The Role of Flowcharts for Improving Spelling Outcomes for Students with Learning Disabilities

Dissertation

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By

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Abstract

The purpose of this dissertation is to evaluate the effectiveness of graphic organizers, specifically flowcharts, as a tool to support decision-making during spelling for students identified with learning disabilities. This dissertation is composed of five chapters. The first chapter is an introduction about how graphic organizers support students with executive functioning difficulties, a common challenge for students with learning disabilities. The second chapter is a systematic literature review analyzing the current literature about the effects of reading, writing, and spelling interventions for students with learning disabilities. The third chapter is a research study that used single-case research methodology to evaluate the effectiveness of a spelling flowchart on outcomes for students with learning disabilities. The fourth chapter is a practitioner paper that provides educators with strategies for using flowcharts and multiple exemplars for incorporating them as decision-making tools in the classroom. Finally, the fifth chapter details my future career goals and research aims.

Dedication

This dissertation is dedicated to my students. Thank you for trusting, teaching, and inspiring me. I am honored to be a part of your journey.

Also, I would like to dedicate this dissertation to my unwavering support system. Thank you to my husband, Drew, for always believing in and loving me every step of the way. To my mom, thank you for always encouraging me to read, think, and for cultivating my love of learning. To all my wonderful family, thank you for your support and caring. Specifically, I want to thank Jason, Cindy, Jim, Janet, and John. I love you all dearly!

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Publications

Alber-Morgan, S.R., Konrad, M., Harris, A.B., Sulaimon, S., Telesman, A.O., & Helton, M. (2022). Adapt Curriculum Tasks and Materials for Specific Learning Goals. In J. McLeskey, L. Maheady, B. Billingsley, M.T. Brownell, & T.J. Lewis (Eds.), *High Leverage Practices for Inclusive Classrooms* (2nd ed., pp. 189–200). Routledge.

Criss, C.J., Konrad, M., Alber-Morgan, S.R., Brock, M.E., & Harris, A.B. (under review) *Comparative Effects of Using Performance Feedback with and without Goal Setting on Teachers' Classroom Management Skills*.

Sulaimon, T., Harris, A.B., Alber-Morgan, S.R., & Konrad, M. (Submitted*)*. (under review) *The Effects of Technologically Mediated Strategy Instruction on Comprehension of Students with Reading Fluency Deficit*.

Harris, A.B., Konrad, M., & Shawbitz, K.N. (under review) *A Spelling Flow Chart Intervention for Students with Disabilities: A Pilot Study.*

Fields of Study

Major Field: Education Studies

Area of Emphasis: Special Education and Applied Behavior Analysis

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Chapter 1. Introduction

Students with learning disabilities often have poor postsecondary outcomes (Konrad et al., 2007; Wagner, 2005); they tend to experience challenges with successfully attaining employment, actively engaging in their communities, and maintaining daily living routines (Gerber, 2012). Approximately 32.7% of students with learning disabilities attended postsecondary schools, which is much lower than their same-aged peers who are not identified with learning disabilities (i.e., 61.8%; Wagner et al., 2005).

Although there are many contributing factors, ineffective instruction is likely a significant indicator of poor outcomes for students with learning disabilities. Federal law mandates that educators provide effective, evidence-based instruction combined with appropriate adaptations and supports for students with disabilities to access the curriculum (Alber-Morgan et al., 2022; IDEIA, 2004). Unfortunately, educators report that inadequate resources, specifically insufficient time and materials, limit their ability to provide this effective instruction to students with disabilities (Lubin & Fernal, 2022). Although ineffective instruction is partially to blame, these deficits in underlying skills also impact academic outcomes for these students (Pressley & Harris, 2009). To optimize instructional impact, educators must target these underlying learning processes to support students in academic areas.

Executive Functioning for Students with Disabilities

Academic performance is impacted by a student's executive functioning (Best et al., 2009). Executive functions are a set of underlying processes and interrelated skills that support goal-directed behavior, such as completion of a long-term project (Anderson, 2008). Specifically, executive functioning encompasses a student's ability to plan, set goals, organize, prioritize, memorize, shift, and self-monitor (Meltzer & Krishnan, 2007). Students with disabilities often exhibit executive functioning deficits, and these deficiencies affect academic output and performance (Rosen et al., 2014). Students with executive functioning deficits particularly struggle with complex academic tasks (e.g., reading comprehension, writing summaries, multi-step math word problems) that require students to sort, organize, and prioritize important components of the task or problem-solving activity (Meltzer & Krishnan, 2007). Fortunately, systematic instruction on executive functioning skills improves student outcomes (Meltzer et al., 2021).

Systematic instruction requires educators to break down a larger skill into an organized sequence of subskills (Archer & Hughes, 2011). Smith and colleagues (2016) detailed the following as necessary components of systematic instruction: (a) succinct language, (b) connecting with prior knowledge, (c) scaffolding so students are able to identify important connections, (d) recursive review, (e) adequate rehearsal and practice time, (f) feedback on misunderstanding during acquisition of new content, and (g) visual supports to simplify content and to reduce language and verbal processing requirements. Several components of this systematic instruction are embedded in graphic organizers (Ewoldt & Morgan, 2017).

Graphic Organizers

One executive function, working memory, can operate more efficiently when the learning process is visible and easily observable (Smith et al., 2016). Graphic organizers are highly adaptable visual tools that can be used in a myriad of ways in classrooms with diverse populations of students. Educators can use graphic organizers when planning and implementing instruction (Dye, 2000), and research has demonstrated graphic organizer efficacy for students with a variety of disabilities (Boon et al., 2018; Spooner et al., 2019). Further, when taught in inclusive settings, these tools also benefit students without disabilities (Regan et al., 2017).

Educators can customize the structure and type of graphic organizer to optimize for their intended use. In a meta-analysis about their usage for students with learning disabilities, Dexter and Hughes (2010) outlined the following as frequently employed types of graphic organizers: (a) cognitive mapping; (b) semantic mapping; (c) semantic feature analysis; (d) syntactic/semantic feature analysis; and (e) visual display. Certain structures lend themselves to specific kinds of academic tasks. For example, cognitive mapping can help students understand complex relationships and organize ideas (Alber-Morgan et al., 2022; Baxendal, 2003; Dexter & Hughes, 2010). Each of these graphic organizer types can be constructed or created in a variety of ways, be it fully student-generated, teacher-provided, teacher-led, or a hybrid implementation where the teacher provides the structure with spaces for students to complete (Gonzalez-Ledo et al., 2015; Kim et al., 2004). With these implementation and structural options, practitioners can adapt and tailor a graphic organizer to their students' level of independence. The flexibility of graphic organizer types and options of support when implementing enable teachers to create the exact visual organizer for a specific task with the level of support their students need.

Given the adaptability of structure and implementation, it is unsurprising that graphic organizers lead to improved student outcomes in a variety of academic areas (O'Connor et al., 2017). Graphic organizers are effective tools for planning and organizing during the writing process (Evmenova et al., 2020; Gonzalez-Ledo et al., 2015). Literature reviews analyzing math and reading interventions determined that outcomes for students with disabilities consistently improved when interventions incorporated graphic organizers (Nylund, 2008; Sargent, 2020). Cuillo and Reutebuch's (2013) literature review documented the positive effects of technology-based graphic organizers for written expression and content knowledge outcomes. Further, graphic organizers can support instruction beyond core academic content areas. Visual displays can aid social-emotional learning and help reduce disruptive behavior (McDaniel & Flower, 2015; Rock, 2004).

Scholars have identified several strategies for implementing graphic organizers effectively. When introducing these tools, educators should explicitly teach the structure of the graphic organizer, how to use it, and give multiple opportunities to practice using the tool with feedback (Ciullo & Reutebuch, 2013; Knight et al., 2013). Practitioners should select the type and implementation approach based on the demand of the academic task and their students' specific needs.

Dissertation Purpose and Preview of Chapters

The purpose of this dissertation is to evaluate the effectiveness of a graphic organizer, specifically a flowchart, as a tool to support decision-making when spelling for students with disabilities. I will analyze and discuss the effectiveness and promise of the flowcharts on multiple spelling outcomes in the remaining four chapters of this dissertation.

Chapter 2

I present findings from a systematic literature review about spelling outcomes for students with learning disabilities following reading, writing, and spelling interventions.

Chapter 3

I present findings from a single-case research study that used a multiple probe across behaviors design to examine the effects of the flowchart intervention on spelling outcomes for students identified with learning disabilities.

Chapter 4

I provide a guide for educators to create and use flowcharts in their practice. I articulate considerations for creating flowcharts and multiple uses for using flowcharts in the classroom with examples.

Chapter 5

I conclude this dissertation with a discussion of my experience with research, my career goals, and potential research agenda.

Terminology

The below terms are discussed throughout the next four chapters. This list of definitions can serve as a reference.

- Orthography: patterns of phonological and graphic representations of language
- Graphotactic regularities: frequently used legal combinations of letters (Deacon et al., 2008)
- Graphotactic context: graphemes relation to those around them (Treiman & Wolter, 2018)
- Sublexical: relating to parts of a word such as phonemes or sequences of phonemes (Vitevitch, 2003)
- Lexical: relating to the whole word as a unit (Vitevitch, 2003)
- Phoneme: smallest unit of sound in a language
- Grapheme: letter or letters that represent a phoneme

Chapter 2. Literature Review

The following chapter details the current, published literature detailing spelling outcomes for students with learning disabilities after receiving reading, writing, or spelling interventions.

Abstract

For students with disabilities, spelling is a challenging academic task further complicated by the complexities of the English orthography. In this updated review of the literature, I explore the effects of spelling, writing, and reading interventions on spelling outcomes for school age children with learning disabilities (LD). Since 2014, seven studies implemented interventions germane to this purpose. I summarized study characteristics and analyzed quality using Council for Exceptional Children's (CEC) *Standards for Evidence-Based Practices in Special Education*. Spelling outcomes improved in most studies, and effects ranged from inconclusive to highly effective for improving spelling outcomes. Implications for practice, limitations and avenues for future research are discussed.

Keywords: spelling, learning disabilities, quality indicators

The Effects of Spelling, Writing, and Reading Interventions on Spelling Outcomes for Students with Learning Disabilities: A Systematic Review

Approximately 2,346,000 school-aged children in United States public schools receive special education services for a learning disability (LD; US Department of Education, 2022), which is "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell or to do mathematical calculations" (IDEIA, 2004). In a study evaluating how learning disabilities manifest for students receiving services for "specific learning disabilities" (SLD), Bonti and colleagues (2021) found that 81% of these students demonstrated difficulties in spelling. Students with LD produce more spelling errors than their peers without disabilities (Graham et al., 2017), which affects how teachers, peers, and potential employers perceive these students' writing capabilities and overall intelligence (Graham & Harris, 2006; Pan et al., 2021).

The task of spelling for students with LD is further complicated by complexities in the English orthography (i.e., patterns of phonological and graphic representations of language), which has many irregularities and inconsistencies (Borleffs et al., 2017; Seymour et al., 2003). Although the English orthography appears irregular, research by Hanna and colleagues (1966) analyzing more than 12,000 phonemes (units of sound) found that the phonemes were spelled with predictable and consistent patterns. Moreover, approximately 84% of English spelling is predictable when word origin, meaning, part of speech, and sound structure within the word are taken into account (Hanna et al., 1966;

Moats, 2005). Spelling instruction on these regularities supports students with LD in multiple literacy domains.

Spelling and reading are concomitant tasks with overlapping processes. Fortunately, spelling instruction can benefits students' resulting reading and writing performance (Moats, 2005; Santoro et al., 2006). When students build foundational literacy skills like identifying sounds in words and connecting those sounds with the orthographic letter representations, their spelling improves (Berninger et al., 2002; Graham & Santangelo, 2014). Additionally, students' reading rates improve when they create more accurate orthographic representations (Martin-Chang & Madden, 2014). Students' orthographic knowledge and resulting spelling improves when they receive targeted instruction on whole word (lexical) and grapheme-phoneme relationships (sublexical; Sayeski, 2011).

Authors of past reviews and meta-analyses have identified several approaches that improve spelling outcomes for students with LD. Self-study spelling practice interventions, such as copy-cover-compare (CCC), are primarily independent tasks which involve students managing and correcting their errors. Students increase spelling outcomes with these self-study interventions (Hochstetler et al., 2013; Zielinski et al., 2012), particularly when given multiple practice opportunities for words (Joseph et al., 2012). Students' spelling performance increases when they receive immediate feedback on spelling errors and complete an error correction procedure (Alber & Walshe, 2004; Barbetta et al., 1994; Morton et al., 1998; Nies & Belfiore, 2006).

Students with LD also benefit from explicit spelling instruction. Specifically, spelling outcomes improve with systematic, explicit, rule-based phonics and morphology instruction (Galuschka et al., 2020; Graham & Santangelo, 2014; Williams et al., 2017; Wanzek et al., 2006). Explicit instruction interventions often incorporate other evidence-based practices (EBPs) such as providing multiple opportunities to respond and immediate feedback (Darch et al., 2006; Jitendra et al., 2004; Owens et al., 2004).

The most recent reviews about spelling outcomes for students with LD were completed in 2006 (Wanzek et al., 2006) and in 2017 (Williams et al., 2017) analyzing 8 and 10 years of published research, respectively. Wanzek and colleagues (2006) found positive effects for interventions with independent student practice although larger improvements were associated with explicit instruction interventions that incorporated multiple opportunities to practice and immediate corrective feedback. Williams and coauthors (2017) also found improved outcomes following explicit instruction interventions with these components. Although the most recent synthesis did not evaluate study quality, Wanzek and colleagues (2006) briefly analyzed study quality using What Works Clearinghouse standards (Institute of Educational Sciences, 2003) and found that none of the 19 studies included all best evidence criteria.

In this paper, I conducted an updated review of the literature to examine spelling outcomes for students with LD. I explored how multiple types of interventions (i.e., spelling, writing, and reading) affected spelling outcomes. Further, I examined study quality using the Council for Exceptional Children's (CEC) *Standards for Evidence-*

Based Practices in Special Education (Cook et al., 2014b). Specifically, I addressed the following questions:

1. What are the effects of spelling, writing, and reading interventions on spelling outcomes for students with LD in kindergarten through 12th grade?
2. What are the characteristics of these interventions and do any of these characteristics moderate effects?
3. How did the identified studies meet CEC's quality indicators (QIs) for evidence-based practices?

Method

I supplemented inclusion criteria and search procedures from two prior reviews about spelling outcomes for students with learning disabilities (i.e., Wanzek et al., 2006; Williams et al., 2017).

Inclusion and Exclusion Criteria

My goal was to identify all relevant studies since 2014, so I broadened inclusion criteria from subsequent reviews to include additional experimental designs and non-peer-reviewed dissertations and theses. Studies had to meet all of the following criteria to be included in this review:

1. Authors employed a single-case research design, RCT, treatment-comparison design, or group design without a comparison/control group.
2. Participants were in grades PreK-12.

3. Participants were identified with a learning disability (e.g., SLD, dyslexia, dysgraphia, dyscalculia); if not all participants had LD, data for students with LD could be disaggregated.
4. A reading, writing, and/or spelling intervention was implemented.
5. One of the dependent variables measured was a spelling outcome.
6. The intervention was implemented in English with the goal of teaching English spelling to students who primary language was English.

Studies were excluded for any of the following reasons: (a) a non-experimental design (e.g., case study) was employed; (b) participants were not diagnosed with LD, (c) spelling was not specifically measured even if it was incorporated into a measure (e.g., conventions measure or correct word sequences); (d) the intervention was for students learning English as a foreign or secondary language; or (e) the study was not written in English.

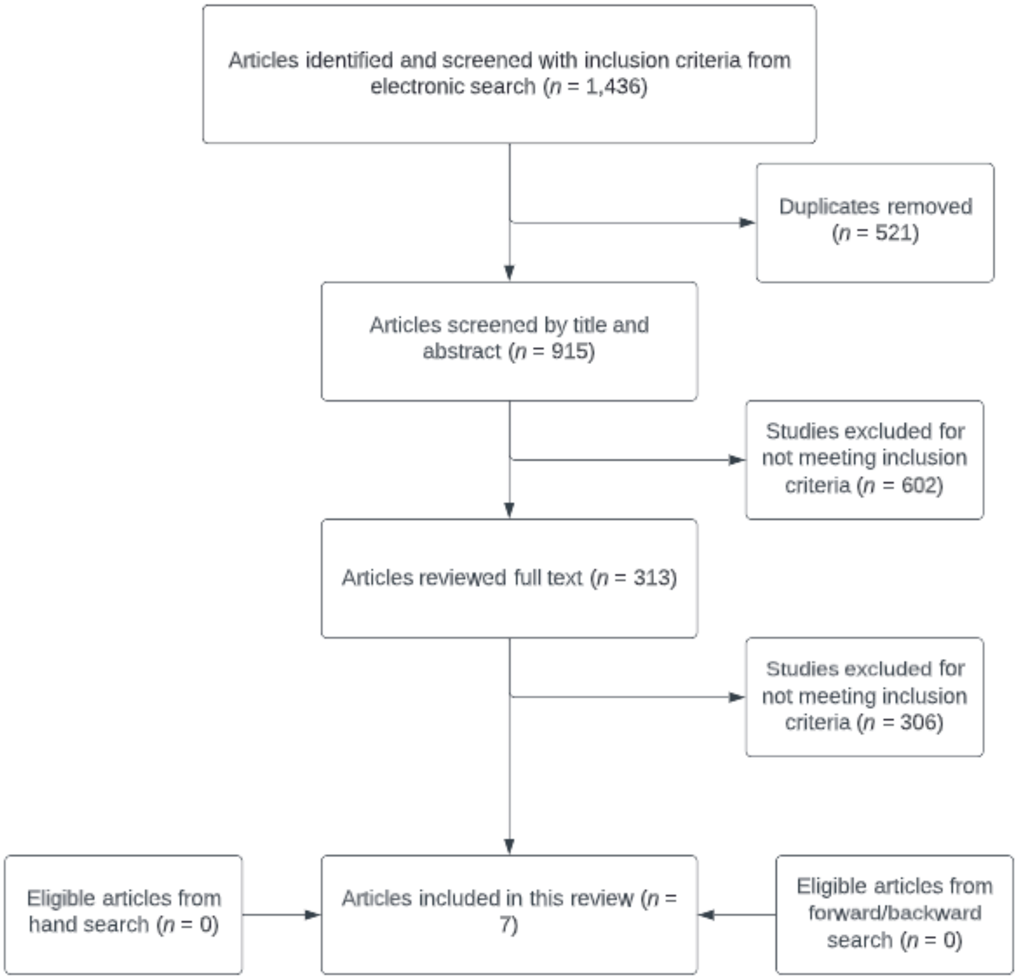
Search Strategy

I conducted a comprehensive review of the literature to identify pertinent studies. First, I conducted a computer search of the same databases that Williams and colleagues (2017) searched: APA PsycINFO, Educational Research Complete, and ERIC. I additionally searched both the Psychology and Behavioral Sciences Collection and the Social Sciences Abstracts databases. I selected three main search terms to select all reading, writing, and spelling studies (“read*” OR “spell*” OR “writ*”). To capture literature about the target population, I included “learning dis*” or “LD” or “mild handicap*” or “reading dis*” or “writing dis*” or “dyslex*” “SLD” or “dys*”. To ensure the literature was experimental in nature, the search included the following: experiment* OR evalut* OR "single-case design" OR "single-subject design" OR "multiple baseline" OR "multiple probe" OR multielement OR multi-element OR "alternating treatment" OR reversal OR withdrawal OR "repeated acquisition" OR changing criterion OR "randomized control trial" OR "randomized controlled trial. This search yielded 915 unique hits (see Figure 1).

