

University of Memphis

University of Memphis Digital Commons

Electronic Theses and Dissertations

2021

A COMPARISON OF ERROR CORRECTION METHODS EMBEDDED IN THE ORTON-GILLINGHAM APPROACH TO SPELLING

Melissa Lee Miller-Benson

Follow this and additional works at: <https://digitalcommons.memphis.edu/etd>

Recommended Citation

Miller-Benson, Melissa Lee, "A COMPARISON OF ERROR CORRECTION METHODS EMBEDDED IN THE ORTON-GILLINGHAM APPROACH TO SPELLING" (2021). *Electronic Theses and Dissertations*. 2677.
<https://digitalcommons.memphis.edu/etd/2677>

This Dissertation is brought to you for free and open access by University of Memphis Digital Commons. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of University of Memphis Digital Commons. For more information, please contact khggerty@memphis.edu.

A COMPARISON OF ERROR CORRECTION METHODS EMBEDDED IN THE
ORTON-GILLINGHAM APPROACH TO SPELLING

By

Melissa Lee Miller-Benson

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education

Instruction and Curriculum Leadership

The University of Memphis

December 2021

Abstract

The present study examined the effects of two error repair procedures on the spelling performance of five students who were rising first through third grades. Each participant was diagnosed with a learning disability in reading and spelling. Using an Adapted Alternating Treatments Design, a teacher-led questioning procedure and a student-led visual comparison procedure were implemented in the unbranded Orton-Gillingham instructional model. Teacher-led questioning is the scaffolded model of error repair described in Orton-Gillingham Simultaneous Oral Spelling instruction. Student-led visual comparison is a method which is well documented in the literature as highly effective for students with learning disabilities. The intervention results across participants showed little difference in students' spelling accuracy under each condition. Responses to social validity questions indicated that student preference could be a determining factor in selecting which error correction method to implement in the Orton-Gillingham approach to spelling instruction.

Table of Contents

Chapter	Page
1. Introduction	1
2. Method	9
Participants and Setting	9
Materials	12
Experimental Design	13
Procedures	14
Dependent Variables and Measurement	16
Interobserver Agreement, Procedural Integrity, and Social Validity	17
3. Results	18
4. Discussion	32
References	37

Oral and written language converge at encoding which is the ability to hear sounds and write the corresponding symbols. The value of correctly encoding sounds, most often referred to as spelling, cannot be underestimated. Spelling is an essential component of multiple literacy and reasoning skills that are applied across academic subjects (Brice, 2004; Grskovic & Belfiore, 1996). As such, early performance is predictive of future levels of achievement in related skills which include word reading, reading comprehension, and written expression (Erion, Davenport, Rodax, Scholl, & Hardy, 2009; Graham, Harris, & Chorzempa, 2002; Hebert, Kearns, Hayes, Bazis, & Cooper, 2018; Jaspers et al., 2012; Viel-Rouma, Houchins, & Fredrick, 2007; Wanzek et al., 2006).

Accurate spelling requires a high level of competency in multiple language domains including orthography (system of written spelling patterns and speech to print correspondence), phonetics (pronunciation and perception of speech sounds), phonology (rules determining how speech sounds are sequenced and arranged), and morphology (smallest units of meaning used to create words) (Graham, Collins, & Rigby, 2017; Moats, 2000; Neis & Belfiore, 2006; Wanzek et al., 2006; Werful, Schuele, & Reed, 2019). Competency in these domains contributes to elementary and secondary school success, as well higher education opportunities and employment prospects (Alber & Walshe, 2004; Vaughn, Schumm, & Gordon, 1992). Likewise, deficits in any of these language skills can disrupt learning to spell and impede literacy (Graham, 1999; Moats, 2000; Santangelo, 2018; Vaughn, Schumm, & Gordon, 1992).

Spelling is one of the most complex literacy skills for all students to master and the most common area of difficulty for students with learning disabilities (Vaughn,

Schumm, & Gordon, 1992; Williams, Walker, Vaughn, & Wanzek, 2017). Students with learning disabilities incorrectly spell from two to four times more words than students without disabilities, which places this population at a disadvantage academically and vocationally (Deno, Marsten, & Mirkin, 1982; Graham, Collins, & Rigby, 2017; Poplin, Gray, Larsen, Banikowski, & Mehring, 1980; Santangelo, 2018). The persistent consequences of poor spelling include limited writing proficiency, poor academic performance, miscommunication, and negative first impressions (Erion, Davenport, Rodax, Scholl, & Hardy, 2009; Graham, Harris, & Chorzempa, 2002; Jaspers et al., 2012; Noell, Connell, & Duhon, 2006; Santaro, Coyne, & Simons, 2006; Viel-Ruma, Houchins, & Fredrick, 2007; Wanzek et al., 2006).

As one of the most difficult skills to master, spelling is also the most difficult area to remediate for students with learning disabilities. Therefore, poor spelling skills remain the most frequently cited area of difficulty for adults with learning disabilities (McNaughton, Hughes, & Clark, 1994; Vaughn, Schumm, & Gordon, 1992; Williams, Walker, Vaughn, & Wanzek, 2017). However, utilizing formal, evidence-based spelling practices can lead to improvements in spelling proficiency (Al Otaiba, Rouse, & Baker, 2018; Graham & Santangelo, 2014; Wanzek et al., 2006; Weiser & Mathes, 2011). Examination of the existing literature on spelling instruction is necessary to the identification of experimentally sound practices.

Spelling instruction can be divided into three categories: traditional, specialized, and remedial (Heron, Okyere, & Miller, 1991). Conventional practices, like those common to commercial spelling programs, have been identified as traditional practices throughout the literature (Graham, 1983; Wirtz, Gardner, Weber, & Bullara, 1996).

Traditional lesson sequences commonly assign a word list on Monday and assess the words on Friday. Students spend the intervening days engaged in word practice activities such as writing the words three times, using words in sentences, alphabetizing words, writing stories with words, and coding syllables within words (Dagdag, McLaughlin, & Weber, 2002; Mann, Bushell, & Morris, 2010; Wirtz, Gardner, Weber, & Bullara, 1996; Zannikos, McCallum, Schmitt, & Pearson, 2018). Numerous studies have determined that although traditional practices are widely implemented, they are the least effective for many students including students at-risk for spelling difficulties and those with learning disabilities (Alber & Walshe, 2004; Mann, Bushell, & Morris, 2010; Murphy, Hern, Williams, & McLaughlin, 1990). The most frequent criticisms of traditional practices have included the focus on memorization, insufficient time for mastery, lack of immediate feedback, and poor generalization (Mann, Bushell, & Morris, 2010; McNeish, Heron, & Okyere, 1992; Murphy, Hern, Williams, & McLaughlin, 1990; Wirtz, Gardner, Weber, & Bullara, 1996).

Specialized approaches, unlike traditional practices, are empirically established practices for improving spelling performance. This group of instructional activities can be further organized by the type of implementation including teacher-directed methods (modeling, spelling rules, time delay, distributed practice), peer-mediated methods (flow lists, copy-cover-compare), and semi-independent methods (directed rehearsal, computer-based, self-correction) (Heron, Okyere, & Miller, 1991). Of these methods, self-correction is recognized as the most impactful specialized approaches (Heron, Okyere, & Miller, 1991). The benefits of self-correction have been attributed to the use of immediate feedback, increased exposure to the correct spelling, intensified focus on letter sequences,

individually paced practice, active responding, and provision of multiple response opportunities (Al Otaiba, Rouse, & Baker, 2018; McGuffin, Martz, & Heron, 1997; McNeish, Heron, & Okyere, 1992). Historically, self-correction under a teacher's guidance has been recognized as the single most important component in spelling success (Alber & Walshe, 2006; Grskovic & Belfiore, 1996; McGuffin, Martz, & Heron, 1997; McNeish, Heron, & Okyere, 1992; Morton, Heward, & Alber, 1998).

Immediate self-correction has also been established as the spelling technique with the best outcome for students with learning disabilities (Alber & Walshe, 2004; Al Otaiba, Rouse, & Baker, 2018; McNeish, Heron, & Okyere, 1992; Morton, Heward, & Alber, 1998; Santangelo, 2018; Viel-Ruma, Houchins, & Fredrick, 2007; Williams, Walker, Vaughn, & Wanzek, 2017). Effective components related to self-correction that improve spelling skills among this population include provision of active learning opportunities and intentional focus on correct letter sequences (Alber & Walshe, 2004; Al Otaiba, Rouse, & Baker, 2018; McNeish, Heron, & Okyere, 1992). These two features are credited with reducing permanent spelling error patterns among students with learning disabilities (Al Otaiba, Rouse, & Baker, 2018; McNeish, Heron, & Okyere, 1992).

Remedial approaches encompass instructional practices designed for students struggling with the acquisition of reading and spelling skills. Assignment to this category is based on a single characteristic: the lesson plans are individualized. Several methods have been included in this category; however, the Orton-Gillingham approach has emerged as the longstanding choice (Rose & Zirkel, 2007).

The Orton-Gillingham approach originated from the work of neuropsychologist and pathologist Samuel T. Orton and his collaborator Anna Gillingham. Gillingham was tasked with organizing the techniques that originated in Orton’s clinical research and developing a teacher training program. Gillingham, who was later joined by Bessie Stillman, expanded her initial work with Orton. The results of their collaboration were published as *The Gillingham Manual: Remedial Training for Children with Specific Disability in Reading, Spelling, and Penmanship* (1997). Now in its eighth edition, Gillingham and Stillman’s work is considered the most important resource for the Orton-Gillingham approach.

The name, Orton-Gillingham, was never trademarked and has since been appropriated by publishers of curricula based upon the original work of Orton, Gillingham, and Stillman. To establish a clear distinction between the original approach and its derivatives, the Institute of Education Sciences created the labels “unbranded Orton-Gillingham” and “branded Orton-Gillingham” (Sayeski, Earle, Davis, & Calamari, 2019). Commercial programs based on the Orton-Gillingham approach are recognized as branded materials. Individual publishers offer training in the use of their materials. Unbranded Orton-Gillingham refers to the original conceptual framework developed by Orton, Gillingham, and Stillman. Training in this approach is facilitated through the Academy of Orton-Gillingham Practitioners and Educators. This organization was founded by individuals trained directly by Orton, Gillingham, Stillman or one of their selected students.

