Traditional vs Multisensory:

Assessing the Impact of Writing Tools on Letter Formation Mastery

Through Direct Instruction

By

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ABSTRACT

The purpose of this study was to determine the impact of direct instruction paired with multisensory tools on letter formation mastery, in comparison with direction instruction paired with traditional writing tools (paper and pencil) on letter formation mastery in early elementary students who experience persistent letter formation difficulties. Three early elementary students who experience persistent challenges with letter formation were selected for participation in this multiple-baseline across subjects study. Each student participated in three study phases. The first phase was a baseline phase to assess their existing letter formation knowledge. Next, students participated in direct instruction lessons on letter formation using paper and pencil tools. The third phase of the study maintained the structure of the direct instruction lessons used in the prior phase but used a multisensory writing tool instead of paper and pencil tools. Each student's rate of progress towards letter formation mastery was assessed to determine if the writing tool influenced the impact of direct instruction on students' letter formation acquisition. Overall, each student demonstrated varying rates of growth in phase two and phase three of the study. All

students demonstrated greater rates of growth during phase two in comparison to phase three. Each student showed notable growth immediately following exposure to direct instruction. Based on the findings of this study, direct instruction paired with traditional writing tools had a greater impact on letter formation acquisition than direct instruction paired with multisensory tools. Several limiting factors including elements of the study design and students' positive responses to initial direct instruction in phase two could have impacted these results.

Traditional vs Multisensory:

Assessing the Impact of Writing Tools on Letter Formation Mastery Through Direct Instruction

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Chapter 1: Introduction

Research in the field of writing instruction is relatively sparse in comparison to the heavily researched field of reading instruction (Jacobs & Fu, 2014). The ability to write letters automatically and legibly is an important academic skill (Effenberg et al., 2015). Unlike other academic skills, effective letter formation can facilitate or hinder participation in other subject areas (Effenberg et al., 2015). The ability to write legibly is also relevant outside of the traditional classroom environment. Legible handwriting facilitates participation in society from the most basic forms of functional communication to more advanced applications such as creative expression and social communication (Effenberg et al., 2015).

When compared to other domains of early elementary instruction, research into letter formation instruction is comparatively shallow. Possible factors contributing to this gap in research could be the complexity of the process of learning to write. Thomassen and Teulings (1983) recognize how a young child's development of handwriting is impacted by a host of complex factors including motor skills, cognitive skills, natural tendencies and culture. The complex process of learning letter formation is addressed through adjacent settings and disciplines that sometimes overlap. General education teachers are expected to teach correct letter formation in kindergarten as part of the standard course of study. Although the standard course of study is sufficient to support most students, some students with disabilities require additional support to acquire early writing skills. Special education teachers provide targeted intervention to support these students with their acquisition of early writing skills. Occupational therapy can be implemented to address sensory and fine motor challenges, which can adversely impact a child's ability to grip their writing tools and plan motor movements necessary for letter

formation (Jackman & Stagnitti, 2007). Special educators, general educators and occupational therapists approach their students' letter formation needs differently. Professionals across these domains have diverse educational backgrounds and qualifications. These differences could contribute to variant approaches used by teachers and therapists to support students with emergent writing needs.

In the early elementary classroom, instruction in letter formation is frequently embedded in phonics curricula. Phonics curricula generally teach letters in an order supported by research on phonics acquisition (Balajthy, 2014). Phonics-based curricula have different scopes and sequences, each supported by different research based approaches. General and special educators may use curricula with conflicting approaches. This disconnect is perfectly illustrated in the setting for this study. The elementary school that served as the setting for this study uses the *Fundations* phonics curriculum in the general education setting and the *Sounds Sensible* phonics curriculum in the special education setting.

Sounds Sensible is a supplemental reading intervention designed by Sheila ClarkEdmands, who is an Orton-Gillingham Fellow (Balajthy, 2014). *Sounds Sensible* provides direct instruction in critical reading skills that were identified by the National Reading Panel in 2000

(Balajthy, 2014). The *Sounds Sensible* curriculum is a "pre-reading" program that focuses on exposing emergent readers to early phonological concepts. The program sequences the introduction of consonants based on increasing phonological difficulty, citing extensive research regarding phonics acquisition (Balajthy, 2014). The *Sounds Sensible* curriculum is designed to directly feed into the SPIRE program. SPIRE stands for "Specialized Program Individualizing Reading Excellence". The SPIRE program builds on the skills taught through *Sounds Sensible*

by teaching increasingly difficult phonemes and spelling patterns (Balajthy, 2014). The county that served as the setting for this study mandates the implementation of *Sounds Sensible* and Spire for early elementary students with disabilities related to reading.

The *Fundations* curriculum offers another research based approach to support struggling readers. The *Fundations* curriculum is aligned with principles of the Orton-Gillingham approach to reading instruction, as well as science of reading research (Research Base, n.d.). Research shows that implementation of the *Fundations* curriculum results in positive learning outcomes for students with learning disabilities, as well as children without known disabilities (Research Base, n.d.). *Fundations* is designed to feed into the larger *Wilson Reading System*, similar to the way that *Sounds Sensible* feeds into the larger Spire curriculum. The *Fundations* and *Wilson Reading System* curricula are endorsed by multiple independent reviewers (Research Base, n.d.). Use of the *Fundations* and *Wilson Reading System* is implemented by many departments of education at the state level (Research Base, n.d.). The county that served as the setting for this study mandates the use of the *Fundations* curriculum in early elementary general education classrooms.

The *Sounds Sensible* and *Fundations* curricula are both research-based interventions rooted in principles of direct instruction. However, their approaches to letter formation instruction vary significantly in wording. See Figure 1 and Figure 2 for an example of the differences in each curriculum's approach to direct instruction of letter formation. The *Fundations* and *Sounds Sensible* curricula also differ in their approaches to pacing and sequencing of letters taught. The *Fundations* approach starts by teaching the sound and formation of the following letters in the following order: t, b, f, n, m, i, u, c, o, a, g, d, s, e, r, p, j,

l, h, k, v, w, y, x, z, and q (*Fundations*, 2018). The *Fundations* curriculum teachers two or three letters a week to expose students to all lowercase letters within 12 weeks (*Fundations*, 2018).

Sounds Sensible's scope and sequence is less regimented to allow for more flexibility to re-teach letters as needed. *Sounds Sensible* lessons teach one letter per lesson and allows lessons to be split over two days if necessary. *Sounds Sensible* also offers reinforcing lessons for each letter that can be implemented as necessary, based on student achievement (Balajthy, 2014). *Sounds Sensible* teaches one letter at a time, in the following order: p, b, t, d, c, k, g, f, v, s, z, j, m, n, w, a, h, l, r, x, and y. *Sounds Sensible* teaches the "short a" sound and the remaining short vowel sounds are covered in the Spire curriculum (*Sounds Sensible*, n.d.).

Students who receive any portion of their reading or writing instruction in special education are receiving instruction in a different sequence and language than the general education setting. This disconnect makes it difficult for students with special education services to generalize their instruction to the general education setting and limits opportunities to reinforce skills learned in special education.

While *Sounds Sensible* and *Fundations* use different language and sequencing, they share some characteristics. Both opt for complex language, large words, and numerous steps to teach letter formation. Early elementary students who have been identified for special education in writing must already be acquiring letter-formation skills at a slower rate than their typically developing peers. Varying levels of exposure to two different curricula with equally complex language may hinder acquisition of these critically important early writing skills.

The *Learning Without Tears* writing curriculum offers an alternative approach to letter formation instruction. The scope and sequence of letter formation taught through the *Learning*

Without Tears approach is based on sensorimotor development, not phonological awareness (Owens, 2004; *Learning Without Tears*, n.d.). *Learning Without Tears* teachers letter formation in the following order: F, E, H, L, B, R, D, P, M, N, K, V, U, W, X, Y, Z, C, O, Q, G, S, A, I, T, J, c, o, s, v, w, t, a, d, g, u, I, e, l, k, y, j, p, r, n, m, h, b, f, q, x, and z (*Learning Without Tears*, n.d.). *Learning Without Tears* uses direct instruction in simplified language and short steps to teach letter formation (*Learning Without Tears*, n.d.).

The body of research supporting the *Learning Without Tears* approach to letter formation instruction is somewhat sparse (Owens, 2004). *Learning Without Tears*' foundation of research appears especially shallow when compared to the depth and volume of the research behind the *Sounds Sensible* and *Fundations*. When comparing the amount of foundational research behind these three different approaches, it is helpful to consider the discrepancy in national attention and interest devoted to reading research in comparison to writing research. While this discrepancy is widely acknowledged regarding general writing research, the sensorimotor components of the *Learning Without Tears* add an additional layer of complexity that could exacerbate existing research shortages. Sensorimotor approaches could be considered through multiple research lenses across adjacent disciplines including the fields of special education, occupational therapy, psychology, and child development.

The relatively shallow foundation of research into sensorimotor approaches to letter formation instruction has not appeared to impact the popularity of the *Learning Without Tears* curriculum in the United States. Twelve states including Texas and California have adopted the *Learning Without Tears* curriculum for use with general education students (Owens, 2004; *Learning Without Tears*, n.d.). This popularity has generated some research interest to assess if

its widespread use is backed by positive results. A 2004 study assessed the impact of *Learning Without Tears* instruction on letter formation acquisition in 81 students (Owens, 2004). Results showed that exposure to *Learning Without Tears* instruction over a 10 week interval improved the size and spacing of students' letters (Owens, 2004).

This thesis provided students who experience persistent letter formation challenges with direct instruction using simplified, student friendly language. This study adapted elements of the *Learning Without Tears* approach to letter formation instruction. *Learning Without Tears* incorporates multisensory elements as well as traditional writing tools in direct instruction lessons (Owens, 2004). The purpose of this study was to assess the impact of traditional writing tools in comparison to multisensory writing tools using the condition of direct instruction in letter formation. Multisensory elements of *Learning Without Tears* lessons were avoided to achieve this purpose. This study incorporated elements of *Learning Without Tears*' simplified language for direct instruction and sensorimotor based scope and sequence. See Figure 3 for an example of *Learning Without Tears*' simplified language for teaching formation of uppercase "B" in comparison to the *Fundations* and *Sounds Sensible* approaches. See Figure 4 for the scope and sequence used for direct instruction of letter formation in this study. Note that letters are grouped based on their starting point and taught in order from letters composed of the simplest writing strokes to the most complex.

Chapter 2: Review of Literature

Letter Formation Research

Even though writing research is relatively sparse, some aspects of letter formation are proven through research and generally accepted as fact. Correct letter formation for each letter is not random. The starting point and strokes for each letter of the alphabet is strategic and intentional (*Learning Without Tears*, n.d.). Although it may not seem important for an emergent writer who may only generate a few letters at a time, learning the correct starting point for each letter it is intended to streamline the writing process as students increase the pace of their writing output (Özmen & Atbasi, 2016). Similarly, researchers agree that it is critical to consider typical motor development for emergent writers, ensuring that they are learning developmentally appropriate writing strokes in increasing complexity (Özmen & Atbasi, 2016).

Direct Instruction

Direct instruction is a broad term that encompasses a wide variety of educational strategies (Cox, n.d.). The National Institute for Direct Instruction (NIFDI) explains that direct instruction is a research-based instructional approach that can be applied to teach a range of academic concepts (Cox, n.d.). Direct instruction works by breaking a skill or concept into small steps, and delivering scaffolded instruction to students in simple, explicit language. Direct instruction emphasizes mastery by only focusing a small percentage of a lesson on new material and allowing frequent opportunities to review and apply previously learned skills (Cox, n.d.). Skills are typically taught in isolation first. Once students grow more comfortable and competent

with simple skills taught in isolation, these skills are integrated into increasingly complex applications (Cox, n.d.). An important element of direct instruction is that students are instructed at their ability level, whether individually, or in a group of individuals at the same instructional level (Cox, n.d.). By focusing on small increments of new material and clearly defining learning expectations, chances of misinterpreting the instruction is significantly reduced, leading to improved learning outcomes (Cox, n.d.). Elements of direct instruction are commonly applied to letter formation instruction.

The *Learning Without Tears* curriculum incorporates many aspects of direct instruction into their approach to letter formation instruction (*Learning Without Tears*, n.d.). *Fundations* and *Sounds Sensible* each incorporate elements of direct instruction when teaching reading skills and letter formation skills. *Learning Without Tears*, *Fundations*, and *Sounds Sensible* all include elements of scripted language and sequential steps, which are considered characteristics of direct instruction (Cox, n.d.). Figures 1, 2, and 3 offer a visual example of these diverse interpretations of direct instruction to teach the same concept: uppercase “B” letter formation.

The foundation of research regarding direct instruction is extensive (Cox, n.d.). Elements of direct instruction are well-known in academic settings and it is widely regarded as an effective framework to teach academic concepts (Cox, n.d.). Direct instruction is applied across educational settings without significant questions regarding its research base. Each of the three curricula acknowledged in this study have distinct differences in their application of direct instruction. Each curricula provides direct instruction in letter formation, albeit with varying levels of clarity and simplicity. The broad criteria used to describe direct instruction means that each of these approaches approach could qualify as a form of direct instruction without significant difficulty.

The research regarding direct instruction is largely accepted in educational settings, and the broad definition of what qualifies as direct instruction means that many studies and approaches fall under this umbrella of research. Research regarding the use of multisensory tools in letter formation lessons is less prevalent. The three studies analyzed below provide insight into the small, existing body of research regarding multisensory approaches to letter formation acquisition. The fourth study addresses research into the development of curriculum-based writing assessments on letter formation which assisted in the development of data collection tools used to answer the research question regarding letter formation and writing tools.

Study 1: Multisensory vs. Cognitive Approach

Introduction

Researchers at the University of Victoria, British Columbia sought to examine current handwriting interventions (Zwicker & Hadwin, 2009). Multisensory approaches to handwriting instruction are based on the hypothesis that providing a child with various sensory opportunities helps their nervous system integrate information more efficiently. When 198 occupational therapists across the United States were surveyed, over ninety percent reported that they use multisensory approaches in their handwriting instruction (Zwicker & Hadwin, 2009). Even though most occupational therapists surveyed reported using multisensory approaches, empirical evidence supporting this practice is both scarce and inconclusive. Hadwin and Zwicker hypothesized that cognitive interventions may be more effective than the popular multisensory interventions. They designed a study to compare student's response to cognitive and multisensory interventions to determine if multisensory instruction is as effective as its widespread use would suggest (Zwicker & Hadwin, 2009).

Methods

Zwicker and Hadwin developed a randomized controlled trial to compare three handwriting interventions: cognitive, multisensory, and no intervention (the control group). Study participants were 72 first and second graders who were referred for occupational therapy services based on handwriting difficulties (Zwicker & Hadwin, 2009). None of the children in the study had received direct interventions for handwriting concerns prior to the study. The 72 participants were randomly divided into three groups: cognitive, multisensory, and the control group. Students in the two intervention groups received treatment in one weekly thirty-minute session for ten consecutive weeks. Each treatment group was introduced to letters in the same sequence. Zwicker and Hadwin sequenced letters for instruction based on similar stroke patterns. This has been shown to reinforce correct motor patterns and reduce issues with reversals, rotations and inversions (Zwicker & Hadwin, 2009).

The cognitive approach incorporated elements of comparing the visual appearance of letters with the interventionist, practicing forming the letter with paper and pencil, and evaluating their writing production by identifying their best-formed letter (Zwicker & Hadwin, 2009). The multisensory intervention involved using chalk to form letters on a chalkboard, using sky-writing to trace letters in the air with their finger, tracing letters in sand, tracing bumpy glitter glue letters, using a marker, and using a pencil. Both interventions involved elements of direct instruction, as well as modeling, tracing and copying. However, the cognitive intervention emphasized the metacognitive awareness of writing, while the multisensory group emphasized the "feel" of the letter (Zwicker & Hadwin, 2009).