After the computer search, I completed a hand search of the major journals. I explored the same journals as the two subsequent reviews: *Exceptional Children*, *Journal of Educational Psychology*, *Journal of Learning Disabilities*, *The Journal of Special Education, Learning Disability Quarterly*, *Learning Disabilities Research & Practice*, *Reading Research Quarterly*, *Remedial and Special Education*, and *Scientific Studies of Reading*. I examined the timeframe from 2014 to 2022 for the computer and hand search as the most recent review examined literature before 2014. I did not identify any studies through the hand search.

Following the computer and hand searches, I completed a forward and backward search of studies that met inclusion criteria. This resulted in no additional studies. Results of the computer, hand, backward, and forward searches and screening process are detailed in Figure 1.

Figure 1. Flow of Search Procedures



Coding Procedures

I coded study characteristics and applied the 2014 CEC Standards for EBPs to all included studies (Cook et al., 2014b). I selected these standards because they are commonly used and accepted in the field of special education to determine EBPs for students with disabilities. To better understand characteristics of interventions that effectively improved spelling outcomes, I coded 48 variables examining aspects about each study's research method, experimental design, intervention, and measures. Relative to the method and intervention, I coded characteristics of the participants, intervention package, instructional features, setting, interventionist, group size, mode, duration, and dosage. When cataloging study measures, I indexed all data collection procedures and results of spelling outcomes, treatment integrity, IOA, maintenance and generalization assessments.

After surveying these study characteristics, I examined studies for methodological quality indicators from the CEC (Cook et al., 2014b). Assessing quality of studies enables researchers to examine the evidence supporting an instructional method. The CEC QI standards consist of the following eight standards: context and setting, participants, intervention agent, description of practice, implementation fidelity, internal validity, outcome measures, data analysis. These quality indicators pertain only to single-case research and group comparison studies; as such, I did not apply these standards to studies without eligible designs. I evaluated 22 elements for single-case designs and 24 elements for group designs. I referenced Cook and colleagues (2014a) when determining if a study met specific standards.

Study Effects

I summarize study effects by type of research design, specifically using success estimates for single-case studies and effect sizes for group designs. I evaluated study effects only for participants with LD, I conducted visual analysis of the graphs in single-case research studies to examine trend, level, variability, and immediacy of effect within and across phases to create success estimates for the interventions (Gast & Ledford, 2014). I divided the number of successful effect demonstrations by the number of opportunities to demonstrate effect (Reichow & Volkmar, 2010). My reported success estimates are based on my interpretation of the single-case graphs, so readers are encouraged to conduct their own visual analysis on articles included in this review. For the group designs, I reported effect sizes using Cohen's *d* when possible.

Coding Interobserver Agreement (IOA)

One doctoral student was trained with a detailed coding manual, instruction to use the manual, modeling, rehearsal, and feedback to screen and code variables. Point-by-point agreement was calculated. Overall screening agreement was 92.1% and variable coding was 89.4%. When there was a disagreement, I stuck with the first author determination.

Results

Seven studies met inclusion criteria for this literature review. Five studies implemented single-case designs. Table 1 describes summaries of the interventions, and Table 2 summarizes intervention conditions, research designs, spell outcomes measured, and findings. Two group designs were identified that used pre/posttest scores to analyze treatment effectiveness. One of these group designs evaluated pre/posttest scores within subjects (Wright et al., 2015) and the other study compared pre/posttests of the control and treatment groups (Brimo, 2016). Although I identified seven studies in the literature, I excluded Wright and colleagues' (2015) study when discussing how intervention characteristics moderated study effects for reasons articulated below (see Study Design and Experimental Effects section). The remaining six study findings are described by (a) participant characteristics, (b) study design and experimental effects, (c) intervention type, (d) instructional features, (e) setting, (f) implementer and group size, (g) dosage and duration, (h) spelling outcomes, (i) maintenance and generalization measures, and (j) social validity and fidelity measures. I evaluated the studies to determine the extent to which they met CEC's QIs (see Table 3).

Table 1. Overview of Studies

Study	Intervention Type	*N*, grade, age	Implementer(s)	Duration, Dosage
Aguirre & Rehfeldt (2015)	Spelling	*N* = 3 Grade: NR Age: 17–18y	Experimenter (RT)	3–20m, 3-5 days weekly Sessions: 15 Total: 45–300m
Brimo (2016)	Reading and spelling	*N* = 10 Grade: 3rd Age:9–10y	2 trained graduate students (RT)	25.19m, 3 days weekly Sessions: 30 Total: 756m
Curcic & Platt (2019)	Writing	*N* = 3 Grade: 3rd Age: 9.6–10.7y	First author (RT)	30m, 3 days weekly Sessions: 24 Total: 720m
Engel (2022)*	Spelling	*N* = 3 Grade: 4th Age:9–10y	2 special education teachers 2 paraeducators	15m, 3 days weekly Sessions: 30 Total: 450m
McCallum. Schmitt, Evans, Schaffner, & Long (2014)	Spelling	*N* = 4 Grade: 6th Age: NR	Experimenter (RT)	NR Sessions: 18 Total: NR
Wright, Mitchell, O'Donoghue, Cowhey, and Kearney (2015)	Reading	*N* = 28 Grade: NR Age:12–14	2 graduate students (RT)	60m, twice weekly Sessions: 8 Total: 480m
Zannikos (2015)*	Spelling	*N* = 4 Grade: 5th Age: 10–11y	Special education supervisor with certification in school psychology (RT)	11.45m, daily Sessions: 15 Total: 172m

Note. *=dissertation, NR = not reported, , y = years, RT = member of the research team, m = minutes

Participant Characteristics

I report results and analyses are included for the 24 participants who were identified with LD in these studies. Four studies included information about how disabilities were determined. Curcic and Platt (2019) reported one student was identified with the IQ discrepancy model and two students were identified through the response to intervention process. Three studies reported diagnoses from school records (Brimo, 2016; Wright et al., 2015; Zannikos, 2015) but did not describe specific identification criteria or procedures. The remaining studies did not report status determination information (Aguirre & Rehfeldt, 2015; Engel, 2022; McCallum et al., 2014).

All studies described participant gender, with 8 females (33.3%) and 16 males (66.7%). Most of the students were in upper elementary or middle school. There were 12 third graders (Brimo, 2016; Curcic & Platt, 2019), 3 fourth graders (Engel, 2022), 4 fifth graders (Zannikos, 2015), and 2 sixth graders (McCallum et al., 2014). Two studies reported age instead of grade. The participant relevant to this review in the study by Wright and colleagues (2015) was aged 12 years and 2 months. Aguirre and Rehfeldt (2015) conducted the only study to work with high school students, and the one participant identified with LD was 17 years old. Of the studies reviewed, only three included race or ethnicity information for participants (Curcic & Platt, 2019; McCallum et al., 2014; Zannikos, 2015). Five students were described as African American and three students were White.

Study Design

I identified five studies that used single-case designs and two group designs for review. I did not locate any randomized control trials.

Table 2. Summary of Interventions with Findings

Study, Intervention Conditions	Research Design	Spelling Outcomes Measured	Findings*	SE
Aguirre & Rehfeldt (2015) • B: Students were prompted to spell a practice word and complete a 30 probe trial • Control Post (CP): Students were presented textual target stimuli only prior to spelling each word on probe • Visual Imagining Instruction (VII): Students were presented textual target stimuli and told to imagine seeing the word prior to spelling each word on probe • Visual Imagining Instruction + Consequences (VIIC): same as visual imagining condition with the addition of immediate feedback and an error correction procedure	Multiple probe across participants	% of correct written spelling responses on 30-word probes	B: 10-14 CP: 20-26 VII: 36-50 VIIC: 100	1/1
Brimo (2016) • Control group: students received reading-based instruction, completed computer activity, and worksheet • Treatment group: 15 lessons which targeted a single affix or reviewed all learned affixes with listening, sorting, saying, identifying, and writing activities	Quasi-experimental	Spelling multimorphemic words task	$d = 0.28$	N/A

Note. *=dissertation, SE = success estimate, B = baseline, N/A = not applicable, I = Intervention; M = maintenance, P = participant; L = list

Table 2. continued

Study, Intervention Conditions	Research Design	Spelling Outcomes Measured		Findings*	SE
Curcic & Platt (2019) • B: students wrote summary without instruction or support • I: explicit instruction on POWER strategy, text summarization using *Dragon Dictation* app, summarizations recorded on iPads, revised drafts on computer with instructor support • M: return to baseline conditions	Multiple baseline across participants	Words spelled correctly in written summaries	 P1 P2 P3	PND = 100.0% B: 2-9 I: 12-73 M: 30-57 B: 13-28 I: 30-68 M: 54-72 B: 8-12 I: 15-41 M: 30-52	3/3
Engel (2022)* • I1: copy-cover-compare with spaced practice • I2: copy-cover-compare with massed practice	Alternating treatment	Words spelled correctly on 6-word probes	 P1 P2 P3	Posttest Retention I1: 0-6 I1: 0-3 I2: 0-2 I2: 1-3 I1: 1-4 I1: 1-3 I2: 0-2 I2: 1-3 I1: 4-6 I1: 4-6 I2: 3-6 I2: 2-6	N/A
		Change in percent of correct letter sequences (%) on 6-word probes	P1 P2 P3	I1: -23-70 I1: -6-43 I2: 3-47 I2: 13-53 I1: 3-43 I1: 10-37 I2: -10-36 I2: -7-36 I1: 20-57 I1: 24-57 I2: -11-34 I2: 7-40	

Note. *=dissertation, SE = success estimate, B = baseline, N/A = not applicable, I = Intervention; M = maintenance, P = participant; L = list

Table 2. continued

Study, Intervention Conditions	Research Design	Spelling Outcomes Measured		Findings*			SE
McCallum. Schmitt, Evans, Schaffner, & Long (2014) • B: students completed the spelling probe without instruction or feedback • I: students were taught taped spelling intervention procedures, then were given an mp3 which read aloud each word on the probe, paused for the student to spell, read the correct spelling for the student to correct their work • M: return to baseline conditions	Multiple probe across word lists	Total words correct on 10-word spelling probe		L1	L2	L3	1/1
			P1	B: 0	2	0–3	
				I: 1–5	4	5–7	
				M: 1–4	2–4	6–7	
			P2	B: 0–1	1–2	1–3	
				I: 1–2	1–4	2–4	
				M: 0–2	1–3	3	
		Correct letter sequences on 10-word spelling probe	P1	B: 37–41	48–52	51–62	
				I: 48–73	63–69	59–72	
				M:52–66	54–67	65–74	
			P2	B: 41–43	44–50	54–62	
				I: 49–58	48–64	60–72	
				M: 49–54	51–61	62–64	
Wright, Mitchell, O'Donoghue, Cowhey, and Kearney (2015) • T: explicit instruction about reading comprehension strategies followed by group discussion, homework activities to apply strategies	Pre/posttest within subjects comparison	% correct of 30-word list		Pretest: 48.0% Posttest: 48.0%			N/A

Note. *=dissertation, SE = success estimate, B = baseline, N/A = not applicable, I = Intervention; M = maintenance, P = participant; L = list

Table 2. continued

Study, Intervention Conditions	Research Design	Spelling Outcomes Measured	Findings*		SE
Zannikos (2015)* • B: students completed 30-word probe without instruction or feedback • I1: copy-cover-compare practice of probe words • I2: taped spelling intervention practice of probe words M: return to baseline conditions	Alternating treatment	Total words correct on 10-word spelling probe (mean for each phase)	P1	B: 0.0 I1: 7.0 I2: 7.5 M: 9.5	
			P2	B: 1.5 I1: 7.4 I2: 4.6 M: 6.5	
			P3	B: 0.5 I1: 2.1 I2: 2.1 M: 6.4	
			P4	B: 0.0 I1: 6.0 I2: 3.6 M: 5.0	

Note. *=dissertation, SE = success estimate, B = baseline, N/A = not applicable, I = Intervention; M = maintenance, P = participant; L = list

Table 2. continued

Study, Intervention Conditions	Research Design	Spelling Outcomes Measured		Findings*	SE
Zannikos (2015)* (continued)		Correct letter sequences on 10-word spelling probe (mean for each phase)	P1	B: 26.0 I1: 59.5 I2: 64.0 M: 73.5	8/8
			P2	B: 42.0 I1: 64.4 I2: 55.1 M: 63.5	
			P3	B: 32.0 I1: 30.6 I2: 28.4 M: 59.5	
			P4	B: 6.5 I1: 57.0 I2: 49.0 M: 44.0	

Note. *=dissertation, SE = success estimate, B = baseline, N/A = not applicable, I = Intervention; M = maintenance, P = participant; L = list

Single-Case Design

Five studies employed a single-case research design. Two studies determined a functional relation through a multiple probe design (Aguirre & Rehfeldt, 2015; McCallum et al. 2014), and one study used a multiple baseline design (Curcic & Platt, 2019). Aguirre and Rehfeldt (2015) employed multiple probe across participants to analyze the effects of an intervention on the percent of correct written spelling responses on 30-word probes. McCallum and colleagues (2014) explored the effects of a taped spelling intervention (TSI) on total words correct and correct letter sequences using a multiple probe across word lists. Curcic and Platt (2019) examined effects from a treatment package on words spelled correctly in written summaries with a multiple baseline across participants.

The remaining two studies used alternating treatment designs to explore intervention effects. Zannikos (2015) compared the effects for CCC and TSI using an alternating treatment design for four students diagnosed with LD. Engel (2022) implemented an alternating treatment design comparing the effects of spaced and massed practice on the number of words spelled correctly and percent change of correct letter sequences.

Group Studies

Two studies examined pre/posttest scores to evaluate the efficacy of their interventions. One quasi-experimental study employed a non-randomized control group that was matched to the experimental group by test scores (Brimo, 2016). One group study did not include a control group, instead examining effects by comparing pre/posttest scores within subjects (Wright et al., 2015).

Study Design and Experimental Effects

Most studies had positive effects on spelling outcomes, although effects differed from inconclusive to highly effective. I reported effects based on the type of study design. For studies that implemented a single-case research design, I created success estimates based on level, trend, variability, and immediacy of effect (Gast & Ledford, 2014). Additionally, I classified single-case designs as having positive, negative, or mixed/neutral effects based on presence and direction of a function relation (Cook et al., 2014b).

Two studies used group designs (Brimo, 2016; Wright et al., 2015). All participants in Brimo's (2016) study had LD, so I was able to report effect size using Cohen's *d*. Wright and colleagues' (2015) study included one participant with LD, so I reported all data for this student.

Success Estimates

I calculated success estimates for all studies with baseline data (Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019; McCallum et al., 2014; Zannikos, 2015), and positive effects were demonstrated a total of 29 times (91%) across the eight participants in these four studies. This estimate suggests that the four interventions were effective and visual analysis provides additional insight.

Two studies, a multiple baseline across participants (Curcic & Platt, 2019) and a multiple probe across participants (Aguirre & Rehfeldt, 2015), were highly successful with positive effects for students with LD demonstrated 4 times (100%). In Curcic and Platt (2019), all three participants demonstrated immediate increases with introduction of the intervention and maintained high levels with no overlap between baseline and intervention data for any of the participants. When examining the effects of an interventions that is implemented in successive stages, researchers can compare baseline scores to scores when the full treatment package is implemented (Ennis & Losinski, 2019). I applied this strategy for Aguirre and Rehfeldt's (2015) study. The participant with LD in Aguirre and Rehfeldt (2015) increased her percentage of correctly written spelling responses, improved immediately with each iteration of the intervention, never dropping into the ranges of previous phases.

Results from McCallum and coauthors (2014) indicated the intervention had mixed effects for the two participants with LD. Although the authors reported a functional relation with positive effects for both students, I observed a functional relation with positive effects for one participant and mixed effects that were questionably meaningful for the other participant. Effects of the Taped Spelling Intervention (TSI) for these students were demonstrated 9 times (75%) across all spelling outcomes. Although the first participant visibly improved, the second participant's intervention data overlap and remain at relatively similar levels with baseline data. The y-axis on the graphs of correct letter sequences start at 30, so the visual difference between levels is larger than it would be if the y-axis started at zero. The social significance for these participants is questionable as the first participant averaged 41% and the second averaged 19% accuracy on the 10-word probe with the intervention in full effect.

Effects for Zannikos (2015) were demonstrated 8 times for CCC (100%) and 8 times for TSI (100%). During intervention and maintenance conditions, all four students improved their number of correct letter sequences and total words correct over their one baseline data point. Two students improved more quickly with TSI and the other two students' CCC and TSI data paths overlapped too much to determine which intervention was more effective. I observed a functional relation with positive effects for both interventions over the single baseline data point, although findings were mixed as to which intervention was more successful.

Engel (2022) implemented an alternating treatment design comparing the effects of spaced and massed practice on the number of words spelled correctly and percent change of correct letter sequences. I did not calculate a success estimate for this study because baseline data was not reported. Visual inspection of the three participants' data leads to ambiguity about which intervention was more effective for improving because of frequent overlap and large variability in levels and trends.

Effect for Group Studies

The two group studies examined intervention effects using pre/posttest scores. In Brimo's 2016 study, students in the experimental group improved scores on a spelling multimorphemic word task, although the increases were not statistically significant (d = 0.28). The author theorized the small effects could be related to the pilot study's small sample size.

Wright and researchers (2015) implemented a reading comprehension intervention and incorporated a spelling assessment as a control task in their pre/post assessment battery. Researchers examined spelling to determine if the improvements on reading comprehension assessments were due to the intervention or maturation effects, so it is unsurprising that the participant with LD demonstrated no improvement (pretest = 48%, posttest = 48%). Since the researchers assessed spelling only to examine maturation effects, I did not include this study when analyzing how the following study characteristics moderated study effects.

Intervention Type

Inclusion criteria mandated studies implement a spelling, writing or reading intervention. I located four spelling interventions, one writing intervention, and one intervention that targeted both reading and spelling.

Spelling. Aguirre and Rehfeldt (2015) implemented a visual imaging intervention where the researcher prompted the student to practice words and gave feedback to students after each word. Although the interventionist facilitated the practice, most of the task was completed unaided.

Three studies implemented self-study spelling interventions (Engel, 2022; McCallum et al., 2014; Zannikos, 2015). McCallum and coauthors (2014) evaluated the effects of a novel taped spelling intervention (TSI). During TSI, students listened to an MP3 player that said the target word, paused for students to write the word on their paper, and then spelled the word correctly. Engel (2022) compared the effects of CCC strategy on spelling outcomes using an alternating treatment design in two temporal conditions, spaced and massed practice. Zannikos (2015) compared two self-study interventions, CCC and TSI, using an alternating treatment design for four fifth grade students diagnosed with learning disabilities.

