

# The Science of Teaching Reading is Incomplete without the Science of Writing: A Randomized Control Trial of Integrated Teaching of Reading and Writing

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## ABSTRACT

**Purpose:** We conducted a randomized control trial of an instructional program, SRSD Plus, which integrates reading for writing to inform, writing, oral language, spelling and handwriting for students in Grades 1 and 2.

**Method:** A total of 10 teachers and their 248 students in Grade 1 ( $n = 121$ ) and Grade 2 ( $n = 127$ ) in the southwestern part of the US participated. The teachers included 6 White individuals, 2 Asian Americans, 1 Hispanic individual, and 1 person from another racial or ethnic background. Among the students, 46% were Asian American, 33% were Hispanic, 14% were White, and 5% were identified as multiracial. Teachers were randomly assigned to the SRSD Plus or business-as-usual (BAU) condition; students were assessed at pretest and posttest on writing, oral language, transcription, and reading skills.


**Results:** Multilevel model results showed that students in the SRSD Plus condition outperformed those in the BAU condition in spelling, vocabulary, sentence proficiency, planning from source text, discourse knowledge, and writing productivity and writing quality in source-based informational genre ( $.14 \leq \text{Effect Size [ES]} \leq .72$ ), but not in word reading or handwriting fluency. Furthermore, although not the target genre, there was a positive transfer effect on writing outcomes in the opinion genre ( $.22 \leq \text{ES} \leq .34$ ).

**Conclusion:** Integrated reading and writing instruction in SRSD Plus can improve primary grade students' writing, discourse knowledge, planning, oral language, and spelling skills. Theoretical and practical implications and future directions are discussed in the context of the Science of Teaching Reading.

Reading and writing are essential skills for learning and academic achievement. Recent debate on the Science of Reading and Science of Teaching Reading (Kim & Snow, 2021) has brought substantial public and policy attention to reading development and instruction. The Science of Reading refers to “the accumulated knowledge about reading, reading development, and best practices for reading instruction obtained by the use of the scientific method” (Petscher et al., 2020, p. S268). Kim and Snow (2021) expanded the construct to the Science of *Teaching* Reading (Kim & Snow, 2021), which emphasizes teaching as a key mechanism for student learning, the importance of systematically

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gathering evidence on how reading is taught, and identifying effective instructional practices for students with different needs and characteristics in different contexts.

However, largely missing in this discussion is writing – writing development, writing instruction, and its relationships with reading (Graham, 2020). Leaving writing out of this discussion is contrary to theoretical models and evidence. For example, a recent large-scale meta-analysis showed that word reading and spelling are strongly related (average  $r = .82$  across all tasks and  $r = .92$  when reliability of measures is high) and reading comprehension and written composition are moderately related ( $r = .44$ ; Kim et al., 2024). Furthermore, approximately 75% of individuals with writing difficulties also had reading difficulties (Katusic et al., 2009). A meta-analysis showed that children identified with reading disability had substantially lower writing performance in aspects such as writing quality, organization, vocabulary, syntax, and spelling (Graham et al., 2021). Importantly, studies have shown that writing instruction can support reading development, and reading instruction can help develop writing skills, and teaching them together can improve both reading and writing skills (Graham & Hebert, 2010; Graham et al., 2018). In the present study, we report results of a randomized controlled trial of SRSD Plus, which systematically integrates evidence-based reading and writing instruction for children in Grades 1 and 2 (Harris, Kim et al., 2023).

## Theoretical and empirical background

According to the interactive and dynamic literacy model (Kim, 2020, 2022), reading and writing draw on essentially the same skills (see also the shared knowledge hypothesis, Fitzgerald & Shanahan, 2000) and have bidirectional relationships. Lexical literacy skills—word reading and spelling — involve encoding, storing, and retrieving phonological, orthographic, and semantic information, and draw on phonological, orthographic, and semantic knowledge and awareness (also see Adams, 1990; Treiman, 1992). Discourse literacy skills — reading comprehension and written composition — are built on lexical literacy skills and their component skills, *and* additionally draw on language skills such as vocabulary and grammatical (morphosyntactic and syntactic) knowledge, higher order cognitive skills (e.g., inference, perspective taking, reasoning, monitoring), self-regulation (e.g., goal setting, self-monitoring, self-talk), background knowledge, and socio-emotional aspects (e.g., self-efficacy, attitude, motivation; Kim, 2020, 2022).