Although the unbranded Orton-Gillingham approach is widely recognized as a remedial intervention, the method’s tenets more closely align with evidence-based,

specialized approaches. Language concepts (phonology, orthography, morphology, semantics, and syntax), from basic to complex levels, are delivered using explicit instruction. Students are trained to apply this information about written language to spelling tasks. Individualized lessons are systematically planned to incorporate modeling, continuous feedback, error-correction, task variance, distributed practice, and directed rehearsal. Skills are presented sequentially, and the level of difficulty is incrementally increased which insures mastery rather than temporary memorization.

The correction procedure blends teacher-directed and semi-independent methods. In the Orton-Gillingham error correction process the instructor provides prompts formulated as questions that attempt to link the student's error to prior instruction. Carefully sequenced from least to most support, these questions guide the student to identify and correct the spelling error. The student identifies and corrects the misspelling in response to the cues. The self-correction procedure examined in the literature is independently implemented by the student comparing their spelling to a correct model, The Orton-Gillingham process is initiated and scaffolded by the instructor and relies upon linguistic cues.

The lack of research and lifelong impact of spelling proficiency increase the significance of identifying effective instructional practices. The priority of such an investigation is heightened because the most requested form of intervention for students with learning disabilities is Orton-Gillingham instruction which has strong support based upon anecdotal evidence (Ritchey & Goeke, 2007; Rose & Zirkle, 2007). Although unbranded Orton-Gillingham instruction incorporates multiple evidence-based practices, the overall method has not been thoroughly examined (Ritchey & Goeke, 2006; Rose &

Zirkle, 2007). Thorough evaluation of this approach is especially warranted as it is a popular intervention, and seven states (Arkansas, Minnesota, Mississippi, Missouri, North Dakota, Rhode Island, and Wisconsin) specifically require districts to use Orton-Gillingham based materials and train faculty in Orton-Gillingham methodology (Stevens et al., 2021).

Fulk and Stormont-Spurgin's (1995) review of spelling literature identified eight studies evaluating the effect of a range of multi-sensory practices on the spelling accuracy of students with learning disabilities. The six studies that incorporated multi-sensory instruction and an auditory component involving letter naming demonstrated positive results. However, none of the studies were identified as an Orton-Gillingham based approach.

The Ritchey and Goeke (2006) literature review of all forms of Orton-Gillingham instruction identified twelve experimental or quasi-experimental studies that demonstrated higher levels of reading success under any form of Orton-Gillingham instruction than the method of comparison. Of the five studies that determined Orton-Gillingham instruction was more effective than the compared intervention, only two measured spelling performance. A quasi-experimental study conducted in a clinical setting that compared a branded Orton-Gillingham spelling program to traditional remedial spelling instruction yielded insignificant results. The second, which was experimentally based, compared a modified version of a branded Orton-Gillingham program to non-phonetic spelling instruction and to a no intervention control group with a population of college students. Results were interpreted as positive for the adapted version of a branded Orton-Gillingham program.

The Ritchey and Goeke (2006) review highlighted several issues to consider when evaluating instruction labeled as Orton-Gillingham and when drawing conclusions about study results. Older studies included in the review used less stringent research standards, and newer studies did not address important methodological components including procedures, implementation fidelity, and description of dependent variables used as a comparison (Ritchey & Goeke, 2006).

A recent meta-analysis of Orton-Gillingham instruction sought to update and extend the work completed by Ritchey and Goeke in 2006 (Stevens et al., 2021). Applying a more stringent inclusion criteria, the authors identified 24 studies with only six studies in common with Ritchey and Goeke's (2006) review. The Stevens et al. (2021) meta-analysis only included one of the studies that assessed spelling that were found in the Ritchey and Goeke (2006) review. Stevens et al. (2021) conducted their analysis on reading outcomes only in response to widespread state legislation requiring multi-sensory intervention for students with or at risk for reading disabilities. Their meta-analysis did not provide enough data to support Orton-Gillingham reading instruction as an evidence-based intervention, but determined the methodology held promise for improving reading outcomes. Orton-Gillingham spelling instruction was not reviewed in the findings which increases the need for high-quality studies of the Orton-Gillingham approach to spelling in addition to reading research.

Most of the remaining research evaluating the effects of self-correction on spelling accuracy of students with learning disabilities has compared the approach to traditional practices rather than to the sought-after Orton-Gillingham approach. The purpose of this study, therefore, was to compare spelling accuracy of elementary students

with learning disabilities under two different correction methods, teacher-led questioning versus student-led visual comparison, embedded in unbranded Orton-Gillingham spelling instruction. Evaluation of the unbranded Orton-Gillingham error correction component was selected for several reasons. First, instructional elements of the Orton-Gillingham approach, apart from error correction, align with empirically based practices. Next, student-led visual comparison has been identified as a highly effective spelling practice for students with learning disabilities (Alber & Walshe, 2004; Grskovik & Belfiore, 1996; McNeish, Heron, & Okyere, 1992; Viel-Ruma, Houchins, & Fredrick, 2007; Wirtz & Gardner, 1996). However, research has remained limited when evaluating best spelling practices for students with learning disabilities (Fulk & Stormont-Spurgin, 1995; McLaughlin, Manfred, Derby, & Everson, 2015; McNaughton, Hughes, & Clark, 1994).

Method

Participants and Setting

Five students, ages 7 years-4 months to 9 years-6 months, participated in the study. All students were Caucasian and attended private schools in a metropolitan area of the mid-southern United States. At the time of the study, students were rising first through third graders. All students were identified as having or at risk for having a learning disability in reading and spelling by independent psychologists using a medical diagnosis as determined by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) in lieu of the legal definition as established in the Individuals with Disabilities Education Act (IDEA). Each student was referred for Orton-Gillingham therapy during the summer by either a school learning specialist, speech-language pathologist, or private psychologist. Students did not receive any type of reward for

participation or spelling performance. All participants exhibited weakness in phonological awareness and phonological memory as indicated by the Comprehensive Test of Phonological Processing-Second Edition (CTOPP-2). On the Test of Written Spelling-Fifth Edition (TWS-5), students ranked in the 2nd to 63rd percentile. This study was approved by the Institutional Review Board of the researchers' university prior to the beginning of the study.

Jack was a 7 year-4-month-old male entering first grade at a parochial school. On the CTOPP-2, Jack's performance on phonological awareness tasks placed him in the 21st percentile. This rank is below average based on norm-referenced criteria. On a separate set of tasks evaluating phonological memory, his scores fell in the 1st percentile which is very poor. Close examination of testing items revealed that Jack had difficulty isolating and identifying phonemes within spoken words as well as repeating verbally presented series of digits and sounds. His spelling results on the TWS-5 were in the 63rd percentile of a norm-referenced population and were considered within the range of average scores. Analysis of his correct and incorrect spellings on the TWS-5 indicated higher accuracy on sight words than on phonics-based words.

Sam was an 8-year 3-month-old rising second grader at an independent school for boys. On the CTOPP-2, Sam's composite score for phonological awareness was below average and ranked in the 21st percentile. On phonological memory tasks, he demonstrated performance skills that fell in the 30th percentile. His spelling results on the TWS-5 fell in the average range and ranked in the 32nd percentile.

Virginia was 9-years and 6-months old. She scored in the 3rd percentile, characterized as borderline poor-very poor, on phonological awareness skills as measured

by the CTOPP-2. On the CTOPP-2's phonological memory tasks, Virginia performed in the 12th percentile of the normed population which fell in the lower end of the below average range. She spelled more sight words correctly on the TWS-5 than phonics-based words. Her score fell in the 2nd percentile which is characterized as on the borderline of poor-very poor.

Kent was a 7-year 9-month-old male who demonstrated average skills on phonological awareness tasks presented on the CTOPP-2. His composite score on these measures fell in the 25th percentile. On phonological memory tasks, Kent performed in the 16th percentile as determined by the CTOPP-2. His scores were characterized as below average. He correctly spelled an equal number of phonics-based words and sight words on the TWS-5.

Grayson was an 8-year 5-month-old male who scored in the 50th percentile on phonological awareness tasks per the CTOPP-2 which is characterized as average. On the phonological memory portion of the CTOPP-2, his performance fell in the 16th percentile and was considered below average. On the TWS-5, Grayson demonstrated average skills. His score placed his performance in the 37th percentile.

Individual intervention sessions were conducted during the summer across four weeks by the first author. During the fifth week students did not receive instruction. Follow-up probes were administered in sessions 9 and 10. Students were scheduled for intervention sessions twice weekly on non-consecutive days. All meetings were held in a small therapy room within the learning support center at an independent school. None of the participants attended this school. The room contained a small table, two chairs,

whiteboard, and bookshelves. Students sat across the table from the interventionist, facing away from the door.

Materials

A countdown timer, black fine point Sharpie brand permanent marker, blank 3x5" white index cards, researcher made data recording forms, blank 8 ½" x 11" Frog Street Press Smart Start Writing Paper (5/8" rule), and My Pal Jumbo Round Pencils were used during intervention sessions. A pencil grip was supplied if the student normally used one in handwriting activities. Plastic multi-colored buttons, one inch in diameter, were used as manipulatives during segmentation and letter naming activities.

Two published assessments were used during pre-intervention testing. The Comprehensive Test of Phonological Processing-2nd Edition (CTOPP-2) and the Test of Written Spelling-5th Edition (TWS-5) were selected to provide norm-referenced description of each student's phonological and spelling skills (Larsen & Hammill, 2013; Wagner, Torgeson, Rashotte, & Pearson, 2013).