Writing. Curcic and Platt's (2019) writing intervention involved instruction on the POWER strategy for planning writing (Englert et al., 1991), students using the *Dragon Dictation* app on their iPads to record a draft summary, and culminated in the students completing a final text summarization on a computer which they revised with support from the researcher.

Combination. Brimo (2016) implemented a 15 lesson reading and spelling intervention consisting of oral and written activities where students listened, sorted, produced, identified, and wrote specific inflectional and derivational affixes. This intervention targeted common morphemes and affixes.

Spelling and writing interventions were most effective in improving spelling outcomes demonstrating effects 26 times (90.0%) and 3 times (100.0%), respectively. The intervention that combined spelling and reading activities also lead to spelling increases, although these increases were not statistically significant (Brimo, 2016). Results for Engel (2022) were inconclusive about which temporal practice condition was more effective for spelling outcomes.

Instructional Features

I analyzed the features of the interventions to examine effects by instructional components. Three self-study spelling interventions incorporated multiple practice opportunities and self-correction procedures. Two self-study interventions demonstrated effects 25 times (89.3%; McCallum et al., 2014; Zannikos, 2015); TSI demonstrated effects 15 times (83.3%) and CCC demonstrated effects 6 times (100.0%). Engel's (2022) implemented CCC across two temporal conditions with inconclusive results.

The studies that incorporated multiple practice opportunities and frequent instructor feedback lead to increased spelling outcomes, with two demonstrating effects 4 times (100.0%; Aguirre & Rehfeldt, 2015, Curcic & Platt, 2019) and one leading to smaller, less significant gains (Brimo, 2016). In the study by Aguirre and Rehfeldt (2015), researchers provided multiple practice opportunities, first prompting the student to complete spelling practices independently then providing feedback on the completed practices. The two studies that involved multiple opportunities to respond and frequent feedback from the instructor demonstrated effects 4 times (100.0%; Brimo, 2016; Curcic & Platt, 2019). When examining studies that implemented multiple practice opportunities and either self-correction or specific error correction procedures, effects were demonstrated 26 times (90.0%; Aguirre & Rehfeldt, 2015; McCallum et al., 2014; Zannikos, 2015).

Studies that incorporated technology demonstrated effects 28 times (90.0%). Although participants in these studies generally improved their spelling, results from McCallum and colleagues' (2014) results mixed. Researchers used a variety of technology: iPhones (Zannikos, 2015), MP3 players (McCallum et al., 2014), computers and iPads (Curcic & Platt, 2019).

Setting

All authors reported school type. Two schools were rural public (Curcic & Platt, 2019; Engel, 2022), one was urban public (Zannikos, 2015), one was an urban charter

(McCallum et al. 2014), one was a private day school for children who presented with learning disabilities (Brimo, 2016), and one was a nonprofit boarding schools for adolescents with complex learning disabilities (Aguirre & Rehfeldt, 2015). Two papers reported that research activities occurred in schools with low socio-economic status (SES; Curcic & Platt, 2019; Zannikos, 2015). Four studies did not report SES information (Aguirre & Rehfeldt, 2015; Brimo, 2016; Engel, 2022; McCallum et al., 2014).

Implementer and Intervention Group Size

The majority of studies had members of the research team trained students (McCallum et al., 2014; Zannikos, 2015) or conducted intervention procedures (Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019; Brimo, 2016). Spelling outcomes improved in interventions implemented by a member of the intervention team, although magnitude of improvements ranged greatly. Engel (2022) was the sole researcher to train special educators and paraeducators to implement intervention procedures, and results from this study were inconclusive.

Of the studies that incorporated technology, one study incorporated continued instructor support when using the technology (Curcic & Platt, 2019) and others faded instructor support after training to use the technology (McCallum et al., 2014; Zannikos, 2015). Three interventions were primarily independent student practice preceded by instruction on self-study procedures (Engel, 2022; McCallum et al., 2014; Zannikos, 2015). The two self-study spelling interventions for which I could make success estimates (i.e., McCallum et al., 2014; Zannikos, 2015) demonstrated effects a total of 28 times (90.3%), although results for McCallum and colleagues (2014) were mixed and questionably clinically significant. One study implemented ongoing instruction in small groups with gains that were statistically insignificant (average group size $n = 2.5$; Brimo, 2016). Studies implemented one-on-one demonstrated effects 4 times (100.0%; Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019).

Dosage and Duration

I determined dosage by examining the number of sessions reported, the frequency with which these sessions occurred, and the amount of time over which those sessions occurred. I calculated total duration in minutes by multiplying the reported length of sessions by the number of sessions.

Individual intervention sessions often were shorter if they occurred at a higher frequency per week (e.g., 11.45 minutes daily for Zannikos, 2015), and were longer if they occurred with less frequency (e.g., 30 minute sessions held three times weekly for Curcic & Platt, 2019). Engel (2022) compared frequencies of spelling practice, with students practicing 15 minutes per day in one sitting (i.e., massed practice) or broken into three separate practice times (i.e., spaced practice) each lasting 5 minutes. Results were inconclusive as to which dosage was more effective. Dosages could not be calculated for McCallum et al. (2014) because session length was not reported, although authors reported that the intervention occurred over 18 consecutive school days in a 4 week period.

Total duration of the studies ranged from 172 minutes (Zannikos, 2015) to 756 minutes (Brimo, 2016). Aguirre and Rehfeldt (2015) reported that sessions lasted 3 to 20 minutes each, which would be 45 to 300 minutes total. Total duration could not be calculated for McCallum and colleagues (2014) because they did not report session length. Neither dosage nor duration appeared to moderate effects.

Spelling Outcomes

Inclusion criteria for this review required studies measure at least one spelling outcome. Three studies measured two spelling dependent variables using curriculum-base measurement (CBM) techniques (Engel, 2022; McCallum et al., 2014; Zannikos, 2015). Four studies assessed the accuracy of spelling at the word level (Curcic & Platt, 2019; Engel, 2022; McCallum et al., 2014; Zannikos, 2015). One study examined percentages related to whole word accuracy, specifically exploring the percent of correctly written spelling responses (Aguirre & Rehfeldt, 2015). Four studies measured spelling on a sublexical level either by examining correct letter sequences (Engel, 2022; McCallum et al., 2014; Zannikos, 2015) or affix spelling in multisyllabic words on a pre/posttest (Brimo, 2016).

Spelling outcomes were primarily measured using researcher-created assessments or lists that researchers created from other sources. Spelling interventions assessed outcomes using researcher-selected words from curricular lists (Engel, 2022), AIMSweb (McCallum et al., 2014; Zannikos, 2015), or online an American College Test (ACT) preparation source (Aguirre & Rehfeldt, 2015). Brimo (2016) utilized a spelling multimorphemic words task which was created with colleagues in a prior study (i.e., Apel et al., 2013). The writing intervention assessed spelling in writing samples (Curcic & Platt, 2019). Although the source of words used in assessments did not appear to moderate effects, the level of analysis for spelling accuracy did. Assessments that measured words granularly demonstrated effects (i.e., 14 times, 100.0%) at a higher rate than whole-level assessments (i.e.,15 times, 83%).

Maintenance and Generalization Measures

Four studies collected maintenance data (Curcic & Platt, 2019; Engel, 2022; McCallum et al., 2014; Zannikos, 2015). Students completed a retention probe in Engel (2022) five days after their posttest for each spelling list. Maintenance data collection for McCallum and colleagues (2014) started immediately following the intervention phase, dipping below intervention levels and often overlapping with baseline data. Zannikos (2015) assessed students two weeks following the intervention, and all students maintained high levels of accuracy over baseline. Three weeks following intervention, Curcic and Platt (2019) wrote summaries in the same conditions as baseline (i.e., without the *Dragon Dictation* app, POWER instructional steps, or instructor support) and all students maintained high levels comparable to their responding at the end of the intervention phase. The two studies that measured maintenance data at least two weeks after intervention demonstrated effects 19 times (100.0%; Curcic & Platt, 2019; Zannikos, 2015).

Two studies analyzed generalization of spelling to novel words or academic tasks (Curcic & Platt, 2019; Zannikos, 2015). Positive spelling outcomes in Zannikos (2015) did not generalize to untaught words. Curcic and Platts' (2019) participants generalized spelling increases to summaries about different text types.

Social Validity and Fidelity Measures

Four studies assessed the social validity of their interventions, one with an open-ended interview (Curcic & Platt, 2019) and three with surveys (Engel, 2022; McCallum et al., 2014; Zannikos, 2015). Results for Engel (2022) could not be interpreted because of a semantic error. Students' responses for the other three studies were mostly positive about the interventions' acceptability, feasibility, and effectiveness. Although fidelity measures did not appear to moderate effects, studies that assessed social validity of their interventions and reported interpretable results demonstrated effects 28 times (90.3%; Curcic & Platt, 2019; McCallum et al., 2014; Zannikos, 2015).

CEC Quality Indicator Analysis

A summary of QI analysis for each study is depicted on Table 3. I did not apply these standards to Wright and colleagues' (2015) study as it did not have a research design for which the quality indicators applied. The six evaluated studies displayed an overall mean of 96.0% QIs met, with a maximum of 100.0% (Aguirre & Rehfeldt, 2015; Brimo, 2016; Curcic & Platt, 2019) and minimum of 86.3% met (Zannikos, 2015). The articles published in peer-reviewed journals met more quality indicators (Aguirre & Rehfeldt, 2015; Brimo, 2016, Curcic & Platt, 2019; McCallum et al., 2014) than the dissertations (Engel, 2022; Zannikos, 2015).

Three studies satisfied all standards for quality (Aguirre & Rehfeldt, 2015; Brimo, 2016; Curcic & Platt, 2019), which is the requirement to be considered methodologically sound (Cook et al., 2014b). These studies were implemented by members of the research team and incorporated ongoing feedback. Two studies were implemented with explicit instruction in groups (Brimo, 2016; Curcic & Platt, 2019). All three of these studies demonstrated increases on spelling outcomes, with two demonstrating effects 4 times (100.0%; Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019) and smaller, statistically insignificant gains for the other (Brimo, 2016).

Several patterns relative to specific quality indicators emerged during this analysis. All studies met quality indicators relating to context and setting, participants, intervention agents, description of practice, and data analysis. Two studies did not fulfill standard 5.3 regarding implementation fidelity assessment throughout phases of the intervention as fidelity was not assessed during baseline (McCallum et al., 2014; Zannikos, 2015). Zannikos (2015) collected data once during baseline, which is insufficient for establishing internal validity (QI 6.6) and gauging the effect of the intervention on study outcomes (QI 7.4) for single-case research. Engel (2022) reported two outcomes: words spelled correctly and percent change in CLS. The percent change in CLS compared scores on pretests to immediate posttests and retention tests, enabling readers to examine the difference in outcomes following intervention. The author only reported words spelled correctly on posttests and retention tests, omitting scores on pretests. This exclusion obfuscates the effect of the intervention on spelling outcomes.

Table 3. Quality Indicator Analysis

	Quality Indicator	Aguirre & Rehfeldt, 2015	Brimo, 2016	Curcic & Platt, 2019	Engel, 2022	McCallum et al., 2014	Zannikos, 2015
1.1	Context and setting	Yes	Yes	Yes	Yes	Yes	Yes
2.1	Participant demographic description	Yes	Yes	Yes	Yes	Yes	Yes
2.2	Participant disability information and determination method	Yes	Yes	Yes	Yes	Yes	Yes
3.1	Intervention agent role and description	Yes	Yes	Yes	Yes	Yes	Yes
3.2	Intervention agent qualifications or training description	Yes	Yes	Yes	Yes	Yes	Yes
4.1	Intervention procedures description	Yes	Yes	Yes	Yes	Yes	Yes
4.2	Study materials description	Yes	Yes	Yes	Yes	Yes	Yes
5.1	Implementation fidelity assessed and reported	Yes	Yes	Yes	Yes	Yes	Yes
5.2	Intervention dosage or exposure reported	Yes	Yes	Yes	Yes	Yes	Yes
5.3	Implementation fidelity assessed throughout intervention and for all units of analysis	Yes	Yes	Yes	Yes	No	No

Table 3. continued

	Quality Indicator	Aguirre & Rehfeldt, 2015	Brimo, 2016	Curcic & Platt, 2019	Engel, 2022	McCallum et al., 2014	Zannikos, 2015
6.1	Systematic manipulation of IV	Yes	Yes	Yes	Yes	Yes	Yes
6.2	Description of baseline	Yes	Yes	Yes	Yes	Yes	Yes
6.3	Limited or no access to intervention in baseline	Yes	Yes	Yes	Yes	Yes	Yes
6.4	Group assignment description	N/A	Yes	N/A	N/A	N/A	N/A
6.5	Minimum of three experimental effects Demonstrations	Yes	N/A	Yes	Yes	Yes	Yes
6.6	Baseline phase has 3 or more data points	Yes	N/A	Yes	N/A	Yes	No
6.7	Experimental design controls for threats to internal validity	Yes	N/A	Yes	Yes	Yes	Yes
6.8	Overall attrition is low	N/A	Yes	N/A	N/A	N/A	N/A
6.9	Differential attrition is low	N/A	Yes	N/A	N/A	N/A	N/A
7.1	Socially important outcomes	Yes	Yes	Yes	Yes	Yes	Yes
7.2	Dependent variable description	Yes	Yes	Yes	Yes	Yes	Yes
7.3	All outcome measures reported	Yes	Yes	Yes	No	Yes	Yes

Table 3. continued

Quality Indicator	Aguirre & Rehfeldt, 2015	Brimo, 2016	Curcic & Platt, 2019	Engel, 2022	McCallum et al., 2014	Zannikos, 2015
7.4 Appropriate outcome measures	Yes	Yes	Yes	Yes	Yes	No
7.5 Adequate reliability/IOA	Yes	Yes	Yes	Yes	Yes	Yes
7.6 Evidence of validity	N/A	Yes	N/A	N/A	N/A	N/A
8.1 Appropriate data analysis techniques	N/A	Yes	N/A	N/A	N/A	N/A
8.2 Single-case graph depicts data for each unit of analysis	Yes	N/A	Yes	Yes	Yes	Yes
8.3 Effect size statistics reported	N/A	Yes	N/A	N/A	N/A	N/A
Total Number of Quality Indicators met	22	24	22	20	21	19
% of Quality Indicators met	100.0	100.0	100.0	95.2	95.5	86.4

Discussion

Spelling is a challenging academic task for students with learning disabilities (Galuschka et al., 2020; Wanzek et al., 2006; Williams et al., 2017). Fortunately, spelling outcomes can improve with appropriate reading, writing, and spelling interventions (Graham & Santangelo, 2014). In this updated review of the literature, I identified seven studies in these domains that measured a spelling outcome since 2014. Two were group designs and five were single-case designs. Group designs included one quasi-experimental and one pre/posttest within subjects design without a control group. The types of single-case designs employed were two multiple probes, one multiple baseline, and two alternating treatments. I detailed experimental effects for these studies using visual analysis and success estimates for single-case research designs. I analyzed study characteristics to explore how they correlated with experimental effects. Findings from this review corroborate and extend the literature regarding spelling outcomes for students with learning disabilities in several ways.

First, spelling and writing interventions were generally effective in improving student spelling outcomes, although magnitude and significance of increases varied. These findings are consistent with prior literature reviews (Wanzek et al., 2006; Williams et al., 2017). The following three interventions were highly effective: Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019; and Zannikos, 2015. Results for the remaining articles carry less import as gains were small and not statically significant (Brimo, 2016), had questionable social significance (McCallum et al., 2014), or results were inconclusive (Engel, 2022). Unlike prior reviews (Wanzek et al., 2006; Williams et al., 2017), the reading intervention in this review did not have positive effects on spelling outcomes (Wright et al., 2015).

Second, I explored study characteristics to see if any moderated effectiveness. I did not detect participant grade, group size, implementer, fidelity measurement, dosage, or duration as moderators of effectiveness as studies were very similar in these respects. Most participants attended a public elementary or middle school, most interventions were implemented individually by a researcher, assessed procedural fidelity and IOA, and had session lengths between 11 and 30 minutes, occurring three to five times per week. Only one study implemented ongoing instruction in groups (Brimo, 2016). Most studies assessed with oral dictation of researcher-created tests or researcher-selected words lists. Alternatively, one study analyzed spelling from students' writing samples (Curcic & Platt, 2019). Two studies conducted maintenance assessments (Engel, 2022; McCallum et al., 2014) while two others conducted both maintenance and generalization assessments (Curcic & Platt, 2019, Zannikos). These findings are consistent with patterns identified by prior literature reviews (Wanzek et al., 2006; Williams et al., 2017).

Furthermore, several study characteristics did appear to moderate outcomes. Multiple studies measured two spelling outcomes using CBM scoring techniques to assess accuracy at the lexical and sublexical levels. Sublexical measures demonstrated effects more quickly than word-level measures, suggesting that this level of feature analysis can be more responsive to incremental spelling improvements. Similar to Williams et al. (2017) two categories of interventions emerged: (a) self-study interventions (i.e., CCC and TSI), and (b) explicit instruction interventions. Spelling outcomes generally increased for both types of intervention. Two highly effective studies implemented in one-on-one settings, incorporated multiple opportunities to practice, and immediate instructor feedback (Aguirre & Rehfeldt, 2015; Curcic & Platt, 2019). Student outcomes improved when students had multiple opportunities to practice and either self-corrected errors or completed an error correction procedure with an instructor. Although past research implementing instruction on specific sounds or spelling words were effective (Darch et al., 2006; Owens et al. 2004), the one study identified in this review with this type of explicit instruction demonstrated small, insignificant gains (Brimo, 2016). Studies that incorporated technology increased student spelling outcomes, confirming results from prior syntheses (Wanzek et al., 2006).

Third, the quality of studies was generally sound. Overall, the studies met 96.0% of QIs. Three studies met 100.0% of QIs (Aguirre & Rehfeldt, 2015; Brimo, 2016; Curcic & Platt, 2019), which is the standard for studies to be considered methodologically sound when determining EBPs (Cook et al., 2014b). Participants increased spelling outcomes in the three studies encompassing all QIs, although results for Brimo (2016) were smaller and not statistically significant. All studies met QIs regarding context and setting, participants, intervention agents, description of practice, and data analysis. The most unmet standard was 5.3 as two studies did not assess implementation fidelity during baseline to fulfill this (McCallum et al. 2014; Zannikos, 2015). Studies published in peer-reviewed journals met more QIs than did dissertations. Of the three studies that incorporated the lowest percentages of QIs (i.e., Engel, 2022; McCallum et al., 2014; and Zannikos, 2015), two of these studies were dissertations that used alternating treatment designs (Engel, 2022; Zannikos, 2015); as such, it is difficult to discern if study design, lack of peer-review in publishing, or a combination of these factors impacted level of quality.

Implications for Practice

Findings from this review have implications for all educators of students with learning disabilities and administration who create arrangements for this instruction. Self-study interventions such as CCC and interventions that incorporated technology were generally effective for increasing spelling outcomes. These self-study interventions are beneficial in that they are relatively quick, require little teacher oversight, and are cost effective. Additionally, these self-study procedures can be used for many words, so it is scale-able to multiple instructional levels and abilities. Spelling improved in all studies implemented in one-on-one settings. Furthermore, students benefitted from multiple practice opportunities and timely error correction. When planning for instruction, educators should incorporate these instructional components and administrators should create opportunities for one-on-one instruction and provide appropriate technology. Instructors can glean more information when assessing multiple levels of accuracy (Bear et al., 2020; Hauerwas & Walker, 2004). Educators and administration should evaluate the quality of research (e.g., Cook et al., 2014b) prior to implementing any interventions with students.