Oral language skills, such as vocabulary and syntactic skills, are necessary to parse linguistic information and construct a mental representation of propositions of given texts (i.e., comprehension; Kim, 2016; Kintsch & Rawson, 2005; Wagner et al., 2007) and to accurately express and convey one's ideas (i.e., Berninger et al., 2002; Kim et al., 2011, 2014, 2015). Higher order cognitive skills are also important for readers to connect propositions in the text with their world and content knowledge, and propositions from different parts of the texts to infer or fill in information that is not explicitly stated in the text (i.e., inference; Cain & Oakhill, 2007; Cain et al., 2004; Kim, 2017), and for writers to present ideas and propositions in a logical and coherent way to meet the needs of audience and intended goals (Kim & Graham, 2022; Kim & Schatschneider, 2017). Reading and writing also rely on self-regulation, as each involves the ability to monitor and control one's cognitive processes (Graham et al., 2012; Harris & Graham, 2018; Kim & Graham, 2022; Limpo & Alves, 2013). Self-regulated readers are better at setting goals, monitoring their understanding, and employing and adjusting reading strategies (e.g., Baker & Brown, 1984; Veenman et al., 2006). Similarly, self-regulated writers are more adept at setting goals, planning, self-assessing and monitoring, maintaining attention and persistence, and using appropriate writing strategies (Harris & Graham, 2016). Meta-analyses showed that explicit teaching of self-regulation strategies improves students' writing skills (Graham & Perin, 2007; Graham et al., 2012, 2023).

Knowledge, such as world, topic knowledge, and discourse knowledge, also plays a crucial role in reading and writing. World and topic knowledge are important for integrating the text-based mental representation to construct a quality situation model (Kendeou et al., 2003; Kintsch, 1988). They also provide source materials for written composition and allow rapid access to content,

which releases cognitive resources available for other writing processes (Benton et al., 1995; Kellogg, 1987). Discourse knowledge includes knowledge of text structure and associated key linguistic features, and procedures and strategies (Bereiter & Scardamalia, 1987; Kim & Graham, 2022; Olinghouse et al., 2015). Text structure knowledge provides an organizational structure to help identify important information and understand relations among propositions in different parts of the text for comprehension (Duke & Pearson, 2002). Text structure knowledge, typically referred to as genre structure knowledge in writing, helps writers organize and present their thoughts in a way that is aligned with the target genre and writing goals (Armbruster et al., 1989; Englert & Thomas, 1987; Harris & Graham, 1985). Furthermore, reading and writing skills develop in tandem with socio-emotional factors critical to learning, such as attitudes, beliefs, self-efficacy, and motivation (Harris & Graham, 2018; Kim & Graham, 2022; Kim & Park, 2019).

The interactive dynamic literacy model (Kim, 2020, 2022) also hypothesizes that reading and writing have an interactive or bidirectional relation such that development of one bootstraps development of the other. Reading experiences invoke, strengthen, and reinforce mental representation of the knowledge, skills, and processes that are involved in both reading and writing, thereby supporting writing development. Writing experiences similarly facilitate reading development. Although correlational studies have resulted in inconsistent findings about bidirectional relations (Ahmed et al., 2014; Berninger & Abbott, 2010; Kim et al., 2018; Shanahan & Lomax, 1986), research on teaching reading and writing has indicated a consistent picture. A meta-analysis reviewing 54 experiments showed that teaching reading improves writing outcomes such as writing quality (effect size [ES] = .63) and spelling (ES = .56; Graham et al., 2018). In addition, writing instruction improves reading outcomes: Teaching spelling improves word reading and reading fluency skills, and having students write about the text they read, write summaries of a text, respond to a text, and write notes about a text improved their reading skills with ESs ranging from .40 to .77 (Graham & Hebert, 2010).