Word Lists

Individualized word lists, which included real and non-words (e.g.: frip; gotch; trisk), were created based on weaknesses indicated by the CTOPP-2 and TWS-5. The initial list for each student was composed of twenty-five words. From this list, ten misspelled entries were selected as target words for the student's first spelling lesson.

Spelling Probes

Spelling probes were conducted at the beginning of each intervention session. These probes included the ten target words/non-words and ten additional untaught words/non-words for future use. The untaught words were chosen based upon the student's spelling progress. Words remained in the lesson plan until spelled correctly on a bi-weekly probe. For each word in the spelling probe, the researcher hand printed self-checking cards which consisted of a correct model with a black marker on a 3x5" unlined index card.

Experimental Design

This study was conducted using an adapted alternating treatments design (AATD). This single-subject design was introduced as a tool to experimentally compare two independent variables applied across distinct but functionally equivalent dependent variables (Shepley, Ault, Ortiz, Vogler, & McGee, 2020; Sindelar, Rosenburg, & Wilson, 1985). The AATD was designed for investigations into behaviors that are not reversible which has made the design popular in skill acquisition research particularly in educational settings (Shepley, et al., 2020). It has been used as a method for analyzing the superiority of compared interventions and making empirically based instructional decisions as well as for conducting component analysis (Sindelar, Rosenburg, & Wilson, 1985; Zannikos, McCallum, Schmitt, & Pearson, 2018). Because of the unlikely return to pre-instructional levels based on the irreversibility of learned responses, AATD has frequently been used in the spelling intervention literature (Erion, Davenport, Rodax, Scholl, & Hardy, 2009; Nies & Belfiore, 2006; Zannikos, McCallum, Schmitt, & Pearson, 2018).

Procedures

After establishing the starting point for each student based on testing information collected prior to intervention, a customized twenty-five-word spelling probe was designed and administered. From this list, ten misspelled words that illustrated common error patterns were selected for initial instruction. This spelling list was divided between conditions by comparing and balancing words. Consideration was given to length of words, presence of non-words, and complexity of word features. At the beginning of each intervention session, a spelling probe was administered. The conditions were counterbalanced by shuffling the deck of word cards prior to dictation in the same manner as Barbetta, Heron, & Heward, (1993).

Across both treatment conditions, words were presented to the student according to the Simultaneous Oral Spelling procedure which is inherent to unbranded Orton-Gillingham instruction (Gillingham & Stillman, 1997). First, the teacher pronounced the word after which the student repeated the word. Next, the student segmented the sounds in the word using manipulatives. Following sound segmentation, the student orally named each letter in sequence using the same manipulatives. After oral segmenting and letter naming, the student simultaneously named and wrote each letter of the word on paper. A word was recorded as correct if the student wrote all letter sequences error-free within ten seconds of presentation. In addition to incorrect or omitted letters, letter reversals were scored as errors. If the student did not complete the spelling within ten seconds, time was called, and the next word was dictated. Students did not receive feedback or any type of reinforcement under either condition.

In Condition A (teacher-led questioning), after the word was presented and written according to the procedure described above, the interventionist reviewed the spelling. If an error was identified, the teacher-led questioning routine was initiated. Leading questions were based upon letter-sound correspondence, spelling rules, or letter formation. Upon identifying the error, the student wrote the correct spelling adjacent to the misspelled word. This correction procedure is customary for the unbranded Orton-Gillingham approach.

Under Condition B (student-led visual comparison), the words were presented and written the same way as in Condition A. However, in Condition B, a student-led visual comparison method, modeled after procedures described by Morton, Heward, and Alber (1998), was implemented after each word was written. During this condition, a correct model of the target word printed on an index card was presented to the student after the word was written. First, the student placed the model directly above the written response. The student touched and named the first letter of the printed model with the index finger of the non-writing hand. The student underlined the corresponding letter in the response and named that letter. If the response agreed with the model, the student moved to the next letter and repeated the process. In the event the letters in the model and response were not in agreement, the student crossed through the incorrect letter in the response with a single line and wrote the correct information above the miscue. The correct spelling of the word was written adjacent to the original response after the entire word was checked. Prior to intervention, students received instruction in the visual comparison method in the form of three guided practice trials. The student demonstrated mastery on

the visual comparison procedure when three consecutive independent trials were completed with 100% accuracy.

Dependent Variables and Measurement

This study measured cumulative words correct (CWC) and percent of correct letter sequences (CLS) under both conditions. Measuring correctly spelled whole words was selected as a dependent variable because it has been a long-established practice for determining spelling accuracy in academic settings. Credit was only awarded for words correctly spelled within the allotted time with accurately formed letters. After administration of each spelling probe, accurate responding for words correct was recorded on a cumulative graph to reflect growth across time.

Students with learning disabilities have responded especially well to the focus on correct letter sequences found in self-correction practices in lieu of memorization common to other methods. While CLS data may yield greater variation among scores, it is a reliable method of conducting in-depth error analysis (Erion, Davenport, Rodax, Scholl, & Hardy, 2009; Grskovic & Belfiore, 1996).

Correct letter sequences are collected by examining the number of correct letter pairs in a word. Using the procedure described in Grskovic and Belfiore (1996), letter sequences were counted by adding a ghost character (^) before the first letter and after the last letter of the correctly spelled word. For example, the word “dog” has four possible successive letter pairs: ^d, do, og, g^. With this measurement system, students were awarded credit for each sequence and therefore able to earn partial credit for words not spelled with complete accuracy. For letter sequences to be recorded as correct, the word

must have been written within the time limit with correctly formed letters. On each word list, the percent of CLS was calculated by dividing the number of correct letter sequences produced by the student by the total number of possible correct sequences.

Interobserver Agreement, Procedural Integrity, and Social Validity

An independent observer trained in the unbranded Orton-Gillingham approach scored 30% of the spelling probes that were administered during the study. Interobserver agreement (IOA) for CWC and CLS was calculated by dividing the number of correct responses recorded by observer 1 by the number of correct responses recorded by observer 2. The quotient was then multiplied by 100 which resulted in an agreement of 100% for CWC and CLS.

A task analysis checklist was used to assess procedural integrity. An audio recording of 50% of the sessions was provided to an independent scorer. Procedural fidelity was recorded at 100% for all steps of the checklist in both conditions.

The experimenter administered a brief social validity questionnaire to the participants during the six-week follow-up session. The selected questions were based on Alber and Walshe's (2004) social validity questionnaire. In their study, students read and responded to the questions in writing. However, given the age and ability level of participants in the current study, the questions were read aloud to the participants who were asked to respond orally. Students responded to two questions concerning their preference for spelling correction methods and effectiveness:

1. Which error correction method did you like best?
2. Which error correction method helped you learn more words?

Results

Intervention results for CWC are presented in Figure 1. Visual analysis of CWC results, including maintenance data, demonstrate teacher-led questioning was slightly more effective for two students (Virginia and Grayson), student-led visual comparison was more slightly for two students (Jack and Sam), and both conditions were equally effective for one student (Kent).

Results for CLS under both conditions are shown in Figure 2. As is characteristic of CLS data, results during intervention demonstrated more variability in both conditions than evidenced by CWC. Examination of the change in CLS from the initial probe to the maintenance sessions, indicates that three students demonstrated a greater increase in CLS under student-led visual comparison (Jack, Virginia, and Grayson). Two students made greater gains from initial probes to their final follow-up session under teacher-led questioning (Sam and Kent).

Jack responded more quickly to teacher-led questioning for CWC during intervention. His performance remained higher under this condition throughout intervention. Although he made steady gains under student-led visual comparison, his performance level remained lower than in teacher-led questioning. However, during the two maintenance probes in sessions 9 and 10, Jack's performance in student-led visual comparison continued in an upward trend surpassing his results for cumulative words correct under teacher-led questioning. Jack's results indicate that student-led visual comparison had a more durable effect on his whole word spelling performance.

The percentage of CLS under student-led visual comparison showed little variability in his performance during intervention in contrast to his accuracy under teacher-led questioning. However, in the final maintenance probe, Jack reached his highest level of CLS in both conditions. Under teacher-led questioning, his accuracy improved from 69% in session 1 to 93% in session 10 maintenance probe. His performance under student-led visual comparison increased from 64% accuracy in session 1 to 84% accuracy in session 10 maintenance probe.

Sam's CWC performance under student-led visual comparison steadily increased from session 3 to session 8 and surpassed gains for teacher-led questioning. Results under teacher-led questioning followed a similar pattern across intervention except for session 7 during which his performance was stable. Spelling gains were not maintained under either condition on the session 9 maintenance probe; however, Sam correctly spelled more words correctly under student-led visual comparison. Sam was absent for the maintenance probe in session 10. Sam's CLS results maintained an upward trend under each condition through the fourth session. His accuracy declined in session 5 and became variable through session 8. His CLS performance improved in both conditions on the session 9 maintenance probe. Under teacher-led questioning, his accuracy increased from 64% to 85 % in maintenance session 9 and from 68% to 79% under student-led visual comparison.

Virginia's spelling performance indicates that the effect of teacher-led questioning was delayed until session 4 and until session 6 under student-led visual comparison. In session 7, her CWC performance under student-led visual comparison increased so that data paths crossed. This upward trend continued to the final session

during which her performance under student-led visual comparison surpassed teacher-led questioning. Gains were not maintained under either condition in both maintenance probes although performance under teacher-led questioning was higher than student-led visual comparison for CWC.

Virginia's CLS results demonstrate an immediate gain under both conditions in session 2. She was absent for session 3. Beginning in session 4, her accuracy under teacher-led questioning began a downward trend. Although her performance recovered in the maintenance probes, her results on the session 10 maintenance probe demonstrate a decline from 74 % accuracy in session 1 to 72% accuracy in the session 10 maintenance probe. Under student-led visual comparison, Virginia's performance remained variable from session 4 through session 8. However, her accuracy under student-led visual comparison increased from 46% in session 1 to 69% in the final maintenance probe in session 10.