Limitations and Directions for Future Research

Limitations to this review indicate areas for future research. First, I identified seven studies for this time period. Given the small sample of studies, additional research targeting spelling outcomes is needed. Second, most studies employed single-case research designs. Future research should employ randomized control trials and quasi-experimental designs. Third, most participants were in late elementary or middle school so study findings primarily concern these groups. More research is needed on early elementary and high school-age students to determine what interventions are effective for these populations. Fourth, many studies did not assess maintenance or generalization of spelling. This aligns with prior reviews (i.e., Wanzek et al., 2006; Williams et al., 2017); as such, more research is needed to explore how interventions impact these distal outcomes. Since one goal of interventions is to provide sufficient instruction so that students are able to generalize skills to new situations and to maintain increases, these types of measures are of upmost important to researchers and practitioners (Cooper et al., 2020). Fifth, only one study included specific disability determination information (Curcic & Platt, 2019). Future researchers should include this information in their studies so that patterns relating to the determination process across studies can be explored. Sixth, I identified many studies that did not disaggregate data for students with LD when during the search and screening process. These students' outcomes were often combined with students who were diagnosed with other disabilities or with students who did not have a diagnosed disability. As such, implications for students with LD could not be inferred. Researchers are encouraged to disaggregate results by disability type to explore how results differ across populations. Finally, it is important to note that improvements to spelling outcomes does not inherently mean students became better spellers. As noted above, this relates to the need for analyzing how spelling improvements generalize to new situations (e.g., classwork; Alber-Morgan et al., 2016) and analyzing maintenance of spelling skills targeted by instruction.

Further, there were several limitations to how I reviewed the literature. First, I might have missed studies that should have been included in this review. For example, I did not include sufficient search terminology for qualitative studies. Additionally, I relied on authors definitions of LD. This potentially impacted the students I included and excluded, and impacted how I interpreted the studies that I did include.

Conclusion

The purpose of this literature review was to investigate the effectiveness of spelling, writing, and reading interventions on spelling outcomes for students with LD published between 2014 and 2022. I identified seven studies that met inclusion criteria. Results were generally positive, although effects ranged from inconclusive to highly effective. Findings suggest that spelling outcomes improve with one-on-one instruction, multiple practice opportunities, and immediate error correction.

Chapter 3. Experimental Study

The following chapter describes an experimental study conducted to examine the effects of a spelling flowchart intervention on spelling outcomes for three students with disabilities.

Abstract

This research study is a replication of a pilot study which examined the effectiveness of a spelling flowchart intervention on spelling outcomes. I employed a multiple probe across spelling behaviors to examine experimental effects. Visual and statistical analyses are included. Students' lexical and sublexical spelling accuracy increased with the intervention. This study extends prior research by exploring effects for three elementary students with similar profiles who were all in grade 3, identified as Black males, and were diagnosed with SLD and ADHD. Although participants maintained spelling improvements, their generalization data were mixed. Implications for practice and research are discussed, as well as limitations of the study.

Keywords: spelling, flowchart, graphic organizer, learning disabilities, ADHD

The Effects of a Spelling Flowchart Intervention on Spelling Outcomes for Three Elementary Students with SLD and ADHD

Life is filled with text demands: emails, advertisements, product packaging, traffic signs, text messages, and more. To be productive and independent members of society, people must be skilled at navigating text as writers and readers (Alexander, 2005). Proficient spelling helps one be a more proficient writer and reader (Graham et al., 2008; Graham & Santangelo, 2014). However, spelling is a cognitively demanding and challenging task, especially for students with learning disabilities (Bonti et al., 2021), because it requires students to make decisions while drawing upon their prior knowledge and this can overwhelm students' working memory (Berninger et al., 2002). Specifically, students must correctly apply their knowledge of the English alphabet, sounds, word origin, and spelling patterns when spelling words (Garcia et al., 2010; Moats, 2005).

The challenge of English spelling for students with learning disabilities is further convoluted by the variability of graphic representations in the English orthography (Galuschka et al., 2020). One such complexity is that multiple graphemes can produce a single phoneme in English (Seymour et al., 2003). For example, the phoneme /j/ can be represented by the graphemes g, j, dge, and ge. One might perceive these complexities as erratic; however, English spelling is actually quite predictable when spellers account for word origin, meaning, and sound structure (Moats, 2005). Spellers are more accurate when they are taught about language structure, word etymology, and resulting graphotactic regularities (Fry, 2004; Moats, 2009).

When selecting the correct spelling of the /j/ phoneme, spellers must analyze the graphotactic context of the /j/, meaning the speller examines the location of the /j/ sound in a word and the spelling of the surrounding phonemes (Treiman & Wolter, 2018). When spellers account for this graphotactic context, they are more accurate at identifying and selecting the most common and accepted letter arrangements within words (i.e., graphotactic regularities; Pacton et al., 2013).

Balancing all these considerations can be particularly challenging for students with disabilities as they need more support than their peers when identifying the salient information (Nelson et al., 2022). Fortunately, researchers have identified several components of instruction that particularly benefit students with disabilities. Students with disabilities increase their spelling accuracy with interventions that incorporate explicit instruction, multiple practice opportunities, and error correction procedures (Wanzek et al., 2006; Williams et al., 2017). Moreover, students improve when the explicit instruction is systematic and targets individual concepts that incrementally grow in complexity (Graham & Santangelo, 2014). One curricular adaptation with documented positive effects for students with disabilities incorporates those principles of systematic and explicit instruction: graphic organizers (Alber-Morgan et al., 2022; Ewoldt & Morgan, 2017).

Educators can tailor the specific structure of graphic organizers and their implementation approach based on their intended use. Structures can vary from top-down webs for planning writing to diagrams for problem solving math word problems (Gonzalez-Ledo et al., 2015; Spooner et al., 2019). Moreover, graphic organizer implementation can be adjusted to the instructor's purpose and level of support students need. The creation and use of graphic organizers can vary from student-directed to teacher-directed, with multiple hybrid versions such as teacher-created graphic organizers filled out by students (Kim et al., 2004). For example, DiCecco and Gleason (2002) provided students with completed concept maps designed to visually present implied relationships in social studies units. Teachers can provide support by supplying prompts on charts for students to plan their writing (Evmenova et al., 2016). Boyle and Weishaar (1997) taught students to independently generate cognitive organizers to support reading comprehension of passages.

Regardless of graphic organizer type, the tools are more effective when they are combined with explicit instruction (Ciullo & Reutebuch, 2013). Knight and colleagues (2013) implemented a graphic organizer in conjunction with explicit instruction to support science content and vocabulary learning with students with autism spectrum disorder and intellectual disabilities. The teacher provided a partially completed graphic organizer to participants with a word bank of new vocabulary words. The teacher used explicit instruction to teach examples and nonexamples of vocabulary, then modeled how to use the graphic organizer, and provided feedback to the students as they used the tool. All participants demonstrated improved conceptual knowledge following the treatment package of the graphic organizer and explicit instruction.

When decision-making during a problem-solving task, students with disabilities benefit from using a specific type of graphic organizer: flowcharts (Gersten & Baker, 1998). Flowcharts, also known as decision trees, can lessen a student's working memory load when problem-solving by making a visible representation of the decision-making process with specific questions about current variables and arrows to potential outcomes (Smith et al., 2016). Although another type of graphic organizer (i.e., cognitive maps) also contains arrows to show connections between concepts (Dexter & Hughes, 2011), flowcharts differ in that the student must make choices between multiple paths based on current contingencies.

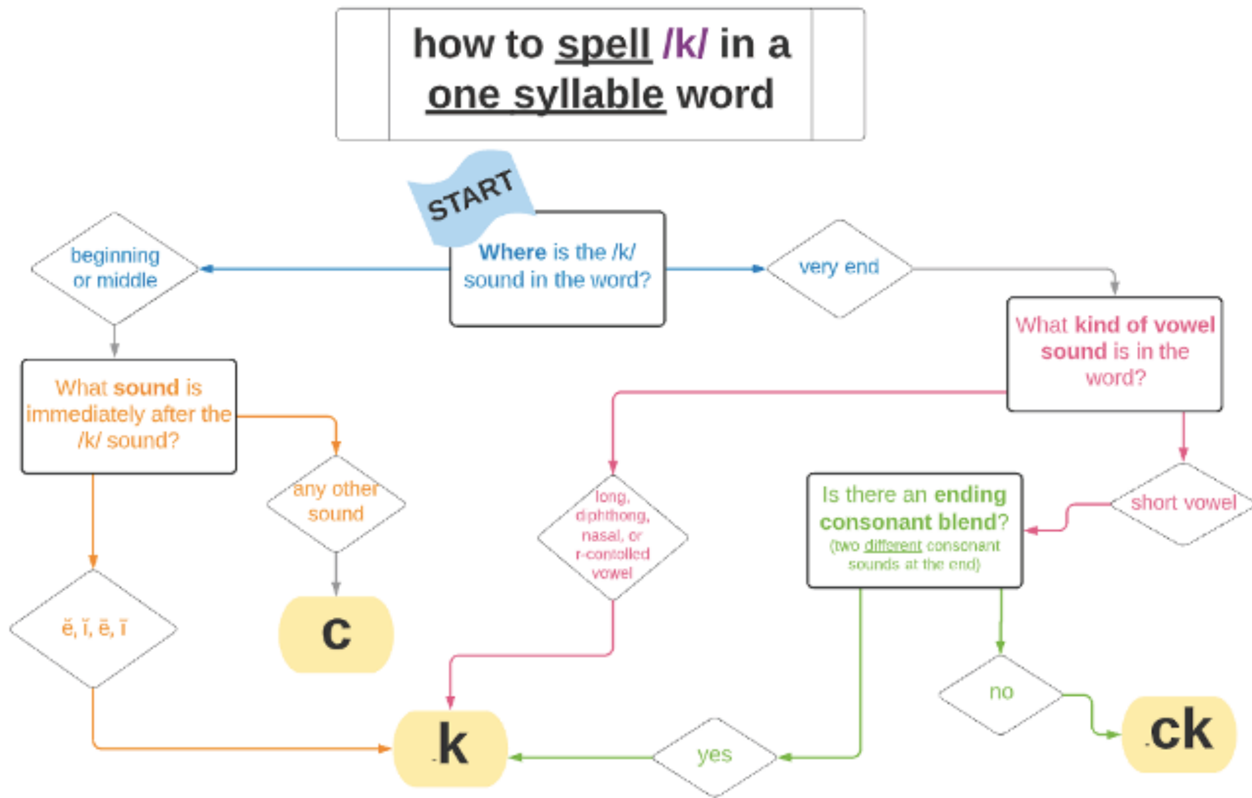
Past research suggests flowcharts are effective tools to support independent application of instruction for students with learning disabilities. In 1988, Woodward and colleagues incorporated a flowchart with explicit teaching of a health unit to high school students with disabilities. On the two standardized assessments of health factual and conceptual knowledge, students increased accuracy and maintained these increases following the intervention. Moreover, these students significantly improved problem-solving skills after using the flowchart. This research was replicated in 1993 with middle school and high school students with learning disabilities (Hollingsworth & Woodward, 1993). Researchers provided students in the treatment group with a flowchart to support their application of learned health facts when problem-solving computer simulations. Although both the treatment and control groups improved health knowledge, the treatment group outperformed the control group on a Video Diagnostic Test that assessed students' application of problem-solving skills.

Furthering the case for flowcharts as effective decision-making tools for students with disabilities, Harris and colleagues (2023) implemented a spelling flowchart intervention with two male students in the 2021–2022 school year. One participant was a grader identified with autism spectrum disorder whereas the other was third grader grader identified with a specific learning disability (SLD) and ADHD. Researchers examined the effects of spelling flowcharts, combined with explicit instruction and training to use the flowcharts, on students' spelling accuracy on daily spelling probes. Spelling accuracy improved on the lexical (i.e., whole word) and sublexical (i.e., word part or within word) levels.

The Current Study

My aim was to expound on these positive results of prior researchers who used flowcharts to support decision-making tasks for students with disabilities. Specifically, I implemented a flowchart intervention to help students during spelling tasks that required decision-making between several potential spelling options. I selected several discrete spelling principles with choices that could be clearly depicted using flowcharts. I referred to these discrete spelling principles as "target concepts." For this study, I targeted the following six target concepts: FLoSS rule application, spelling /j/, spelling /long i/, spelling /long a/, spelling /ch/, and spelling /k/. I created a total of six flowcharts: one flowchart for each of these target concepts (e.g., see Figure 2). These target concepts were selected because each had multiple spelling options (e.g., /k/ can be spelled with c, k, or ck).

Figure 2. Flowchart for the Target Concept /k/



The goal of the intervention was to increase students' spelling accuracy by chunking the decision-making process of selecting a spelling option into smaller and simpler steps. For example, some of the flowcharts first prompted the student to select the location of the target concept in the word, then to identify sounds immediately preceding the target concept. These questions helped the students determine the graphotactic context of the target concept so they could select the correct spelling option. Students received explicit instruction about the flowcharts followed by training that involved modeling, multiple guided practice opportunities, and error correction procedures.

To evaluate the efficacy of the intervention, I analyzed multiple spelling outcomes. I collected data continuously on three dependent variables, two of which were spelling accuracy measures (i.e., target concept accuracy and whole word accuracy) and one of which measured student accuracy using the flowchart tool (i.e., flowchart step accuracy). I also assessed generalization of spelling accuracy by examining students' classwork. Finally, I explored the social validity of the intervention with an interview and questionnaire. Specifically, the following questions guided my research:

1. What are the effects of a spelling flowchart intervention on target concept spelling accuracy?
2. What are the effects of a spelling flowchart intervention on whole word spelling accuracy?
3. What are the effects of a spelling flowchart intervention on flowchart step accuracy?
4. To what extent does spelling accuracy generalize to classwork?

Method

Setting and Participants

This study occurred in an alternative school for K–12 students with emotional and behavioral disorders during the 2022–2023 school year. First, I received IRB approval to conduct the research. Next, I obtained permission from the school administration to recruit students and to conduct research activities in their building. Then, I recruited four students who met the following inclusion criteria: (a) enrolled in grades 2 through 6, and (b) identified with a learning disability. I received parental approval for four students. After all students individually gave verbal assent, I administered a spelling screener to determine if students qualified for intervention (i.e., minimum score of 15.0%, maximum of 70.0%) and the target concepts for which they would receive intervention. Data are reported for only three participants because the fourth student left the school in the middle of the intervention.

Materials

The following items were materials used in this study: pencils, paper, dry erase markers, sheet protectors, list of vowels and consonants, list of spelling steps, school-approved snacks that served as reinforcers, spelling screener, flowcharts, spelling probes, social validity questionnaire. The lists of consonants and vowels, spelling steps, and flowcharts were nested within sheet protectors for longevity.

Spelling Screener

The screener aligned with the research aims of this study. I administered a spelling screener as part of the eligibility determination process. The purpose of this screener was to determine if students would benefit from the intervention, and which target concepts would be selected for instruction. This consisted of 18 words, nine real and nine nonwords, that contain multiple opportunities for a student to demonstrate accurate spelling of target concepts. I coded their errors to determine their accuracy on each target concept.

Spelling Flowcharts

I created one flowchart for each of the following target concepts: applying FLoSS rule, spelling /j/, spelling /long a/, spelling /long i/, spelling /ch/, and spelling /k/. Each flowchart contained the following parts: (a) multiple "decisions" which were questions students must answer (e.g., "What sound immediately follows the /k/?"); (b) "branches" off the decision that represented answers to the questions; and (c) "endpoints" which were the spelling options. The decisions, branches, and endpoints of each target concept's flowchart differed based on the specific sublexical information required to accurately spell a give target concept. The "path" (i.e., the route the student took through decisions and branches to reach an endpoint) each student followed was contingent upon the word they were spelling and that word's specific particular graphotactic context. These flowcharts were nested within sheet protectors, which allowed participants to draw on them with dry erase markers to show the paths they took to arrive at a specific endpoint.

Spelling Probes

At the end of each intervention session, students completed a spelling probe (see Appendices D and E). These probes were standardized so that data could be compared across sessions. Each probe contained six monosyllabic words, three of which were real words and three were nonwords. Further, I kept the number of digraphs and consonant blends consistent across spelling probes. All real words were selected from Arredondo's (2021) words lists.

Appendix D is an example probe for the /ch/ target concept. For each probe targeting consonant and digraph concepts (i.e., /j/, /k/, FLoSS, and /ch/), the six words included three short vowels, one r-controlled vowel, one vowel diphthong, one long vowel, a consonant digraph, and two consonant blends.

Appendix E is an example probe for the /long i/ target concept. For each probe targeting vowel concepts (i.e., /long i/ and /long a/), the probe words included four consonant blends and one consonant digraph.

Dependent Variables

Throughout all phases of the study, I collected data for three dependent variables on the spelling probes: target concept accuracy, whole word accuracy, and flowchart step accuracy. Flowchart step accuracy data were collected in real time while target concept accuracy and whole word accuracy data were determined by examining the spelling probe. See Appendix A for the data collection sheets for these dependent variables.

Target Concept Accuracy

I defined target concept accuracy as the percent of correctly spelled target concepts. For example, if I were analyzing target concept accuracy for the /k/ sound, I would only examine the correctness of the /k/ spelling demonstrations on probe words. I calculated target concept accuracy by evaluating the sublexical spelling accuracy of the target concept. To compute target concept accuracy, I divided the number of correct target concept spelling demonstrations by the number of opportunities to correctly spell the target concept. For example, if the target concept was /k/, ‘pick’ included one opportunity to correctly spell the target concept. The student had one opportunity to spell the /k/ sound correctly with the letters ‘ck.’ If the student spelled ‘pick’ as ‘peck,’ then the student demonstrated 100.0% target concept accuracy as they demonstrated one correct spelling (i.e., ‘ck’) out of the one opportunity they had to demonstrate accurate target concept spelling of /k/.

Whole Word Accuracy

I assessed whole word accuracy by examining the accuracy of each spelling probe word in its entirety. I calculated whole word accuracy by dividing the number of fully correct words on a spelling probe by the number of words on the spelling probe. If the word contained a substitution, addition, or omission, then the whole word accuracy for that word was 0.0%. To continue with the above example, if a student was told to spell ‘pick’ and they wrote ‘peck’, it would result in 0.0% whole word accuracy as the student misspelled the vowel sound.

Flowchart Step Accuracy

This dependent variable examined the path the students took when decision-making using the flowchart. The students drew the path through the flowchart that they took to reach an endpoint with a dry erase marker. I calculated flowchart step accuracy by dividing the number of correct decisions they made on their drawn path out of all the decisions required to select the correct endpoint. Continuing with the above example, the ‘ck’ in ‘pick’ required three correct decisions to select the correct endpoint: (a) selecting the correct location of the /k/ sound in the word; (b) identifying the correct vowel sound in the word, and (c) correctly identifying that there was no ending consonant blend. If a student completed selected the correct branches off the two decisions of the three total decisions needed to select ‘ck’, then the resulting flowchart step accuracy would be $\frac{2}{3}$=66.7%.