Given theoretical rationales and the existing evidence-base, it is not surprising that recommendations for effective literacy instruction include providing students with opportunities to write about the texts they read (Graham & Hebert, 2010), systematically incorporating reading instruction as part of writing instruction (Graham, 2020), and incorporating integrated teaching of reading and writing in addition to separate reading instruction and writing instruction (Graham, 2020; Graham et al., 2016; Kim, 2020, 2022; Mason et al., 2013). In other words, evidence suggests that when reading instruction fails to capitalize on writing instruction and when writing instruction fails to capitalize on reading instruction, students are being deprived of valuable learning opportunities.

### ***An Initial Study of SRSD Plus***

A recent study examined the potential promise of SRSD Plus for students in Grades 1 and 2 from low socio-economic family backgrounds (Harris, Kim et al., 2023). In that initial, small-scale randomized controlled trial study, students were randomly assigned to the SRSD Plus condition or comparison condition, and those in the SRSD Plus condition received small-group (3–4 students) instruction by researcher-hired interventionists who were former teachers. There were no classroom observations of the comparison condition, but classroom teachers reported not having an official writing curriculum, but using the writer's workshop approach. Results showed that students in the SRSD Plus condition had superior performances in writing quality (ES = 1.02), target vocabulary (ES = 2.29), sentence proficiency (ES = .29), and spelling (ES = 1.18) compared to students in the comparison condition. However, there was no detectable effect in handwriting fluency, leading the authors to suggest a need for greater attention to handwriting speed, in addition to accuracy of handwriting, in instruction (Harris, Kim et al., 2023). The present study expands the previous SRSD Plus study in several important ways. First, grades 1 and 2 *teachers* participated in the practice-based professional development (PBPD) of SRSD Plus and implemented it in their classrooms, whereas in the previous study researcher-hired interventionists, who were former teachers, delivered SRSD Plus. Second, teachers in the present study implemented

SRSD Plus as whole-class instruction instead of small-group instruction. Third, we conducted observations of literacy instruction in the comparison condition, thus documenting literacy instruction in the counterfactual condition.

## Present study

In the current study, we examined the effects of an instructional program that systematically integrates reading and writing instruction for children in grades 1 and 2, called SRSD Plus, using a randomized controlled trial design. SRSD Plus is composed of approximately 50–60 minutes of classroom teacher led instruction three times a week for 12 to 14 weeks (a total of 36 sessions). SRSD Plus focuses on reading and writing expository texts in the content area of science. Aligned with the Next Generation Science Standards, Grade 1 texts are about plants and Grade 2 texts are about earth and space. SRSD Plus builds on the evidence-based Self-Regulated Strategy Development instructional model (SRSD; e.g., Graham et al., 2018). SRSD instruction is interactive and discourse based; includes differentiated, explicit, and scaffolded teaching of the writing process; discourse knowledge (e.g., text/genre structure, considering audience); and strategies to regulate reading and writing processes (setting goals, self-assessment, self-instruction, and self-reinforcement; e.g., Harris & McKeown, 2022; Harris et al., 2006, 2008). SRSD Plus additionally addresses word reading and spelling, handwriting fluency, and oral language (vocabulary and sentence structure), which are important to reading comprehension and written composition (see above). Details about SRSD Plus instruction are found in the Method section.

Written composition was assessed in two genres: informative essays in response to source materials, and opinion essays without source materials. Students were further assessed on planning, discourse knowledge, oral language (vocabulary, sentence proficiency), transcription (spelling and handwriting fluency), and word reading immediately before (pretest) and after (posttest) the implementation (see the Measures section below for details).

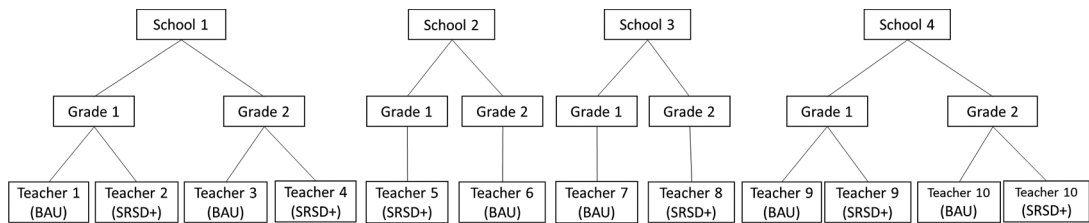
Although only informational writing from source text was targeted in SRSD Plus, students' written compositions for opinion essay writing were assessed to investigate potential generalization. Research indicates limited generalization of learning across "far" genres that have less rhetorical structure in common, indicating each genre needs effective instruction (Graham et al., 2016). However, some SRSD studies have found limited generalization among young students from story writing to personal narrative (close generalization), and persuasive writing to informative writing (far generalization; Harris et al., 2015). Generalization to other genres may be due to shared aspects typical across genres, such as topic sentence, catching the reader, and a good ending, which are taught in SRSD instruction as well as transcription and language skills taught in the plus instruction.