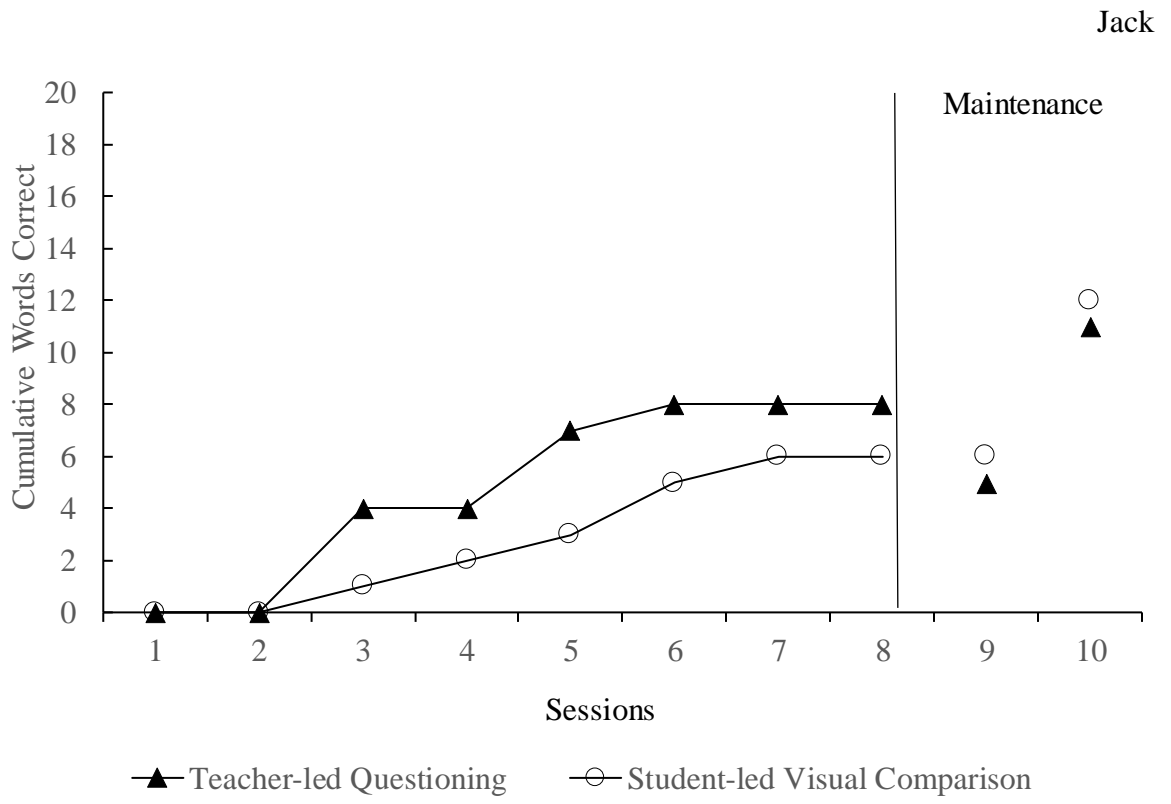
Kent demonstrated immediate gains in CWC under both conditions. During sessions 2 through 6, the trend for both conditions was closely aligned with teacher-led questioning demonstrating slightly higher results. In session 7, like Virginia, the data paths crossed. However, his performance under teacher-led questioning increased sharply while results under student-led visual comparison remained stable. Kent's CWC performance decreased during both follow up sessions but demonstrated equal effectiveness.

After demonstrating steady gains in CLS under teacher-led questioning throughout the intervention, Kent's accuracy decreased significantly in both follow up probes. His percent of CLS under teacher-led questioning improved from 60% in session

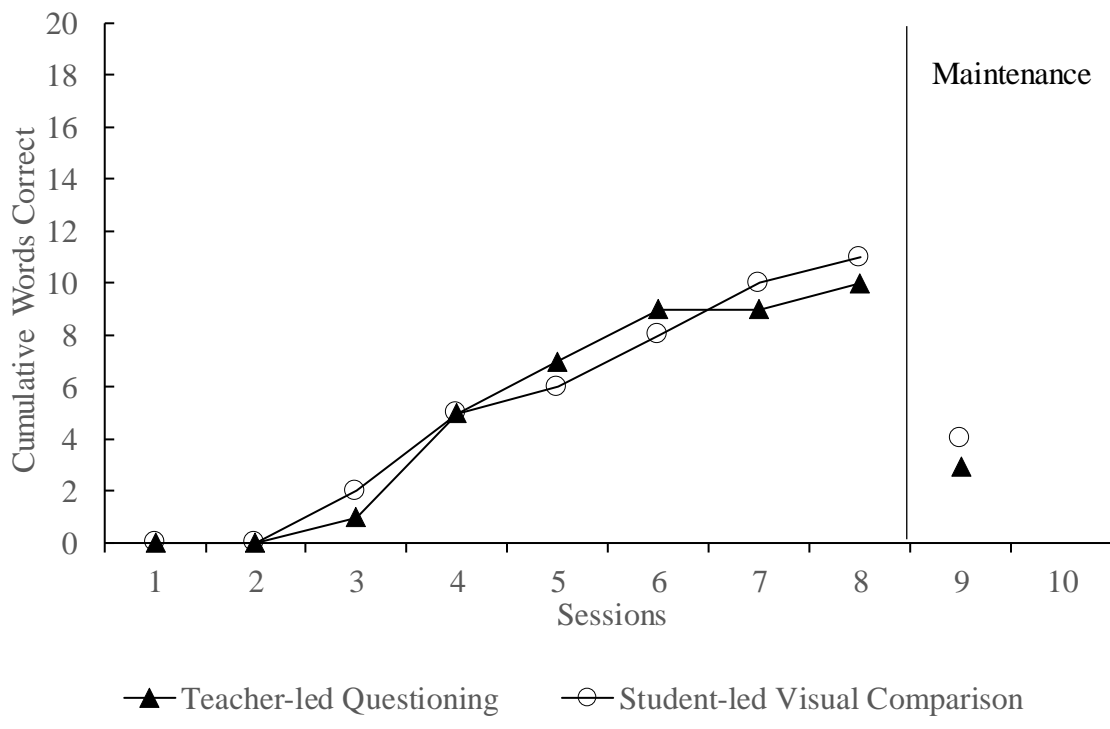
1 to 73% in the final probe during session 10 which was a decrease from his highest of score of 93% accuracy in session 8. Kent's CLS results under student-led visual comparison increased sharply during the first three sessions. In session 4, his accuracy declined significantly. He was absent for sessions 5 and 6. His performance was highly variable in sessions 7 and 8. However, when comparing initial and final CLS accuracy for student-led visual comparison, Kent's performance in CLS for student-led visual comparison increased from 69% accuracy in session 1 to 74% accuracy in the session 10 maintenance probe.

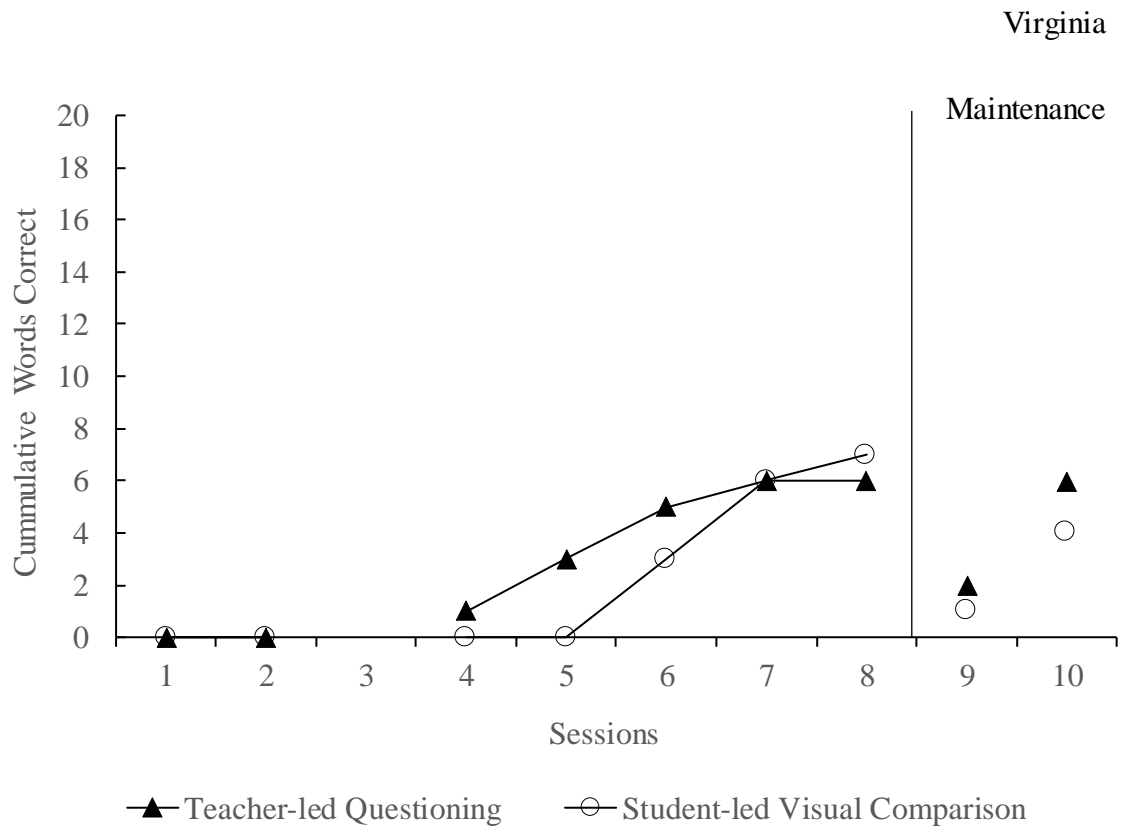
Although performance under both conditions demonstrated an upward trend, Grayson made the greatest gains in CWC under teacher-led questioning. As with other participants, his performance declined in the follow-up probes with results under teacher-led questioning slightly higher than under student-led visual comparison. Examination of CLS, reveals no trend for either condition during intervention. However, maintenance results indicate he achieved greater CLS gains in student-led visual comparison with an increase from 57% in session 1 to 81% in session 10. However, he achieved his highest levels of accuracy for CLS under teacher-led questioning in both session 1 (72%) and session 10 (84%).