Decision-Making Dependent Variable

Given that I assessed three dependent variables, I selected one around which I systematically manipulated the independent variable. Since the goal of this study was to improve students’ spelling accuracy, I decided that my decision-making dependent variable should be a spelling outcome(i.e., target concept accuracy or whole word spelling). I selected target concept accuracy because this was the more exact and sensitive measure to target concept spelling instruction (Johnston et al., 2009).

Generalization

To explore generalization of spelling skills, I explored participants’ spelling on classroom assignments. In line with suggestions from prior spelling research (i.e., Alber-Morgan, et al., 2016; Garcia et al., 2014), I analyzed spelling accuracy of self-generated writing samples. The participants’ teacher provided me with work samples for each student during baseline and maintenance periods. The classroom assignments were journal reflections about a book that the teacher read during morning meeting. I assessed each student’s target concept accuracy and whole word accuracy of words that included the target concept which was targeted for their instruction.

Experimental Design and Analyses

I implemented a multiple probe across behaviors design to evaluate the effects of the intervention on the dependent variables. Although multiple probe designs employ similar logic to multiple baseline designs, I selected a multiple probe design because this design enabled intermittent monitoring of dependent variables (Horner & Baer, 1978; Tawney & Gast, 1984). Intermittent monitoring was preferable for this intervention because students often feel frustrated when spelling words for which they haven't received instruction, so intermittent monitoring enabled less baseline data collection. Additionally, intermittent monitoring of dependent variables decreased the length of time for each session and minimized the amount of time students were removed from their classrooms.

I replicated this multiple probe design across participants to explore intervention effects for different students. The data (i.e., target concept accuracy, whole word accuracy, and flowchart step accuracy) for each target concept were graphed on one tier. For example, if a student qualifies on the spelling screener for intervention on the FLoSS, /long i/, and /long a/ target concepts, then that student will have one tier of data for each of these target concepts.

Visual and Statistical Analyses

I conducted visual analysis of the multiple probe graphs to determine the presence of a functional relation. Specifically, I examined the trend, level, variability, and immediacy of effect on the data across experimental phases (Gast & Ledford, 2014).

I also conducted statistical analyses of the students' data. During interventions where data from a training phase might obscure intervention effects because there is potential overlap with baseline data during acquisition of a new skill, some researchers suggest comparing baseline data to phases when the treatment is in full effect when completing statistical analyses (Ennis & Losinski, 2019a; Ennis & Losinski, 2019b; Garwood, et al., 2019; Losinski et al., 2021). As such, I compared participants' baseline data to their data in the fading and maintenance phases. I determined that the intervention was in full effect during fading and maintenance because students had to demonstrate sufficient accuracy spelling the target concept with the flowchart in order to complete the training phase and to enter the fading phase.

In line with current recommendations for single-case design analysis (Kratotchwill et al., 2010), I analyzed the data with two types of statistical analyses. I examined the overlap of data between baseline and intervention using the percentage of nonoverlapping data points (PND) and Tau-U. PND is frequently used to summarize effects in single-case research and is calculated by dividing the number of data points in the treatment phase which surpass the highest baseline data point by the total number of data points in the treatment phase (Scruggs et al., 1987; Scruggs & Mastropieri, 2013). PND results of 50.0% or below are considered ineffective, 50.0%-69.0% are questionably effective, 70.0% and above are considered effective (Scruggs et al., 1987). Additionally, I calculated Tau-U with a free online calculator (http://singlecaseresearch.org/calculators/tau-u/). To interpret the impact of the intervention on the dependent variables using Tau-U, Vannest and Ninci (2015) recommended interpreting values <.20 as small effects, .20 to .60 as moderate, .60 to .80 as large, and higher than .80 as very large.

Procedures

I conducted sessions four days per school week, Monday through Thursday. All sessions were one-on-one and lasted 5–20 minutes each. I worked with students in hallway or in a quiet space of their classroom.

Across baseline, training, fading, and maintenance phases, I kept the session structure consistent with three parts: (a) a lesson opening; (b) the spelling probe of the target concepts; and (c) a lesson wrap up. During the lesson opening, I reviewed behavior expectations, provided school-approved reinforcer options for students to earn during the lesson, briefly reviewed the list of vowels and consonants (i.e., this took no more than one minute), and reviewed the list of spelling steps (see Appendix C). During the spelling probe part of the session, the student completed a probe for a specific target concept. I gave behavior-specific praise (e.g., "nice job segmenting and spelling the /k/ with 'c!'") and performed an error correction procedure as needed after the student had completely spelled each word. For the error correction procedure, I first repeated the probe word, then read the word they wrote, and then I modeled how to correctly spell the probe word following the list of spelling steps. During the lesson wrap up, I reviewed the behavior expectations from the lesson opening and discussed with the student if they met the expectations. All students met the behavior expectations during each session and thus earned their selected reinforcer.

Pre-baseline

Prior to baseline, I explained the purpose of the study and asked for student assent. I then gave the student the spelling steps, explained what each step meant, and administered the spelling screener. I instructed students to write all of the sounds they heard in the word even if they did not feel confident that they spelled the word correctly. I used the spelling screener results to determine the target concepts on which to intervene for each participant.

Baseline

During this phase, I completed the detailed session parts above (i.e., lesson opening, spelling probe, and lesson wrap up). Students continued to receive business as usual instruction in their classroom. The teacher reported that this instruction was not systematic, and that she selected free resources that aligned with state standards when planning instruction. Students were given access to the flowchart during this phase but did not receive instruction or feedback on their usage. During this phase, I provided behavior specific praise and feedback on spelling accuracy after each word on the spelling probe.

Training

During training, I explicitly instructed the students to use the flowchart. I explained its purpose and the specific decisions, branches, and endpoints of the flowchart. Then I modeled how to use the flowchart for one word, provided two guided practice opportunities for the student to use the flowchart and spell with immediate feedback. If the student made an error on their flowchart path or in spelling during these two guided practice words, they completed a third guided practice word.

Students were required to achieve mastery criteria prior to advancing into the fading condition. I defined mastery criteria as a minimum of 80.0% target concept accuracy on two consecutive spelling probes.

Fading

I reduced instructional support during the fading phase. Specifically, I did not provide a model word, and students only completed two guided practice words before attempting the spelling probe. I waited until a participant demonstrated a steady state of responding for target concept accuracy prior to moving to the maintenance condition for each tier.

Maintenance

This represented a return to baseline conditions. There was no instructor modeling to use the flowcharts or guided practice, although I did give behavior specific praise and feedback on spelling accuracy.

Integrity Measures

I trained a secondary observer to assess procedural fidelity and to calculate interobserver agreement (IOA). The secondary observer was a first-year doctoral student who had previously taught in schools. Procedural fidelity and IOA data were collected for 25% of sessions and were collected across all study phases for all participants.

Procedural Fidelity

The secondary observer assessed procedural fidelity using a checklist of steps specific to each phase of the study (see Appendix B for example procedural fidelity sheet). Procedural fidelity for Blaine, Kameron, and Miyan was 98.1%, 99.3%, and 99.0%, respectively.

Interobserver Agreement

IOA was calculated using trial-by-trial agreement (Cooper et al., 2019). I calculated agreement on each item as an agreement or nonagreement. The total number of agreements was divided by the total number of items scored to determine IOA. Agreement was calculated across all phases for all concepts. The resulting IOA was 100.0%, 98.4%, and 99.3% for Blaine, Kameron, and Miyan, respectively.

Results

Participants' data for target concept accuracy, whole word accuracy, and flowchart step accuracy are graphed on Figures 3–5. Statistical analyzes are presented in Table 4. Blaine qualified for instruction on three target concepts: /long a/, /long i/, and /ch/. Three concepts were targeted for Kameron: /long i/, /long a/, and /k/. For Miyan, instruction was provided for three concepts: /long a/, /long i/, and /ch/. Through visual analysis, I determined a functional relation between the intervention and dependent variables for all tiers of spelling behaviors across all participants. Statistical analyses indicated that the intervention was effective.

Intervention Effects on Target Concept Accuracy

Blaine

/Long a/. Blaine's baseline target concept accuracy was very stable and low for /long a/ (*M* = 0.0%, range: 0.0%–0.0%). His data immediately improved during training (*M* = 66.7%, range: 33.3%–100.0%). His accuracy maintained higher levels than baseline during fading (*M* = 88.9%, range: 83.3%–100.0%) and maintenance conditions (*M* = 87.5%, range: 66.7%–100.0%).

/Long i/. During baseline, Blaine's /long i/ accuracy was at stable, low levels (*M* = 2.1%, range: 0.0%–33.3%). Following the baseline phase, his data remained at higher levels during training (*M* = 91.7%, range: 83.3%–100.0%), fading (*M* = 88.9%, range: 83.3%–100.0%), and maintenance conditions (*M* = 90.7%, range: 66.7%–100.0%).

/Ch/. Blaine's target concept accuracy was variable and at low to moderate levels under baseline conditions (*M* = 18.2%, range: 0.0%–50.0%). He achieved mastery criteria after two sessions during the training phase (*M* = 83.3%, range: 83.3%–83.3%). Blaine's accuracy was higher than baseline levels in all subsequent phases, and remained stable during fading (*M* = 94.4%, range: 83.3%–100.0%) and maintenance conditions (*M* = 100.0%, range: 100.0%–100.0%).

Kameron

/Long i/. Kameron's target concept accuracy was at constant, low levels during baseline (*M* = 0.0%, range: 0.0%–0.0%). His data immediately improved during training (*M* = 70.8%, range: 33.3%–100.0%). His accuracy sustained these high levels over baseline levels during fading (*M* = 77.8%, range: 66.7%–83.3%) and maintenance (*M* = 91.7%, range: 66.7%–100.0%).

/Long a/. During baseline, Kameron's /long a/ target concept accuracy was at steady and low levels (*M* = 4.2%, range: 0.0%–33.3%). His first datapoint in the training phase is the only datapoint that overlaps with baseline levels, and the other 12 data points in training (*M* = 66.7%, range: 33.3%–83.3%), fading (*M* = 100.0%, range: 100.0%–

100.0%), and maintenance (*M* = 85.7%, range: 66.7%–100.0%) are at higher levels than baseline data.

/K/. Kameron's /k/ target concept accuracy was variable and at low to moderate levels during baseline (*M* = 21.1%, range: 0.0%–50.0%). Although this variability continued throughout the subsequent phases, his accuracy generally remained at higher levels than baseline levels in training (*M* = 78.6%, range: 16.7%–100.0%), fading (*M* = 87.5%, range: 66.7%–100.0%), and maintenance (*M* = 89.6%, range: 50.0%–100.0%).

Miyan

/Long a/. Miyan's baseline data were at steady, low levels (*M* = 0.0%, range: 0.0%–0.0%). His data improved immediately with training to use the flowcharts (*M* = 61.1%, range: 16.7%–83.3%). He maintained these increases over baseline data through fading (*M* = 75.0%, range: 50.0%–83.3%) and maintenance (*M* = 83.3%, range: 66.7%–100.0%).

/Long i/. Similar to his /long a/ baseline data, Miyan's /long i/ target concept accuracy was at constant, low levels during baseline (*M* = 0.0%, range: 0.0%–0.0%). Miyan's data immediately increased with introduction of the intervention and never overlapped with the baseline data during training (*M* = 83.3%, range: 66.7%–100.0%), fading (*M* = 100.0%, range: 100.0%–100.0%), or maintenance (*M* = 88.1%, range: 66.7%–100.0%).

/Ch/. Miyan's /ch/ baseline accuracy was at low levels with some variability (*M* = 19.4%, range: 0.0%–33.3%). Although this variability continued throughout the rest of the /ch/ intervention phases, his target concept accuracy improved over baseline levels during training (*M* = 66.7%, range: 16.7%–100.0%), fading (*M* = 94.4%, range: 83.3%–100.0%), and maintenance (*M* = 92.9%, range: 66.7%–100.0%). Only one session for target concept accuracy fell to baseline ranges after the intervention was introduced, and this was the second session of fading.

Intervention Effects on Whole Word Accuracy

Blaine

/Long a/. Blaine demonstrated steady low levels of whole word accuracy in baseline (*M* = 0.0%, range: 0.0%–0.0%). His data immediately improved in training and demonstrated as ascending trend (*M* = 42.9%, range: 16.7%–83.3%). Although variable, his data remained at higher levels than baseline during fading (*M* = 61.1%, range: 50.0%–67.7%) and maintenance (*M* = 56.3%, range: 33.3%–83.3%).

/Long i/. Blaine's baseline data consistently demonstrated low levels of accuracy (*M* = 2.1%, range: 0.0%–16.7%). His data immediately improved with introduction of the intervention and sustained increases over baseline levels. Blaine demonstrated variable whole word accuracy throughout training (*M* = 66.7%, range: 33.3%–100.0%), fading (*M* = 72.2%, range: 66.7%–83.3%), and maintenance (*M* = 58.5%, range: 16.7%–83.3%).

/Ch/. Blaine's whole word accuracy for words with /ch/ sound were slightly variable at low levels (*M* = 7.6%, range: 0.0%–33.3%). His data improved in training (*M* = 66.7%, range: 66.7%–66.7%), and only fall into baseline ranges once during fading (*M* = 66.7%, range: 33.3%–100.0%) and maintenance (*M* = 58.3%, range: 50.0%–83.3%).

Kameron

/Long i/. During baseline, Kameron demonstrated consistent, low levels of whole word accuracy (*M* = 0.0%, range: 0.0%–0.0%). His first data point during training remained in baseline ranges, then improved with some variability (*M* = 37.5%, range: 0.0%–66.7%). Kameron's data remained higher than levels from baseline conditions during fading (*M* = 66.7%, range: 50.0%–83.3%) and maintenance conditions (*M* = 63.9%, range: 33.3%–83.3%) with some variability.

/Long a/. Kameron demonstrated steady levels of minimal whole word accuracy in baseline (*M* = 0.0%, range: 0.0%–0.0%). His data in training started in baseline ranges, then demonstrated an ascending trend (*M* = 33.3%, range: 0.0%–83.3%). Although highly variable, Kameron's data sustained increases over baseline levels in fading (*M* = 44.4%, range: 33.3%–50.0%) and maintenance (*M* = 52.4%, range: 33.3%–66.7%).

/K/. Kameron's whole word accuracy was remained at low levels throughout baseline (*M* = 1.5%, range: 0.0%–16.7%). His whole word accuracy improved in training (*M* = 50.0%, range: 0.0%–83.3%), fading (*M* = 50.0%, range: 16.7%–66.7%), and maintenance (*M* = 50.0%, range: 33.3%–66.7%), only falling into baseline ranges twice.

Miyan

/Long a/. Under baseline conditions, Miyan's whole word accuracy was constantly at very low levels (*M* = 0.0%, range: 0.0%–0.0%). Although his first data point in training conditions remained in baseline ranges, the subsequent data improved above baseline ranges in training (*M* = 33.3%, range: 0.0%–66.7%), fading (*M* = 37.5%, range: 33.3%–50.0%), and maintenance conditions (*M* = 45.2%, range: 33.3%–66.7%).

/Long i/. Miyan demonstrated consistent, low levels of whole word accuracy under baseline conditions (*M* = 0.0%, range: 0.0%–0.0%). His data immediately improved with introduction of the intervention and remained at higher levels than baseline levels. His improved accuracy in training (*M* = 44.4%, range: 16.7%–100.0%), fading (*M* = 44.4%, range: 33.3%–50.0%), and maintenance (*M* = 54.8%, range: 33.3%–66.7%) were variable.

/Ch/. His accuracy for whole words containing the /ch/ was minimal and steady (*M* = 1.4%, range: 0.0%–16.7%). During intervention, his data improved over baseline levels with only one data point falling into baseline ranges. Although variable, Miyan's /ch/ whole word accuracy increased during training (*M* = 41.7%, range: 0.0%–66.7%), fading (*M* = 66.7%, range: 50.0%–83.3%), and maintenance (*M* = 52.4%, range: 33.3%–83.3%).

Intervention Effects on Flowchart Step Accuracy

Blaine

/Long a/. Blaine's flowchart step accuracy was extremely stable and low during baseline (*M* = 0.0%, range: 0.0%–0.0%). His data immediately improved during training (*M* = 72.9%, range: 50.0%–90.0%), and sustained these increases over baseline conditions during throughout fading (*M* = 93.3%, range: 90.0%–100.0%) and maintenance sessions (*M* = 86.3%, range: 70.0%–100.0%).

/Long i/. Similar to the /long a/ baseline data, Blaine's flowchart step accuracy was at low levels and demonstrated no variability (*M* = 0.0%, range: 0.0%–0.0%). His accuracy increased during training (*M* = 95.0%, range: 90.0%–100.0%). His data were at high levels with little variability during fading (*M* = 96.7%, range: 90.0%–100.0%) and maintenance (*M* = 92.2%, range: 80.0%–100.0%).

/Ch/. Blaine demonstrated minimal levels of accuracy during baseline (*M* = 0.0%, range: 0.0%–0.0%). In subsequent phases, Blaine's data was improved over baseline levels with no overlap with baseline ranges. Specifically, Blaine's data were at high levels in training (*M* = 75.0%, range: 70.0%–80.0%), fading (*M* = 87.2%, range: 70.0%–100.0%), and maintenance conditions (*M* = 96.7%, range: 90.0%–100.0%) with little variability.

Kameron

/Long i/. During baseline, Kameron demonstrated stable, low levels of flowchart step accuracy (*M* = 0.0%, range: 0.0%–0.0%). His accuracy immediately improved with training (*M* = 87.5%, range: 80.0%–100.0%). His data sustained these improved levels throughout fading (*M* = 93.3%, range: 90.0%–100.0%)and maintenance (*M* = 95.0%, range: 80.0%–100.0%). Data from training, fading, and maintenance conditions remained higher than ranges from baseline conditions.

/Long a/. Kameron's demonstrated minimal flowchart step accuracy with no variability during baseline (*M* = 0.0%, range: 0.0%–0.0%). His data demonstrated an ascending trend over baseline levels in training (*M* = 83.3%, range: 50.0%–100.0%), and continued at these high levels of accuracy throughout fading (*M* = 76.7%, range: 70.0%–80.0%) and maintenance (*M* = 80.0%, range: 70.0%–100.0%).

/K/. Similar to his /long i/ and /long a/ data, Kameron's /k/ flowchart step accuracy was consistently low (*M* = 0.0%, range: 0.0%–0.0%). Following introduction of the intervention, his data immediately improved and never overlapped with baseline ranges. He demonstrated some variability, albeit at high levels, throughout training (*M* = 78.6%, range: 45.5%–100.0%), fading (*M* = 87.2%, range: 84.6%–92.9%), and maintenance phases (*M* = 84.3%, range: 78.6%–100.0%).

