A Synthesis of Spelling Interventions for Secondary Students with Disabilities

Kelly J. Williams, Christy R. Austin, and Sharon Vaughn

The University of Texas at Austin

Author Note

Kelly J. Williams, The Department of Special Education, The University of Texas at Austin; Christy R. Austin, The Department of Special Education, The University of Texas at Austin; Sharon Vaughn, The Department of Special Education, The University of Texas at Austin.

Correspondence concerning this article should be addressed to Kelly J. Williams, The University of Texas at Austin, College of Education SZB 228, 1912 Speedway D4900, Austin, TX 78712-1284. Phone: 856-625-1357 E-mail: kellyjwilliams@utexas.edu

Abstract

This synthesis examined the effects of spelling interventions on spelling outcomes for students with disabilities in Grades 6 through 12. Thirteen single-case design studies were identified for inclusion in the review. No studies used a treatment/comparison design. The most common types of interventions involved systematic study strategies, such as cover-copy-compare, as well as technological assistance. Most of the spelling interventions increased spelling outcomes for words directly taught or studied in the intervention or increased the percentage of words spelled correctly in written compositions. For students with LD or EBD, spelling interventions usually emphasized study strategies, while interventions for students with other disabilities (OI, ID, and AUT) emphasized the use of technology. Noticeably absent from these interventions were the direct teaching of phoneme to grapheme correspondences and morphemic approaches, which are often used with students in the elementary grades (Sayeski, 2011; Simonson and Gunter, 2001; Wanzek et al., 2006; Williams et al., 2017).

Spelling is a complex skill that involves the encoding of spoken words into print using correct letter sequences (Ehri, 2000; Templeton, 2002). Development of proficient spelling is no easy feat, especially considering the complexity of the English orthography. The English language consists of multiple layers that impact spelling development (Bear, Invernizzi, Templeton, & Johnston, 2008; Ehri, 1987; Invernizzi & Hayes, 2004; Moats, 2009). At the most basic level, the *alphabetic layer*, there is a direct correspondence between phonemes and graphemes (Bear et al., 2008; Graham, 1999). Spelling increases in difficulty when knowledge of phoneme-grapheme relationships is not sufficient to encode a word. In the *pattern layer*, single sounds can be spelled with more than one letter, or letters may be included that do not actually represent sounds (Bear et al., 2008; Invernizzi & Hayes; 2004). This layer overlaps the alphabetic layer and requires individuals to use groups of letters to guide written spelling. The last layer of English orthography is the *meaning layer*, where letter groups such as prefixes, suffixes, stems, or roots, have a direct connection to meaning (Bear et al., 2008; Invernizzi & Hayes, 2004). Knowledge of these spelling-meaning relationships helps signal the derivational relation among words and also fosters vocabulary development (Bear et al., 2008; Invernizzi & Hayes, 2004). Understanding the construction of the English language helps inform methods for teaching spelling to students.

Methods for Teaching Spelling

Traditionally, spelling instruction is emphasized in the primary grades (K-3) and researchers have observed that teachers spend an average of 90 minutes each week teaching spelling (Graham et al., 2008). Students learn to spell through a variety of methods including incidental learning, developmental word study, basal spellers or stand-alone programs, and/or through technology (Graham, 1999; Graham et al., 2008; Schlagal, 2002). In incidental methods,

teachers do not use a predetermined program or curriculum, but instead select words from student compositions or reading materials and provide mini-lessons on an as-needed basis (Graham et al., 2008; Schlagal, 2002). In contrast to incidental methods, developmental word study approaches provide carefully sequenced instruction at the student's developmental level (Templeton & Morris, 2000). Students are taught to use phonemes and morphemes to spell new words (Simonsen & Gunter, 2001). Another method involves using basal or stand-alone programs for spelling. These typically include grade-level lists of words that students study each week and are then tested on at the end of the week (Schlagal, 2002). Students often memorize lists of words, often without regard for phonological or morphological patterns. Similarly, the whole-word approach requires students to memorize irregularly spelled words (Simonsen & Gunter, 2001). Students can also be taught systematic study strategies to help them memorize new words and these strategies often include the components of: pronouncing a word prior to writing, writing each word, checking accuracy of spelling, saying the letters aloud while spelling a word, tracing words, and visualizing letters of words (Graham, 1999). Lastly, students can also learn to spell with technological assistance such as computers or word prediction software (Graham, 1999; MacArthur, 1998; MacArthur, 1999).

Importance of Spelling for Students with Disabilities

Students with disabilities often have difficulty spelling words in isolation and in context (Fletcher et al., 2007; Friend & Olsen, 2008; Graham et al., 2016; Graham, Collins, & Rigby-Wills, 2017; Romani et al., 2005). One reason spelling may be difficult is because students are required to remember more than 70 letters or letter combinations to spell phonemes (Ehri, 2000). Furthermore, spelling is closely related to reading (Friend & Olsen, 2008; Graham, Harris, & Chorzempa, 2002; Graham & Santangelo, 2014; Noell, Connell, & Duhon, 2006; Romani,