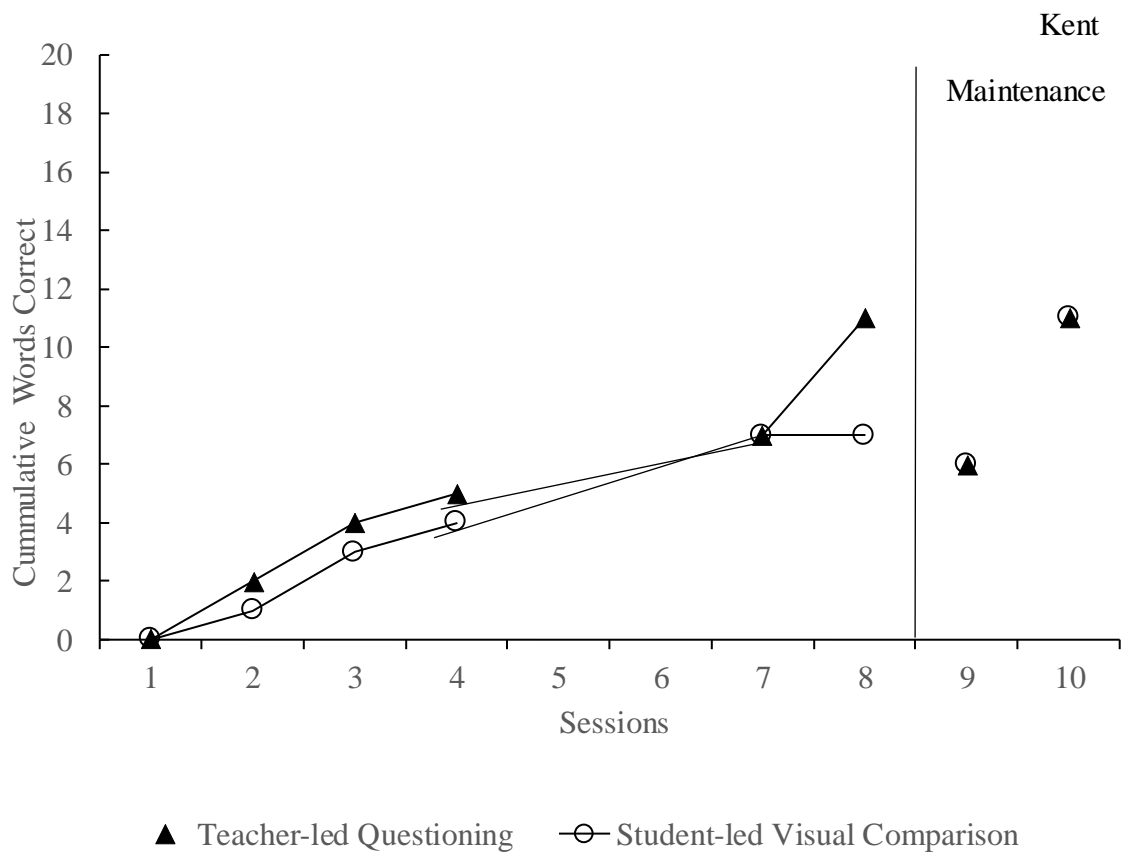
Regarding social validity, Jack and Kent found student-led visual comparison more appealing. Both students commented that student-led visual comparison was quicker and required less talking. Despite his preference, Kent noted that teacher-led questioning was more effective for learning words. Sam, Virginia, and Grayson preferred teacher-led questioning over student-led visual comparison. These students also perceived they learned more words under this condition.



Sam







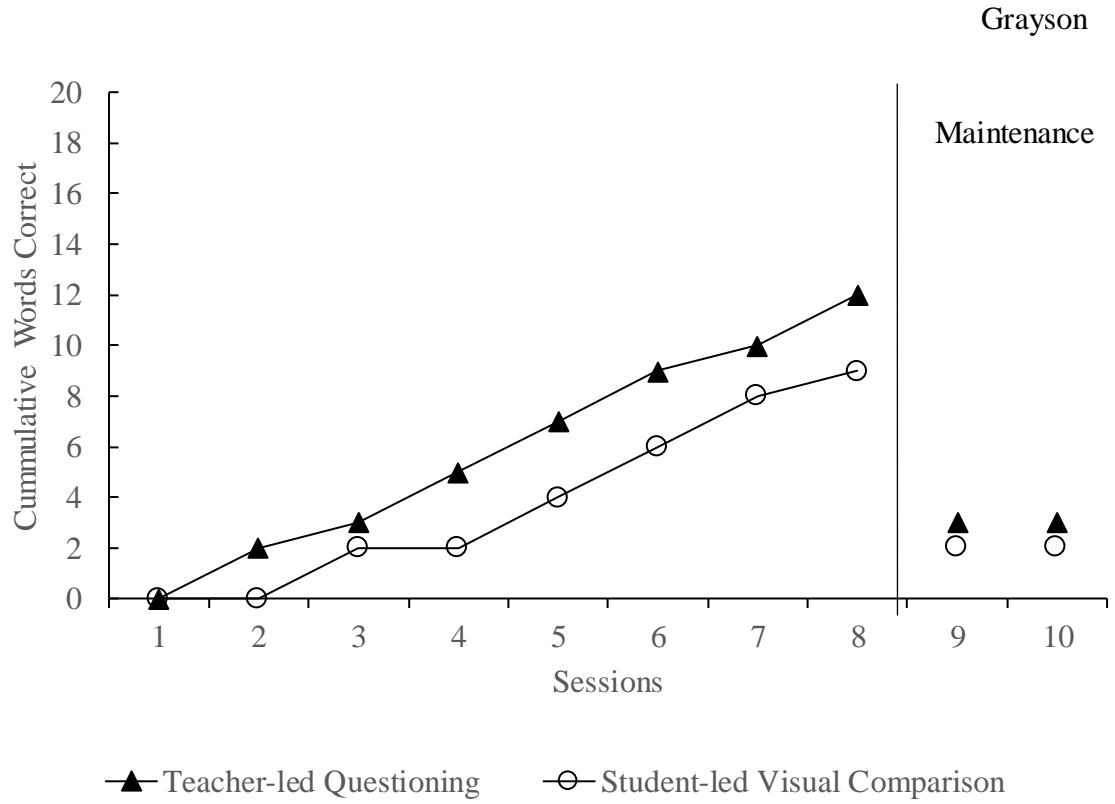
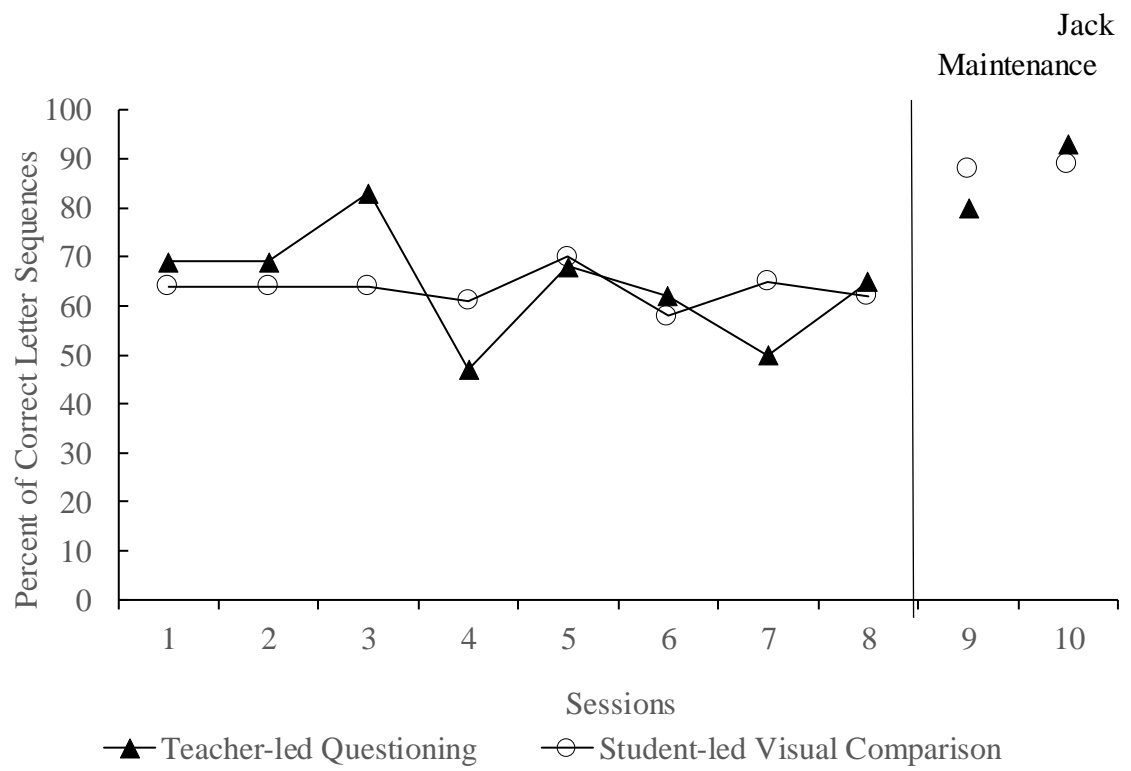
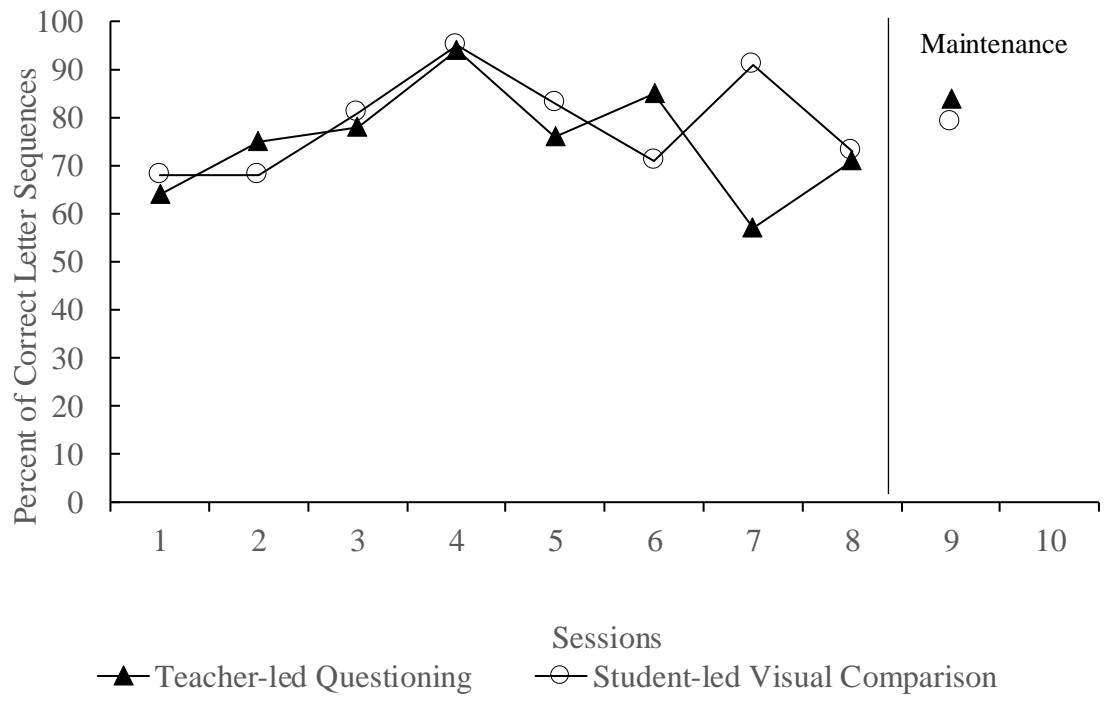
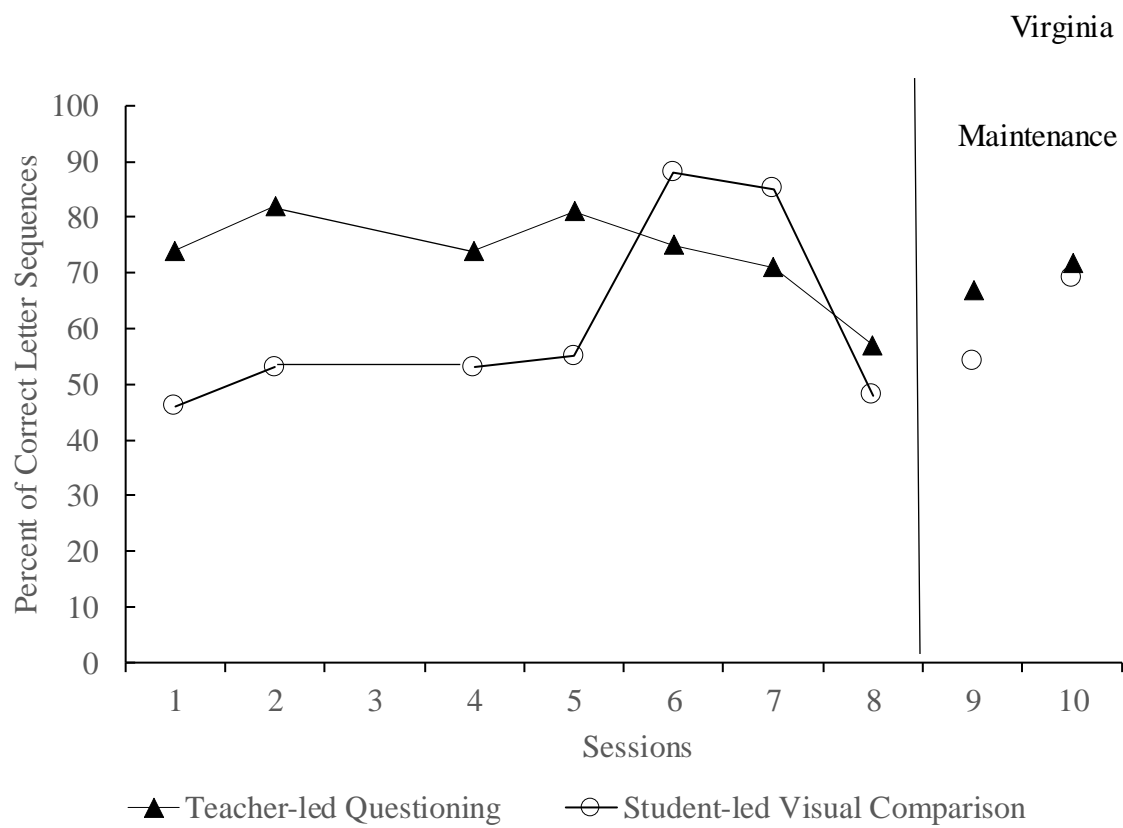