Based on previous research and the first study of SRSD Plus, we hypothesized that students in the SRSD Plus condition would outperform those in the comparison condition in writing (planning from source text, productivity, and quality), discourse knowledge, oral language, spelling, and handwriting fluency. We further hypothesized that SRSD Plus instruction would result in some level of generalization to opinion essay writing. However, we did not anticipate a positive effect on word reading, which was measured by a distal, normed test (see the Measures section below for details), because effects on a distal measure would require greater intensity and dosage than the current 12 to 14 weeks of instruction in SRSD Plus.

## Method

### *Research design and participants*

A randomized controlled trial was conducted with 10 teachers who taught 248 students in Grade 1 and Grade 2 in four schools in the southwestern region of the United States. Six teachers were White, two teachers were Asian American, one teacher was Hispanic, and one teacher was Other race/ethnicity.



**Figure 1.** Assignment to conditions by schools and teachers. *Note.* BAU = Business-As-Usual; SRSD+ = SRSD Plus

Their years of teaching varied from 1 year to 28 years ( $M = 8.11$ ); four of them had a Master's degree while the rest had a Bachelor's degree. All were certified teachers.

Of the 248 students, 121 students were in Grade 1 ( $M_{age} = 6.80$ ,  $SD = .39$ ; 52% female;  $n = 61$  in the SRSD Plus condition &  $n = 60$  in the business-as-usual [BAU] condition) and 127 students were in Grade 2 ( $M_{age} = 7.64$ ,  $SD = .47$ ; 50% female;  $n = 59$  in the SRSD Plus condition &  $n = 68$  in the BAU condition). According to school records, the racial and ethnic characteristics of the student sample were as follows: approximately 14% White, 46% Asian American, 33% Hispanic, 5% multiracial, 2% African American, and .4% Other, and .8% had missing racial and ethnic information. Approximately 18% of the students were eligible for the free and reduced lunch program and 24% were identified as English learners. Approximately 2% of the students had an identified disability. Students with identified intellectual disabilities and severe behavioral problems were not eligible for the study. There was approximately 6% attrition (11 students in the BAU condition and five in the SRSD Plus condition), so the sample size at posttest was 232. Attrition did not differ by treatment status ( $p = .16$ ), eligibility for the free and reduced lunch program ( $p = .38$ ), English learner status ( $p = .63$ ), or biological sex ( $p = .43$ ).

Originally, the intention was to randomly assign teachers to either the SRSD Plus or BAU condition within each grade at a school. However, due to recruitment challenges caused by COVID-19 during the 2021–2022 academic year, that assignment process became complicated (refer to Figure 1). In School 1, therefore, where some courses were taught in Arabic, there were two teachers responsible for teaching English language arts at each grade level. One teacher from each grade was randomly assigned to either the SRSD Plus or BAU condition. Schools 2 and 3, which provided English instruction exclusively, served students from the same neighborhood with highly similar demographic backgrounds. These schools had only one class per grade level, making it impossible to accommodate both the SRSD Plus and BAU conditions within the same school. Consequently, Grade 1 in School 2 was randomly assigned to the SRSD Plus condition, while Grade 1 in School 3 was assigned to the BAU condition. This assignment was reversed for Grade 2 (see Figure 1). School 4 offered a Mandarin-English bilingual program, and there was only one teacher per grade responsible for teaching English literacy skills. Each teacher taught two classes, allowing them to teach both the SRSD Plus and BAU conditions (see School 4 in Figure 1). It is important to note that despite Schools 1 and 4 having bilingual programs (Arabic and English in School 1, and Mandarin and English in School 4), all instruction in both the SRSD Plus and BAU conditions was conducted in English in students' classrooms.