Olson, & Di Betta, 2005; Santoro, Coyne, & Simmons, 2006). The phonological skills in reading and spelling overlap considerably, and students with spelling disabilities often have phonological deficits that impact reading and spelling performance (Friend & Olsen, 2008). Graham and Santangelo (2014) investigated the impact of spelling instruction on reading, writing, and spelling outcomes for students with and without disabilities in grades K through 12. Formal spelling instruction improved spelling outcomes when compared to no instruction or incidental instruction (ES = 0.54) and positively impacted reading performance (ES = 0.44). Similar results were found by Weiser and Mathes (2011) in their synthesis of the impact of encoding instruction (i.e., directly teaching students how to spell phoneme-grapheme correspondences in writing and with manipulatives) on reading and spelling outcomes for at-risk elementary students and older students with LD who read below a third-grade level. Encoding instruction was found to increase students' knowledge of the alphabetic principle, development of phonemic awareness, and growth of reading and spelling skills. Wanzek et al. (2006) synthesized the literature from 1995 to 2003 involving reading and spelling interventions and their impact on spelling outcomes for students with LD in grades K through 12. Studies that used explicit instructional methods and incorporated multiple opportunities for practice and immediate corrective feedback led to the largest increases in spelling achievement. Williams, Walker, Vaughn, and Wanzek (2017) replicated and extended the Wanzek et al. (2006) synthesis to include studies from 2004 to 2014. Again, interventions that included explicit instruction or self-correction strategies improved spelling outcomes for words directly taught in the interventions (Williams et al., 2017).

Spelling is also related to written expression (Graham, Harris, & Hebert, 2011; Graham & Sangangelo, 2014). Two recent meta-analyses have examined the writing characteristics for students with ADHD and LD (Graham et al., 2016; Graham, Collins, & Rigby-Wills, 2017). In

both meta-analyses, students with ADHD and LD performed significantly worse on measures of spelling achievement than their normally achieving peers (ES = -0.80 and ES = -1.50 respectively). In Graham and Santagelo's (2014) meta-analysis, formal spelling instruction increased spelling accuracy in written compositions for students in grades 1 through 6 (ES = 0.94). Increasing spelling accuracy in compositions is important because written compositions with spelling errors are often scored more harshly by teachers than the same compositions without spelling errors (Graham et al., 2011). The results from the aforementioned reviews and meta-analyses emphasize not only how spelling deficits impact students' reading and writing performance, but also the importance of teaching spelling to improve spelling, reading, and writing outcomes.

The Current Synthesis

The previous reviews and meta-analyses identified some gaps in the literature. Most participants in the reviewed studies received interventions in the elementary grades. Even fewer studies attempted to teach spelling to older students in grades 6 through 12. By the time students reach the secondary grades (6-12), spelling is rarely ever taught directly. The Common Core State Standards for English Language Arts state that secondary students should "demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing" which includes spelling accuracy in grades 6 through 12 (National Governors Association Center for Best Practices, 2010, p. 51). Although spelling is not expected to be taught in the secondary grades, many students with disabilities may struggle to spell accurately and fluently and these problems may persist into adulthood (Fletcher et al., 2007; Friend & Olsen, 2008; Graham et al., 2016; Graham et al., 2017; Maughan et al., 2009; Romani et al., 2005). Moreover, while the reviews and meta-analysis identified participants as struggling

spellers or those with LD, most did not identify or include participants with other types of disabilities that commonly receive special education services. Although students with LD comprise the largest subgroup of students receiving special education services in the United States (37%), many other students with disabilities struggle with acquiring basic literacy skills and may have instructional goals in spelling (U.S. Department of Education, 2015). Overall, very little is known about the nature and impact of spelling instruction for students with other disabilities and those in the secondary grades. The purpose of this synthesis was to extend the work conducted by Williams and colleagues (2017) which examined the effect of spelling and reading interventions on spelling outcomes for students with LD in grades K-12. The current synthesis examined the effects of spelling interventions on spelling outcomes for students with all disabilities only in Grades 6 through 12. The research question was: What are the effects of spelling interventions on spelling outcomes for secondary students with disabilities?

Method

Data Collection

To locate all relevant research studies, a systematic search of the literature was conducted. Because the current synthesis is an extension of the Williams and colleagues (2017) synthesis, similar search procedures and inclusion criteria were used to locate articles. First, a computer search was performed utilizing the databases of ERIC, Education Source, and PsychINFO to find studies from January of 2004 to April of 2016. One primary search term was used (spell*) to capture all studies related to the domain of spelling. Secondary or sub-search terms included “dis*” or “special education” or “special needs” or “dys*.” The search was further limited by including only peer-reviewed articles in academic journals published in English. The initial search identified 2,706 articles after duplicates had been removed. Titles and

abstracts were read to determine initial eligibility. Once a corpus of studies was identified, studies were further examined to determine if they met the inclusion criteria.

After completion of the computer search, a hand search was conducted and included cross-categorical special education research journals that were identified as being representative of the field. The hand search examined studies published from April 2014 to April 2016 in each of the journals to confirm that all relevant studies had been identified in the computer search. A two-year time period was used to ensure that all relevant studies had been captured with the electronic search. The hand search included the following journals: *Exceptional Children, Journal of Educational Psychology, The Journal of Special Education, Reading Research Quarterly, Remedial and Special Education,* and *Scientific Studies of Reading.* No additional articles were found through this method. Since no additional studies were found during this two-year period, the hand search ended at April of 2014. An ancestral search (Cooper, 2010) was also conducted using the reference lists of the articles included in this synthesis and the syntheses by Weiser and Mathes (2011) and Graham and Santangelo (2014). No additional studies were located in these reference lists.