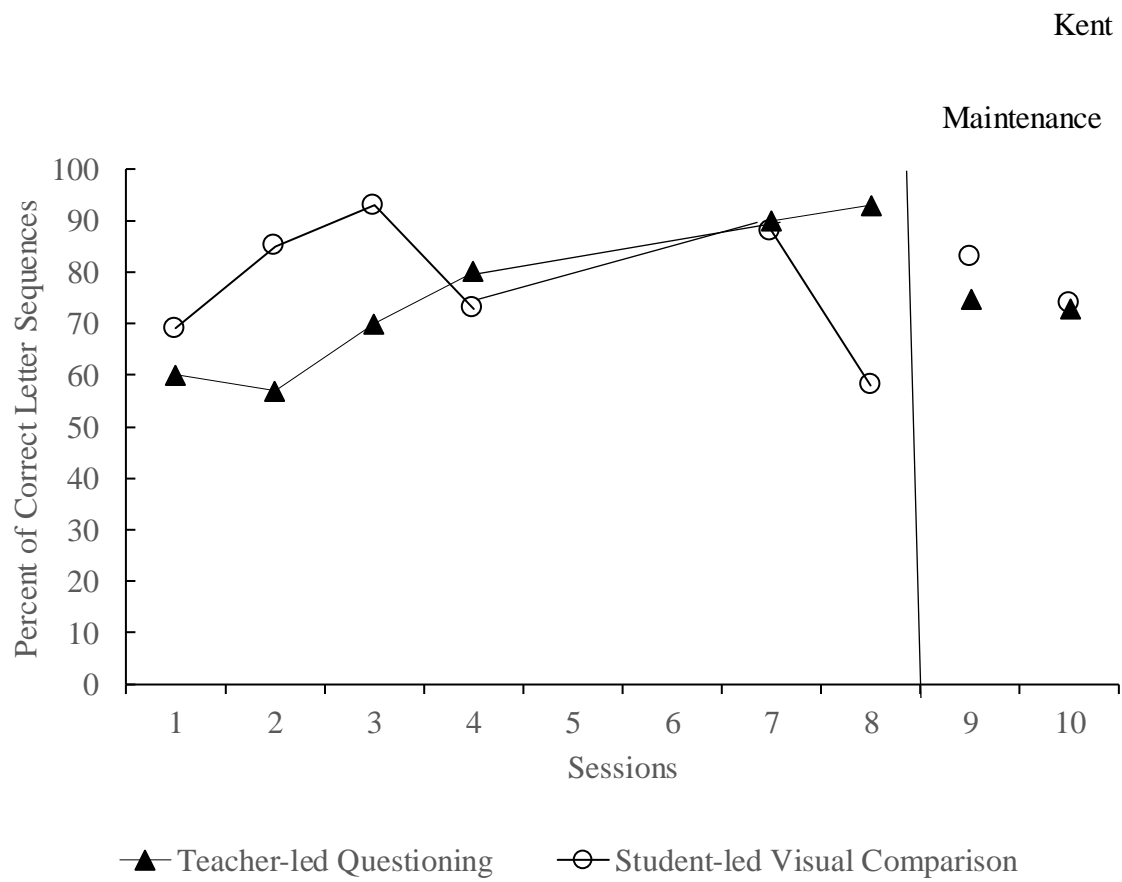
Figure 1
Cumulative Words Correct by Participant