Schools 1 to 3 used Wonders (McGraw Hill) as the literacy curriculum, whereas School 4 used Fountas and Pinnell Literacy Continuum, Second Edition (Heinemann) along with teacher-developed supplemental materials.

### **SRSD plus instruction**

SRSD Plus consisted of two components: the SRSD close reading and writing instruction portion and the Plus portion, which are detailed in the next sections. SRSD Plus is designed to align with CCSS and similar state standards. Anchor informational texts were developed in science content aligned with the

Next Generation Science Standards (NGSS; National Research Council, 2013). Texts focused on plants in Grade 1 and earth and space in Grade 2. These anchor texts incorporated targeted vocabulary words, sentence structures, spelling patterns, and structural elements of quality writing for the expository texts.

The SRSD Plus instruction was composed of a total of approximately 50–60 minutes (with approximately 25–30 minutes for the SRSD instruction and 25 minutes for the Plus component), three times a week, over a period of 12 to 14 weeks during the winter and spring. All five teachers and the Instructional Coordinator received PBPDT to become competent with the SRSD Plus instructional procedures. The Instructional Coordinator served as the organizer and primary liaison between the research team and the participating teachers. Students in the BAU condition received typical writing instruction from their regular teachers. Throughout the entire implementation period, the SRSD Plus Instructional Coordinator visited each teacher individually at least once a week to discuss instructional progress and any questions or issues (e.g., students' challenges with materials or pacing, approaches to differentiate instruction).

### ***SRSD instruction***

SRSD instruction is not intended to be scripted and reflects strong respect for and reliance on teacher judgment based on knowledge of their students and context, the task, and formative assessment. SRSD instruction is characterized by active, discussion-based, differentiated, scaffolded, and explicit learning about the writing process and powerful, validated strategies for writing. SRSD instruction also focuses on the knowledge (e.g., academic and general vocabulary, genre and general writing knowledge, declarative knowledge, procedural knowledge, and conditional knowledge) needed to use these strategies. Students develop self-regulation strategies for managing the writing process and their own behavior (e.g., goal setting, self-assessment of writing performance related to goals, self-instructions, and self-reinforcement). Social-emotional goals in SRSD, targeted by multiple aspects of instruction, include enhancing motivation, self-efficacy for writing, attitudes and beliefs about writing, peer collaboration (Harris & Graham, 2018).

Students are active collaborators in SRSD; group and peer collaborations and discussions are integral. Aspects of topic, audience, purpose, text structure, sentence structure, and writing quality are investigated and discussed while reading exemplar texts, rewriting poor texts, and during peer feedback. Generalizable characteristics of effective writing (i.e., “grab your reader,” “wrap it up right”) are identified and goals address both content and quality of students' writing (Harris & Graham, 2018; Harris et al., 2008). More details can be found in the supplemental materials of the previously described study of SRSD Plus for students in Grades 1 and 2 from low socio-economic family backgrounds (Harris, Kim et al., 2023).

### ***Plus instruction***

The Plus instruction encompassed reading, spelling, handwriting fluency, vocabulary, and sentence structure and students were guided and instructed to apply their learning of handwriting, spelling, vocabulary, and sentence construction during the SRSD instruction. Each session lasted for approximately 25 minutes. A total of 36 sessions were divided into 7 units, with each unit consisting of 5 sessions. The first session of each unit focused on reading comprehension or close reading of the anchor texts, as well as the introduction of target vocabulary words and sentence structures. The second session continued with instruction on vocabulary and sentence proficiency. Sessions 3, 4, and 5 focused on word reading, spelling, and handwriting fluency instruction.

Throughout the instruction, evidence-based instructional approaches were employed, following the principles of modeling (“I do”), guided practice (“We do”), and independent practice (“You do”) as outlined by Rosenshine (2012). Close reading of anchor texts involved explicit teaching of text structure/genre structure (as noted in the SRSD section above), comprehension questions, and the

explicit teaching of target vocabulary words and sentence structures. The target vocabulary words consisted of Tier 2 words that held high utility value, such as “essential” and “contrast,” as well as science content words like “photosynthesis” and “habitat.” All the vocabulary words were selected from the anchor texts and the majority of them were key words to comprehending the text and understanding the theme of each unit. Evidence-based practices were applied in teaching these vocabulary words, including providing child-friendly definitions and example sentences in addition to the sentences found in the anchor text (Beck et al., 2002; Biemiller & Boote, 2006; Coyne et al., 2007). The vocabulary instruction was integrated in the “Plus” component as part of vocabulary instruction and reading comprehension instruction, as well as the SRSD section where students reviewed key vocabulary words and engaged in reading the text to deepen their understanding and text structure.