Studies were eligible for inclusion in the synthesis if they met the following criteria: (a) published from January 2004 through April of 2016, (b) participants were formally identified as receiving special education services for a Learning Disability (LD), Other Health Impairment (OHI), Orthopedic Impairment (OI), Autism (AUT), Speech or Language Impairment (SLI), Emotional/Behavioral Disorder (EBD), or Intellectual Disability (ID) and were in Grades 6 through 12 or ages 11 to 21, (c) designs were either treatment/comparison or single-case, (d) a spelling intervention was implemented, (e) at least one spelling outcome was measured, and (f) instruction was in English. Studies were excluded if they were not published in English, did not

disaggregate results for students with disabilities or for spelling related outcomes, or if they utilized single-group or qualitative designs. Studies were also excluded if they were not published in a peer-reviewed, academic journal or if they included a multicomponent intervention or one not directly related to spelling. Additionally, if studies included participants who were identified with blindness, deafness, hearing impairment, traumatic brain injury, or visual impairment, they were excluded. The rationale for excluding students with these disabilities is that written spelling performance in English may not necessarily be a goal for these students or English may be considered the second language in which students are learning these skills. Since the goal was to examine English-only first-language instruction, studies with these participants were excluded.

Data Analysis

Coding Procedures. Thirteen studies met inclusion criteria and were coded using the *Code Sheet and Guide for Education-Related Intervention Study Syntheses* (Vaughn, Elbaum, Wanzek, Scammacca, & Walker, 2014). All studies were double-coded by two researchers trained in the coding procedures. The primary coder served as the "gold-standard" and coded all studies independently (Gwet, 2001). Prior to double-coding, a second researcher coded a study not from this corpus and inter-rater reliability was calculated. The two coders had greater than 90% agreement on the code sheet. Then, the second coder reviewed each original code sheet and discrepancies were discussed. Information was recorded on the code-sheet about general study characteristics, participant information, type of design, treatment and comparison groups, clarity of causal inference, quality of study, general findings, precision of outcome, and measures and effect sizes. Participant information was coded using forced choice items (e.g., socioeconomic status, risk type, criteria for classifying students with disabilities) and open-ended items (e.g.,

number of participants for each gender, age/grade of subjects, exceptionality of subjects). Design information was coded using forced-choice and open-ended items; this included type of design, assignment/selection of participants for intervention, any reported fidelity checks or pre-test scores, and selection criteria for participants. A description of the treatment(s) was also included. Single-subject studies' results were coded using an open-ended item where the results were described for each participant in detail.

Effect Size Calculation. All studies included in the review used single-case designs, so Tau-U was used to calculate effect sizes. Tau-U is a nonoverlap method that accounts for trend within baseline phases and can be used with small data sets (Vannest & Ninci, 2015). While Tau-U can be interpreted differently based upon the outcome, for the purpose of this study Tau-U represents the percent of nonoverlap between phases, and values of 0 to 0.20 are considered small changes, 0.20 to 0.60 moderate changes, 0.60 to 0.80 large changes, and 0.80 and above are very large changes (Parker et al., 2011; Vannest & Ninci, 2015). Because Tau-U requires raw data from the graphs, raw data needed to be extracted from the graphs using digital software. In a review of plot digitizing programs, Moeyaert and colleagues (2016) found that WebPlotDigitizer is one program that is reliable and valid for extracting data for use in single-case design studies. The graphs from each study were saved as image files and were uploaded into the WebPlotDigitizer application in order to convert data points into numerical values (Rohatgi, 2015). All extracted values were rounded to the nearest whole number, as each spelling test outcome in the corpus of studies reported the number of whole words correct, not allowing for partial credit. Raw data for each participant in each study were entered into a spreadsheet. Raw data from each phase were then entered into the Single-Case Effect Size Calculator, which is a

web application that provides calculations for nonoverlap and parametric effect sizes from single-case design studies (Pustejovsky, 2017).

Results

Ten new studies were identified in the electronic search, and three were previously identified in the synthesis conducted in 2017 by Williams and colleagues (Hochstetler et al., 2013; VielRuma et al., 2007; Zielinnski et al., 2012) for a final corpus of 13 single-case design studies with 30 participants. No studies used a treatment/comparison design. The most common types of designs were multiple-baseline and reversal designs. Two studies used alternating treatment designs (Schlosser & Blischak, 2004; VielRuma, Houchins, & Fredrick, 2007) and one study used changing-conditions (Evmenova et al., 2010); however, results from this study should be interpreted with caution because a functional-relation was not established between baseline and the treatment conditions, as there was no return to baseline. Because of the variety in designs and lack of reporting of raw data in the original studies, Tau-U could not be calculated for all studies.

Table 1 provides a summary of the reviewed studies including the design, participant characteristics, and intervention type, while Table 2 summarizes the intervention characteristics, measures, results, and Tau-U. Most of the participants in the included studies were identified with and receiving services for LD and 77% of the participants were male. Socioeconomic status (SES) was only reported in three studies (Darrow, McLaughlin, Derby, & Johnson, 2012; Evmenova, Graff, Jerome, & Behrmann, 2010; Hochstetler, Mclaughlin, Derby, & Kinney, 2013), and participants were classified as being from low- or middle-class SES. One study (Vedora & Stromer, 2007) reports results of two separate studies with the same participants, so these are described separately in the tables. N/A in the table indicates that Tau-U could not be

calculated. Results are summarized by (a) general study findings and effectiveness, (b) intervention type and characteristics, and (c) type of disability.