Results

Zwicker and Hadwin calculated the means and standard deviants of each group's pre-test and post-test scores, as well as the change between these scores. Interestingly, their data did not reflect a statistically significant difference in change scores across the three groups. Zwicker and Hadwin's hypothesis that students in the cognitive group would demonstrate more growth than students in the multisensory group was not supported in their findings (2009). A more in-depth analysis of their data revealed no statistically significant differences when results were divided based on gender of the participating students. When results were divided based on the grade level of participating students, a few conclusions were illuminated. All of the first grade students increased their legibility scores from the pretest to the posttest, with a slightly higher rate of improvement in the multisensory group. Second grade students showed little improvement with the multisensory intervention, with achievements comparable to the progress of the group that received no intervention whatsoever. Second graders who received the cognitive intervention showed greater improvement and less variance than second graders in the multisensory and control groups (Zwicker & Hadwin, 2009).

Implications

Zwicker and Hadwin's study found that the cognitive intervention did not have a significantly better or worse impact than the multisensory approach (2009). Their findings did not yield conclusive evidence that multisensory approaches are as effective as their popularity would suggest. Over ninety percent of surveyed occupational therapists reported using a multisensory approach to letter formation instruction. While Zwicker and Hadwin's findings did not suggest that multisensory interventions are detrimental to a student's ability to form letters

correctly, results of their study raised questions about their widespread use to support letter formation in occupational therapy (2009).

Study 2: Multisensory Approach at Pre-School Level

Introduction

Researchers at Aristotelian University of Thessaloniki in Greece designed a study with pre-school age children to assess the efficacy of the multisensory method of instruction for early reading and writing skills (Zafrana et al., 2000). Evidence cited for the importance of multisensory opportunities comes from Greenough's research that suggests a richly stimulating environment is helpful for forming neuron connections in the brains of young children (Zafrana et al., 2000). Researchers set out to address the idea that it could be harmful for pre-school age children to learn reading and writing skills. This assumption is based on the belief that children in pre-k may not be mature enough to benefit from writing instruction and its introduction at this developmental stage may not be appropriate (Zafrana et al., 2000). Researchers hypothesized that existing evidence about childhood development and language development suggest that most children possess an internal disposition that makes them curious about spoken and written language, and instruction at the pre-school age would not be premature. Researchers believed that an equally inviting and stimulating environment which allowed preschool students flexible opportunities to explore writing would lead to acquisition of early writing skills (Zafrana et al., 2000).

Methods

Researchers designed a pilot study without controls (Zafrana et al., 2000). The purpose of the study is to evaluate the efficacy of an early childhood reading and writing program with multisensory elements. Seventeen children participated in the pilot program. Their ages ranged

from three and a half to five years old. Their participation in the pilot program was assessed for a three month period, from January to March. The program consisted of two phases. In the first phase, teachers taught the students in short, fifteen minute lessons on two letters each, with three lessons each week. The second phase allowed students to choose activities to practice reading and writing skills individually, based on their interest. The teachers' role became more discreet during this phase. Choices for activities related to writing involved tracing sandpaper letters, and writing letters with a pencil. Researchers tracked the activities students elected to participate in, and their progress over time (Zafrana et al., 2000).

Results

Out of all the reading and writing activities available for the children to choose from during the second phase of the study, writing and copying letters from a model were the most popular (Zafrana et al., 2000). Early in the pilot program, letters formed by each student were large and irregular. As the study progressed, each student's writing samples reflected improved control and legibility (Zafrana et al., 2000). Researchers noted that students used the sandpaper letters to help them when practicing how to write letters correctly. When students were practicing writing letters with the pencil, if they had difficulty with a letter, the student would often leave their station and find the sandpaper card with that letter. They would trace the sandpaper letter with their finger, then proceed to write the letter correctly on the paper (Zafrana et al., 2000). Researchers noted that student participation in the second phase of the study was high, and students were especially engaged and motivated in the activities because they had the chance to choose them. Students demonstrated improvements in reading skills simply by identifying and copying individual letters and whole words, suggesting that writing can facilitate the development of early reading skills (Zafrana et al., 2000).

Implications

Results of this study confirmed the hypothesis that children of preschool age are not only able to learn early reading and writing skills, but they also expressed interest and engagement (Zafrana et al., 2000). Researchers emphasized the importance of the student's environment, highlighting that the choice of multiple activities and a wide variety of sensory experiences contributed to the high level of student engagement. Researchers expressed interest in assessing students later, to see if they maintained knowledge they acquired during the pilot program, and study how much practice may be necessary for students to maintain the knowledge acquired during the three month pilot program. Researchers recognized that their sample size was relatively small, and a larger sample size would be necessary to make broader conclusions about multisensory reading and writing instruction for pre-school age children (Zafrana et al., 2000).

Study 3: Acoustic Multisensory Approach to Character Acquisition

Introduction

A group of psychologists in Germany researched the use of an acoustic multisensory tool to support "character writing" in young children (Effenberg et al., 2015). For the purposes of this literature review, the use of the term "character writing" in this study should be considered equivalent to the term "letter formation". Researchers began by acknowledging the importance of writing skills and the role they play in helping individuals communicate in society (Effenberg et al., 2015). Researchers acknowledged that, while multisensory strategies have been explored for decades, recent technological advances have opened up possibilities for new multisensory approaches (Effenberg et al., 2015). They cited evidence that children respond to the use of modern technology in academic settings with elevated engagement and interest. Researchers also identified a lack of research into acoustic multisensory approaches (Effenberg et al., 2015).

The multisensory focus of this study addressed the use of sonification. Sonification is the use of audio to communicate information, only sonification does not involve speech sounds (Effenberg et al., 2015). Researchers provided several examples well-known examples of sonification. They pointed out sonification in the form of beeping sounds used in Sonar location, used to provide a listener with spatial information. Similarly, they explained how a Geiger counter uses sonification in the form of static-like noise that, when produced, provides the listener with information about levels of radiation in their environment. Researchers developed a program that produced sonification as students' formed letters in real time. A unique sound was produced as students applied pressure with their writing tool. Researchers called the sonification "SoundScript" (Effenberg et al., 2015).

Methods

Researchers designed an experimental pilot study involving 15 kindergarten students split into three randomized groups. The purpose of the study was to compare each group's letter formation acquisition through three different instructional approaches: the sound group, the sonification group, and the control group (Effenberg et al., 2015). The sound group received auditory input, but not sonification. Each student was between five and six years old and had no known diagnoses of neurological or developmental disorders. The researchers focused on three characters only: 'a', 'k', and 'm'. Researchers selected these letters because of their varying complexities. An adult researcher wrote each of the characters digitally. These characters were used as a model for the participating children (Effenberg, et al., 2015). Each character was presented five times each in random order, and the children were instructed to reproduce each character twice directly after it was presented, before the next character was presented. The students' writing was captured using a digital tablet underneath a normal piece of paper. The

student wrote each letter with a normal ball-point pen so they would be able to see the marks as they made the letter. The tablet digitally stored each writing sample. Each child participated in five thirty minute lessons with breaks of two to three days in between each session. Students participated in the intervention for about three weeks. Student progress was assessed using a pretest and post-test (Effenberg, et al., 2015).

Results

Researchers tracked two aspects of the students' writing quality across the study. Dynamic Time Warping (DTW) was used to analyze the digital copies of each students' writing strokes. DTW tracked the time it took each student to write the given letter. A shape matching algorithm was used to compare the shape of each letter produced (Effenberg, et al., 2015). The only group that exhibited a statistically significant change in DTW data was the group that received the sonification intervention. Each group performed similarly based on the shapematching data, and no statistically significant conclusions were drawn in this area (Effenberg, et al., 2015).

Implications

This pilot study was the first of its kind, attempting to apply sonification to letter formation acquisition as a new multisensory approach. Results of the pilot study suggested the potential for further positive outcomes regarding this acoustic multisensory tool (Effenberg, et al., 2015). Researchers acknowledged that sonification yielded a statistically significant positive result based on temporal outcomes, not the shape matching algorithm. However, the shapematching algorithm did not indicate any negative effects of sonification. This study resulted in a solid starting point for future research into acoustic multisensory approaches.

Further research regarding acoustic multisensory approaches to letter formation acquisition could incorporate more letters of the alphabet and study its effects over a longer interval of time.

Study 4: Curriculum-based Letter Writing Measure

Researchers Coker and Ritchey (2014) began by reviewing an influential model of adult handwriting development that is commonly applied to early writing. This model identifies the following three cognitive processes for writing: planning, translating, and revising. Coker and Ritchey acknowledged that translation involves the ability to encode letters. They recognized that emerging writers would not be able to demonstrate planning and revising skills until they first learned to translate their ideas into writing. Coker and Ritchey recognized the importance of identifying and treating emergent writing needs as early as possible to avoid the compounding consequences of delayed action. They recognized the need for improved curriculum-based tools to quantify emergent writing skills and screen for needs in these areas (Coker & Ritchey, 2014).

Coker and Ritchey (2014) researched four different screening measures related to emergent reading and writing skills. Coker and Ritchey asked two primary research questions. They set out to learn if early writing measures would be able to predict risk status for writing needs in kindergarten. They also asked whether the addition of early reading measures would improve their ability to accurately predict these risks (Coker & Ritchey, 2014). Coker and Ritchey's research regarding the screening measure for letter writing will be the focus of this review due to its relevance to the research question regarding letter formation mastery and writing tools.

Coker and Ritchey analyzed students' ability to write upper and lowercase letters that were presented to the student in a randomized order (2014). The order of letter presentation was standardized for alternating forms of the letter writing measure. Responses were scored based on

their legibility. Coker and Ritchey cited research indicating that letter reversal is very common in young students, and not necessarily an indication of a more serious problem (2013). Based on this research, reversed letters were considered correct unless the reversal resulted in a different letter, such as the student writing a letter "b" when presented with a letter "d". The highest possible score for each measure was 52, which would mean each upper and lowercase letter was written correctly. Reliability estimates encompassed alternate form reliability, split half reliability and internal consistency. Reliability estimates for the letter writing measure fell between .90 and .94 (Coker & Ritchey, 2013).

Summative Implications

The three studies regarding multisensory writing approaches provided insight into different multisensory approaches to letter formation acquisition and their efficacy. These studies spanned multiple disciplines. One study was conducted by Occupational Therapists in the United States, another was conducted in a pre-school setting in Greece, and another was conducted by a team of psychologists in Germany. The diverse disciplines and geographic locations offer an opportunity for some interesting conclusions. These studies highlight how seemingly targeted criteria for inclusion in this review (multisensory approaches to letter formation) can easily result in research in more than one adjacent discipline.

These studies show just how diverse multisensory approaches to writing instruction can be. More research into the use of multisensory tools to support letter formation acquisition will be necessary to fill the cavernous gaps in this field of research.

Direct instruction is a well-researched intervention in comparison to multisensory approaches to letter formation instruction. Direct Instruction's solid research base provides a stable foundation to support further research into multisensory writing approaches. Zwicker and

Hadwin's (2009) study approach multisensory instruction as an intervention. Instead, the impact of multisensory tools could be studied as a condition for another intervention: direct instruction. The traditional *Learning Without Tears* approach uses direct instruction to teach letter formation with multisensory and traditional tools within the same lesson (Owens, 2004; *Learning Without Tears*, n.d.). Isolating the use of multisensory tools could illuminate findings that are not possible through the combination of multisensory and traditional tools used in *Learning Without Tears*. While the application of direct instruction to letter formation instruction is not a novel concept, the approaching traditional and multisensory writing tools as conditions could result in interesting findings. Further research is necessary to answer the following research question: **Will multisensory or traditional writing tools have a greater impact on direct instruction in letter formation mastery.**

Chapter 3: Methods

Research Design

A multiple-baseline across subjects design was employed to address the research question regarding the impact of writing tools on direct instruction in letter formation. A multiple-baseline study was appropriate since the effect of this intervention could not be withdrawn once the intervention started. Once students are taught correct letter formation, they are unable to return to a baseline phase without this knowledge. It would be impossible to assess the impact of the intervention and writing tools by returning to a baseline phase. Instead, a multiple-baseline design involved implementing the intervention at different times with multiple students. Students served as their own control group by comparing their phase two and phase three results to their abilities demonstrated in the baseline phase. While student's individual results were analyzed based on their individual progress, using three individual students for the study allowed their results to be compared to see if a trend existed across their three responses, and by staggering their baselines, effects of history and maturation are minimized. Three students were selected for participation in this study. The results of three students' responses to the intervention offered the opportunity to draw more conclusions than if only one or two students had participated.

Setting

The study took place in a semi-urban elementary school located in Southeastern North Carolina. Students participated in all study activities in their special education classroom, which was a familiar environment for each student. Students were pulled to one of two small-group

tables in the classroom to participate in each phase of the study. During phase one, progress monitoring probes were completed in a one on one setting with the student and the teacher. During phase two and phase three, the direct instruction lessons were provided in a one on one setting at a small group table. In some instances, other students were present in the classroom during the time of the intervention, but not in proximity to the student involved in the study. A quiet learning environment was provided to the maximum extent possible.

Students participated in study lessons and progress monitoring probes at various times of day to accommodate their individual schedules. Students participated in study activities in the morning during morning-work time, after school, and during a station of their reading and writing block which was devoted to additional writing practice based on individualized IEP goals. The focus of this study addressed elements of each student's existing IEP goals and they did not miss any *Fundations* or *Sounds Sensible* instruction to participate in the study.
Participation in the study supplemented student's existing writing instruction.

Participants

Student 1

Student 1 (S1) was a male student in first-grade. He turned seven years old during the study. S1 qualified for specially designed instruction due to his needs related to Autism. S1 had a unique educational history that made him a prime candidate for participation in this study. S1's historical access to the learning environment was significantly impacted by COVID-19 and related hardships. S1's preschool year was unexpectedly cut three months short due to COVID19 related school closures. In Kindergarten, S1 struggled to access remote learning opportunities for a variety of reasons. S1's sensory needs made it difficult for him to meaningfully engage in virtual learning options. S1's family experienced persistent housing challenges throughout the

2020/2021 school year, which made it difficult for him to access virtual learning as well as inperson learning when it was made available in March of 2021. S1 experienced significant absences related to frequent moves and persistent housing needs, which resulted in more than 100 absences during his kindergarten school year and 70 absences during his first-grade year. S1's family was able to secure stable housing in the spring of 2022 and he attended school consistently starting in January of 2022. He attended school on a three-hour modified day due to his needs. S1's access to letter formation instruction was significantly limited by absences. S1 was a prime candidate due to his letter formation needs that resulted from a significant lack of access to instruction in this area. S1's strengths related to writing were his letter-sound knowledge and letter name knowledge. S1's challenges related to writing involved his stamina to write more than a few letters at a time, as well as his ability to control his tool to write letters in the given space. S1 consistently struggled to grip the pencil correctly during writing activities. After the conclusion of this study, S1's school-based team met to share assessment data collected as a result of a reevaluation. The occupational therapist at S1's school assessed his fine motor and sensory needs. Her findings resulted in the addition of occupational therapy services to support his sensorimotor needs. This decision was made after the conclusion of this study. Observations of S1's grip and date collected during this study were considered as supplemental sources of information by the Occupational Therapist.

Student 2

S2 was a male student in second grade. He turned eight years old during the study. S2 received specially designed instruction under the I.D.E.A. category of Other Health Impairment due to his needs related to Attention-Deficit/Hyperactivity Disorder (ADHD). S2 was diagnosed with ADHD at a young age and received specially designed instruction since kindergarten. S2 was screened for fine motor concerns in kindergarten. Screening results pointed to some needs

related to fine motor control and motor planning, but the team at the time determined that those needs were not significant enough to warrant a full evaluation, and Occupational Therapy services were not considered. S2 made significant progress on his writing goals through access to special education instruction. However, some challenges with letter formation persisted in spite of interventions with the *Sounds Sensible* curriculum. While S2 was able to write most letters legibly, he formed some letters with atypical marks and struggled to write many letters automatically. S2's letter formation needs were not so significant that they impeded his access to writing activities and warranted services outside of his existing special education supports. However, his letter formation needs appeared to slow down his writing process, which resulted in less writing produced over time. His letter formation needs also resulted in frustration when he struggled to produce legible writing to reflect his ideas. S2 was never identified as a student in need of fine motor support, but he appeared to develop some letter formation habits at a young age that were now slowing him down and causing difficulties that would only be magnified as expectations for writing speed and quantity increase by grade level. S2 did not appear to be responding to the complicated language in *Sounds Sensible* lessons. He was observed making the same errors on the same letters. He was not observed repeating or generalizing any of the direct instruction language from *Sounds Sensible* lessons. S2 was identified as a candidate for the study due to his letter formation needs that were not remediated through his existing interventions at the time of the study. S2 possessed the strongest functional writing skills out of any other student in the study. He was older than the other two students and therefore had more time and opportunities to practice letter formation. This also meant he had more time to develop incorrect letter formation habits. S2 had excellent attendance throughout the academic year this study occurred in. S2 reported practicing letter formation and writing at home. S2 exhibited challenges related to

stamina in comparison to other second grade students, but stamina was noted as a relative strength for him in comparison to the other participants of the study.