Target sentence structures differed slightly for Grade 1 and Grade 2. In Grade 1, the following were included: the concept of a sentence; accurate use of “and” and “but;” high-frequency conjunctions such as “when, because, after;” and adding adverbs to enrich expression. Instruction in Grade 2 included the concept of a sentence; accurate use of “but” and “so;” adding adverbs to enrich expression; use of adjectives in the “so (adjective) that ” and “too (adjective) to (verb)” structures; and a conjunctive adverb, “however.” These were taught using sentence combination and completion activities based on previous evidence (Saddler & Graham, 2005; Strong, 1986).

Vocabulary and sentence structure instruction in Sessions 1 and 2 was as follows: Session 1 included introduction of target words and sentence structures followed by practice activities and Session 2 included reading anchor texts with attention to target words, sentence structures, and key ideas, along with a review and practice activities for vocabulary words and sentence structures.

Spelling and word reading instruction utilized a word study approach where phonological, orthographic, and morphological structures of a word were explicitly taught. Students were introduced to words with target patterns (e.g., -ake) and engaged in word sorting using orthographic, phonological, and morphological information (Apel et al., 2004; Bear et al., 2016). Students had opportunities to read words, identify patterns, and spell words. Target patterns in Grade 1 included, for example, CVVC (e.g., seed, soak), diphthongs (oi & oy), and r-controlled (e.g., torn); Grade 2 patterns included diphthongs (e.g., crown), Cle (e.g., candle), and complex phonograms (-ight, -ought). Handwriting fluency was taught informed by previous evidence where students had opportunities to practice writing letters and words from memory using various activities (e.g., Berninger et al., 1997; Wanzek et al., 2017). Students were taught how to write letters and words, and had opportunities to write them with accuracy and speed. As noted above, the previous study (Harris, Kim et al., 2023) suggested a need for greater attention to the speed aspect, in addition to accuracy and well-formedness of handwriting. Therefore, we made slight adjustments to our handwriting instruction. In the previous iteration, the handwriting race where students were asked to copy a given sentence accurately and rapidly in 1 minute was conducted only in Session 5 of each unit. However, this was expanded to Sessions 4 and 5 in the Plus instruction in this study.

Word reading, spelling, and handwriting instruction in Sessions 3, 4, and 5 included: Session 3 introduced target spelling patterns with sorting activities (teacher-directed and student sorting); Session 4 had a handwriting practice (1 min sentence copying), spelling group sorting, recording of spelling patterns in spelling journals, and word hunt; and Session 5 had group word building, handwriting practice (1 min sentence copying), and spelling from memory and overall review.

### **Professional development and follow-up support for SRSD plus**

The approach used in this study, referred to as practice-based professional development, was introduced by Ball and Cohen in 1999, and remains highly influential today (Harris, Camping et al., 2023). The focus of PBPD is development of teacher knowledge (pedagogical and content), understandings, beliefs, and skills for teaching, with support for using what has been learned once classroom implementation begins. PBPD addresses the complex reality of practice by: (a) collective

participation of teachers with similar needs (i.e., professional learning communities); (b) basing professional development on the characteristics, strengths, and needs of current students; (c) attention to content and pedagogical knowledge needs of teachers; (d) opportunities for expert modeling, active learning, and practice of new methods being learned; (e) use of materials (curriculum, etc.) that are identical to those to be used in the classroom, and (f) feedback on performance while learning (Ball & Cohen, 1999; Borko et al., 2010). PBPB allows deep learning of both what and how to teach, and was combined in this study with evidence-based practices for reading and writing instruction.