<Table 1>

<Table 2>

General Study Findings and Effectiveness

In all studies, participants were generally able to increase spelling accuracy for words directly taught in the interventions or for words written in compositions. When examining the data through visual analysis and comparing treatment phases with baseline phases, the participants spelled more words correctly and made fewer errors in writing after spelling interventions were implemented. All spelling measures were researcher-developed and the researchers did not report reliability or validity information. Furthermore, most studies did not assess the maintenance of spelling performance and generalization of spelling skills to untaught words. Two studies (Purrazella & Mechling, 2013; Schlosser & Blischak, 2004) assessed student performance on novel or untaught words, but these were words that other study participants had been learning, not those with similar orthographic or phonetic patterns. Vedora and Stromer (2007) conducted follow-up tests to determine if participants had maintained spelling performance; however, only one of the two participants had maintained the previously learned words. The following sections describe the results of the interventions by the type of measure (i.e., spelling tests or written compositions), Tau-U, and descriptive findings.

Results for spelling tests. Nine studies included in the review assessed spelling performance through spelling words in isolation. The number of words on each spelling list in each condition varied from four to 18 words. In six of these studies (Cieslar et al., 2008; Darrow et al., 2012; Hochstetler et al., 2013; Manfred et al., 2015; Vedora & Stromer, 2007; Viel Ruma

et al., 2007; & Zielinnski et al., 2012), participants mastered most of the words on each researcher-created list. On average, students mastered 70% to 100% of the words. For each of these nine studies, the percentage of nonoverlap (Tau-U) was large (0.60 – 0.80) or very large (>0.80). However, there was some variability among participants and sets of words. There was only a moderate degree of non-overlap for participant 2 in Manfred et al. (2015) as well as participant 3, set 3 for Purrazzella and Mechling (2013), indicating that the treatment was less effective for those participants. In Hochstetler et al. (2013) participant 2 had difficulty spelling the words in set 2 and there was a small degree of non-overlap (< 0.20) between baseline and treatment. This was also true for participant 2 in McCallum et al. (2013) and participants 1 and 2 in VielRuma et al. (2007). Additionally, the participants the McCallum et al. (2013) Schlosser and Blischak (2004) and Viel Ruma et al. (2007) mastered few spelling words per list, suggesting that these findings are not necessarily practically significant because students were still demonstrating very low levels of spelling accuracy.

Results for Spelling in Written Compositions. Three studies examined spelling accuracy in written compositions with and without word prediction software (Evmenova et al., 2010; Mezei & Heller, 2005; Tumlin & Heller, 2004). In Evemenova et al. (2010), participant 1 increased spelling accuracy from 61% without the software to approximately 92% with the word prediction software. Tau-U values for each treatment condition were very large, suggesting a high level of non-overlap. However, in this study, there was no return to baseline phase where the word prediction software was removed, so a functional relation was not established and results should be interpreted with caution. All three participants in Mezei and Heller (2005) decreased the number of words spelled incorrectly in written compositions with the use of the word prediction software. On average, when participants did not use word prediction software,

they made 5% to 14% errors in their written compositions. When they used the word prediction software, this number decreased to 0% to 4% errors. Similar results were found for both participants in Tumlin and Heller (2004) and the four participants decreased the number of words spelled incorrectly in written compositions with the use of the word prediction software. Word prediction software helped decrease the percentage of spelling errors for participants in all three studies.

Descriptive Findings. Tau-U could not be calculated for three studies, which included 9 participants. Two of the studies did not include the raw data or graphs for each of the data collection points (Mezei & Heller, 2005; Tumlin & Heller, 2004). Results from these two studies are described in the previous section and in Table 2. In the third study, Vedora and Stromer (2007), a multiple-probe design was used which made it difficult to calculate an effect. In this design, data is not meant to be compared from the probes/baseline to the treatment phases because the treatment phases are where students are learning or acquiring the skills. The probes given in-between the intervention phases give a more accurate representation of the skills acquired in the intervention phases. Vedora and Stromer (2007) investigated the use of two CBI teaching conditions on written and anagram spelling tests. Both participants were able to spell more words correctly after the teaching trials. Overall, through qualitative descriptions and Tau-U calculations, it can be concluded that all of the interventions in the review increased spelling outcomes for words that were taught or increased the accuracy of written spellings in compositions.

Intervention Type and Characteristics

The studies in this synthesis implemented spelling interventions and measured spelling in isolation or in written compositions. After coding the descriptions of the interventions, each

intervention was classified as a specific type of intervention (e.g., systematic study interventions, technological assistance interventions, or combined). Three methods of spelling instruction emerged: systematic study, technological assistance, or a combination of these two. Classifications of the interventions are listed in Table 1 and descriptions of the interventions are provided in Table 2. Findings by type of intervention are described in the following sections.