Student 3

S3 was a female student in kindergarten. S3 began receiving specially designed instruction in early Kindergarten through services that were planned at the end of her pre-school year. S3 received specially designed instruction under the I.D.E.A. category of Developmental Delay. S3 received reading and writing instruction in her general education and special education classes, which means she was exposed to the different language and scope and sequences of the *Sounds Sensible* and *Fundations* curricula. At the beginning of this study, S3 was making incremental progress towards mastery of her writing goals, which involved letter formation. S3 was identified as a candidate for this study due to her slow progress towards letter formation mastery. When observed by her special education teacher and general education teacher, S3 did not appear to apply language from *Fundations* or *Sounds Sensible* to her writing independently. S3's noted writing strengths were her desire to write and enjoyment of producing a high volume of letters and pre-writing strokes, even if they were not legible or accurate. She did not shy away from writing and enjoyed drawing and writing, producing drawing and pre-writing strokes in a large volume. S3 did exhibit frustration when tasked with writing a letter that was difficult for her, or when she was asked to correct letters she formed incorrectly. Observations of S3's writing behaviors resulted in a notable finding. When she was unable to recall the shape of a challenging letter after trying for a few seconds, S3 immediately opted to draw a shape or symbol that was not intelligible. S3's writing strengths included her stamina and willingness to write, even if the letters produced were not legible. S3's writing challenges involved her tendency to quickly

produce an intelligible shape when she tasked with writing an unfamiliar letter and placing her letters in the appropriate spaces during writing activities.

Exclusionary Factors

The students included in this study were identified due to their letter formation needs not already addressed through Occupational Therapy services. Students included in this study received direct instruction in letter formation at varying levels, depending on the minutes of specially designed instruction they qualified for. Students were exposed to a different program and different approach to direct instruction in the special education and general education settings. Regardless of the minutes of direct instruction and curriculum these students received exposure to, persistent challenges suggested that an alternative approach could be beneficial. Students included in this study were examples of those who "fell between the cracks" where their writing needs were not significant enough to warrant Occupational Therapy services. However, their needs were significant enough to qualify for specially designed instruction in the area of writing. Due to the added variable of direct instruction in letter formation during occupational therapy, students who received occupational therapy to address sensorimotor needs were not included in this study.

Data Collection

The independent variable in this study was the change in writing tools across phase two and phase three. The dependent variable in this study was student mastery of letter formation. This variable was measured by scoring student's letter formation on periodic progress monitoring probes. This study adopted elements of the curriculum based measurement researched by Coker and Ritchey (2014), which was described in the literature review. Students in this study were assessed using a similar progress monitoring probe for letter formation. For this study, students

were shown a card with a letter of the alphabet and directed to write the given letter in a box on their copy of the data collection sheet. Uppercase letters were presented first, in randomized order. Next, the data collection sheet was flipped over, and the student was asked to perform the same task with lowercase letters. Students wrote uppercase and lowercase letters one time each in each probe, for 52 letters per probe. These progress monitoring probes were completed bi-weekly during the baseline phase, and weekly during phase two and phase three. Progress monitoring probes during the intervention phases were always evenly spaced between four direct-instruction lessons. A typical intervention week involved one direct instruction lesson each day Monday through Thursday, with a progress monitoring probe on each Friday.

Students could earn a maximum of 104 points on each probe, with 2 points allotted for each letter. One point was awarded for correct letter formation, and one point was awarded for legibility. The observer watched the student form each letter and noted correct or incorrect letter formation on their copy of the data collection sheet. After the student finished the probe, the observer reviewed the student's work and assessed each letter for legibility in isolation. Students' weekly progress monitoring scores were calculated by adding their points for legibility and points for letter formation together to get a numerical score between 0 and 104. These notes were typed into a spreadsheet that documented the types of errors students made on each letter. For an example, view Figures 25, 26, and 27. These figures show the spreadsheets that contain each student's data on each individual letter in each probe. The sum of legibility and letter formation points is calculated and graphed for each probe. This sum is highlighted in yellow at the bottom of each column. For example, Figure 25 shows S1's progress monitoring data. The first baseline probe resulted in 49 total points for letter formation and legibility, and the score is highlighted at the bottom of the column furthest to the left. The columns to the right show sequentially ordered

progress monitoring scores. On Figures 25, 26, and 27, the black bars separating columns indicate the separation between phase one, phase two, and phase three for each student.

Materials

Materials used during the baseline phase of the study were the teacher-generated progress monitoring probe, 52 cards with uppercase and lowercase letters, and a pencil for each student to write with. A copy of the progress monitoring probe was used by the teacher to take notes on student letter formation as students participated in each probe. These notes were input into an Excel spreadsheet after the data collection session ended (see end of Appendices). The teacher used a clipboard to angle their data collection sheet so that students would not be able to see the teacher's notes. Materials for phase two of the study included all of the same materials as phase one, with the addition of the direct instruction lesson sheets (Figure 8). A highlighter was used by the teacher to facilitate letter formation during direct instruction lessons, but students still only used a pencil to write with. During phase three of the study, students used the shallow tray with shaving cream for letter formation. This replaced the lesson sheet for students, and the lesson sheet was only used by the teacher to keep the lesson on track. Wipes and paper towels were kept nearby to clean up the area as needed.

Phase One: Baseline

The first phase of this study involved assessing each student's existing level of letter formation mastery. During this baseline phase, students received their typical writing instruction in their general education classes and special education classes. No additional intervention was implemented. Data was collected bi-weekly using the progress monitoring probe. These probes were used to develop a picture of which letters students were consistently able to produce automatically and legibly, and which letters presented a persistent challenge. An individual plan

of instruction was developed for each student based on their baseline performance. Student's baseline probes were analyzed. Letters that students received 50% or less of the points possible for were identified for direct instruction lessons. See Figure 7 for an example of the instructional plan for Student 1 after their baseline probes were analyzed. Yellow letters are letters in need of direct instruction. Green letters are letters not in need of direct instruction.

Phase Two: Direct Instruction with Traditional Tools

During the second phase of the study, students received direct instruction in letter formation based on their individual instruction plans that were developed after the baseline phase. Students received two direct-instruction lessons for each letter identified as a target letter in need of direct instruction. Lessons were planned to last about ten minutes, and students received one direct-instruction lesson each day. For example, if a student earned 50% or less of the points possible for the letters "F" and "E" during the baseline phase, their first week of instruction in phase two involved two lessons on "F", followed by two lessons on "E". Each student received four direct instruction lessons before they were assessed using the same progress monitoring probe used in the baseline phase.

Phase Two lessons involved different elements of direct instruction from teacher modeling to facilitated practice with faded supports. Lessons were designed based on research related to direct instruction and elements of the *Learning Without Tears*' approach to direct instruction. Notes were embedded on the lesson sheet to guide teacher instruction during each section (see Figure 8). Each lesson followed the same order of events beginning with a warmup, followed by teacher modeling of the target letter, which gradually faded into student opportunities to practice tracing and producing the target letter independently. During the warmup, students practiced writing letters they demonstrated mastery of in the baseline phase. After students

completed some direct-instruction lessons, previously taught letters were mixed into the warm-up to reinforce their acquisition. The warm-up involved ten repetitions of various previously taught or previously mastered letters. The next part of the lesson was teachermodeling of correct formation of the target letter. With the lesson paper facing the student, the teacher demonstrated the correct letter formation while saying the steps out loud for five repetitions. The next phase of the lesson involved the teacher forming the target letter with a highlighter, and the student tracing the highlighted letter with their pencil. The remainder of the lesson involved fading of teacher support based on the student's performance. The teacher could intervene to guide and assist at any point of the lesson based on the student's performance. By the end of each direct instruction lesson, the student had the opportunity to form the focus letter 30 times. While each student formed the focus letter with varying level of support, from tracing to independent writing, each lesson resulted in 30 repetitions of the focus letter for each student.

Note that the teacher adapted the level of support provided on each letter based on the student's performance. Based on the student's first letter "R" during the fourth section of the lesson, it appeared they were not yet ready to form the target letter when only given the starting point to work from. If they were allowed to continue independently, they may have continued to repeat an incorrect formation of the target letter which would not reinforce correct formation habits. Instead, the teacher increased the level of support by going back to having the student trace the teacher's model. Regardless of the level of support in each section of the lesson, each student repeated the focus letter 30 times in each lesson.

Phase Three: Direct Instruction with Multisensory Tools

Phase three of the study involved direct instruction lessons that were very similar to the lessons used in Phase two. Each lesson started with a warm-up session where the student

practiced ten previously taught letters. The warm-up phase was still followed by observing the teacher model the correct letter formation for 5 repetitions. The remainder of the lesson still allowed the student opportunities to practice forming the target letter with varying levels of supports. The structure of phase three lessons mirrored the exact structure of phase two lessons. The only difference from phase two to phase three is that lessons in phase three involved multisensory tools instead of the paper and pencil practice in phase two. The progress monitoring probe and data collection procedure remained the same as phase one and phase two. The weekly progress monitoring probes were the only points in phase three where students used a paper and pencil.

A lesson sheet from phase two was used by the teacher to keep the multisensory lesson on track since there would be no concrete evidence of each letter as it was completed during the multisensory lessons. The lesson sheet from phase two was used to help the teacher monitor focus letter repetitions to ensure that phase three lessons had the same number of repetitions for each focus letter as phase two lessons. Focus letter repetitions were carefully monitored to ensure that students had the same amount of practice with focus letters taught during phase two and phase three of the lesson.

The multisensory writing tool selected for this study was shaving cream. One multisensory tool was selected for each multisensory lesson with each student in order to maintain consistency across lessons. The purpose of this study was not to compare the impact of different multisensory writing tools, which is why one multisensory tool was selected. Shaving cream was selected because it has a unique texture that students would not be typically exposed to in the classroom setting. While some students in the study had historically used multisensory tools such as sand or playdoh, shaving cream was selected as the multisensory tool for this study

since it had never been used before by any of the three participants. Each student enthusiastically consented to participate in lessons with shaving cream. Students seemed to enjoy working with a material with a novel consistency they had not encountered before in the educational setting.

Students used a small five inch by eight inch shallow tray that was filled with a thin layer of shaving cream. The rectangular tray was intended to emulate the gray rectangles students formed each letter inside during the phase two lessons and each baseline phase. The tray gave students boundaries to guide their writing. Students would complete letter repetitions with the shaving cream by drawing the letter in the tray of shaving cream with their dominant pointer finger. After a student completed a letter repetition, the teacher used a small spatula to smooth over the shaving cream and "erase" the letter and reset the tray for another repetition. The teacher modeled correct formation of the focus letter by drawing the letter in the shaving cream with the tray facing the student so that the letter faced the correct direction for the student. For sections of the lesson that involved starting at a dot that indicates the correct starting point, the teacher made the dot in the shaving cream with their pointer finger. The student used this dot as their starting point for the letter. After noticing that the small tray would slide around on the table, pieces of Velcro were attached to the back to secure it to the table and stabilize it when students wrote in the shaving cream.

Interobserver Reliability

Interobserver reliability regarding letter legibility was calculated at each phase of the study. The interobserver for this study was a special education teacher working in the school setting. Before the study began, the researcher met with the interobserver and provided a detailed explanation of how students' writing would be assessed on progress monitoring probes. Each progress monitoring probe assessed students in two aspects of their letter writing: correct

formation and legibility. Since letter formation could not be assessed in real time by the interobserver, legibility was the sole element of scoring assessed for reliability. It was only possible to observe letter formation in real time as the students were completing the progress monitoring probes. The interobserver was unable to attend progress monitoring sessions and observe letter formation in real time. However, legibility could be assessed by the interobserver at any point after the progress monitoring probes were completed. After students completed progress monitoring probes and they were scored by the primary researcher, they were shown to the interobserver.

The interobserver assessed legibility on one probe from each student during each phase of the study. The interobserver viewed each of the letters in isolation and stated out loud what letter they believed to be written. The primary researcher recorded these observations and compared them to their initial legibility findings, noting conflicting observations. The primary researcher calculated the rate at which the interobserver agreed about the legibility of each letter. The result was three rates of agreement for three baseline probes, one from each student. These three rates were averaged to determine interobserver reliability for phase one. This process was repeated during phase two and phase three. The interobserver and primary researcher agreed on legibility with 87% of the letters assessed in phase one, 95% in phase two, and 96% in phase three. The rate of agreement on legibility increased during each phase of the study. This could have been caused by decreasing variability and increased consistency in students' writing as they progressed through each phase of the study. In the baseline phase, each student's writing was much more variable. Some letters were completely illegible while others visually resembled a different letter than the one they were asked to produce. As students progressed into phase two and phase three, their writing grew increasingly legible and consistent. As students became more accurate with

their letter formation and reduced formation mistakes, there was less room for interpretation when assessing legibility.

Chapter 4: Results

Each student participated in twelve progress monitoring probes over the course of three month study. The number of probes each student completed in each phase varied due to the multiple baseline design, but each student participated in twelve probes total. Their scores on weekly progress monitoring probes were graphed to visually illustrate trends reflected in each students' data. Figure 11 shows graphed results of each student's progress monitoring probes across each phase of the study. Each student's results reflected an increase in letter formation skills and letter legibility from the baseline phase into phase two and phase three, with the most growth occurring in phase two for each student in the study. When individual student results were further analyzed, more information was revealed.

Results: Student 1

See Figure 12 for a graph containing S1's cumulative study data. The mean of S1's progress monitoring scores increased during each phase of the study, from an average score of 45.3 points in phase one, to an average score of 71.5 points in phase two, to an average score of 92.4 points in phase three. The range of S1's baseline scores across phase one was 8. The range of S1's phase two scores was 26, with his lowest score falling at the beginning of phase two and his highest score falling at the end of phase two, illustrating his growth in this phase. The range of S1's phase three scores was calculated as 10. This range indicated a smaller spread of data than phase two, but the lowest score in phase three was the first probe in this phase, and the highest score in phase three was the latest score. A negative growth rate was reflected in S1's baseline data. During phase two of the study, S1 demonstrated a positive growth rate with an

average growth rate of 12 points per probe. S1's growth rate slowed to an average of two points per probe during phase three, but the trendline remained positive. S1's data showed the immediacy of the effects of the intervention introduced in phase two. S1's first score in phase two showed an increase of 20 points from the baseline phase. Overall, S1 made significant improvements in his letter formation and legibility over the course of the study with growth occurring at a quicker rate in phase two than phase three.

Student 1 was the first student to move out of the baseline phase into the intervention phase. While each of S1's baseline data points were calculated as stable, they showed a negative trendline. S1 was in a challenging position. He possessed the letter knowledge to recognize most letters by sight and give the correct letter names for most letters. He would grow extremely frustrated when he was not able to produce a letter that looked like the model. His comments indicated frustration and acute awareness of his inability to form the letter correctly. Due S1's significant challenges with stamina and increasing levels of frustration, the decision was made to transition him into the second phase of the intervention first.