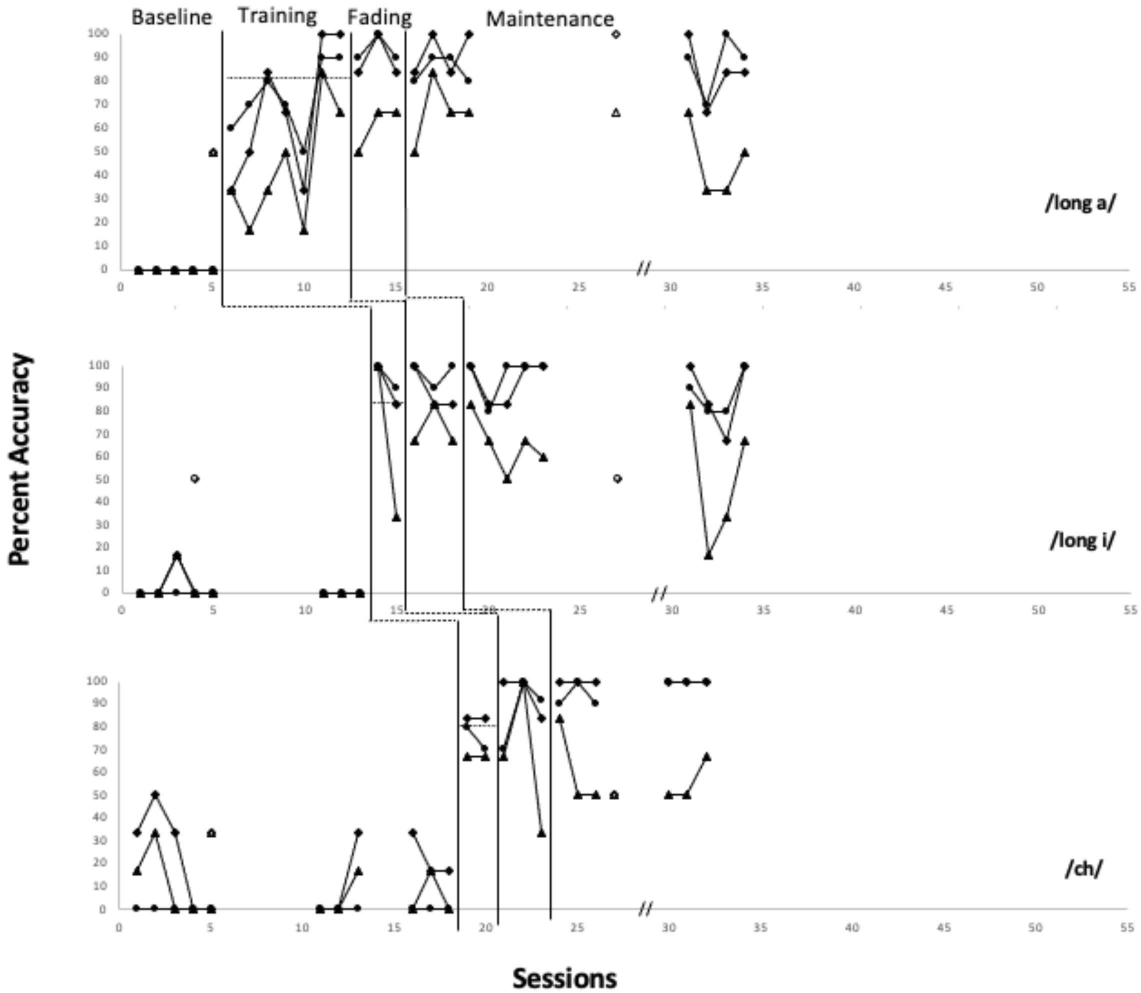
Miyan

/Long a/. Miyan's flowchart step accuracy demonstrated no variability and was at extremely low levels during baseline (*M* = 96.7%, range: 90.0%–100.0%). His data immediately improve over baseline levels throughout training (*M* = 96.7%, range: 90.0%–100.0%), fading (*M* = 96.7%, range: 90.0%–100.0%), and maintenance phases (*M* = 96.7%, range: 90.0%–100.0%).

/Long i/. During baseline, Miyan's flowchart step accuracy was low and stable (*M* = 96.7%, range: 90.0%–100.0%). Following introduction of the intervention, Miyan's accuracy immediately improved and sustained higher levels than baseline levels under training (*M* = 96.7%, range: 90.0%–100.0%), fading (*M* = 96.7%, range: 90.0%–100.0%), and maintenance conditions (*M* = 96.7%, range: 90.0%–100.0%).

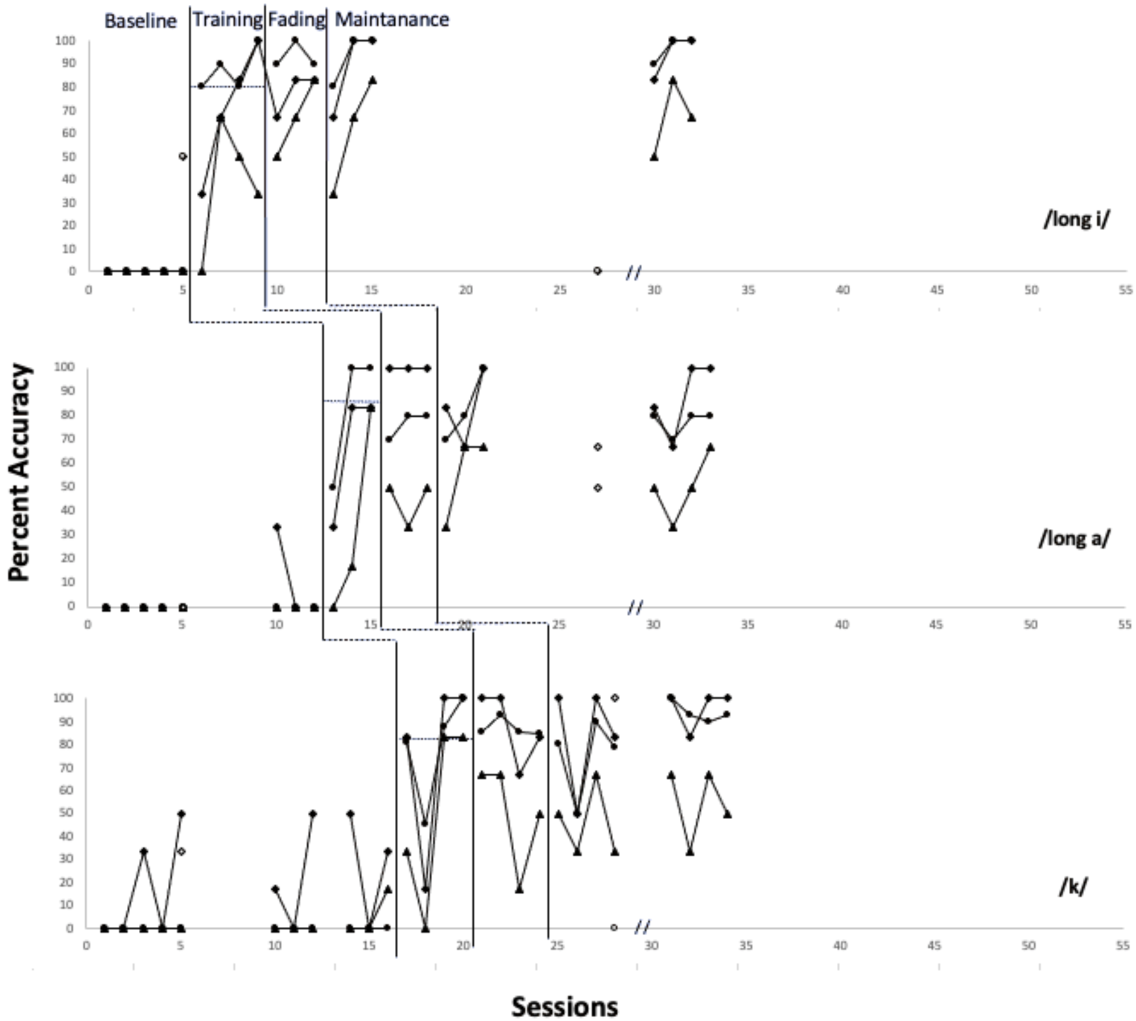
/Ch/. Similar to data patterns /long a/ and /long i/ baseline conditions, Miyan's flowchart step accuracy was very low and demonstrated no variability (*M* = 0.0%, range: 0.0%–0.0%). His data in subsequent phases are higher than baseline levels with no overlap with baseline ranges. He demonstrated high levels of accuracy in training (*M* = 60.8%, range: 23.1%–90.0%), fading (*M* = 94.4%, range: 84.6%–100.0%), and maintenance conditions (*M* = 87.4%, range: 66.7%–100.0%).

Figure 3. Blaine's Results



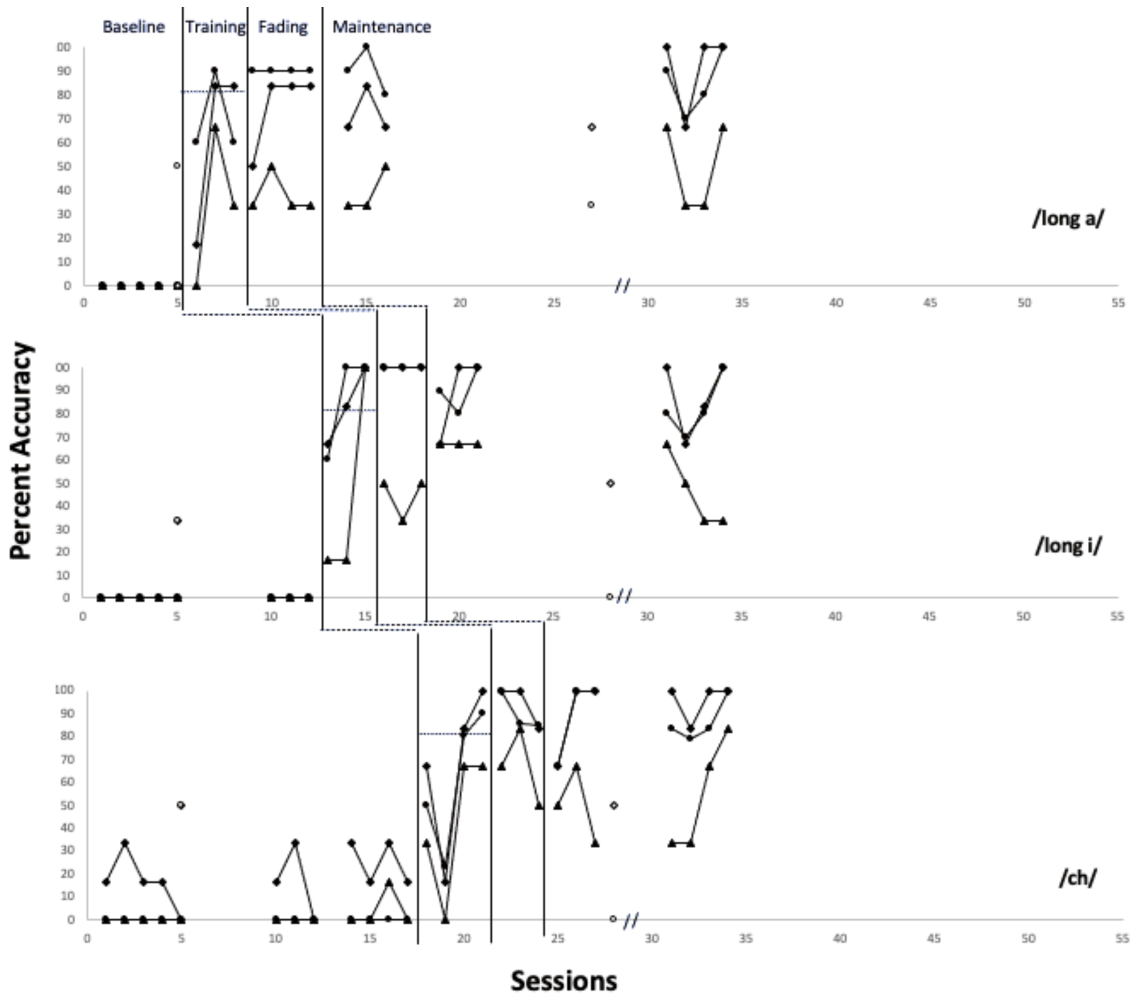
Note. Dashes in x-axis indicate a 2–week time period. Closed diamonds represent target concept accuracy, closed triangles represent whole word accuracy, and closed circles represent flowchart step accuracy. Open diamonds represent generalization data for target concept accuracy, and open triangles represent generalization of whole word accuracy.

Figure 4. Kameron's Results



Note. Dashes in x-axis indicate a 3–week time period. Closed diamonds represent target concept accuracy, closed triangles represent whole word accuracy, and closed circles represent flowchart step accuracy. Open diamonds represent generalization data for target concept accuracy, and open triangles represent generalization of whole word accuracy.

Figure 5. Miyan's Results



Note. Dashes in x-axis indicate a 4–week time period. Closed diamonds represent target concept accuracy, closed triangles represent whole word accuracy, and closed circles represent flowchart step accuracy. Open diamonds represent generalization data for target concept accuracy, and open triangles represent generalization of whole word accuracy.

Statistical Analysis

PND results are reported on Table 4. I used Scruggs and colleagues' (1987) guidance to interpret effects. PND results (*M* = 99.1%, range: 91.7%–100.0%) indicated that the flowchart intervention was effective for increasing target concept accuracy, whole word accuracy, and flowchart step accuracy across all target concepts and for all participants.

Additionally, I calculated Tau-U. I used Tau-U because there was no observed trend in baseline for any of the tiers across the participants. Using Vannest and Ninci's' (2015) recommendations for interpreting Tau-U statistics, the Tau-U results demonstrate that the intervention had very large effects (i.e., all Tau-U scores were greater than .80).

Table 4. PND and Tau-U Results

Participant	Target Concept	Dependent Variable	PND (%)	Tau-U Analysis		
				Tau	*p*	90% CI
Blaine	/long a/	TCA	100.0	1	.002	[.47, 1]
		WWA	100.0	1	.002	[.47,1]
		FSA	100.0	1	.002	[.47,1]
	/long i/	TCA	100.0	1	<.001	[.56,1]
		WWA	100.0	.99	<.001	[.55,1]
		FSA	91.7	1	<.001	[.56,1]
	/ch/	TCA	100.0	1	<.001	[.50,1]
		WWA	100.0	.99	<.001	[.55,1]
		FSA	100.0	1	<.001	[.50,1]
Kameron	/long i/	TCA	100.0	1	<.001	[.45,1]
		WWA	100.0	1	.003	[.45,1]
		FSA	100.0	1	.003	[.45,1]
	/long a/	TCA	100.0	1	<.001	[.54,1]
		WWA	100.0	1	<.001	[.54,1]
		FSA	100.0	1	<.001	[.54,1]
	/k/	TCA	91.7	.98	<.001	[.57,1]
		WWA	91.7	.99	<.001	[.59,1]
		FSA	100	1	<.001	[.60,1]
Miyan	/long a/	TCA	100	1	.002	[.47,1]
		WWA	100	1	.002	[.47,1]
		FSA	100	1	.002	[.47,1]
	/long i/	TCA	100	1	<.001	[.54,1]
		WWA	100	1	<.001	[.54,1]
		FSA	100	1	<.001	[.54,1]
	/ch/	TCA	100	1	<.001	[.58,1]
		WWA	100	1	<.001	[.58,1]
		FSA	100	1	<.001	[.58,1]

Note. TCA = target concept accuracy; WWA = whole word accuracy; FSA = flowchart step accuracy; CI = Confidence Interval

Generalization

Generalization data are graphed on Figures 3–5. The participants' teacher provided classwork for which the students did not receive spelling feedback. Blaine attempted seven words with his target concepts in both his baseline and maintenance work samples. In baseline, Kameron attempted six words that contained his target concepts. Kameron's writing sample contained from maintenance had five words that contained his target concepts. Miyan attempted words with his target concepts seven times in baseline and six times in maintenance work samples.

Target Concept Accuracy

Blaine. For the /long a/ target concept, Blaine demonstrated 50.0% accuracy in baseline. He correctly spelled 'play' and incorrectly spelled 'brave' (i.e., he spelled it 'brav'). His accuracy was 100.0% in maintenance when he accurately spelled the /long a/ in the following words: 'name,' 'lake,' and 'take' (which he spelled as 'tace').

Blaine spelled the /long i/ target concept with 50.0% accuracy in baseline when he accurately spelled 'my' and spelled 'like' as 'liyk.' In maintenance, he demonstrated 50.0% target concept accuracy by again correctly spelling 'my' but misspelling 'by' (i.e., he wrote 'biy').

For his final target concept, /ch/, Blaine demonstrated 33.3% accuracy on his writing sample when he accurately spelled the /ch/ in 'chip' (he wrote 'chp'). He was 50.0% accurate when spelling /ch/ in 'chicken' and punch (which he spelled as 'chikn' and 'pucnh,' respectively).

Kameron. Kameron demonstrated 50.0% accuracy for the /long i/ during his baseline writing sample. He accurately spelled ‘my’ and misspelled ‘white’ as ‘wit.’ He spelled the /long i/ with 0.0% accuracy in maintenance when he spelled ‘like’ as ‘lik.’

Kameron spelled ‘safe’ as ‘saf,’ which resulted in 0.0% accuracy for /long a/ target concept accuracy in baseline. During maintenance, Kameron demonstrated 50.0% accuracy when he spelled ‘play’ and ‘name’ (which he spelled as ‘nae’).

Relative to the /k/ target concept, Kameron was 33.3% accuracy in baseline when he correctly spelled the /k/ in ‘cussing’ and incorrectly spelled ‘work’ and ‘black’ (i.e., he wrote ‘woc’ and ‘blac’). In writing sample from maintenance, Kameron spelled /k/ with 100.0% accuracy in ‘like’ and ‘dark’ (which he spelled as ‘lik’ and ‘drk’).

Miyan. Miyan demonstrated 0.0% target concept accuracy for /long a/ in baseline. He spelled ‘tails’ twice as ‘tals.’ During maintenance, he spelled the /long a/ with 66.7% accuracy in the following words: ‘plays,’ ‘ate,’ and ‘game’ (which he spelled as ‘playz,’ ‘ate,’ and ‘gam’).

Miyan spell the /long i/ target concept with 33.3% accuracy in baseline when he correctly spelled ‘my’ and misspelled ‘fight’ and ‘hive’ (which he spelled as ‘fit’ and ‘hiv’). During maintenance, he demonstrated 50.0% target concept accuracy when he spelled ‘likes’ as ‘lix’ and ‘bite’ as ‘bide.’

For the /ch/ target concept, Miyan demonstrated 50.0% accuracy during baseline when spelled ‘pitch’ as ‘pich’ and accurately spelled ‘chin’. In his writing sample from maintenance, Miyan spelled ‘ouch’ as ‘owch’ and ‘catch’ as ‘cach,’ which resulted in 5.0% target concept accuracy.

Whole Word Accuracy

Blaine. He demonstrated 50.0% whole word accuracy on words with the /long a/ target concept in baseline, correctly spelling ‘play’ and misspelling ‘brave.’ He improved slightly in maintenance when was 66.7% accurate spelling words containing the /long a/ target (i.e., he correctly spelled ‘name’ and ‘lake,’ but spelled ‘take’ as ‘tace’).

Relative to whole word accuracy for words containing /long i/, Blaine was 50.0% accurate in baseline. He correctly spelled ‘my’ and spelled ‘like’ as ‘liyk.’ In maintenance, he was 50.0% accurate on words containing the /long a/ when he spelled ‘my’ and ‘by’ as ‘biy.’