Systematic Study Interventions. Systematic study strategies involve instructing students to use a specific strategy to learn words systematically (Graham, 1999). Interventions employing these strategies incorporate elements such as saying words correctly prior to spelling, writing each word, verifying accuracy of each word, pronouncing letters while spelling words, and/or tracing or visualizing letters in words (Graham, 1999). These methods also tend to have multiple opportunities for students to practice and receive immediate corrective feedback (Sayeski, 2011; Wanzek et al., 2006; Williams et al., 2017). Seven studies implemented interventions with some type of systematic study method (Cieslar et al., 2008; Darrow et al., 2012; Hochstetler et al. 2013; Manfred et al., 2015; McCallum et al., 2013; VielRuma et al., 2007; Zielinnski et al., 2012). The predominant strategy was Cover-Copy-Compare (CCC), and other strategies included a taped spelling intervention and error self-correction strategy that was very similar to CCC. In the five studies using CCC, participants typically read each spelling word, copied the word, covered the word, wrote the word from memory, uncovered and checked the word, and then rewrote incorrectly spelled words anywhere from one to three times each. In the taped spelling intervention (McCallum et al., 2013), students listened to each word spelled aloud, wrote the word, listened again to the word, and then spelled the word a second time. The error self-correction intervention implemented by Viel Ruma et al. (2007), was similar to McCallum et al.'s (2013) intervention in that the participants listened to a dictated word, spelled the word,

checked the spelling, and then self-corrected misspelled words. All seven of these interventions had the common systematic study features and also allowed for immediate, corrective feedback and multiple opportunities for students to practice spelling words. Tau-U values for systematic study interventions varied among participants and word sets. Out of the 26 effects calculated, 21 were large or very large, one was moderate, and four were small. Spelling interventions with systematic studyled to improved spelling accuracy with large to very large degrees of non-overlap for most participants.

Technological Assistance Interventions. Graham (1999) suggested that technology could be incorporated into spelling interventions to provide "systematic support" (p. 90) such as immediate, corrective feedback and additional practice and review when learning new words. Assistive technology devices such as word prediction software are another way to teach students to decrease spelling errors in written compositions (MacArther, 1998, MacArther, 1999). Three studies investigated the impact of technological assistance interventions with word prediction software. Word prediction programs led to decreased percentages of errors and increased spelling accuracy in writing compositions typed on the computer in all studies. The most common word prediction software was *Co:Writer*; however, all programs had similar features where students were given word choices as the program predicted the user's next word. Tau-U values could only be calculated for Evemenova et al. (2010), and there was a very large degree of non-overlap for participants in this study. However, there was no return to baseline after this intervention, so results should be interpreted with caution.

Combined Interventions. Three studies in the review included both systematic word study methods and technological assistance (Purrazella & Mechling, 2013; Schlosser & Blischak, 2004; Vedora & Stromer, 2004). Purrazella and Mechling (2013) designed a study that

examined the impact of computer-based instruction (CBI) with forward chaining on percent of letters spelled correctly in words. Participants were presented words on the computer to study and as students practiced the words, letters were systematically removed. Tau-U values were large or very large for all participants and word sets except participant 3, set 3. In Schlosser and Blischak (2004), they implemented a systematic study strategy procedure, Cover-Copy-Compare, but then incorporated three different types of feedback from a speech-generating device (SGD). The speech-generating device provided speech, print, or a combination of both (speech + print) feedback as students practiced their words. Tau-U values for participant 1 were very large and for participant 2 were large. Vedora and Stromer (2004) conducted two experiments where students were taught sets of three words over five block trials on the computer. The computer had students practice spelling words to dictation or pictures, and then had them write the words from memory. Words were practiced until a certain predetermined criterion was reached. These studies all incorporated some type of technological assistance with a method for systematically studying or practicing words. Tau-U could not be calculated for these two experiments.

Disability Type

More than half of the participants in the included studies (n = 16) were identified as receiving special education services for LD or EBD. Students with LD and EBD both have difficulty with academic skills, but they are not a result of intellectual or cognitive deficits (NICHCY, 2012). In this review, participants with LD and EBD were provided with spelling interventions that used systematic study strategies (except in Evmenova et al., 2010). In contrast, students with more severe disabilities (i.e. OI, ID, and AUT) usually have lower levels of cognitive functioning and adaptive behavior deficits (NICHCY, 2012). Participants identified

with these disabilities received interventions that emphasized the use of technological assistance or those that combined technology with study strategies.

Discussion

The purpose of this synthesis was to investigate the impact of spelling interventions on spelling outcomes for students with disabilities in grades 6 through 12. A systematic review of the literature identified 13 studies for inclusion in the synthesis. Results were summarized by (a) general study findings and effectiveness, (b) intervention type and characteristics, and (c) type of disability. As appropriate, Tau-U was calculated and reported to aid comparison in the results across studies.

Overall, the studies included in the synthesis reported increased spelling accuracy for taught words following spelling interventions or increased spelling accuracy in written compositions. Despite this, there was some variability for individual participants and some of the interventions could be interpreted as having minimal practical significance despite improved performance from baseline to intervention phases. For example, in some studies, the participants increased their spelling accuracy, but still spelled most words on the lists given post-intervention incorrectly. Tau-U ratings were typically large or very large for the majority of participants, however these results should be interpreted with caution as Tau-U is a non-parametric statistic and the values used to determine the size of the effect may be considered arbitrary. There can be large or very large degrees of non-overlap present in the data, but the changes in overall spelling performance may be minimal.

Two types of spelling interventions for older students emerged as potentially effective from the research. First, systematic study procedures were the most common type of spelling intervention (Graham, 1999). In these interventions, students used a specific procedure (i.e.,

Cover-Copy-Compare) to study words and then were tested on those same words. These interventions emphasized repeated practice with words and self-correction of misspelled words. The second type of intervention that emerged from the synthesis was studies using technological assistance through computers or word-prediction software (Graham, 1999). In these interventions, participants learned to use word-prediction software (i.e., Co:Writer) to reduce the number of misspellings in written compositions. Some studies incorporated a combination of both systematic study strategies in addition to technological assistance. These interventions incorporated technology such as a computer, with study strategies like CCC, to increase spelling accuracy. Noticeably absent from the corpus of studies were methods for directly teaching of phoneme to grapheme correspondences or morphemic approaches, which are often used with students in the primary or elementary grades (Sayeski, 2011; Simonson and Gunter, 2001; Wanzek et al., 2006; Williams et al., 2017). Previous research has also suggested that students who struggle with spelling benefit from being taught explicitly at their developmental level (Simonsen & Gunter, 2001; Schlagal, 2002). However, in this synthesis, it was found that for secondary students with disabilities, studies of spelling interventions have only focused on systematic study strategies, technological assistance, or a combination of these two approaches.