S1 made significant progress from the baseline phase into phase two. His overall demeanor and body language exuded increased confidence and reduced frustration in comparison to the baseline phase. S1 appeared to relish moving out of the baseline phase and learning how to correctly form letters that used to frustrate him. Students received four directinstruction lessons on two letters between each progress monitoring probe. Based on this schedule, students were only expected to increase their scores by approximately four points each, since they could earn two points for each letter they received instruction for. S1's average growth rate of 12 points per probe was triple the expected growth based on the direct instruction he received in between each probe. S1's rate of growth indicates that he was generalizing some of

the elements of direct instruction he received to letters he has not received direct instruction in yet. Based on S1's growth, his instructional plan was updated after three weeks in phase two. S1 was moved into phase three after four progress monitoring probes in phase two since his growth rate across these measures had him approaching the ceiling of 104 points.

S1's comments and behavior communicated enjoyment of the activity during the multisensory lessons. S1 continued to show growth based on progress monitoring probes during the multisensory stage of the intervention. His growth during this phase of the study occurred at a markedly slower rate than in phase two. Several factors could have contributed to this slowed growth rate. The scope and sequence for this study taught letters in order of increasing difficulty. This means the letters S1 learned during phase three of the study were more difficult to learn than the letters in phase two of the study. S1 grew from earning 39% of the maximum points possible in the baseline phase to earning 93% of the maximum points possible by the end of phase three. S1 was so close to earning all of the possible points in phase three, it is feasible that his rate of growth would slow down as he neared the ceiling, while also learning more difficult letters in phase three. Based on these factors, it would be difficult to isolate the multisensory tools as the sole cause of his slowed growth rate in phase three. It is possible that multisensory tools were one factor that could have contributed to a slowed growth rate but other factors must also be considered. S1's strong, positive response to the direct instruction shows just how capable he is of mastering letter formation when he has consistent access to instruction that is provided in student friendly language. See Figures 13, 14, 15, and 16 for visual representations of S1's growth across study phases as shown through work samples.

Results: Student 2

See Figure 17 for a graph showing S2's cumulative study data. An analysis of average scores for each phase of the study showed that S2 demonstrated growth in his weekly progress

monitoring probes across phase two to phase three. The mean of S2's progress monitoring scores increased from an average score of 75 points in phase one, to 87.8 points in phase two, to 99.5 points in phase three. The range of S2's baseline scores in phase one was 8. The range of S1's phase two scores was 12, with his lowest score falling at the beginning of phase two and his highest score falling at the end of phase two. The range of S2's phase three scores was 6, with his lowest phase three score at the beginning and the highest score at the end of phase three. During phase two of the study, S2 demonstrated a positive growth with an average growth rate of 4.25 points per probe. S2's growth rate slowed to an average of 2.25 points per probe during phase three, but the trendline remained positive. S2's first phase two probe increased by five points from the baseline phase, showing an immediate reaction to the intervention.

S2 entered the study with more legible handwriting and advanced letter formation skills than the other two students in the study. However, baseline measures illuminated some letters that were consistently illegible or incorrectly formed through atypical marks. S2 had less room for improvement in comparison to S1 and S3 based on his existing letter formation knowledge, but years of repeating incorrect letter formation meant these habits would take time to remediate. S2 participated in four baseline probes. While his baseline probes were calculated as stable after three measures, an additional probe served to solidify his instructional plan by providing one more data point to clearly indicate letters in need of direct instruction and letters that were not in need of intervention.

S2 demonstrated a steady rate of improvement across progress monitoring probes during phase two. S2 averaged a 4.25 point increase between each probe in phase two. Based on the intervention schedule, students were only expected to increase their weekly scores by approximately four points each. S2 demonstrated a growth rate slightly above the expected

growth rate. This indicated that S2 was generalizing elements of the direct instruction to letters he has not been explicitly taught yet. Further evidence of attempts to generalize aspects of the direct instruction to other letters was seen in S2's comments during progress monitoring probes. Due to S2's higher baseline scores and growth through phase two of the study, he was nearing the ceiling of 104 points after four probes in phase two. He was moved into phase three after four weeks in phase two to ensure he had enough time to show growth in phase three without reaching the ceiling too early to make conclusions about the impact of multisensory tools.

S2 continued to show incremental growth across each progress monitoring probe during phase three, although the growth rate slows as S1 approached nearly perfect scores on the last two probes. S2 averaged 2.25 points of growth on each measure in phase three. This was similar to the growth rate of S1 during phase three, and each student neared maximum possible scores on the last measures in phase three. It is difficult to isolate the multisensory tools as the reason for the declining growth rate in phase three due to the increased difficulty of the letters learned later in the study and the proximity to the maximum possible score on the final baseline probes. See Figures 17, 18, 19, and 20 for visual representations of S2's growth across study phases as shown through work samples.

Results: Student 3

See Figure 21 for a graph containing S2's data across the study. The mean of S3's progress monitoring scores increased during each phase of the study, from an average score of 42.6 points in phase one, to 71 points in phase two, to 89.7 points in phase three. The range of S1's baseline scores across phase one was 17. The range of S3's phase two scores was 20, with her first measure showing her lowest score and the last measure showing her highest score in this phase. The range of S3's phase three scores was 6, showing a smaller spread of data than the two

previous phases. During phase two of the study, S3 demonstrated a positive growth rate with an average growth rate of 8.5 points per probe. S3's growth rate slowed to an average of 3.7 points per probe during phase three, but the trendline remained positive. S3's data showed the immediacy of the effects of the intervention introduced in phase two with an increase of 14 points in her first probe after the intervention was introduced. S3 made significant improvements in her letter formation and legibility over the course of the study with growth occurring at a quicker rate in phase two than phase three.

S3 was the youngest student involved in the study. S3's baseline writing confirmed classroom observations of her writing skills. S3 remained in the baseline phase longer than the other two study participants due to the variability in formation and legibility of letters across baseline probes. S3 appeared to understand that some letters she produced during baseline probes were not legible, but she did not seem frustrated or upset. When S3 was presented with a letter card and prompted to write the shown letter, if she did not immediately know how to form the given letter, she would quickly opt to draw lines or shapes that resembled an inventive attempt to write the letter, even if it the result did not look visually similar to the model. S3 demonstrated correct letter formation on some baseline letters, but she occasionally switched between inventive marks and correct formation across probes. This variability made it difficult to discern which letters S3 could form with mastery and which she could not produce with consistency. Due to the high degree of variability in S3's individual letter legibility across probes, she remained in the baseline phase longer than other study participants. More baseline probes helped illuminate which letters S3 can form correctly with consistency and which letters were consistently expressed using inventive marks. S1's final two baseline probes indicated increased consistency which helped in designing her instructional plan for the intervention phases.

S3 averaged 8.5 points of growth across each progress monitoring probe during phase two. This rate of growth was more than double the expected growth based on the amount of direct instruction completed between each probe. This growth indicated that she was generalizing some elements of direct instruction to letters she had not received direct instruction in yet. S3's rate of growth in phase two was less than S1's growth rate and more than S2's growth rate. S3 seemed to learn correct letter formation for "F" and "E" quickly, and demonstrated generalized improvements to letters composed of similar combinations of large, straight lines. Based on observations during phase two direct instruction lessons, letters with diagonal marks seemed challenging for S3. Letters such as "N" and "M" seemed challenging during direct instruction lessons, but S3 still improved from the first direct instruction lesson to the second and improvements on progress monitoring probes.

S3's progress monitoring probes during phase three indicated a steady growth rate of 3.7 points on average. This growth rate was slightly less than half of the growth rate S3 demonstrated during phase two of the study. S3 demonstrated a higher growth rate in phase three than both S1 and S2. S3's present writing skills also had the most room for improvement leading into phase three, when compared with S1 and S2. One factor that could have impacted S3's growth rate in phase three was the scope and sequence's arrangement of letters from easiest to learn to most difficult to learn. Letters learned during phase three were considered more difficult to form than letters learned during phase two. See Figures for visual representations of S2's growth across study phases as shown through work samples.

Addressing the Research Question

This study was designed to answer the following research question: **Will multisensory or traditional writing tools have a greater impact on direct instruction in letter formation mastery?** Across participants in the single-case design, multiple-baseline study, each

participant's letter formation skill increased from the baseline to intervention phases. On average, each participant's letter formation increased 22.5 points after phase two implementation, with an average growth rate of 8.25 points per probe. On average, each participant's letter formation increased 17.1 points after phase three implementation, with an average growth rate of 2.7 points per probe. Immediate improvement was observed across all three participants when intervention was initiated, and changes occurred with timing of phase changes as expected with this design. Overall, phase two intervention showed more growth than phase three.

Chapter 5: Discussion

Summative Findings

Overall, each student demonstrated a strong, positive response to the simplified language to teach direct instruction in letter formation. Each student demonstrated higher rates of growth during the phase involving traditional tools in comparison to the rates of growth seen in the phase involving multisensory tools. One difference between the direct instruction lessons and multisensory lessons that could have impacted growth rates was the physical copy of each completed letter during the phase involving traditional tools. Students had physical evidence of each letter after they wrote it using a pencil. This physical evidence gave students a model to refer back to and assess their progress, making adjustments as they progressed through the lesson. While the same direct instruction theory was applied to multisensory lessons and students still learned from their mistakes as they moved forward, students could not see physical evidence of letters they wrote seconds earlier, since they were “erased” in the shaving cream after each repetition. Students would need to remember what their mistakes looked like without a model in order to correct mistakes moving forward. This aspect of multisensory tools in phase three does not necessarily apply to all multisensory approaches, but many multisensory approaches like the first two studies detailed in the literature review did produce physical evidence of letter repetitions.

Limitations

It was possible to draw some conclusions regarding direct instruction in letter formation and writing tools based on data collected through this study. However, certain limitations should be considered to apply study findings appropriately. The growth rate of each student was higher in phase two than phase three. Based on this piece of data alone, one might conclude that direct instruction paired with traditional writing tools led to a higher growth rate than multisensory tools, and therefore, multisensory tools should be avoided. One limitation in this study was the way letters were sequenced for direct instruction, beginning with more simple letters and ending with more difficult letters. While this decision was based on the strong foundation of research that supports letter formation instruction from simplest letter formation to most complex, it meant that students received instruction in letters that are thought to be easier to learn during phase two of the study. This could have contributed to the inflated growth rate seen across all students during phase two. All students exhibited positive growth trends during phase two and phase three, albeit at varying rates, regardless of the writing tool used for the direct instruction.

One further limitation of the study was illuminated by the unexpected tendency each student exhibited with generalizing elements of direct instruction on letters they had not yet received direct instruction in. Each student exhibited varying levels of improved legibility and letter formation habits on letters not yet addressed through direct instruction lessons. These generalizations resulted in inflated growth rates during phase two of the study because this was the phase in which direct instruction was introduced. It is possible that these generalizations could have led to increased growth rates following lessons with multisensory tools if direct instruction had been introduced with multisensory tools first.

Implications

Moving forward, further research could compare the growth rates of two different groups of students, with one group introduced to multisensory tools and direct instruction during the first intervention phase, and traditional tools during the second intervention phase. Introducing direct instruction to two groups using different tools could reveal more information that was not possible during this study, since all students in this study were introduced to direct instruction with traditional tools first. This hypothetical study would require larger sample sizes to make any conclusions about the growth rates in letter acquisition, and a control group would also provide valuable added information that would strengthen findings.

Although strong conclusions regarding the impact of multisensory or traditional tools could not be decisively proven based on this study due to its certain limitations, one conclusion was clearly evident: students with persistent letter formation difficulties responded to direct instruction in simple, straightforward language. Each student selected for participation this study presented as if they were not capable of demonstrating improved letter formation in spite of interventions through two research-based programs: *Sounds Sensible* and *Fundations*. In reality, the problem in this situation was related to the language used to deliver direct instruction, not the student's inability to demonstrate improved letter formation.

Implications of these findings should be considered in further simultaneous implementation of the *Sounds Sensible* and *Fundations* curricula, especially with students who demonstrate persistent challenges related to letter formation. Moving forward, perhaps these approaches could be modified to reach a compromise that would benefit students. One possible compromise could involve adapting elements of the simplified *Learning Without Tears* language to teach letter formation, but maintaining the phonics based scope and sequence of *Sounds*

Sensible and *Fundations*. The *Learning Without Tears* website suggest that its' approach can be customized to align with "district ELA needs" which may be less flexible (*Learning Without Tears*, n.d.). The motor-based scope and sequence could also still be considered for students who demonstrate persistent challenges with the phonics-based sequence.

Teresa Tomsic is an experienced occupational therapist who provides school-based occupational therapy to early elementary students. When asked about her perspective on letter formation instruction, she repeated a phrase echoed throughout her training as an occupational therapist: "Correct letter formation is 'taught', not 'caught'" (T. Tomsic, personal communication, January 25, 2022). Ms. Tomsic expressed that students do not "absorb" the correct way to form letters just by exposure to print or even watching adults write. Just as students are not able to "catch" the ability to form letters correctly, they are also unable to remediate incorrect formation without explicit instruction. The longer these errors are allowed to persist, the deeper they are cemented as habit and the more difficult they are to remediate (T. Tomsic, personal communication, January 25, 2022).

Approaches to writing instruction are diverse due to the varying disciplines involved in the process of learning to write. However, researchers across each domain involved in writing instruction agree on one truth: learning to write letters is a complex process (Thomassen & Teulings, 1983). The process of learning to write is too complex to be addressed exclusively through one discipline. Special education teachers, general education teachers, and occupational therapists must improve their communication across domains to ensure struggling emergent writers are appropriately supported.

Regardless of the resulting changes or conversations initiated by this study, improved communication across the disciplines of general education, special education, and occupational

therapy is necessary to yield more positive outcomes for students with persistent letter formation challenges. Moving forward, educational professionals can improve their collaboration to ensure these students are receiving instruction in language that is meaningful to them, and not at risk of falling through the cracks between disciplines.

References

Balajthy, E. (2014). Sounds Sensible - EPS Literacy and Intervention. Eps.schoolspecialty.com. https://eps.schoolspecialty.com/EPS/media/Site-Resources/Downloads/products/soundssensible/SoundsSensible_research.pdf?ext=.pdf

Coker DL, Ritchey KD. Universal Screening for Writing Risk in Kindergarten. Assessment for Effective Intervention. 2014;39(4):245-256. doi:10.1177/1534508413502389

Cox, C. (n.d.). Basic philosophy of direct instruction. National Institute for Direct Instruction (NIFDI). https://www.nifdi.org/what-is-di/basic-philosophy.html

Effenberg, Alfred & Schmitz, Gerd & Baumann, Florian & Rosenhahn, Bodo & Kroeger, Daniela. (2015). SoundScript – Supporting the Acquisition of Character Writing by Multisensory Integration. The Open Psychology Journal. 8. 230-237. https://doi.org/10.2174/1874350101508010230.

Fundations Program Overview Level K - Wilson language. https://www.wilsonlanguage.com/. (2018). https://www.wilsonlanguage.com/wp-content/uploads/2019/11/SECURED-*Fundations*-Level-K-Implementation-Guide.pdf

Jackman, M., & Stagnitti, K. (2007). Fine motor difficulties: The need for advocating for the role of occupational therapy in schools. Australian Occupational Therapy Journal, 54(3), 168–173. https://doi.org/10.1111/j.1440-1630.2006.00628.

Jacobs, P., & Fu, D. (2014). Students with learning disabilities in an inclusive writing classroom. *Journal of Language and Literacy Education*, 10(1), 100-113. http://jolle.coe.uga.edu.

Learning Without Tears Programs and Products. Learning Without Tears. (2022, April 29). https://www.lwtears.com/programs-products

Owens, L. (2004). The effects of the handwriting without tears program on the handwriting of students in inclusion classrooms. VCU University Archives. Retrieved June 3, 2022, from https://doi.org/10.25772/49P9-Y787

Özmen, E. R., & Atbasi, Z. (2016). Identifying Interventions for Improving Letter Formation: A Brief Experimental Analysis of Students with Intellectual Disabilities. *International Electronic Journal of Elementary Education, September 2016, 9*(1), 197–209.

Research Base. Wilson Language Training Research Base. (n.d.). https://www.wilsonlanguage.com/programs/research-results/research-base/

Sounds Sensible Scope and Sequence. eps.schoolspeciality.com. (n.d.). https://eps.schoolspecialty.com/EPS/media/Site-Resources/Downloads/products/soundssensible/soundsSensibleScope-sequence.PDF?ext=.pdf

Thomassen, A.J.W.M. & Teulings, Hans-Leo. (1983). The development of handwriting. The Psychology of Written Language: Developmental and Educational Perspectives. 179-213.