Blaine demonstrated 0.0% accuracy in baseline for the following words that containing the /ch/ target concept: ‘chip,’ ‘lunch,’ and ‘watch’ (i.e., he wrote ‘chp,’ ‘lush,’ and ‘wosh’). Following intervention, he demonstrated 0.0% accuracy on words containing the /ch/, spelling ‘chicken’ as ‘chikn’ and ‘punch’ as ‘pucnh.’

Kameron. He spelled words containing the /long i/ with 50.0% accuracy during baseline when he correctly spelled ‘my’ and wrote ‘white’ as ‘wit,’ On his writing sample from maintenance, he demonstrated 0.0% accuracy when he spelled ‘like’ as ‘lik.’

Relative to whole word accuracy for words containing the /long a/, Kameron was 0.0% accurate in baseline and 66.7% accurate in maintenance. In baseline, he spelled ‘safe’ as ‘saf.’ During maintenance, he correctly spelled ‘play’ and spelled ‘name’ as ‘nae.’

Kameron spelled words with the /k/ with 0.0% accuracy in baseline. He spelled 'cussing' as 'cusing,' 'work' as 'woc,' and 'black' as 'blac.' His whole word accuracy was also 0.0% during maintenance when he spelled 'like' as 'lik' and 'dark' as 'drk.'

Miyan. Miyan spelled the /long a/ sound in tails as 'tals' twice on his baseline writing sample, which results in 0.0% whole word accuracy. During maintenance, he spelled the words containing the /long a/ target concept with 33.3% accuracy. He spelled 'ate,' 'game' as 'gam,' and 'plays' as 'playz.'

Relative to words with the /long i/ target concept, Miyan demonstrated 33.3% whole word accuracy in baseline. He correctly spelled 'my,' but made errors with the vowel spelling in 'fight' and 'hive' (i.e., he spelled 'fit' and 'hiv'). During maintenance, he spelled 'likes' as 'lix' and 'bite' as 'bide,' which results in 50.0% whole word accuracy.

Miyan spelled words containing the /ch/ with 50.0% accuracy on his baseline writing sample. He correctly spelled 'chin' and omitted the 't' in 'pitch.' On his writing sample from maintenance, Miyan demonstrated 0.0% whole word accuracy for words with the /ch/ when he spelled 'ouch' as 'owch' and 'catch' as 'cach.'

Discussion

The purpose of this study was to evaluate the effects of a spelling flowchart intervention on spelling outcomes for three students with learning disabilities and ADHD. Students demonstrated low levels of accuracy with some variability prior to intervention. Following introduction of the intervention, multiple levels of spelling accuracy improved. Results from visual and statistical analysis indicate that the spelling flowcharts were effective tools that improved spelling outcomes for all participants. Students maintained these improvements over an extended maintenance phase. Further, students' flowchart step accuracy increased with relatively brief training. Generalization results were generally positive, although inconclusive. These findings are consistent with the pilot study on the efficacy of these flowcharts (i.e., Harris et al., 2023) and indicate that spelling flowcharts are highly effective in improving student outcomes for students with disabilities.

First, all three participants' spelling accuracy on their spelling probes improved with the intervention. Students' accuracy improved for both target concepts and whole words over baseline levels. Large intervention effects were observed through visual and statistical analyses. These results indicate that the students benefitted from explicit, targeted instruction for spelling patterns within words (Harris et al. 2017). Target concept accuracy increased at a quicker rate, was at higher levels, and demonstrated less variability than whole word accuracy for all participants. Similar to prior studies that measured both lexical and sublexical accuracy, spelling improvements are often reflected more immediately and visibly in sublexical measurements than whole word measurements (McCallum et al., 2014; Zannikos, 2015). All three students in this study were in grade 3 and diagnosed with SLD and ADHD. These three participants demonstrated similar data patterns to a participant from a prior study who was in 2nd grade and diagnosed with SLD and ADHD (Harris et al., 2023). When taken together, findings from this study and the prior pilot study implementing a spelling flowchart intervention suggest that students with this profile improved their lexical and sublexical accuracy (i.e., disability diagnosis and age), although more research is needed to explore this.

Second, the spelling flowchart intervention had immediate and positive effects on flowchart step accuracy for all participants. Although students had access to the flowcharts during baseline, students did not attempt to use the flowcharts, and thus did not demonstrate accuracy in using the flowcharts, until they received instruction about these tools with practice opportunities. This is consistent with the literature that recommends educators explicitly teach students to use graphic organizers, then follow up said instruction with guidance and feedback (Ciullo & Reutebuch, 2013). Additionally, effects were observed immediately following introduction of the intervention. All participants demonstrated increased accuracy using the flowcharts on the first day of the training phase. This indicates that relative brief training can have beneficial effects. Further, these improved levels of accuracy maintained over baseline levels for all students across all tiers of spelling behaviors.

Third, generalization measures of target concept accuracy were generally positive. However, generalization measures demonstrated little to no effect on whole word accuracy for participants. By and large, students demonstrated lower levels of spelling accuracy on classwork during baseline conditions when compared to classwork under maintenance conditions. Specifically, students improved target concept accuracy for six of the nine total tiers of spelling behaviors. For two tiers (i.e., Blaine's /long i/ and Miyan's /ch/ tiers), participants demonstrated identical target concept accuracy under baseline and maintenance conditions. Notably, Kameron demonstrated decreased accuracy for the /long i/ target concept accuracy in maintenance.

Whole word accuracy under maintenance conditions remained in similar levels to baseline accuracy, suggesting that the intervention was ineffective for increasing students' accuracy on lexical measures of their classwork. It is important to note that generalization data was assessed using classwork provided by the participants' classroom teacher who reported that participants did not receive support or feedback on their spelling for these assignments. Given that these assignments were authentic work samples, the number of words containing target concepts were impacted. As such, all positive generalization results should be interpreted with caution because of the small number of opportunities to demonstrate accuracy.

Implications for Practice

Using flowcharts in combination with explicit spelling instruction is an effective and feasible approach for improving student outcomes. Student outcomes did not improve in baseline when they were given the flowcharts; spelling accuracy did not increase until students received instruction and guided practice opportunities during the training phase. This study further supports existing research indicating that educators must explicitly teach how to use graphic organizers and provide support to students in order for these tools to be most effective (Ciullo & Reutebuch, 2013). Therefore, educators must be intentional with the graphic organizers they provide students and pair with instruction on how to effectively use these curricular adaptations.

Additionally, educators can glean more information about their students' learning when they assess spelling on multiple levels. Similar with prior research about assessing lexical and sublexical accuracy (McCallum et al., 2014; Zannikos, 2015), the results of this study indicate that students' accuracy on word parts improves prior to their spelling of whole words. This is critical for teachers to know if their instruction on a particular concept is having effects for students. Further, it can help students see their progress and feel a sense of success while engaging in a challenging academic task like spelling.

Limitations and Directions for Future Research

There were several limitations to this research study. First, although a functional relation was observed in their data, single-case research requires replication to determine external validity. As such, further research is needed to explore the effects of this intervention for other participants and in novel settings. Second, a formal social validity measure was not incorporated to assess students' perceptions of the intervention. It is important to understand students' perceptions of the value, feasibility, and importance of an intervention; as such, future research should incorporate a measure to assess social validity. Third, generalization data were calculated using writing samples that were very limited in the number of attempted words that contained target concepts for participants. As such, generalization effects should be interpreted with caution. Future research should examine more writing samples to explore potential generalization of skills. Fourth, no standardized measure was incorporated in this intervention. Additional research should incorporate a standardized measure for written expression to explore generalization of spelling improvements. Fifth, spelling and phonics instruction in this setting was not systematic or recursive. Similar to other alternative school settings for students with challenging behavior (Beken et al., 2009), effective academic instruction for these students was lacking and the classroom teacher openly discussed her need for further training and support to implement adequate instruction. Given the lack of targeted and systematic instruction, intervention effects observed in this study might be more robust than they would be in schools with more structured curriculum and trained staff. Furthermore, it was difficult to discern if the students' improvements were attributable to the impacts of the flowchart intervention or to additional instruction and feedback for spelling. As such, future research should compare this flowchart intervention to other explicit instruction programs.

Conclusion

A spelling flowchart intervention, combined with direct instruction to accurately use the flowchart, supports spelling outcomes for elementary students diagnosed with SLD and ADHD. Findings demonstrate that students' sublexical and lexical accuracy improved with the intervention. These improvements continued after instruction ceased, suggesting that the relatively brief training supported students' maintenance of the new spelling skills. Although generalization data were collected, the effects of the intervention on students' independent classwork are unclear. The results affirm existing research that flowcharts are effective tools to support decision-making for students with disabilities.

Chapter 4. Practitioner Paper

The following chapter describes strategies for practitioners to use when creating flowcharts for their classrooms.

Abstract

Graphic organizers are often used to enhance instruction for students with disabilities. However, one specific type does not get enough attention: flowcharts. In this practitioner paper, I define flowcharts, name their essential components, and provide guidance for teachers when creating them. I recommend strategies for implementing these visual tools. Examples of flowcharts are included that demonstrate how to use these tools as an academic and behavior support.

Keywords: flowchart, graphic organizer, special education

GO with the FLOW!

Federal law mandates that educators provide students with disabilities a free and appropriate public education that is designed to meet the individual needs of learners (IDEIA, 2004). To achieve this, educators often need to modify or enhance classroom tasks and materials to support learning for these students (Alber-Morgan et al., 2022). Students with disabilities often are affected by underlying executive functioning deficits, and this particularly impacts students during complex academic tasks which require students to sort, organize, and prioritize important components of the task or problem-solving activity (Meltzer & Krishnan, 2007). As such, educators must adapt or modify their instruction and materials to support students during these activities. Teachers must use evidence-based-practices (EBPs) to ensure students with disabilities can access these learning tasks (Udvari-Solner & Thousand, 2018).

Explicit instruction is an EBP for students with disabilities (Archer & Hughes, 2011; McLeskey et al., 2022). Explicit instruction is an instructional approach that is direct and systematic, breaking large concepts and tasks into smaller parts (Riccomini et al., 2017). Task analysis is a frequently used tool that chunks a goal-oriented task into discrete steps (Cooper et al., 2020; Snodgrass et al., 2017). A task analysis describes a set of steps that must occur sequentially to complete a larger goal or task (Steege et al., 2007). Task analyses are very helpful for outlining one specific process. But what about when students need to select between processes or they are have to incorporate situational context when completing a process? For example, how does a student know they *should* wash their hands.?

Flowcharts can be thought of as multiple task analyses combined into one tool that can help students accomplish a task while accounting for the current circumstances and considerations. Further, these tools chunk complex processes into succinct language with a logical flow of smaller steps (Smith et al., 2016), and this type of systematic instruction helps minimize the load on working memory.

Flowcharts, also known as decision trees and flow diagrams, are a type of graphic organizer that have been used to support decision-making in a variety of fields. They have been used as tools in dentistry and medical education to help students apply knowledge to situational, real-world problems (DeMeo, 2007; Stachon & Konowicz, 2011). Also, these instruments are frequently used in software development to communicate about code, represent complex ideas, and to problem-solve (Ensmenger, 2016). When flowcharts are used in educational settings, they are most often used in science, technology, engineering, and mathematics fields (Hicks & Bevsek, 2012).

Although flowcharts are a common tool used in other fields, there is evidence they may be useful instructional tools for students with disabilities. For instance, Woodward (1988) examined the impacts of flowcharts to support health content knowledge and decision-making for high school students with disabilities. This research was extended in 1993 when Hollingsworth and Woodward used flowcharts to support instruction on a health unit for middle and high school students with learning disabilities. Results from these studies indicated that students improved their content knowledge and problem-solving skills (Hollingsworth & Woodward, 1993; Woodward, 1988).

Recently, Harris et al. (2023) implemented a flowchart to support spelling instruction. Two students spelled more accurately with the flowchart and were able to use the tools correctly with little training. Additionally, the study described in Chapter 3 of this dissertation found positive results using these flowcharts for students with learning disabilities and ADHD. In both studies with these spelling flowcharts, visual and statistical analyses indicated large, positive effects.

Many academic tasks require students to make decisions and solve problems. For students with disabilities, this can be overwhelming to their executive functioning (Grieve et al., 2014). Often, these students require additional support when problem-solving and making decisions. Specifically, organizing ideas and prioritizing among these ideas is a challenge for students with disabilities (Rosen et al., 2014). Flowcharts can be effective curricular enhancements to support students during these tasks. The purpose of this article is to (a) describe a mnemonic and strategies to support educators in creating a flowchart, and (b) provide examples of flowcharts that could be used to support instruction in classrooms.

Parts of a Flowchart

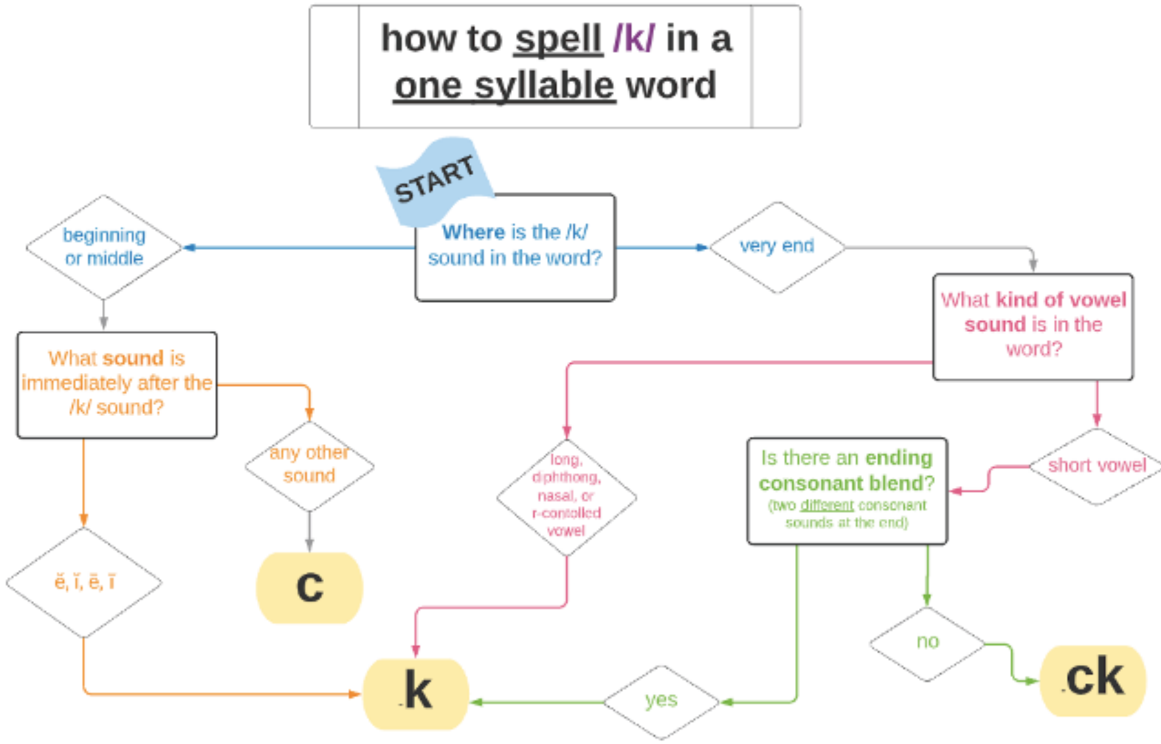
Flowcharts are made by using a variety of parts. While there are many potential parts of a flowchart, I focus on the three that I deem as essential in this paper (see Table 5). I chose to focus on these three elements because this simplifies the structure conceptually and visually, while also maintaining the components to support decision-making.

These critical pieces of a flowchart are depicted in Table 6 and are the following: decisions, branches, and endpoints. The examining the flowchart in Figure 6 shows the following four *decisions* incorporated into the flowchart and are shown in rounded rectangles: (1) Where is the /k/ sound in the word? (2) What sound is immediately after the /k/ sound? (3) What kind of vowel sound is in the word? And (4) Is there an ending consonant blend? These decisions represent questions that a student must answer to move through the flowchart.

Table 5. Flowchart Elements

Elements	Description
Decisions	Guiding questions that help break problem solving process into smaller parts
Branches	Answer options to the decision question
Endpoints	Final outcome of the flowchart

Figure 6. Flowchart Example

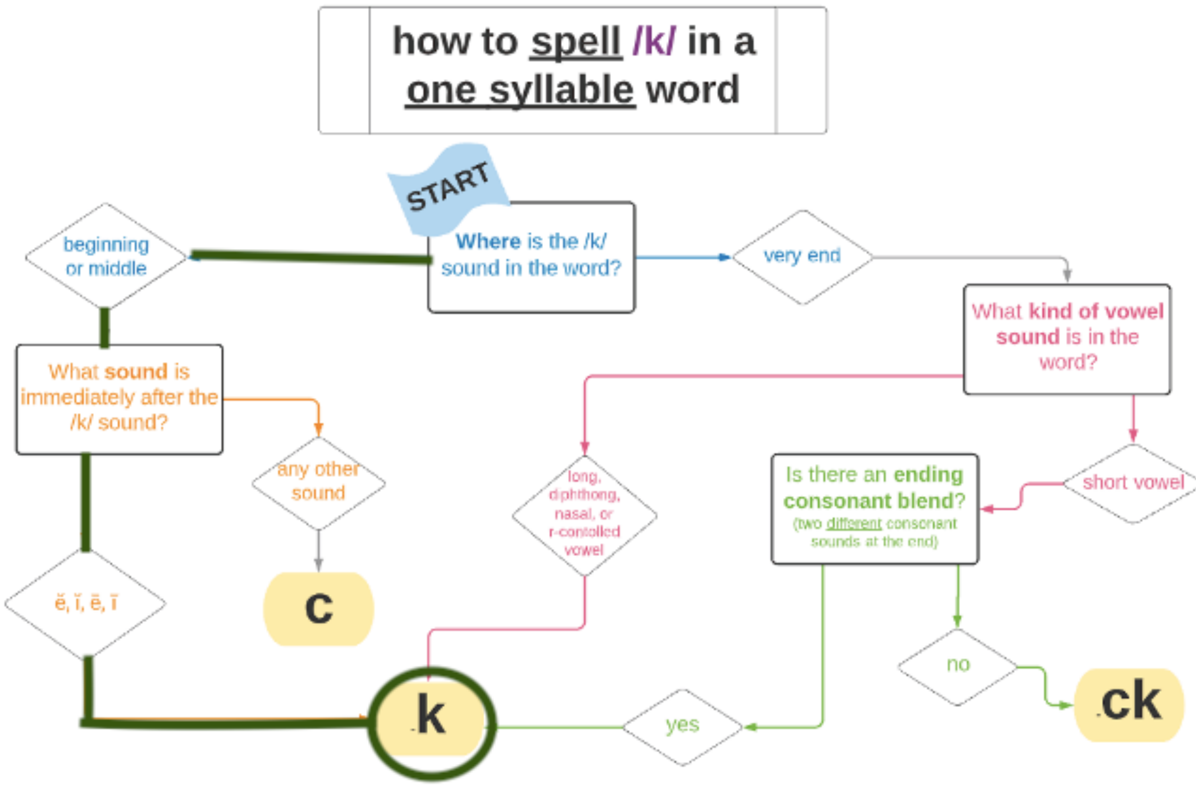


Once a student has considered the decision, they will select a *branch* off of that decision. In Figure 6, off of the first decision are two branches indicated by arrows, one for a student to select if the /k/ sound was at the beginning or middle of the word and a different decision for if the /k/ sound was at the very end. The student would select the appropriate decision given the word they wish to spell.

