activities that students can work toward by demonstrating on-task behavior. At the beginning of the lesson or activity, each student takes an individual board to the choice board. He or she selects two things he or she wants to work toward. As the student demonstrates on-task behavior during instruction, he or she adds a token to his or her board. When the predetermined amount of tokens has been earned, the student is rewarded by the item from the choice board. After implementing this system, the number of on-task behaviors has increased and the off-task behaviors have decreased. Some days are more challenging than others since the objects and activities do not always hold a rewarding value.

4.4. Developmental disabilities impact the ability to learn to write

The ability to learn to write for special education students is impacted by developmental disabilities. Research has shown that moderate correlations suggest that the relationships among many variables are complex and that they are contributing factors to handwriting performance that vary among individual children. Writing problems are related to the presence and severity of minor neurological dysfunction (MND) and more complex tasks of visuomotor integration are impacted by various MND. Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect handwriting. Eye-hand coordination skill is a fundamental component of handwriting and should be evaluated when handwriting legibility is low. Learning is also impacted by tactile defensiveness, low muscle tone, and cognitive brain functioning. These challenges may lead to handwriting problems which are one of the most common reasons for referrals to school-based occupational therapy.

Developmental disabilities impact all of my students. Each student works on handwriting daily. Some students have minor neurological dysfunction while other have more complex challenges. As I have learned more about each student, I've been able to find ways to adapt and modify handwriting to fit the needs of the individuals. Some students were not able to grip a writing utensil at the beginning of the year while others could copy letters. By understanding the challenges each student faces, educators can modify and adapt lessons to fit the needs of individual students.

4.5. Motor planning

Motor planning is a key component when engaging in the activity of writing. Motor planning is the ability of the brain to conceive, organize, and carry out a sequence of unfamiliar

actions. When a child has developed gross motor, fine motor, and oculomotor skills, then handwriting is more legible. These are the prerequisites for writing. Precise control of fingers and the thumb is highly associated with letter formation. The integration of treatment principles into daily living activities for children with poor motor planning would provide practice and repletion for successful motor learning.

I work daily with our occupational therapist. We discuss how students are progress with motor planning. Treatment principles are integrated within our day as activities, games, and learning centers. Students see some of the treatments principles as fun games that are entertaining. Most students do not realize that they are engaging in occupational therapy in the classroom under the instruction of the intensive resource teacher. Pencil grips, weights, and slant boards are part of our everyday tools. Some of the pencils are regular number two pencils, while others are the fat pencils. During math and coloring activities, students may use crayons shaped liked pebbles, pyramids, or triangular. These tools work on forming the tripod grasp with the thumb, pointer finger, and middle finger. The index finger and ring finger are tucked under holding a small object. By providing and using a variety of adaptive tools during our instructional day, students are working on motor planning activities throughout the day.

4.6. Importance of handwriting

Handwriting is important for multiple reasons. Handwriting is necessary for assignments, homework, and many tests including standardized tests for the majority of children. Most academic subjects require handwriting. Legible handwriting continues to be an important skill for children to develop in elementary school and difficulty with this area can affect any child's proficiency at school work.

In our age of technology, legible handwriting may not be as important; however, there are areas where handwriting may be the only form of communication. Many of the standardized tests and other assessments are scored based on a written response. Individuals may not always be able to type in responses; therefore, handwriting is a skill that must be taught and learned by all individuals. At the beginning of the school year, two of my students refused to pick up a pencil and write. They would push the pencil and paper one the floor and walk away. This caused me great concern. How would I instruct and assess these students when they did not write? I discovered that the iPad was a tool that was very rewarding for one of my students. I downloaded a few handwriting apps and learned that the iPad was a great spring board tool to teach handwriting. After much practice and patience, both students are now writing for parts of his and her day. They are beginning to write for enjoyment as well as communication.

4.7. Handwriting skills

The skill of handwriting requires a high level of fine motor coordination and high-precision force regulation. It also requires perceptual, cognitive, and language abilities. Before a child is able to write letters and numbers, there are some prerequisites. A child will need to know directional terms such as left, right, up, down, slant, and curve. These are the key terms when teaching the formation of letters and numbers. Students will need to be able to recognize similarities and differences in forms. The ability to copy lines and shapes is also important. Handwriting cannot take place without a functional pencil grasp.

Before teaching letters, my students work on writing horizontal and vertical lines by looking at an example. When these lines are well developed, they work on slants and curves. While working on these symbols, a tripod grasp is modeled. Some adaptive tools such as a

pencil grip may help with poor tripod grasp. Students begin to copy and form simple shapes then progress to stick letters and finally curved letters. With practice, support, and consistent instruction, students will begin to develop their handwriting skills.

5. Conclusion

The findings of this meta-synthesis highlight the complexity of factors influencing handwriting difficulties. The evidence showed that many factors affect handwriting performance such as brain abnormalities, instruction techniques, on-task behavior, developmental disabilities, and motor planning.

Educators have a better understanding of learning by reading brain research. Students with a learning disability often have brain abnormalities that affect cognitive and motor function. The quality of handwriting and speed has been clearly related to the presence and severity of neurological dysfunction. When teachers understand which part of the brain is accessed during an activity, we can plan and adapt lessons to better fit the needs of our students. Handwriting activates many areas of the brain.

Teachers should use research based practices when instructing students. Data must be used to guide interventions. The teacher needs to carefully sequence activities and adapt these activities to meet the needs of individual students to ensure a higher success. The research stated that children with poor handwriting quality who received regular intervention on an individual basis improved their handwriting skills. When sound teaching methods along with motivating materials were paired more on-task behavior was observed during handwriting instruction.

The ability to learn to write for special education students is impacted by developmental disabilities. Research has shown that moderate correlations suggest that the relationships among

many variables are complex and that they are contributing factors to handwriting performance that vary among individual children. Writing problems are related to the presence and severity of minor neurological dysfunction (MND) and more complex tasks of visuomotor integration are impacted by various MND. Kinesthesia, motor planning, eye-hand coordination, visuomotor integration, and in-hand manipulation are among the variables that affect handwriting.

Motor planning is a key component when engaging in the activity of writing. When a child has developed gross motor, fine motor, and oculomotor skills, then handwriting is more legible. Treatment principles should be integrated throughout a student's day. By using adaptive tools students will have a higher success when writing.

Handwriting is necessary for assignments, homework, standardized testing as well as communicating. By teaching students strategies to overcome their handwriting challenges, they will be more successful in their school environment and in daily living. With practice, support, and consistent instruction, students will begin to develop handwriting skills and be more successful in many areas of their life.

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