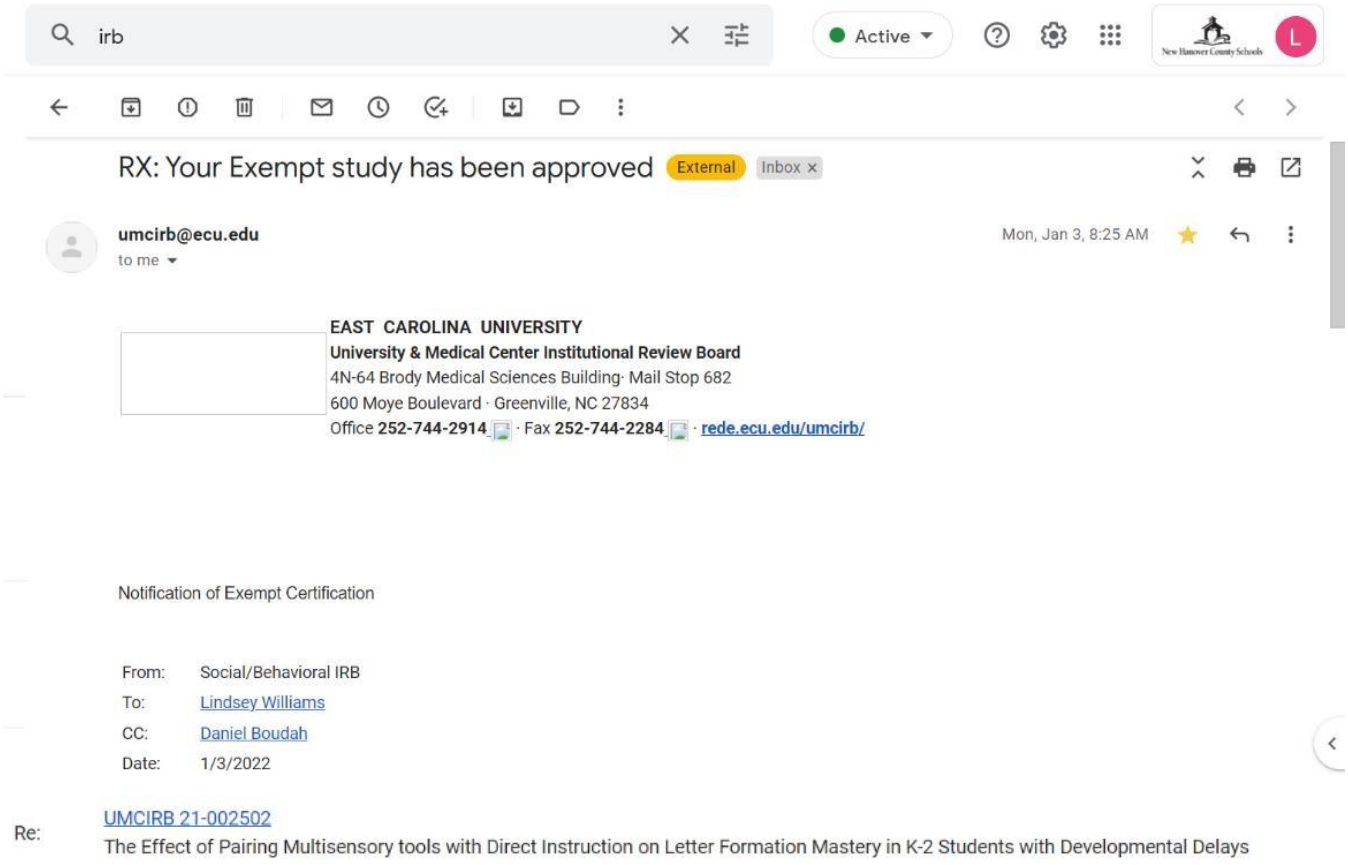
T. Tomsic, personal communication, January 25, 2022.

Zafrana, M., Nikoltsou, K., &; Daniilidou, E. (2000). Effective learning of writing and reading at preschool age with a multisensory method: A pilot study. Perceptual and Motor Skills, 91(2), 435–446. https://doi.org/10.2466/pms.2000.91.2.435

Zwicker, J. G., & Hadwin, A. F. (2009). Cognitive versus Multisensory Approaches to Handwriting Intervention: A Randomized Controlled Trial. OTJR: Occupation, Participation and Health, 29(1), 40–48. https://doi.org/10.1177/153944920902900106

Appendix

Appendix A: IRB Approval Documentation



irb

Active

RX: Your Exempt study has been approved External Inbox ×

umcirb@ecu.edu
to me

Mon, Jan 3, 8:25 AM

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · rede.ecu.edu/umcirb/

Notification of Exempt Certification

From:	Social/Behavioral IRB
To:	Lindsey Williams
CC:	Daniel Boudah
Date:	1/3/2022

Re: UMCIRB 21-002502
The Effect of Pairing Multisensory tools with Direct Instruction on Letter Formation Mastery in K-2 Students with Developmental Delays

I am pleased to inform you that your research submission has been certified as exempt on 1/3/2022. This study is eligible for Exempt Certification under category # 1.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

Appendix B: Figures

Figure 1

Fundations Approach

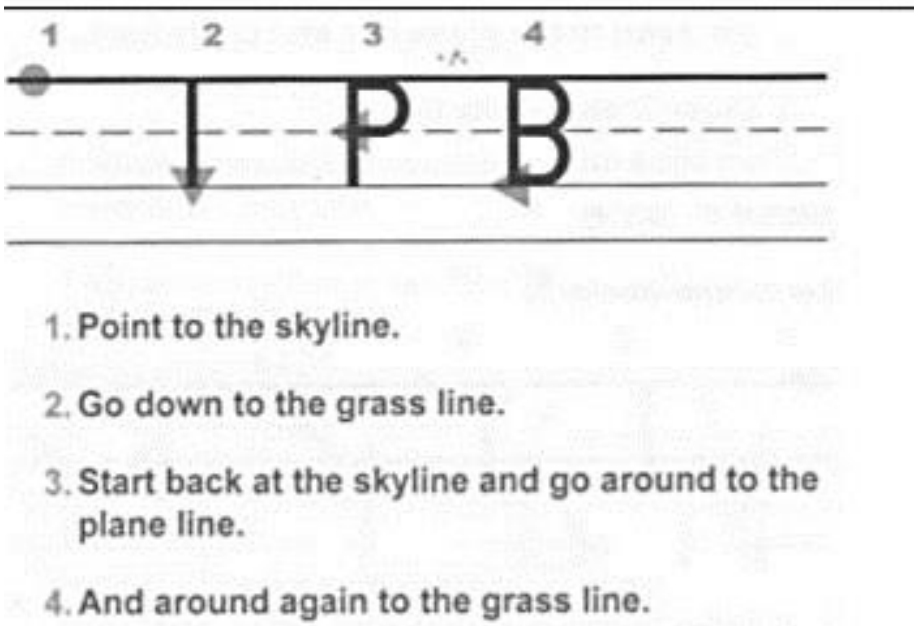


Figure 2

Sounds Sensible Approach

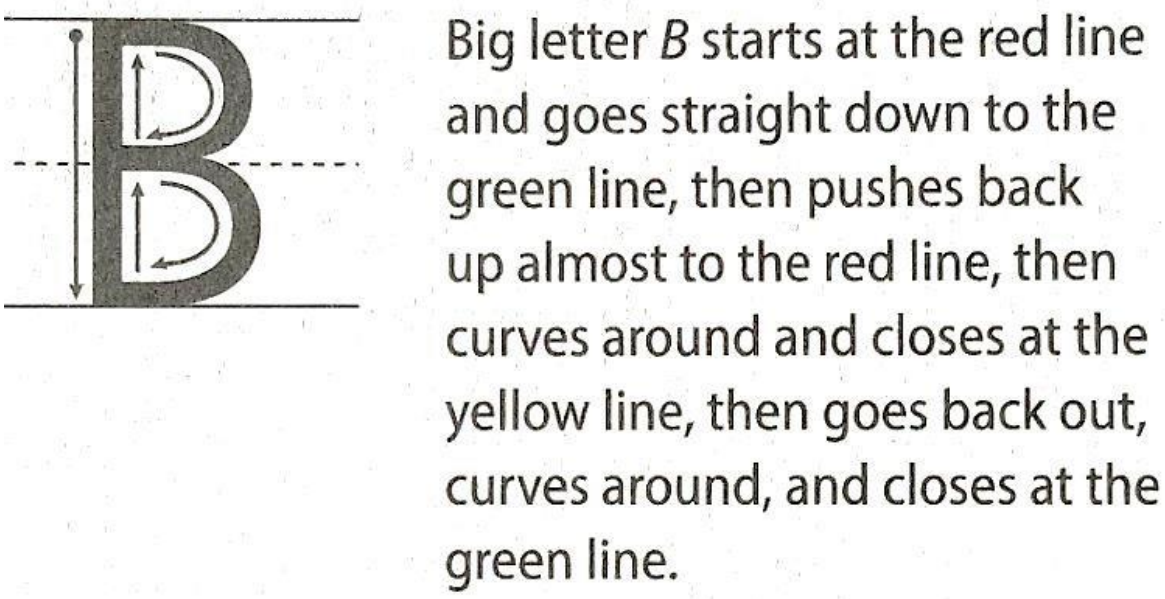


Figure 3

Learning Without Tears Approach

Figure 4

Modified Scope and Sequence for Study

Taught from left to right, top to bottom:

Uppercase Letter Formation

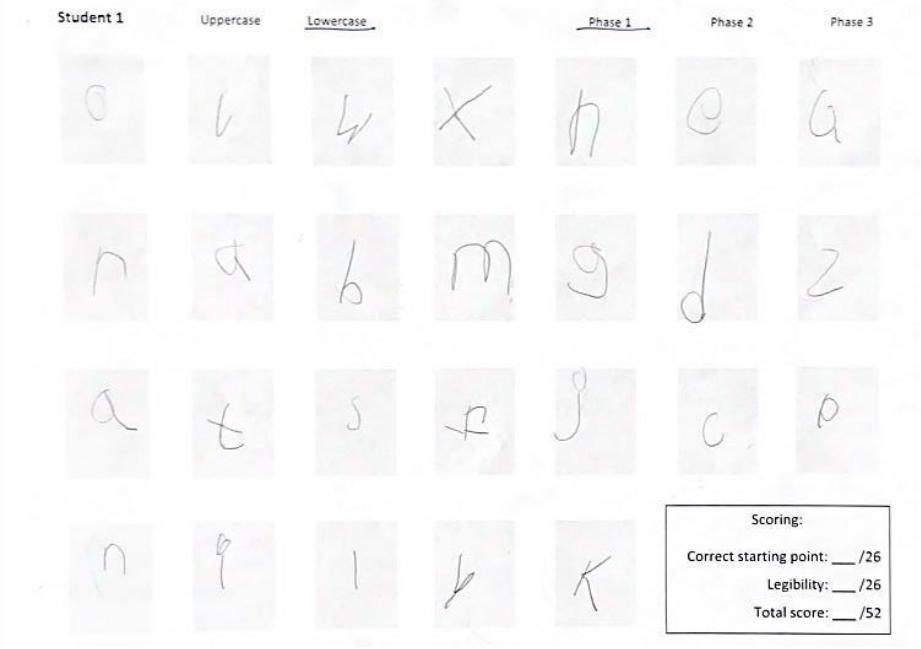
Level 1: (Start in top left, all straight lines)	F E H L
Level 2: (Start in top left, straight + curved lines)	B R D P
Level 3: (start in top left, straight + diagonal lines)	M N K V U
Level 4: (start in top left, straight + diagonal lines)	W X Y Z
Level 5: (center starters, all start with Magic C stroke)	C O Q G
Level 6: (center starters, no magic C stroke)	S A I T J

Lowercase Letter Formation

Level 7: (same as capitals, just smaller + t)	c o s v w t
Level 8: (high frequency, all start with Magic C stroke)	a d g
Level 9:	u i e
level 10:	l k y j
Level 11: (Diving Letters "dive down, come up, swim over")	p r n
Level 12: (Diving Letters "dive down, come up, swim over")	m h b
Level 13: (tricky "f", q taught here to avoid confusion with g, x and z are infrequent)	f q x z

Figure 5

Example of completed progress monitoring probe.



Note: The back looks exactly the same, only used for uppercase letters.

Figure 6

Example of teacher copy of the progress monitoring probe, used for notes.

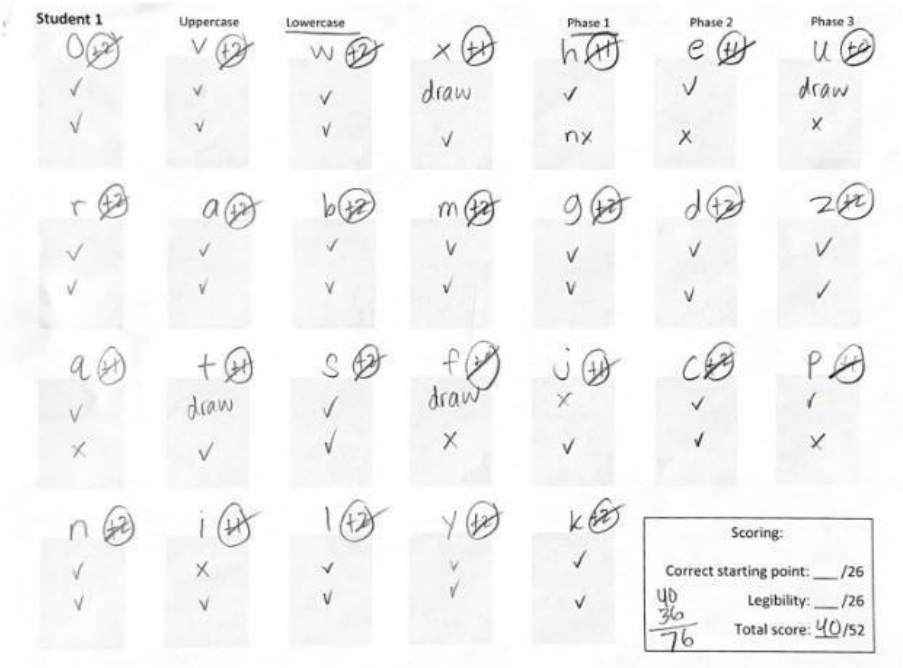
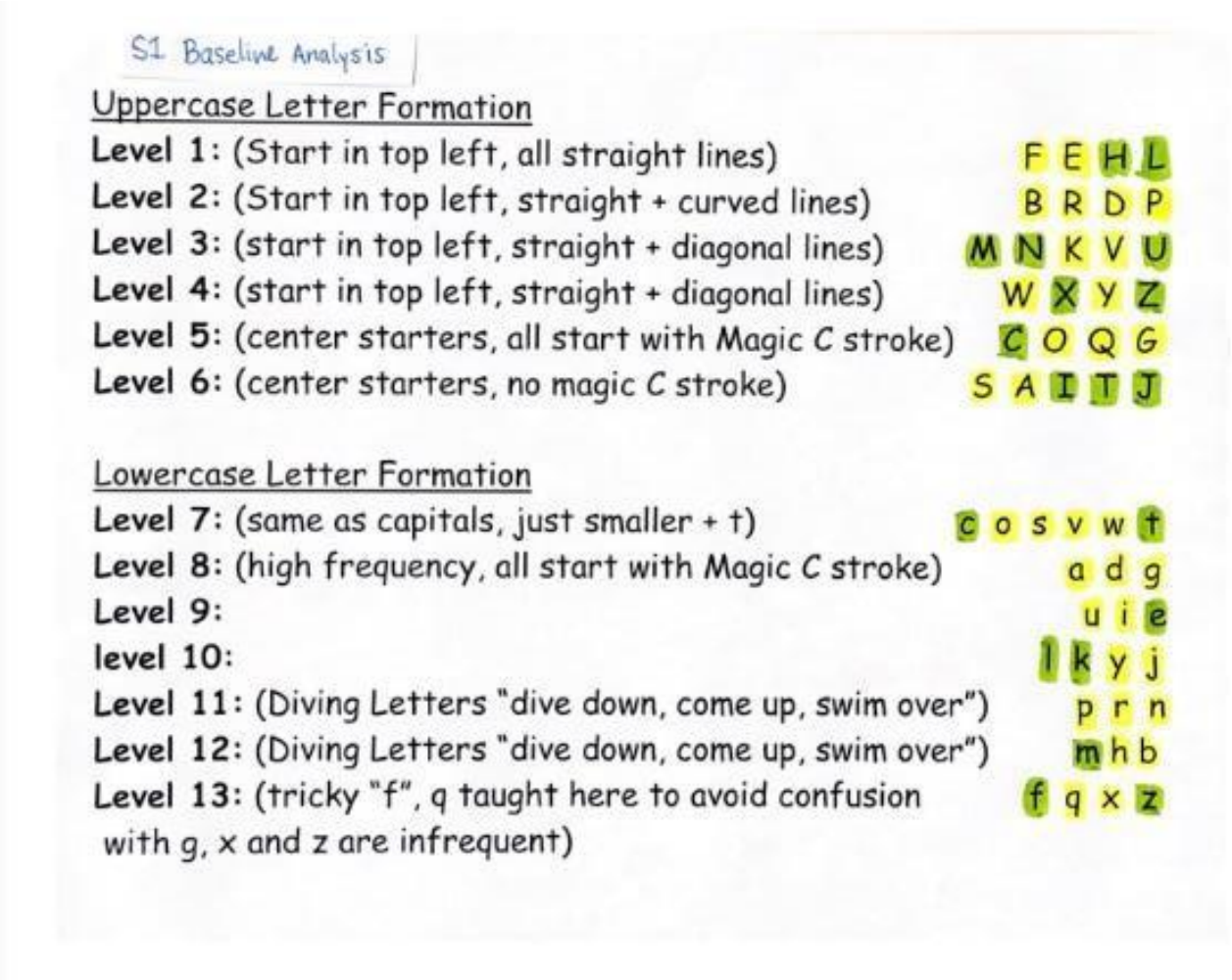