Interestingly, the type of spelling intervention approach was related to participants' disability diagnosis. Participants with disabilities such as LD or EBD participated in interventions that emphasized systematic study strategies, while participants with disabilities such as ID, AUT, and OI, received interventions that used technological assistance or both technological assistance and systematic study strategies. It is possible that because of individual level characteristics associated with specific disability types (i.e., fine motor problems for students with OI), that typical spelling output methods (i.e., handwriting) would not have been

appropriate for this population of students, therefore leading to more technologically based interventions. In Wanzek et al.'s (2006) review of spelling interventions for students with LD, it was determined that some spelling interventions incorporated assistive-technology such as word-prediction software and led to improved spelling outcomes. Despite this implication, only one study in the current review examined the use of word-prediction software for students with LD.

In the interventions that taught spelling words through systematic study or a combination approach, transfer and generalization of spelling skills to untaught words were not assessed, nor was maintenance of spelling performance over time. The researchers in the studies did not select orthographically or phonetically similar words in which participants could generalize their learned spelling skill, which is common in developmental approaches that focus on the *alphabetic, pattern*, and *meaning* layers of the English language. One potential reason for the lack of generalization measures may be because most of the studies focused on some type of systematic study procedure. With these procedures, words might not be selected to represent certain phonemic or morphemic patterns. The participants in these studies were instructed to use the strategy to study a list of unknown, unrelated words, similar to methods used in whole word or basal approaches (Schlagal, 2002; Simonsen & Gunter, 2001). Since the lists studied don't necessarily represent specific patterns that can be generalized, measures may not have been administered to assess generalization. Only one study, Vedora and Stromer (2007), conducted follow-up tests at predetermined intervals to determine if participants had maintained their performance over time. Only one of the two participants maintained previously learned spelling skills. It is surprising that maintenance of spelling skills was not measured over time in the other studies, since many students with disabilities have difficulty maintaining academic skills.

Limitations and Directions for Future Research

The research designs and the methods in the primary studies, as well as the methods of this synthesis limit the conclusions that can be drawn from the studies. None of the studies employed treatment/comparison designs. Because the search terms limited the search to only students with disabilities, it is possible that not many randomized studies could power a study using only students with identified disabilities because a of the number of participants needed. Additionally, some treatment/comparison studies that include students with disabilities may not have met eligibility criteria because results were not disaggregated for participants with disabilities. Future research could possibly explore the use of alternate designs to investigate the impact of spelling interventions on spelling outcomes or could disaggregate the results for students with disabilities.

Another limitation of this synthesis is that it did not incorporate research from un-published studies such as dissertations. There is a potential for publication bias if this unpublished or "grey" literature is not included in the search; however, this information is often difficult to obtain (Rothstein & Hopewell, 2009). Shadish and colleagues (2016) surveyed single-case design researchers to determine the extent to which publication bias might exist in single-case design studies. They found that single-case design studies are more likely to be published if they demonstrate large effects. Therefore, the results of this synthesis should be interpreted with caution, as it is possible that many of the studies included in the synthesis were only published because of their large effects.

Furthermore, there is a known relationship between spelling, reading, and writing instruction (Graham et al., 2002; Graham et al., 2016; Graham, Collins, & Rigby-Wills, 2017; Graham & Santangelo, 2014; Noell et al., 2006; Santoro et al., 2006) and there may be other

studies that did not meet the criteria for this synthesis that included reading or writing with spelling. Spelling is often included as a part of multi-component interventions and improvements in spelling cannot be attributed to the spelling component only. A fine line exists between reading and spelling instruction and it is often difficult to separate the two (Ehri, 2000). In the future, it may be of interest to conduct component analyses to determine the separate and additive impact of spelling and reading or writing interventions on spelling, reading, and writing outcomes.

It is also important to note that the technological assistance interventions use software programs from the late 1990s to early 2000s. Technology has changed considerably since this time period; however, the purpose of this study was to identify all available research studies conducted during this time period and these studies represent what was published in the field. It is beneficial to understand the research that has been conducted in order to develop new interventions that may be based on these older methods. For example, while technology such as Co:Writer may be dated, newer applications may be designed using similar principles. The results of this synthesis suggest that spelling interventions have positive effects on spelling outcomes for secondary students with disabilities, however these increases were not always practically significant. Specifically, systematic study strategies and technological assistance in interventions led to increased spelling accuracy for taught words and in written compositions. Even though there were positive effects and large or very large degrees of non-overlap as reported by Tau-U for most participants, there are still many gaps in this literature. Future research for secondary students with disabilities should examine alternative, explicit approaches to spelling instruction. as well as the impact of those approaches for different types of disabilities. Additionally, it is important to consider how spelling performance is maintained over

time, how spelling generalizes to untaught words, and how spelling interventions may relate to reading and writing achievement.

References

Bear, D. R., Invernizzi, M., Templeton, S., & Johnston, F. (2008). *Words their way: Word study for phonics, vocabulary, and spelling instruction.* Upper Saddle River: Pearson.