Sam







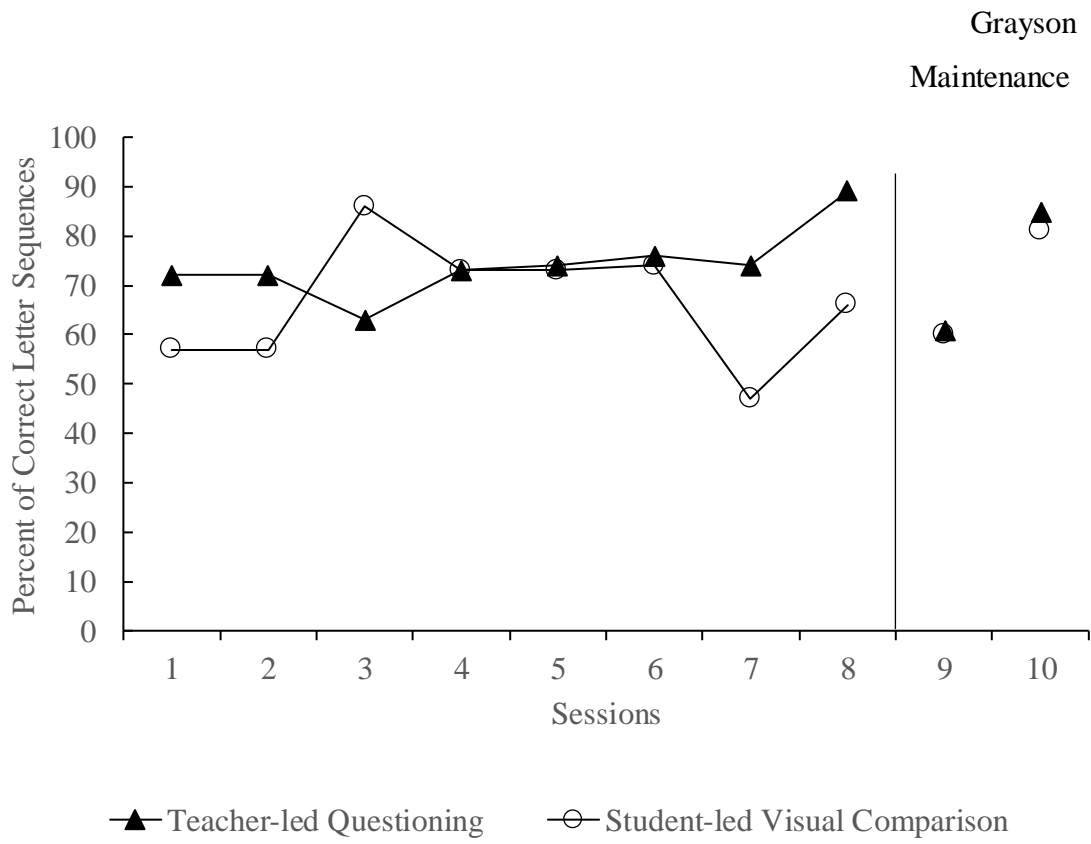


Figure 2

Percent of Correct Letter Sequences by Participant

Discussion

This investigation compared the effects of two different error-correction methods (teacher-led questioning versus student-led visual comparison) embedded within an unbranded Orton-Gillingham approach on the CWC and CLS for five struggling spellers. Across all students during maintenance, the difference between the number of correct words in each condition differed from zero to two words. Although neither error-correction method proved to be significantly superior to the other, there were individual differences regarding social validity.

This study offers a critical evaluation of error-correction implemented in unbranded Orton-Gillingham spelling procedures which, given its popularity, is needed. The results could potentially guide interventionists in the selection of effective spelling interventions for students with learning disabilities. Based on the varying levels of spelling ability among students included in this study, the results demonstrated that both error-correction models may be successfully implemented in lessons targeting multiple levels of spelling complexity, a range of spelling concepts, and a variety of student characteristics. This finding is important because unbranded Orton-Gillingham instruction is used across age groups and levels of spelling ability. The availability of two error correction methods that have minimally different maintenance outcomes may allow teachers to consider selecting a method based on student preference which could capitalize on momentum associated with high social validity. In the absence of student preference, teachers could use the diagnostic information gained from CLS data to select the most successful error correction strategy.

Given the evidence supporting the effectiveness teacher led correction in combination with the use of providing cues based on effective teaching practices including spelling rules, orthographic conventions, sound symbol correspondence, and letter formation, the results of the present study are unexpected. Teacher-led correction encompassed each of these linguistic cues which would suggest this error correction method would demonstrate superiority for increasing spelling accuracy. Student-led visual correction relied on a near point copying task. Although self-correction using a visual model is well documented in the literature, copying tasks are difficult for students with learning disabilities (Fears & Lockman, 2018).

Historically, multi-sensory instruction, including Orton-Gillingham based instruction, has incorporated motor movement in all levels of spelling. Support of this component is found in research that has linked handwriting instruction to improved spelling and composition outcomes (Wolf, Abbott, & Berninger, 2017). Research has also established the association between handwriting and improved letter recognition in pre-school and kindergarten. This is significant because early letter knowledge skills have been linked to improved reading and spelling in later years (Zemlock, Vinci-Booher, & James, 2018). In keeping with the Simultaneous Oral Spelling protocol of unbranded Orton-Gillingham instruction, the present study included handwritten spellings.

However, when output modalities have been compared in attempts to establish a superior mode, the findings are inconclusive. Cunningham and Stanovich's (1990) work determined that handwriting was superior to keyboarding for spelling improvement for students without learning disabilities. A subsequent replication by Vaughn, Schumm, and Gordon (1992) did not support the findings for students with or without learning

disabilities. These studies differed from the present study in that words were rehearsed via a copying procedure and not from dictation. Berninger, Abbott, Rogan, et al, (1998) examined spelling accuracy using handwriting and computer response modes among students with learning disabilities. Their study did not find an overall advantage of either modality. Despite the lack of a main effect, post-test results showed handwriting yielded greater gains for words featuring one to one letter sound correspondence while the computer was more successful for mastering words with complex orthographic patterns. Masterson and Apel (2006) examined the effect of output modality on a diverse student population. Results did not identify a superior modality for spelling acquisition for any level of spelling complexity. None of the studies employed the unbranded Orton-Gillingham approach to spelling. Future research should explore the effectiveness of adding a keyboarding instruction component to the unbranded Orton-Gillingham approach to spelling and evaluating its effectiveness as a spelling response modality.

Because efficiency is a hallmark of highly effective instruction, a component analysis should be conducted to eliminate steps or procedures that may delay spelling gains (Grskovik & Belfiore, 1996; Nies & Belfiore, 2006). This study did not measure the length of time taken to reach mastery under each condition. This is useful information for planning efficient lessons especially when students do not have a preference between correction methods. Reinforcement is another time-related factor that was not included in the present study. Measuring its effect on spelling acquisition relevant to amount of instructional time available and the instructional setting (group or individual) should also be included in future research.

To improve confidence in selecting a correction method especially in group settings, future research should look to increase the diversity of participants. This would enhance external validity as the current study had five participants from similar educational and socio-economic backgrounds. Additionally, it may be important to screen participants for any bias towards the Orton-Gillingham approach. Four of the five participants had previously received Orton-Gillingham instruction and were familiar with teacher-led questioning. Sam, Kent, Virginia, and Grayson had previous experience with teacher-led questioning but had never engaged in student-led visual comparison. Jack did not have experience with either correction method. Prior student exposure could have influenced performance results and social validity responses.

Future studies should include sentence level generalization probes to further substantiate the durability of both error correction procedures. The ability to accurately spell words in isolation is an essential component of explicit instruction, but it is not a functional skill. Rather, the goal of spelling instruction is to achieve accurate, automatic, contextualized spelling. This study failed to incorporate a measure for generalization which limits the results. This omission could easily be rectified in future research as spelling in context is incorporated in the unbranded Orton-Gillingham approach.

Gaps in research remain, however, this study contributes to experimental analysis of the unbranded Orton-Gillingham approach to spelling. It also provides teachers with two equivalent correction methods which provides flexibility when planning instruction for individual and group instruction. Spelling remains a critical component of success in academics and the work force. The lack of research focusing on the use of unbranded Orton-Gillingham spelling instruction for students with learning disabilities demonstrates

a need for a complete component analysis of the method. This in-depth scrutiny would provide the needed evidence required to establish unbranded Orton-Gillingham spelling instruction as an empirically based approach.

References

- Alber, S.R., & Walshe, S.E. (2004). When to self-correct spelling words: A systematic replication. *Journal of Behavioral Education, 13* (1) 51-66.
DOI:10.1023/B:JOB.0000011260.12674.a3
- Al Otaiba, S., Rouse, A. G., Baker, K. (2018). Elementary grade intervention approaches to treat specific learning disabilities, including dyslexia, *Language, Speech & Hearing Services in Schools, 49*(4), 829-842.
https://doi.org/10.1044/2018_LSHSS-DYSLC-18-0022
- Barbetta, P. M., Heron, T.E., & Heward, W.L., (1993). Effects of active student response during error-correction on the acquisition, maintenance, and generalization of sight words by students with developmental disabilities. *Journal of Applied Behavior Analysis, 26*(1), 111-119. <https://doi.org/10.1901/jaba.1993.26-99>
- Berninger, V., Abbott, R., Rogan, L., Reed, E., Abbott, S., Brooks, A., Vaughan, K., & Graham, S., (1998). Teaching spelling to children with specific learning disabilities: The mind's ear and eye beat the computer or pencil. *Learning Disability Quarterly, 21*, 106-122.
- Brice R. G., (2004). Connecting oral and written language through applied writing strategies, *Intervention in School and Clinic, 40*(1), 38-47.
<https://doi.org/10.1177/10534512040400010301>

- Dagdag, R., McLaughlin, T. F., & Weber, K. (2002). The use and evaluation of a sound out or error only sound out procedure on the spelling performance of a third-grade student. *International Journal of Special Education*, 17(2), 93-98.
- Deno, S.L., Marsten, D., & Mirkin, P., (1982). Valid measurement procedures for continuous evaluation of written expression. *Exceptional Children*. 48 (4), 368-371. <https://doi.org/10.1177/001440298204800417>
- Erion, J., Davenport, C., Rodax, N., Scholl, B., & Hardy, J., (2009). Cover-copy-compare and spelling: One versus three repetitions. *Journal of Behavioral Education*, 18 (4), 319-330. doi:10.1007/s10864-009-9095-4
- Fears, N.E., & Lockman, J.J., (2018). How beginning handwriting is influenced by letter knowledge: Visual-motor coordination during children's form copying. *Journal of Experimental Psychology*, 171, 55-70. <https://doi.org/10.1016/j.jecp.2018.01.017>
- Fulk, B. M. & Stormont-Spurgin, M. (1995). Spelling interventions for students with disabilities: A review. *The Journal of Special Education*, 28(4), 488-513. <https://doi.org/10.1177/002246699502800407>
- Gillingham, A. & Stillman, B. (1997). *The Gillingham manual: Remedial training for children with specific disability in reading, spelling, and penmanship*. (8th ed.). Cambridge, MA: Educators Publishing Service.
- Graham, S., (1983). Effective spelling instruction. *The Elementary School Journal*, 83(5), . <https://doi.org/10.1086/461334>