Figure 7

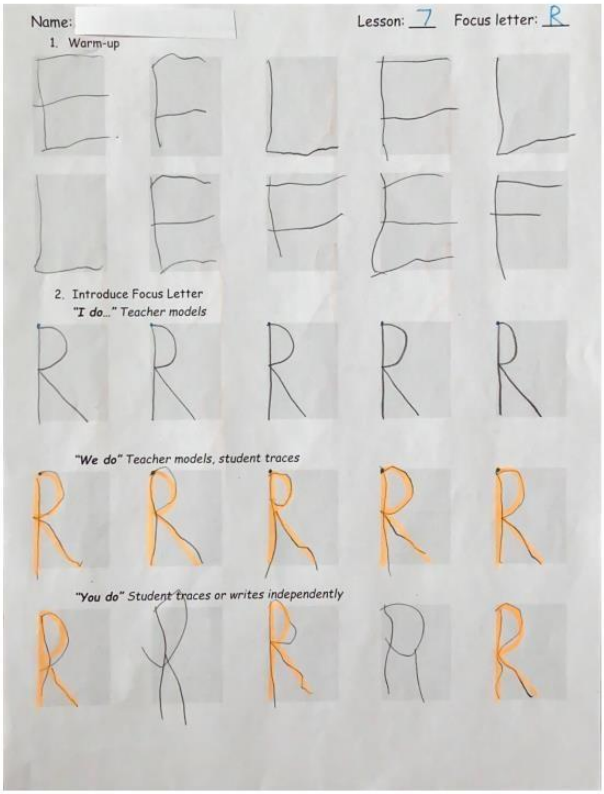
Example of Instructional Plan



Note: The letters “H”, “L”, “M”, “N”, “U”, “X”, “Z”, “C”, “I”, “T”, “J”, “c”, “t”, “e”, “l”, “k”, “m”, “f”, and “z” are highlighted green, indicating the student has demonstrated mastery of these letters. The remaining letters are highlighted yellow, indicating they are in need of direct instruction on these letters.

Figure 8

Example of Direct Instruction Lesson During Phase Two



(Back)

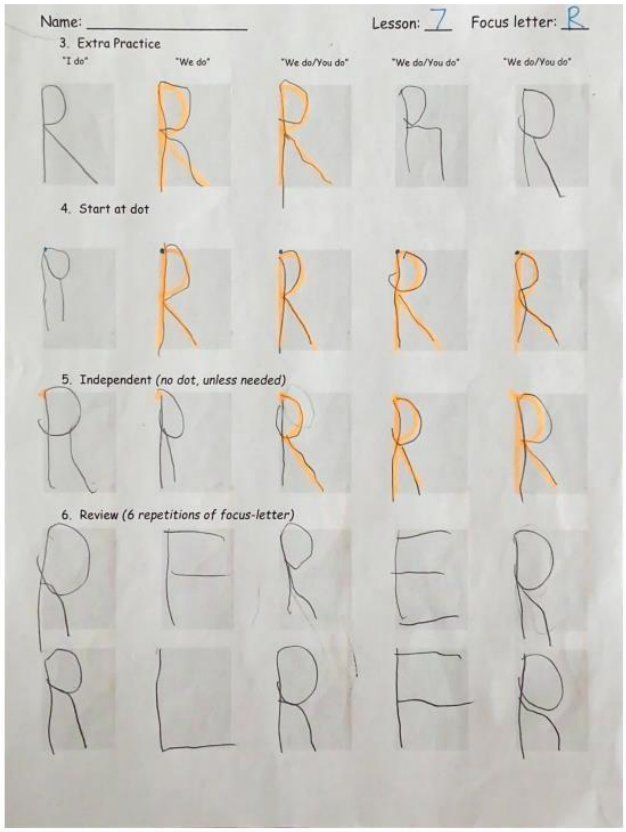


Figure 9

Example of phase two lesson sheet's adapted use during phase three. (MS for Multisensory)

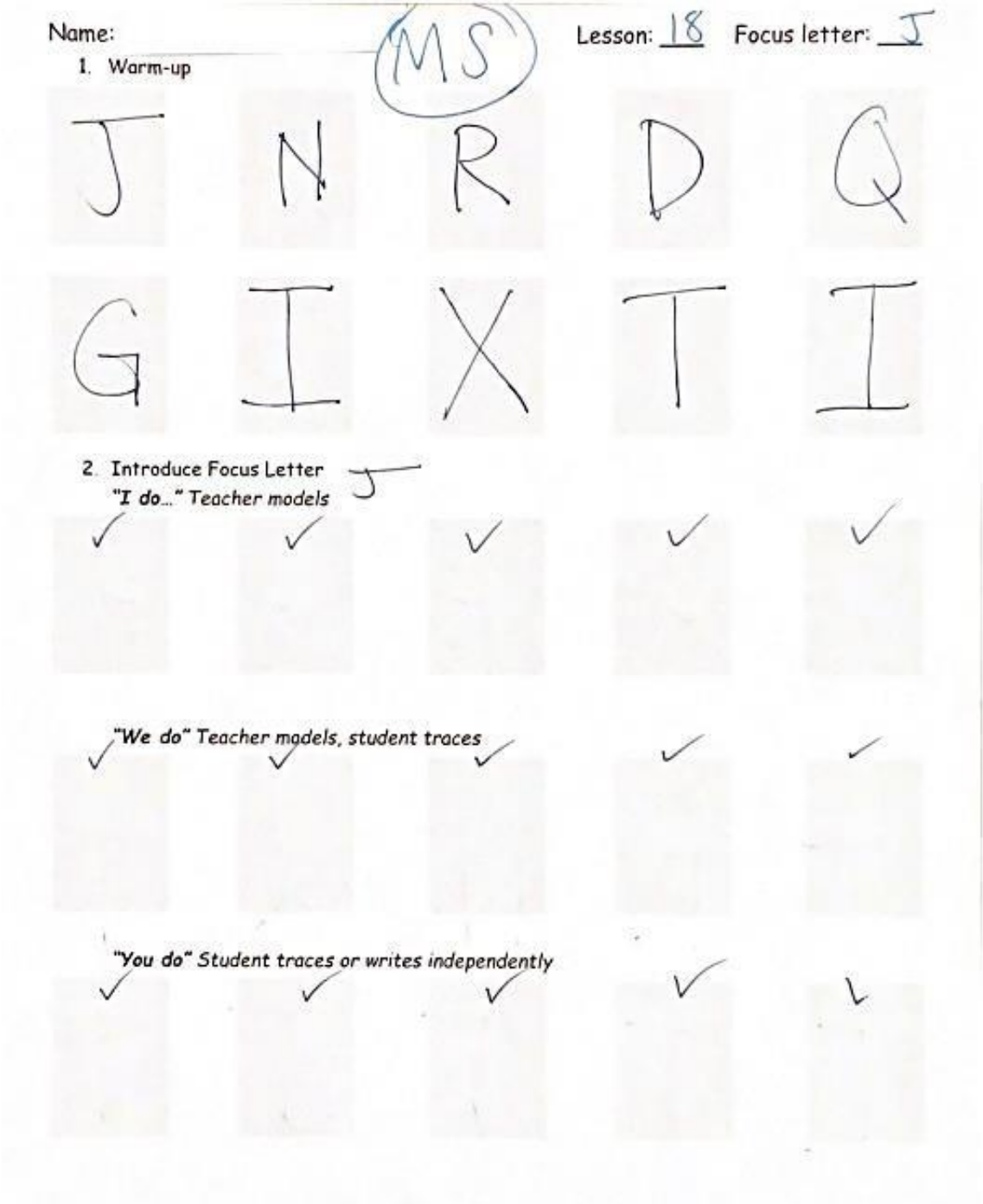
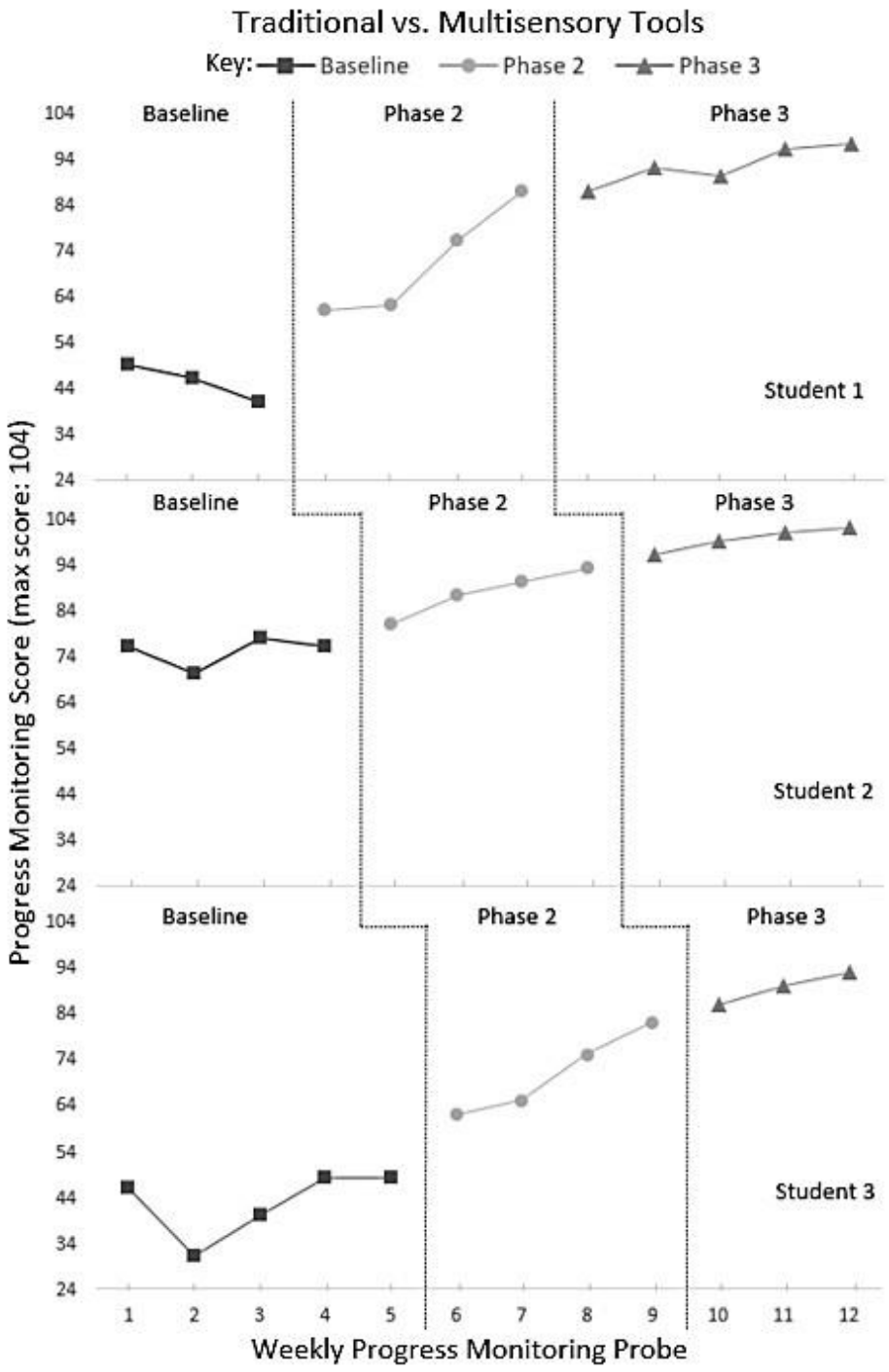


Figure 10

Shaving cream tray used during phase three lessons with example of letter formation in shaving cream and how the tray was "reset" after each repetition. Sharpie for size scale.

Figure 11



Note: Figure 11 shows each student's results compared side by side.