*Cieslar, W., McLaughlin, T. F., & Derby, K. M. (2008). Effects of the copy, cover, and compare procedure on the math and spelling performance of a high school student with behavioral disorder: A case report. *Preventing School Failure: Alternative Education for Children and Youth, 52*(4), 45-52. doi: 10.3200/PSFL.52.4.45-52

Cooper, H. (2010). *Research synthesis and meta-analysis: A step-by-step approach.* Los Angeles: Sage.

*Darrow, D., McLaughlin, T. F., Derby, K. M., Johnson, K. (2012). Using cover, copy, and compare spelling with and without timing for elementary students with behavior disorders. *International Electronic Journal of Elementary Education, 4*(2), 417-426. doi:

Ehri, L. C. (1987). Learning to read and spell words. *Journal of Reading Behavior, 19*(1), 5-31.

Ehri, L. C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics in Language Disorders, 20*(3), 19-36.

*Evmenova, A. S., Graff, H. J., Jerome, M. K., & Behrmann, M. M. (2010). Word prediction programs with phonetic spelling support: Performance comparisons and impact on journal writing for students with writing difficulties. *Learning Disabilities Research and Practice, 25*(4), 170-182. doi**:** 10.1111/j.1540-5826.2010.00315.x

Fletcher, J. M., Lyon, G. R., Fuchs, L. S., & Barnes, M. A. (2007). *Learning disabilities: From identification to intervention.* New York: Guilford Press.

Friend, A., & Olson, R. K. (2008). Phonological spelling and reading deficits in children with spelling disabilities. *Scientific Studies of Reading, 12*(1), 90-105. doi: 10.1080/10888430701773876

Graham, S. (1999). Handwriting and spelling instruction for students with learning disabilities: A review. *Learning Disability Quarterly, 22*(2), 78-98.

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. doi: 10.1177/0014402916664070

Graham, S., Fishman, E. J., Reid, R., Hebert, M. (2016). Writing characteristics of students with attention deficit hyperactivity disorder: A meta-analysis. *Learning Disabilities Research & Practice, 3*(2), 75-89. doi: 10.1111/ldrp.12099

Graham, S., Harris, K. R., & Chorzempa, B. F. (2002). Contribution of spelling instruction to the spelling, writing, and reading of poor spellers. *Educational Psychology, 94*(4), 669-686. doi: 10.1037//022-0663.94.4.669

Graham, S., Harris, K. R., & Hebert, M. (2011). It is more than just the message: Presentation effects in scoring writing. *Focus on Exceptional Children, 44*(4), 1-12.

Graham, S., Morphy, P., Harris, K. R., Fink-Chorzempa, B., Saddler, B., Moran, S., & Mason, L. (2008). Teaching spelling in the primary grades: A national survey of instructional practices and adaptations. *American Educational Research Journal 45*(3), 796-825. doi: 10.3102/0002831208319722

Graham, S., & Santangelo, T. (2014). Does spelling instruction make students better spellers, readers, and writers? A meta-analytic review. *Reading and Writing, 27*(9), 1703-1743.

doi: 10.1007/s11145-014-9517-0Gwet, K. (2001). Handbook of inter-rater reliability. Gaithersburg, MD: STATAXIS.

*Hochstetler, E., McLaughlin, T. F., Derby, K. M., & Kinney, M. (2013). The effects of cover, copy, and compare to teach spelling ot middle school students with learning disabilites and OHI. *Educational Research Quarterly, 36*(4), 25-48. Retrieved from http://erquarterly.org

Invernizzi, M., & Hayes, L. (2004). Developmental-spelling research: A systematic imperative. *Reading Research Quarterly, 39*(2), 216-218. doi: 10.1598/RRQ.39.2.4

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W.R. (2010). Single-case designs technical documentation. Available from What Works Clearinghouse website: http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M, & Shadish, W.R. (2013). Single-case intervention research design standards. *Remedial and Special Education, 34*, 26-38. doi: 10.1177/0741932512452794.

MacArthur, C. A. (1998). Word processing with speech synthesis and word prediction: Effects on the dialogue journal writing of students with learning disabilities. *Learning Disability Quarterly, 21*(2), 1-16.

MacArther, C. A. (1999). Word prediction for students with severe spelling problems. *Learning Disability Quarterly, 22*(3), 158-172.

*Manfred, A., McLaughlin, T. F., Derby, K. M., & Everson, M. (2015). The effects of a modified cover, copy, compare on spelling tests and in written compositions for three students with specific learning disabilities. *Educational Research Quarterly, 38*(3), 3-31.

*McCallum, E., Schmitt, A. J., Evans, S. N., Schaffner, K. F., & Long, K. H. (2013). An application of the taped spelling intervention to improve spelling skills. *Journal of Evidence-Based Practices for Schools, 14*(1), 51-80.

Maughan, B., Messer, J., Collishaw, S., Pickles, A., Snowling, M., Yule, W., & Rutter, M. (2009). Persistence of literacy problems: Spelling in adolescence and at mid-life. *Journal of Child Psychology and Psychiatry, 50* (8), 893-901. doi: 10.1111/j.1469-7610.2009.02079.x

*Mezei, P., & Heller, K. W. (2005). Evaluating word prediction software for students with physical disabilities. *Physical Disabilities: Education and Related Services, 23*, 93–113.