The student would continue evaluating decisions and selecting branches until they come to an *endpoint*. An endpoint represents the final outcome for the flowchart (in Figure 6, this would be spelling the /k/ with either a c, k, or ck).

Although not a structural element of a flowchart, the *path* is the specific course that student took through decisions and paths. Unlike structural elements of the flowchart, the path a student takes is not static. Paths are the thought process a student makes when using the flowchart to select an endpoint. Figure 7 is marked with the correct path a student would take when selecting /k/ spelling for 'kit.' Educators can instruct their students to show their path by drawing on it (e.g., with a dry erase marker on a flowchart nested within a sheet protector) so they can identify on which branch the student made an error. This then allows for immediate and specific corrective feedback on those errors, which is critical for students with disabilities so that they don't practice errors (Bennett & Cavanaugh, 1998).

Figure 7. ‘Kit’ Path on /k/ Flowchart



Developing a Flowchart

When creating a flowchart, teachers should follow the of four steps of FLOW: (1) find your focus, (2) lead to endpoints, (3) orient to those endpoints, and (4) weave together decisions and branches. These steps, along with important questions to guide each step, are depicted on Table 6.

Step 1: Find Your Focus

Educators must determine the overall goal of the flowchart. What is it that you want students to be able to successfully accomplish when using the tool? When selecting a focus, select skills that require systematic thinking. A flowchart is similar to systematic instruction in that it supports learners to problem solve larger by chunking a large skill and problem into smaller, sequenced subskills (Archer & Hughes, 2011). Pick a large goal as your focus that has multiple subskills. See Table 7 for examples of focuses in several academic areas. For Figure 6, the overall focus of the flowchart was to support students in accurately spelling the /k/ sound in a one syllable word. The accompanying subskills to this larger focus related to correctly identifying the location of the /k/ sound in a word, and its relation to the surrounding sounds and spelling of those sounds in a word. Be mindful when selecting a focus—some skills are too expansive to depict in one flowchart (e.g., spelling *all* consonant sounds would be too complex).

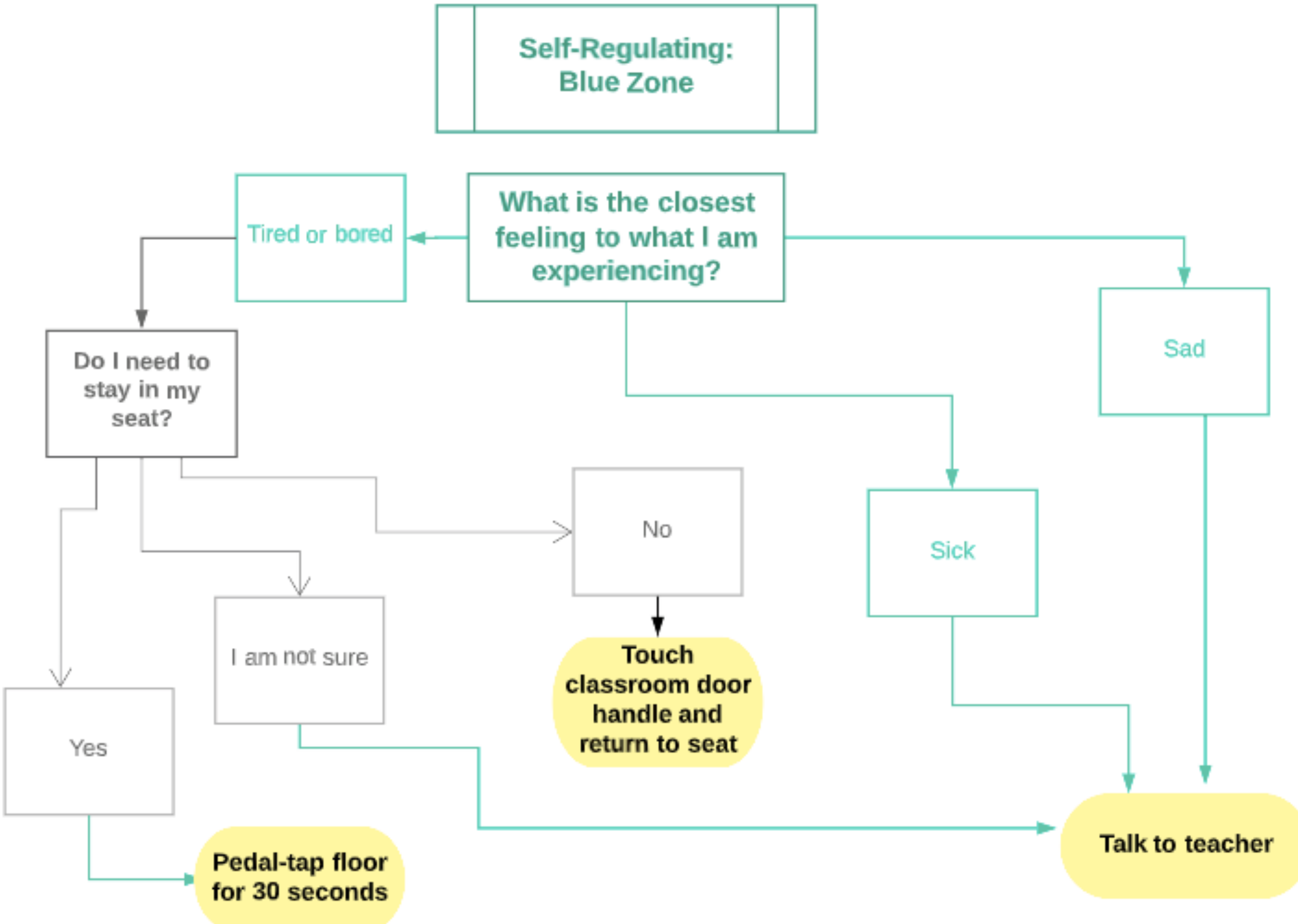
Table 6. FLOW

	Step	Guiding Questions
F	1. Find your **Focus**	What large skill am I targeting? Does this large skill require decision-making or problem-solving?
L	2. **Lead** to Endpoints	What are the specific outcomes I want students to arrive at when decision-making?
O	3. **Orient** to those Endpoints	How will I get students to make those decision? What contextual factors need to be accounted for when decision-making?
W	4. **Weave** together Decisions and Branches	How do these endpoints relate? What decisions best guide my students to those endpoints? How should I sequence decisions in a logical and succinct way?

Table 7. Possible Focuses for Flowcharts

Academic Content Area	Potential Specific Focus or Skill
Writing	• Selecting appropriate transition words • Evaluating the quality of evidence/credibility of sources
Math	• Selecting an appropriate formula to use in a given situation • Multiplying and dividing fractions
Science	• Decision making for trial and error during science labs

Figure 8. Flowchart for Self-Regulation



Step 2: Lead to Endpoints

A teacher must define the endpoints that are the potential outcomes for the focus. What are the outcomes that students must decide between? These are the specific observable behaviors the student will demonstrate if they accurately use a flowchart. When revisiting Figure 6, the focus (i.e., spelling /k/ in a one syllable word) had three potential endpoints (i.e., c, k, and ck). If a student correctly used this flowchart, the teacher would know because of the student's resulting spelling of the /k/ sound on an assignment.

Figure 8 is a flowchart that could be used to help students self-regulate. Specifically, this flowchart is to support students familiar with the Zones of Regulation, and who have identified that they are in the blue zone, select a strategy to help themselves regulate (Kuypers &Winner, 2011). I created this flowchart because students often could identify the zone they were in, but then struggled to identify next steps to self-regulate. The endpoints of this flowchart are teacher-approved options for students to select. If a teacher would prefer students try a different strategy than pedal-tapping, they would change the endpoint to whatever behaviors are accepted.

Step 3: Orient to those Endpoints

List the considerations must make when selecting an endpoint. What contextual factors should be considered when selecting an appropriate endpoint? With Figure 8 in mind, students must analyze if it is an appropriate time for them to get out of their seat. Teachers must explicitly teacher these times to students. For example, a teacher might say students can always have the choice to get out of their seats during independent reading time but never during a math sprint. These contextual factors are necessary to teach so that students are able to independently select an appropriate endpoint. For students to correct use the flowchart in Figure 6, students need to have learned about vowel types and consonant blends in order to correctly select the correct path for spelling /k/. When orienting, you should list all of the contextual factors needed to select an accurate or appropriate endpoint. It can be helpful to do so using post-it notes so that you are focused on identifying each contextual factors and not sequencing them into a list before you've identified all potential factors.

Step 4: Weave together Decisions and Branches

This is when you articulate the contextual factors into decisions. With Figure 6, the contextual factors students must analyze include the following: location of /k/ sound, sounds preceding /k/ sound, and sounds following /k/ sound. When weaving, teachers should articulate specific and targeted questions aimed at determining the current contextual factors. These questions will serve as the guiding pieces that help students focus on one specific factor at a time, and this will support their working memory and cognitive load (Meltzer et al., 2021). Additionally, teachers must sequence the decisions and branches so that they are in a logical order. Students would only need to analyze if there is an ending consonant blend when using the flowchart on Figure 6 for words that end in the /k/ sound and that have a short vowel. As such, it is more appropriate for the question about consonant blends to be sequentially following two decisions that require students to analyze /k/ location and vowel type.

Putting it all Together

Educators must teach students *how* to use flowcharts. When introducing these tools, educators should explicitly teach the structure of the GO, how to use it, and give multiple opportunities to practice using the tool with feedback (Ciullo & Reutebuch, 2013; Knight et al., 2013). For example, when teaching students to use the flowchart in Figure 8, teachers must model correct usage: "I am in the blue zone and my body feels off, I want to get into the green zone. I need to pick a strategy to regulate my body." Then go through the flowchart with students, describe how they are making decisions and their path, and finishing by selecting an endpoint. Next, the teacher must provide practice opportunities for the students to practice using the flowchart. To be most effective, teachers should enhance these practice opportunities with immediate feedback, both behavior specific praise and immediate error correction (Harris et al., 2023). Following these steps increases students' independence and accuracy when using visual tools (Ewoldt & Morgan, 2017). These are adaptable curricular enhancements that can be support problem solving in academic and nonacademic areas. When implementing flowcharts, remember to go with the FLOW!

Chapter 5. Discussion

All students deserve quality education. I am passionate about improving outcomes for students by developing, testing, and disseminating sustainable approaches for better supporting teachers, paraeducators, and families to implement evidence-based practices. My experiences as a practitioner inspired me to start my doctoral studies and to conduct research with students who are historically marginalized. My research is focused on two interconnected topics related to working with students with high-incidence disabilities: effective literacy instruction and training practitioners to implement evidence-based practices. In Chapter 1, I discussed how graphic organizers can be effective curricular adaptations to support executive functioning for students with disabilities. Next in Chapter 2, I reviewed the current literature to discuss spelling outcomes for students with learning disabilities following reading, writing, and spelling interventions. Although intervention effects were generally positive for spelling outcomes, students improved most consistently with one-on-one instruction, multiple practice opportunities, and immediate error correction. These intervention components were incorporated in my research study presented in Chapter 3. I implemented a flowchart tool to support spelling for three elementary students with SLD and ADHD in an alternative setting. Results from this study supported findings from a previous study that student outcomes improved with explicit instruction to use a spelling flowchart tool (Harris et al., 2023). Encouraged by the favorable outcomes from this study, in Chapter 4, I provide a guide for practitioners to use flowcharts in their practice and provide examples for use across academic areas. This final chapter of my dissertation will conclude by outlining the development of this dissertation, and my future career goals and research aims.

Development of this Dissertation

This dissertation is a culmination of my experiences as an educator, student, and researcher. As an educator, I have worked with students aged 3 through 14 in the following settings: a private preschool, an urban charter school, an urban public school, multiple suburban public schools, and a suburban private school for students with learning differences. I was initially trained at The Ohio State University as an early childhood educator in general education. Following this training and preparation as a general educator, I was hired to work as a 2nd/3rd grade teacher at a private school for students with learning differences. Many of these students were diagnosed with dyslexia and ADHD. I was professionally developed to support executive functioning for my students.

I became more interested and versed in literacy education when I was trained in the Orton-Gillingham Approach and became a Classroom Certified Educator. When planning and implementing instruction, I would draw upon the lessons learned during these professional development training sessions. I implemented literacy instruction with cognitive load in mind, and one day I created a flowchart to support decision-making when spelling. Many of my students improved spelling with the new tool and were able to use it independently.

Although I was encouraged by this anecdotal evidence, I wanted to evaluate the flowchart tool under more rigorous—experimental—conditions. I piloted this study during the 2021–2022 school year with two students in an alternative setting (Harris et al., 2023). Both students improved multiple spelling outcomes and used the flowchart tool with fidelity. Further, they reported the tool made spelling easier.

Following these encouraging experimental results, I wanted to continue exploring the effectiveness of this tool for different populations of students with varied background knowledge and disability status. With this goal in mind, I replicated this intervention for my dissertation with three students who had similar background knowledge, age, and diagnosed disabilities (see Chapter 3). I added a generalization measure to explore the potential effects of this intervention on their classwork.

Career Goals

During my experience as a K–12 educator and working with pre-service teachers, I found that most teachers are motivated and enthusiastic about their jobs and want to help their students learn. However, many of these teachers struggled with knowing how to help their students and what to do when they were struggling. When working as a student-teacher supervisor, this was one of my favorite times to coach a pre-service teacher. Teachers need to be explicitly taught how to find research, how to digest what they are reading, and how to implement it. When they do not have these skills, the research-to-practice gap widens and students ultimately suffer.

My goal is to work with pre-service teachers and to provide quality teacher training so that they are more effective educators for their students. I want to balance my time teaching classes and conducting research in schools so that I am using my research to inform my teaching and vice versa. I believe that in doing so I will be producing more applicable research and will be preparing pre-service teachers to be effective when they enter the field.

Future Research Aims

I would like to continue exploring the effects of these flowchart tools to support spelling outcomes with the ultimate goal of refining the structure and providing training so that educators can use it in the field. To achieve this, my research will focus on the following aims: (a) refining the current flowcharts, (b) evaluating the effects of the flowcharts in a variety of settings for diverse populations and with an assortment of instructional arrangements, and (c) testing more generalized effects of the flowcharts.

To achieve the first aim, I would like to improve the existing flowcharts. I want to incorporate “rule breakers” that aren’t addressed by the options (e.g., the /k/ in ‘school’). I want to evaluate how students are able to account for these rule breakers in future studies.

To achieve this second aim, I plan to replicate my previous studies with diverse students, in a variety of student groupings, and with new implementers. I would like to study the effects of these flowcharts for students from different populations. I would like to explore patterns of responding for students from various cultural and socio-economic backgrounds. Further, I would like to explore effects for students diagnosed and at-risk for disabilities, and for students without disabilities. Additionally, I would like to explore how different instructional groupings impact student outcomes: do students need one-on-one instruction to learn to use the flowcharts, or can small group or class wide instruction be effective? To examine this, I would like to implement the intervention in a variety of instructor-to-student ratios. Further, I would like to explore training other educators to implement the intervention.

Finally, I would like to test more generalized effects of the flowcharts. How do improvements generalize to writing skills and independent classwork? Also, I would like to explore impacts on overall spelling as measured by standardized tests of spelling. I would like to explore interactions between the flowchart and executive function skills.

Conclusion

I feel very lucky to have had the opportunity to develop as an educator and scholar at The Ohio State University. As I look forward to the next chapters in my career, I hope to continue exploring effective literacy instruction and supporting teachers to implement evidence-based practices. I will integrate these two interests in my research, teaching, and service efforts. I am excited to see what the future holds!

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Appendix A. Data Collection Sheet

Data Collection: Spelling with Flowcharts

Implementer: ______________________

Student:___________________________

Observer(s):________________________

IOA: Yes No

Date (Time):_________________________

Target Spelling Concept: ______________

Phase: Baseline Training Maintenance

IOA spelling accuracy:_________________

IOA flowchart step accuracy: ___________

Target Concept Accuracy

Target Spelling Concept:		
Spelling Words	# of opportunities to spell target concept	# of correctly spelled target concepts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Percent of Correctly Spelled Target Concepts (total # of correctly spelling concepts/total # of opportunities to spell target concept)		

Flowchart Step Accuracy

Mark + for correctly completed flowchart step, mark – for incorrect flowchart step, and mark x for missed step on the flowchart.

Spelling Words	Accuracy by Step
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Percent of Correctly Completed Flowchart Steps (total # of correctly completed flowchart steps/# of total flowchart steps)	

Whole Word Accuracy

Mark + for correctly spelled word, mark or – for incorrectly spelled word.

Spelling Words	Word Accuracy
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Percent of Words Spelled Correctly (total # of correctly spelled words/# of total words)	

Notes:

Appendix B. Procedural Fidelity Data Sheet

Procedural Fidelity: Baseline

Implementer: ______________________ Date (Time):_________________________

Student:___________________________ Target Spelling Concept: ______________

Observer(s):________________________ Percent Procedural Fidelity: ___________

Section of Lesson	Procedural Steps	Yes	No	
Lesson Opening	1. Implementer asks the student to select a reinforcer for which to work.			
	2. After the student selects a reinforcer, the implementer reminds the student of behavioral expectations required to earn the reinforcer at the end of the lesson (e.g., try your best, use materials expectedly, etc.).			
	3. Implementer reviews known consonants and vowels and provides the student a list of known vowels and consonants.			
Spelling Probe	**Spelling Probe Words**	**Yes**	**No**	**n/a**
	4. Implementer tells the student to follow the list of steps when spelling the words.			
	5. The implementer gives the student spelling probe words one at a time, and waits to give the student another word until they have completed finished writing the previous probe word.			
	6. If the student doesn't say the word, segment it, or use the flowchart, then the implementer reminds the student to complete the list of steps.			
	7. If the student makes an error when spelling, the implementer waits until the student finishes writing the word then the implementer gives corrective feedback.			
Lesson Wrap Up	8. Implementer praises for behavior and/or names what behavior expectations were not met.			
	9. Implementer gives the student reinforcer if the student displayed expected behaviors or withholds the reinforcer if the student didn't meet behavior expectations.			
Percent of Correctly Implemented Steps: (total "yes" steps/ total "yes" and "no" steps)				

Comments:

Spelling Steps

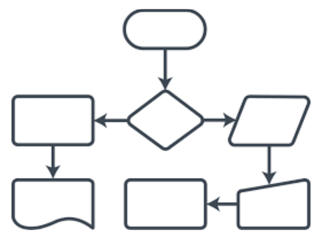
1. Say it

bat

2. Tap it

/b/ /a/ /t/

3. Use the flowchart



4. Spell it

Spelling Probe for /ch/

1. Cheek
2. Match
3. Porch
4. Glotch
5. Choid
6. Shinch

Spelling Probe for /long i/

1. Flight
2. Chive
3. Pry
4. Splive
5. Twy
6. Zight