Figure 12

Student 1 Results

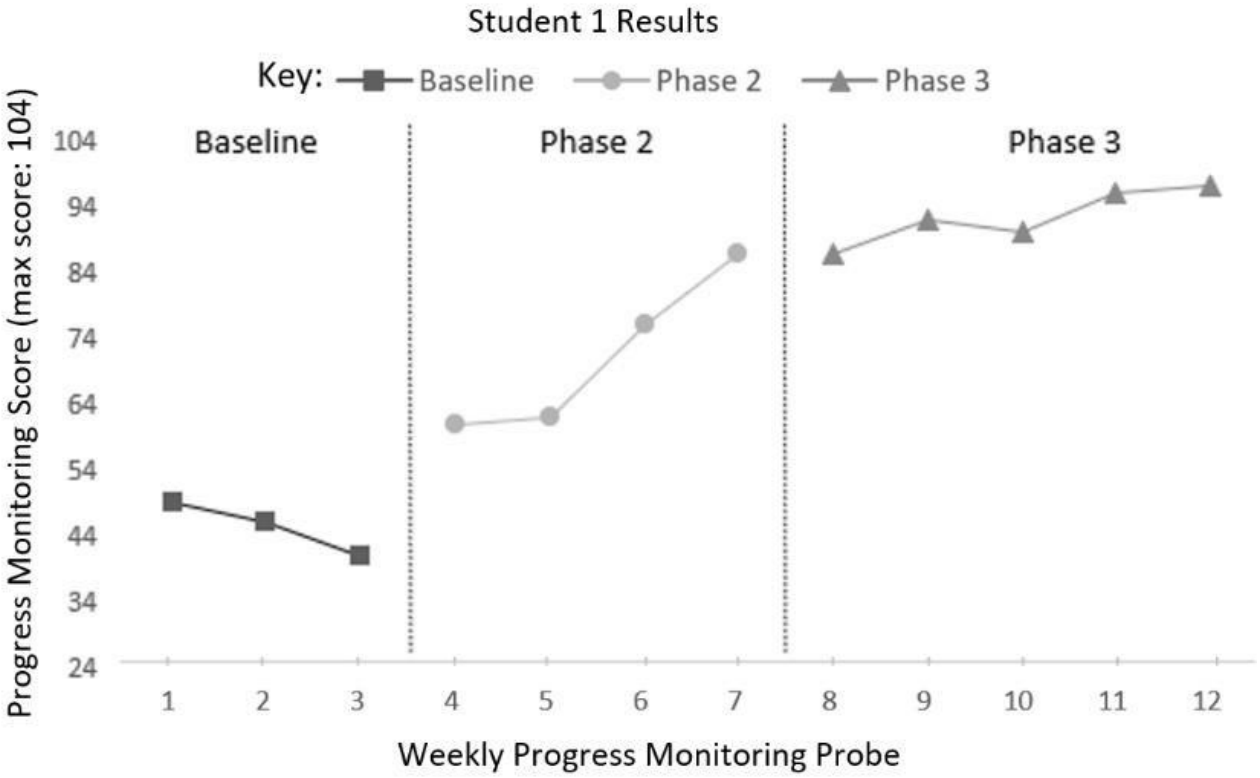


Figure 13

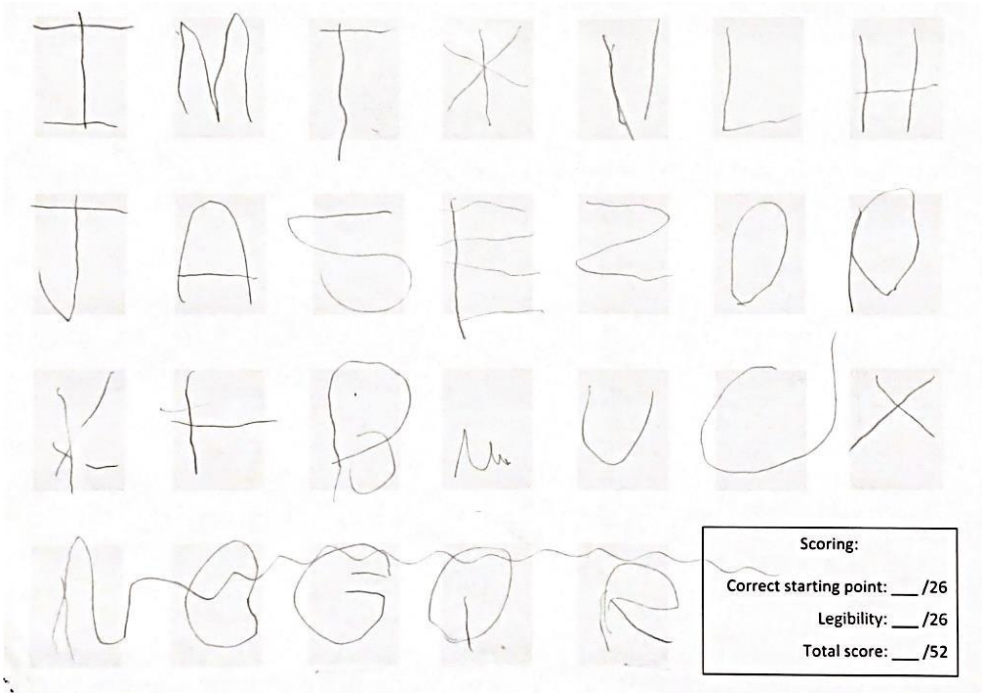


Figure 14

Example of phase three probe completed by S1. Compare to Figure 13.

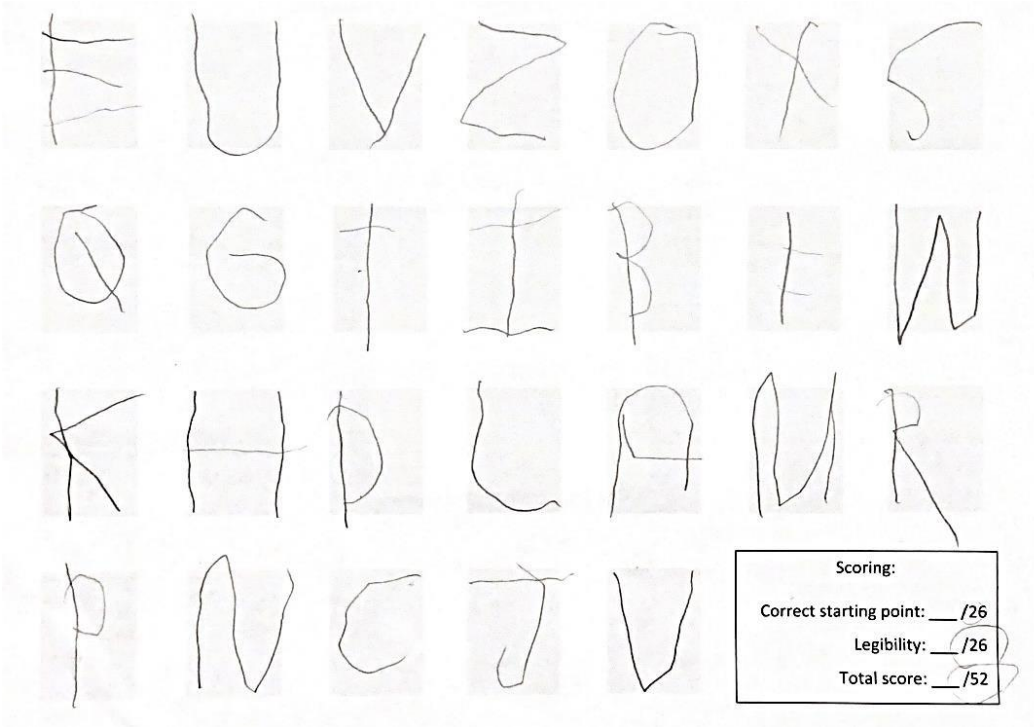
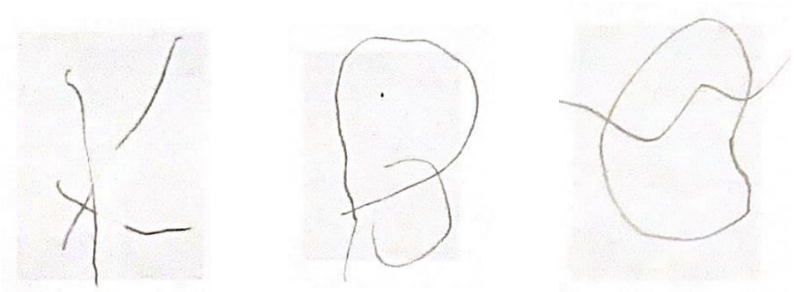


Figure 15

Examples of letters that S1 learned through direct instruction intervention.

Baseline “K”, “B”, and “D”



Phase Three “K”, “B”, and “D”

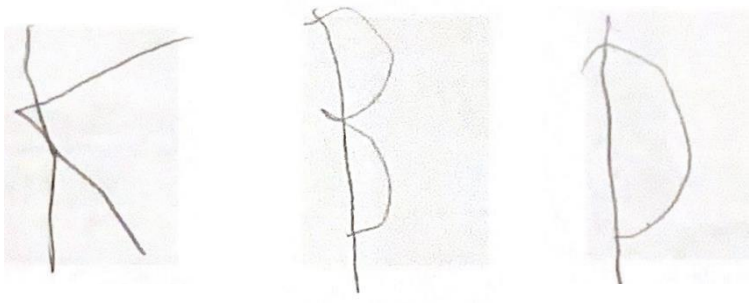
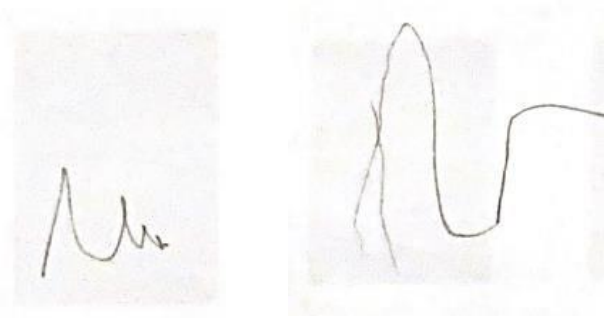


Figure 16

Examples of letters that S1 did not receive direct instruction on, but improved formation and legibility through generalization.

Baseline “M” and “W”



Phase Three “M” and “W”

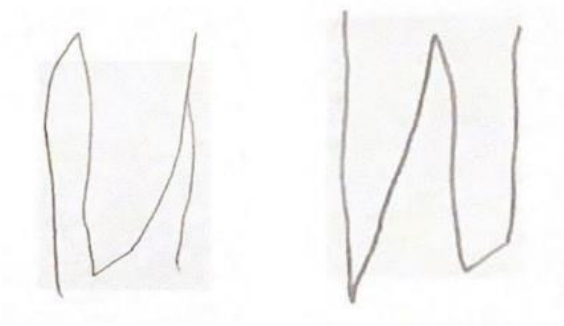


Figure 17

Student 2 Results

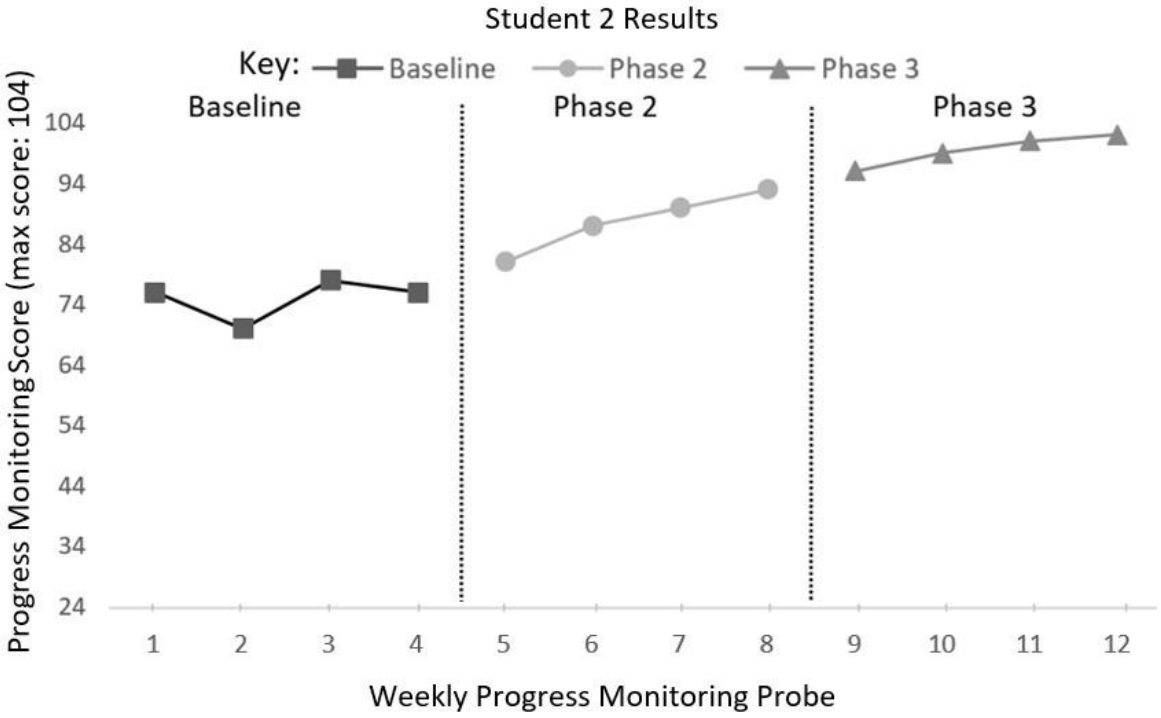


Figure 18

Example of baseline probe completed by S2. Compare to Figure 19.

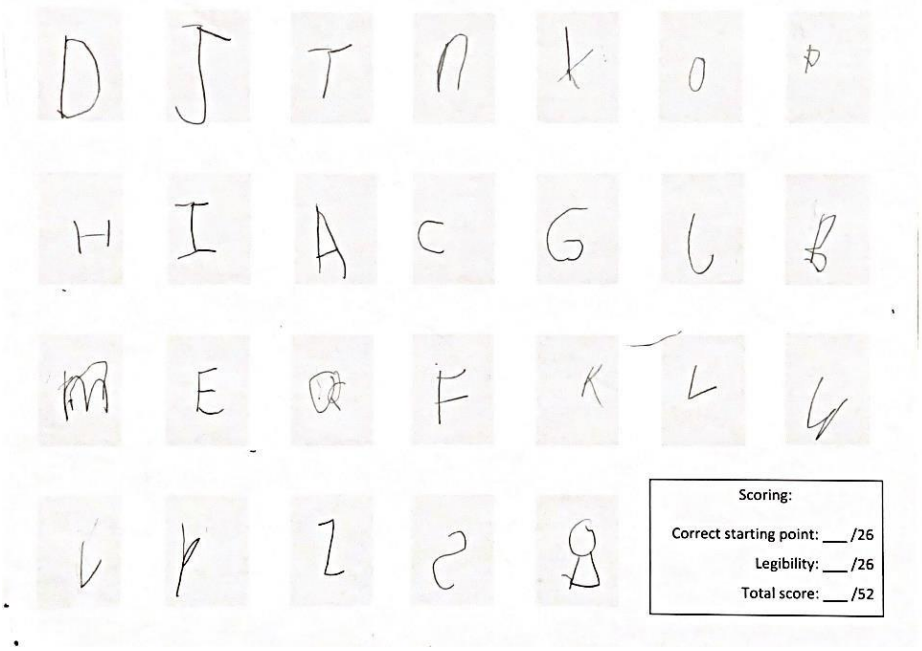


Figure 19

Example of phase three probe completed by S2. Compare to Figure 18.

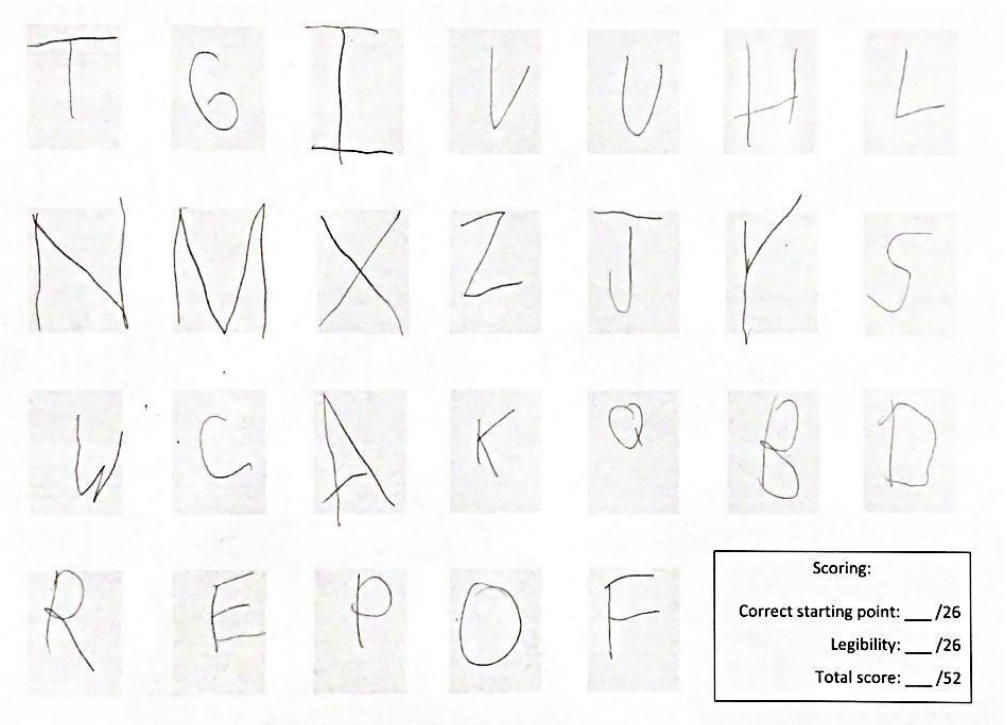
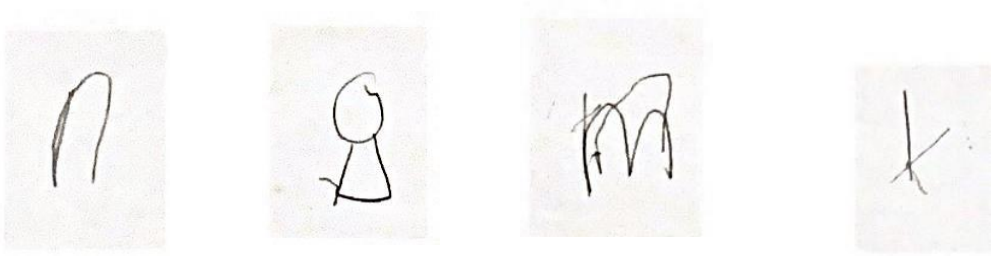


Figure 20

Examples of letters that S2 improved through direct instruction intervention.