Moats, L. (2009). Knowledge foundations for reaching reading and spelling. *Reading and Writing, 22*(4), 379-399. doi: 10.1007/s11145-009-9162-1

Moeyaert, M., Maggin, D., & Verkuilen, J. (2016). Reliability, validity, and usability of data extraction programs for single-case research designs. *Behavior Modification, 40*(6), 1-27. doi: 10.1177/0145445516645763

National Dissemination Center for Children with Disabilities (NICHCY). (2012). *Category of disability under IDEA.* Retrieved from http://nichcy.org

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards for English language arts & literacy in history/social studies, science, and technical subjects.* Retrieved from http://www.corestandards.org/

Noell, G. H., Connell, J. E., Duhon, G. J. (2006). Spontaneous response generalization during whole word instruction: Reading to spell and spelling to read. *Behavioral Education, 15*(3), 121-130. doi: 10.1007/s10864-006-9016-8

Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011). Combining nonoverlap and trend for single-case research: Tau-U. *Behavior Therapy, 42*, 284-299.

*Purrazzella, K., & Mechling, K. (2013). Evaluation of manual spelling, observational and incidental learning using computer-based instruction with a tablet PC, large screen projection, and a forward chaining procedure. *Education and Training in Autism and Developmental Disabilities, 48*(2), 218-235.

Pustejovsky, J. E. (2017). Single-case effect size calculator (Version 0.2) [Web application]. Retrieved from https://jepusto.shinyapps.io/SCD-effect-sizes/

Rohatgi, A. (2015). WebPlotDigitizer (Version 3.9) [Web application]. Austin, TX: Rohatgi.

Romani, C., Olson, A., & Di Betta, A. M. (2005). Spelling disorders. In M. Snowling & C. Hulme (Eds.), *The science of reading: A handbook (pp.431-447). Malden, MA: Blackwell.*

Rothstein, H. R., & Hopewell, S. (2009). Grey literature. In C. Harris, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis (pp. 103-125). New York, NY: Sage.*

Santoro, 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 and Practice, 21*(2), 122-133. doi: 10.1111/j.1540-5826.2006.00212.x

Sayeski, K. L. (2011). Effective spelling instruction for students with learning disabilities. *Intervention in School and Clinic, 47*(2), 75-81. doi: 10.1177/1053451211414191

Schlagal, B. (2002). Classroom spelling instruction: History, research, and practice. *Reading Research and Instruction, 42*(1), 44-57.

*Schlosser, R. W.,, & Blischak, D. M. (2004). Effects of speech and print feedback on spelling by children with autism. *Journal of Speech, Language, and Hearing Research, 47*, 848-862. doi:10.1044/1092-4388(2004/063)

Shadish, W. R., Zeilinsky, N. A. M., Vevea, J. L., & Kratochwill, T. R. (2016). A survey of publication practices of single-case design researchers when treatments have small or large effects. *Journal of Applied Behavior Analysis, 49*(3), 656-673.

Simonsen, F., & Gunter, L. (2001). Best practices in spelling instruction: A research summary. *Journal of Direct Instruction, 1*(2), 97-105.

Templeton, S. (2002). Teaching of Spelling. In J. W. Guthrie (Ed.), *Encyclopedia of Education* (2nd ed., Vol. 6, pp. 2302-2305). New York: Macmillan Reference USA.

Templeton, S., & Morris, D. (2000). Spelling. In M. Kamil, P. Mosenthal, P. Pearson, & R. Barr (Eds.), *Handbook of reading research: Volume 3* (pp. 525-543). Mahwah: Lawrence Erlbaum Associates.

*Tumlin, J., & Heller, K. W. (2004). Using word prediction software to increase typing fluency with students with physical disabilities. *Journal of Special Education Technology, 19*(3), 5-14.

U.S. Department of Education, National Center for Education Statistics. (2015). *Digest of Education Statistics, 2013* (NCES 2014-015). Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2015011

Vannest, K. J., & Ninci, J. (2015). Evaluating intervention effects in single-case research designs. *Journal of Counseling & Development, 93*(4), 403-411. doi: 10.1002/jcad.12038

Vaughn, S., Elbaum, B. E., Wanzek, J., Scammacca, N., & Walker, M. A. (2014). *Code sheet and guide for education-related intervention study syntheses*. Austin, TX: The Meadows Center for Preventing Educational Risk.

*Vedora, J., & Stromer, R. (2007). Computer-based spelling instruction for students with developmental disabilities. *Research in Developmental Disabilities, 28,* 489-505. doi:10.1016/j.ridd.2006.06.006

*Viel-Ruma, K., Houchins, D., & Fredrick, L. (2007). Error self-correction and spelling: Improving accuracy of secondary students with disabilities in written expression. *Journal of Behavioral Education, 16,* 291-301. doi: 10.1007/s10864-007-9041-2

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. doi: 10.1177/00222194060390060501

Weiser, B., & Mathes, P. (2011). Using encoding instruction to improve the reading and spelling performances of elementary students at risk for literacy difficulties: A best evidence synthesis. *Review of Educational Research, 81*(2), 170-200. doi: 10.3102/0034654310396719

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 students with learning disabilities. *Journal of Learning Disabilities, 50*(3), 286-297. doi: 10.1177/0022219415619753

*Zielinski, K., McLaughlin, T. F., & Derby, K. M. (2012). The effect of "cover, copy and compare" on the spelling accuracy of high school students with learning disabilities. *American Secondary Education, 41*(1), 78-95. Retrieved from https://www.ashland.edu

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