- Graham, S., (1999). Handwriting and spelling instruction for students with learning disabilities: A review. *Learning Disability Quarterly*, 22(2), 78-98.
<https://doi.org/10.2307/1511268>
- Graham, S., Collins, A.A., & Rigby-Wills, H., (2017). Writing characteristics of students with learning disabilities and typically achieving peers: A meta-analysis. *Exceptional Children*, 83(2). 199-218.
<https://doi.org/10.1177/0014402916664070>
- Graham, S., Harris, K. R., & Chorzempa, B. F., (2002). Contribution of spelling instruction to the spelling, writing, and reading of poor spellers. *Journal of Educational Psychology*, 94 (4). 669-686. <https://doi.org/10.10037/0022-0663.94.4.669>
- Graham, S., & Santangelo, T., (2014). Does spelling instruction makes students better spellers, readers, and writers? A meta-analytic review. *Reading and Writing*, 27(9), 1703-1743. <https://doi.org/10.1007/s11145-014-9517-0>
- Grskovic, J. A., & Belfiore, P. J. (1996). Improving the spelling performance of students with disabilities. *Journal of Behavioral Education*, 6(3), 343-354.
<https://doi.org/10.1007/BF02110135>
- Hebert, M., Kearns, D. M., Hayes, J. B., Bazis, P., & Cooper, S. (2018). What children with dyslexia struggle with writing and how to help them. *Language, Speech, and Hearing Services in School*, 49(4), 843-863.
https://doi.org/10.1044/2018_LSHSS-DYSLC-18-0024

Heron, T., Okyere, B.A., & Miller, A. D. (1991) A taxonomy of approaches to teach spelling. *Journal of Behavioral Education*, 1 (1), 117-130.

<https://doi.org/10.1007/BF00956757>

Jaspers, K.E., Williams, R.L., Skinner, C.H., Cihak, D., McCallum, R.S., & Ciancio, D.J.

(2012). How and to what extent do two cover, copy, and compare spelling interventions contribute to spelling, word recognition, and vocabulary development. *Journal of Behavioral Education*, 21 (1), 80-89.

<https://doi.org/10.1007/s10864-011-9137-6>

Larson, S.C., & Hammill, D.D. (2013). *Test of Written Spelling-Fifth Edition*. Austin, TX: PRO-ED.

Mann, T. B., Bushell, D., & Morris, E. K. (2010). Use of sounding out to improve spelling in young children. *Journal of Applied Behavior Analysis* 43(1), 89-93.

<https://doi.org/10.1901/jaba.2010.43-89>

Masterson, J. J., & Apel, K. (2009). Effect of modality on spelling words varying in linguistic demands. *Developmental Neuropsychology*, 29(1), 261-277.

McGuffin, M. E., Martz, S. A., & Heron, T. E. (1997). The effects of self-correction versus traditional spelling on the spelling performance and maintenance of third grade students. *Journal of Behavioral Education*, 7(4), 463-476.

<https://doi.org/10.1023/A:1022807402418>

McLaughlin, T. F., Manfred, A., Derby, K. M., & Everson, M. (2015). The effects of a modified cover, copy, compare on spelling tests and in written composition for

three students with specific learning disabilities. *Educational Research Quarterly*, 38(3), 3-31.

McNaughton, D., Hughes, C.A., & Clark, K., (1994). Spelling instruction for students with learning disabilities: Implications for research and practice. *Learning Disability Quarterly*, 17(3), 169-185. <https://doi.org/10.2307/1511072>

McNeish, J., Heron, T. E., Okyere, B. (1992). Effects of self-correction on the spelling performance of junior high students with learning disabilities. *Journal of Behavioral Education*, 2(1), 17-27. <https://doi.org/10.1007/BF00947135>

Moats, L. C. (2000). *Speech to print: Language essentials for teachers*. Baltimore: Paul H. Brookes Pub.

Morton, W. L., Heward, W. L., & Alber, S. R. (1998). When to self-correct? A comparison of two procedures on spelling performance. *Journal of Behavioral Education*, 8(3). <https://doi.org/10.1023/A:1022871230565>

Murphy, J. F., Hern, C. L., Williams, R. L., McLaughlin, T. F. (1990). The effects of the copy, cover, compare approach in increasing spelling accuracy with learning disabled students. *Contemporary Educational Psychology*, 15(4), 378-386. [https://doi.org/10.1016/0361-476X\(90\)90032-V](https://doi.org/10.1016/0361-476X(90)90032-V)

Neis, K.A., & Belfiore, P.J., (2006). Enhancing spelling performance in students with learning disabilities. *Journal of Behavioral Education*, 15, 163-170. <https://doi.org/10.1007/s10864-006-9017-7>

- Noell, G.H., Connell, J.E., & Duhon, G.J. (2006). Spontaneous response generalization during whole word instruction: Reading to spell and spelling to read. *Journal of Behavioral Education* 15(3), 121-130. <https://doi.org/10.1007/s10864-006-9016-8>
- Poplin, M.S., Gray, R., Larsen, S., Banikowski, A., & Mehring, T., (1980). A comparison of components of written expression abilities in learning disabled and non-learning disabled students at three grade levels. *Learning Disability Quarterly*, 3(4), 46-53. <https://doi.org./10.2307/1510674>
- Ritchey, K. D. & Goeke, J. L. (2006). Orton-Gillingham and Orton-Gillingham-based reading instruction: A review of the literature. *The Journal of Special Education*, 40(3), 171-183. <https://doi.org/10.1177/00224669060400030501>
- Rose, T. E. & Zirkel, P. (2007). Orton-Gillingham methodology for students with learning disabilities. *The Journal of Special Education*, 41(3), 171-185. <https://doi.org/10.1177/00224669070410030301>
- Santangelo, T., (2018). Next generation spelling for students with learning disabilities: Translating research into practice. *Perspectives on Language*. 44(2), 30-35.
- Santaro, L.E., Coyne, M.D., & Simmons, D.C., (2006). The reading-spelling connection: Developing and evaluating a beginning spelling intervention for children at risk of reading disability. *Learning Disabilities Research & Practice*, 21, 122-133. <https://doi.org:10.1111/j.1540-5826.2006.00212.x>
- Sayeski, K., Earle, G. A., Davis, R., & Calamari, J. (2019). Orton-Gillingham: Who, what and how. *Teaching Exceptional Children*, 51(3), 240-249. <https://doi.org/10.1177/0040059918816996>

- Shepley, C., Ault, M.M., Ortiz, K., Vogler, J.C., & McGee, M. (2020). An exploratory analysis of quality indicators in adapted alternating treatments designs. *Topics in Early Childhood Special Education*, 39(4), 226-237.
DOI:10.1177/0271121418820-429
- Sindelar, P. T., Rosenberg, M.S., & Wilson, R. J. (1985). An adapted alternating treatment design for instructional research. *Education and Treatment of Children*, 8(1), 67-76.
- Stevens, E.A., Austin, C., Moore, C., Scammacca, N., Boucher, A.N., & Vaughn, S. (2021). Current state of evidence: Examining the effects of Orton-Gillingham reading interventions for students with or at risk for word-level reading disabilities, *Exceptional Children*, 87(4), 397-417. DOI: 10.1177/0014402921993406
- Vaughn, S., Schumm, J.S., & Gordon, (1992). Early spelling acquisition: Does writing beat the computer? *Learning Disability Quarterly*, 15(3),223-228.
<https://doi.org/10.2307/1510245>
- Viel-Ruma, K., Houchins, D., & Fredrick, L. (2007). Error self-correction and spelling: Improving the spelling accuracy of secondary students with disabilities in written expression. *Journal of Behavioral Education* 16(3), 291-301.
- Wagner, R.K., Torgeson, J.K., Rashotte, C.A., & Pearson, N.A. (2013). *Comprehensive Test of Phonological Processing-Second Edition*. Austin, TX: PRO-ED.

- Wanzek, J., Vaughn, S., & Wexler, J., Swanson, E.A., Edmonds, M., & Kim, A., (2006). A synthesis of spelling and reading interventions and their effects on the spelling outcomes of students with LD. *Journal of Learning Disabilities*, 39(6). 528-543. <https://doi.org/10.1177/00222194060390060501>
- Weiser, B. & Mathes, P. (2011). Using encoding instruction to improve the reading and spelling skills of elementary students at risk for literacy difficulties: A best-evidence synthesis. *Review of Educational Research*, 81(2), 170-200. <http://doi.org/10.3102210034654310396719>
- Werful, K. L., Schuele, C. M., & Reed, P., (2019). Linguistic contributions to word-level spelling accuracy in elementary school children with and without specific language impairment. *American Journal of Speech-Language Pathology*, 28, 599-611. https://doi.org/10.1044/2018_AJSLP-18-0064
- Williams, K.J., Walker, M.A., Vaughn, S., & Wanzek, J. (2017). A synthesis of reading and spelling interventions and their effects on spelling outcomes for student learning disabilities. *Journal of Learning Disabilities*, 50(3) 286-297. <https://doi.org/10.1177/0022219415619753>
- Wirtz, C. L., Gardner, R., Weber, K., & Bullara, D. (1996). Using self-correction to improve the spelling performance of low achieving third graders. *Remedial and Special Education*, 17(1), 48-58. <https://doi.org/10.1177/074193259601700106>
- Wolf, B., Abbott, R.D., & Berninger, V.W. (2017). Effective beginning handwriting instruction: Multi-modal, consistent format for 2 years, and linked to spelling and composing. *Reading and Writing*, 30, 299-317

Zannikos, M. E., McCallum, E., Schmitt, A. J., & Pearson, K. E. (2018). A comparison of the taped spelling intervention and cover, copy, and compare for students with learning disabilities. *Journal of Behavioral Education, 27*(3), 301-323.

<https://doi.org/10.1007/s10864-018-9293-z>

Zemlock, D., Vinci-Booher, S., & James, K. H. (2018). Visual–motor symbol production facilitates letter recognition in young children. *Reading and Writing, 31*(6),

1255-1271. <https://doi.org/10.1007/s11145-018-9831-z>