Baseline “N”, “R”, “M”, and “X”



Phase Three “N”, “R”, “M”, and “X”

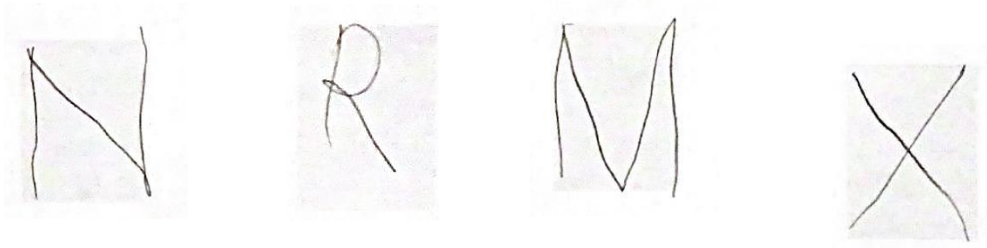


Figure 21

Student 3 Results

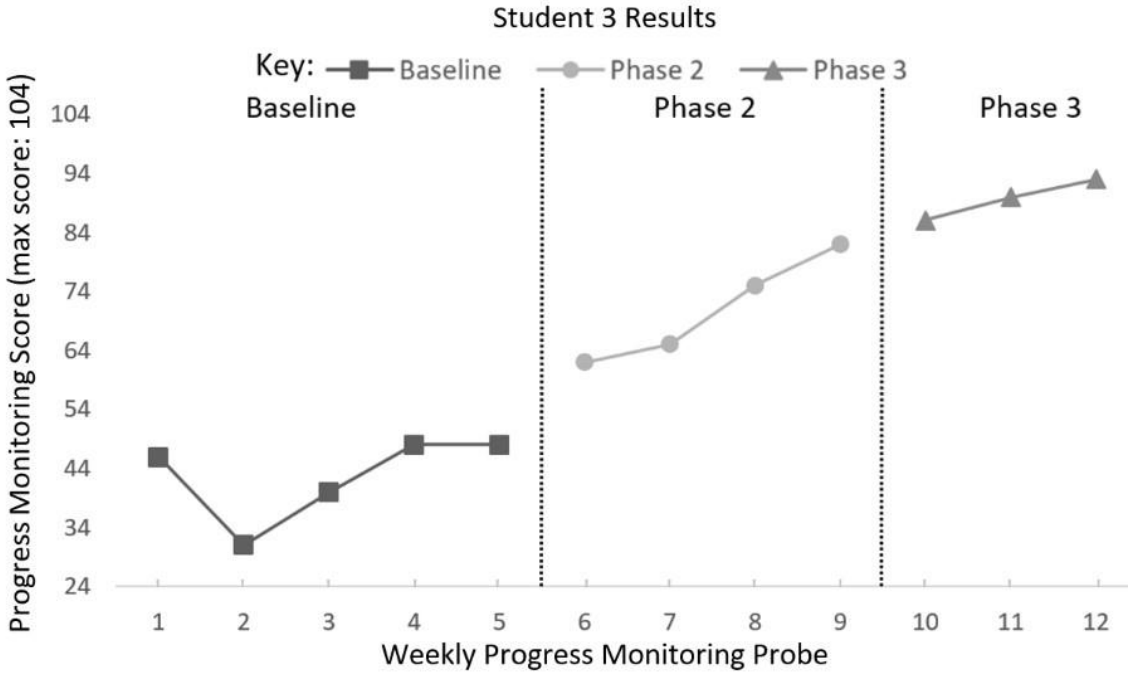


Figure 22

Example of baseline probe completed by S3. Compare to Figure 24.

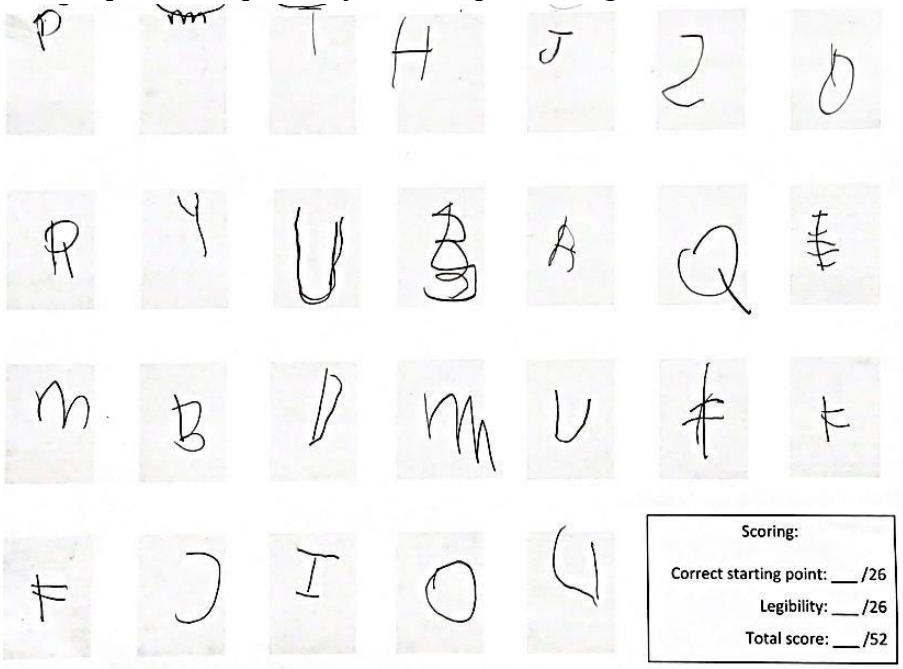


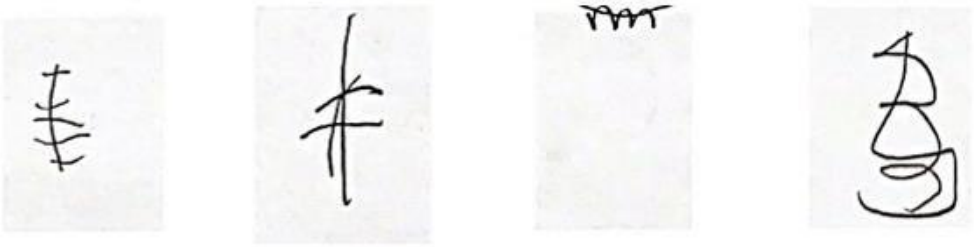
Figure 23

Example of phase three probe completed by S3. Compare to Figure 23.

Figure 24

Examples of letters that S3 improved through direct instruction intervention.

Baseline "E", "X", "N", and "B"



Phase Three "E", "X", "N", and "B"

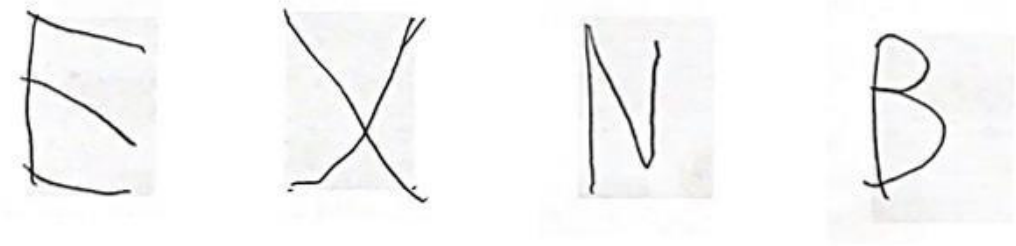


Figure 25

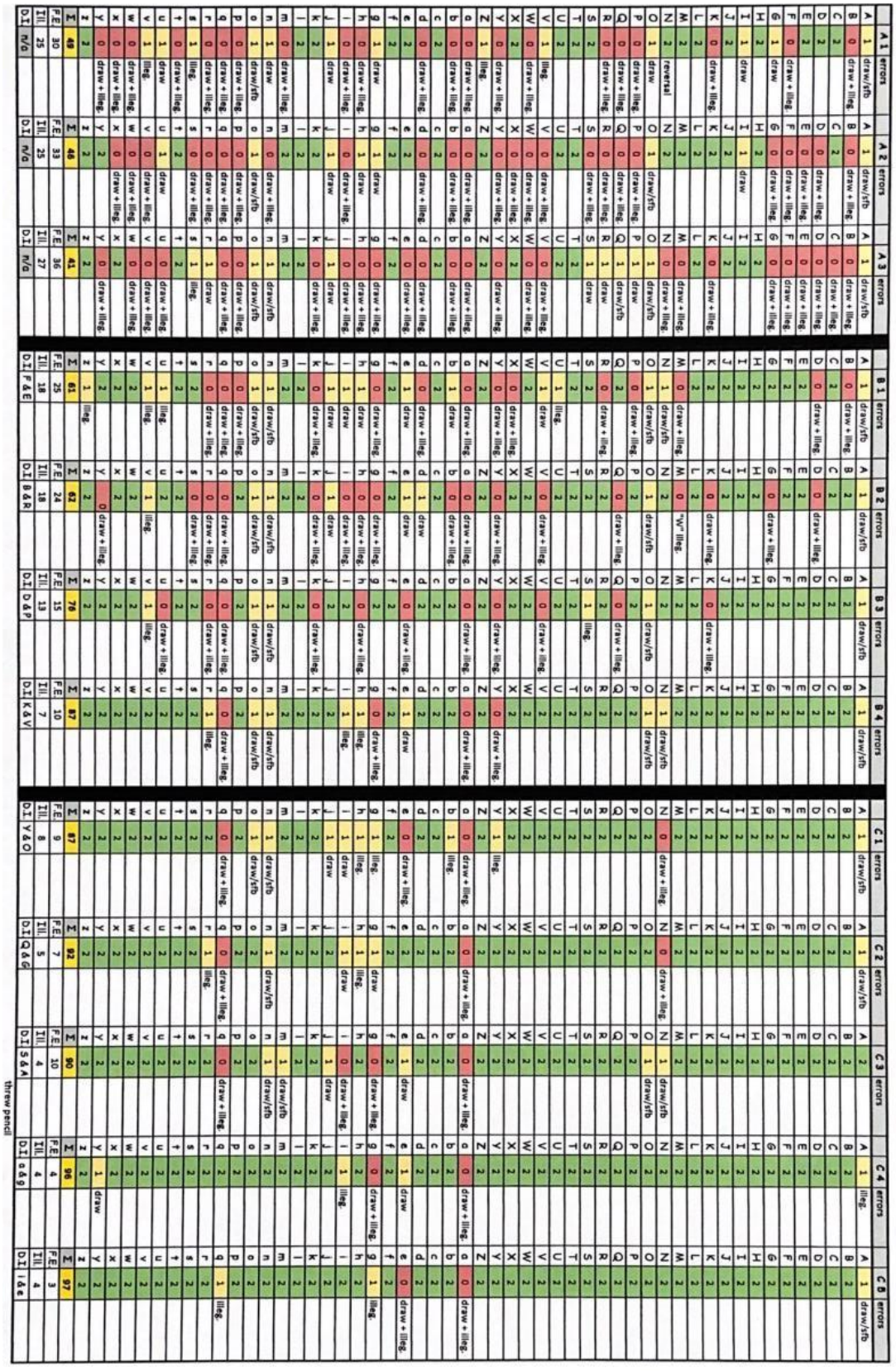

A1 errors
A2 errors
A3 errors
B1 errors
B2 errors
B3 errors
B4 errors
C1 errors
C2 errors
C3 errors
C4 errors
C8 errors
draw/sfb
draw + illeg.
illeg.
D.I. n/a
D.I. F & E
D.I. B & R
D.I. D & P
D.I. K & V
D.I. Y & O
D.I. Q & G
D.I. S & A
D.I. e & g
D.I. i & e
F.E.
Ill.
Σ
threw pencil

Figure 26

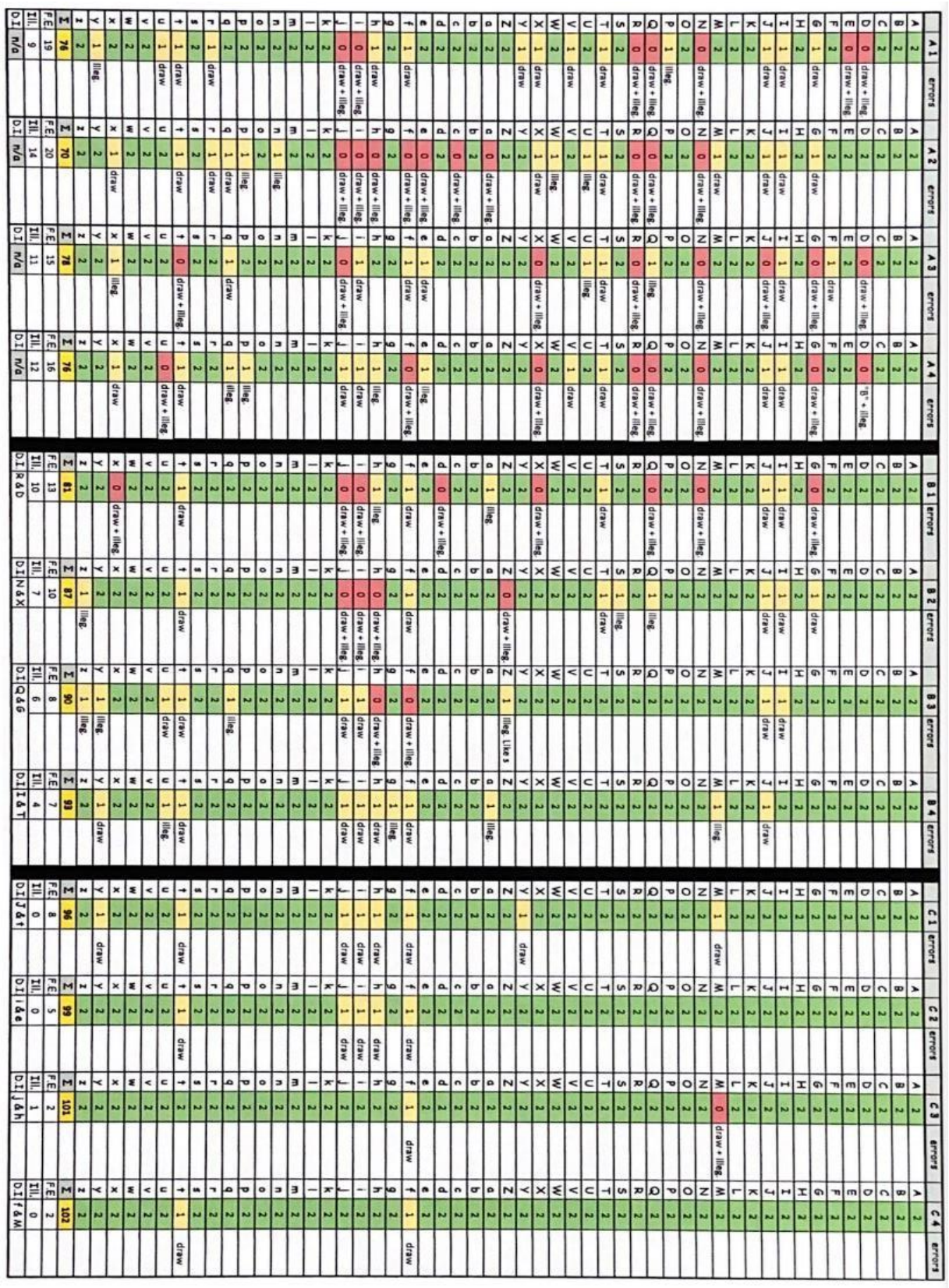


Figure 27