The research team provided implementation support in multiple ways: (a) PBPB for SRSD Plus teachers, with one day focusing on the Plus components and two days focusing on the SRSD instruction; (b) feedback in the first 2 to 3 weeks of implementation; and (c) on-going support via the Instructional Coordinator, weekly visits for individual teachers and support as needed. The professional development provided an overview of goals, relevant research, content of SRSD Plus, interactive modeling of each SRSD and Plus lesson, and teacher-led SRSD instruction for each lesson, with feedback from teachers and PD leaders. All teachers reached criteria in leading each lesson for both SRSD and Plus instruction, as did the Instructional Coordinator. Detailed descriptions of PBPB for SRSD are available (Harris, Camping et al., 2023; McKeown et al., 2019).

As noted previously, our original plan for assignment of schools and teachers had to be adjusted due to challenges related to COVID-19, requiring us to create professional learning communities in unique ways. First, the Instructional Coordinator acted as a member of a professional learning communities in all schools, but spent additional time as needed with teachers in schools 2 and 3 individually or together (only 1 SRSD teacher was in each school, see [Figure 1](#)). In addition, these teachers were offered the contact information for SRSD teachers at their grade levels in the other schools. Second, schools 1 and 4 each had two SRSD teachers, one for first grade and 1 for second grade. These teachers and the Instructional Coordinator served as the professional learning communities in these schools; the grade 1 and grade 2 teachers were encouraged to discuss and support each other on the SRSD plus instruction. The teachers and Instructional Coordinator met as needed and communicated during and after school as needed.

### **BAU control condition instruction**

Teachers in the BAU condition were observed approximately three times during their literacy block. Instruction varied across teachers. In terms of word reading and spelling instruction, some teachers taught spelling patterns explicitly (magic e, or vowel digraphs) using a word study approach (Bear et al., 2016) whereas other teachers focused on a sight word reading approach without explicit attention to letter-sound correspondences, especially in Grade 1 classrooms. In terms of reading comprehension and written composition, teachers tended to focus on narrative reading and opinion writing where text structure (characters, setting, and plot) was taught using graphic organizers along with comprehension questions. Instruction in the opinion genre, which was done using a graphic organizer (opinion along with reasons), was also observed. An exception was a teacher in Grade 2 who taught writing in the expository genre in a systematic and explicit manner. Specifically, the teacher taught explicitly about text structure for expository texts, such as introduction, body (facts and details), conclusion, and illustration, and specifics about each (e.g., different types of conclusion such as asking a question, writing a summary). It is worth noting that this teacher (Teacher 10; see [Figure 1](#)) also taught the SRSD Plus condition in School 4. Most of the classes did not teach sentence structure explicitly except for one teacher in each grade. A teacher in Grade 2 (Teacher 3) in the BAU condition who taught sentence combining (e.g., because) and identifying and using adjectives in sentences, which is similar to the Plus instruction. A teacher in Grade 1 also demonstrated and taught sentence construction using target words (e.g., the teacher modeled “Sofia has more apples than Raya” for the target word *more*).



### **Instructional fidelity**

Instructional fidelity for both SRSD and the Plus instruction was measured by observation of instructional components, using a checklist for the lesson components for instruction that day. Lesson fidelity was computed by dividing the number of lesson steps or components taught by the total number of steps or components expected for that lesson, and multiplying the quantity by 100. To establish reliability, seven instructional sessions for SRSD and 13 sessions for Plus were observed across all the teachers in the SRSD Plus condition in the first two weeks of implementation by the SRSD Plus Instructional Coordinator, an experienced teacher who participated in the practice-based professional development, and a research staffer with a Bachelor's degree in Psychology. Percent agreement for both measures across all sessions was 100% for the SRSD instruction and ranged from 90% to 100% for the Plus instruction.

For fidelity purposes, each teacher's instruction was observed from eight to 13 sessions for SRSD instruction for a total of 63 sessions, and from six to 14 sessions for Plus instruction for a total of 53 sessions across the teachers. For SRSD instruction, the lesson completion rate was 100% in 90% of the sessions, over 90% in 3% of the sessions, over 80% in 3% of the sessions, and 75% in 3% of the sessions. For Plus instruction, the lesson completion rate was 100% in 91% of the sessions, 95% in 7% of the sessions, and 70% in one session. Following fidelity observations, feedback was given on an as-needed basis, primarily when a significant portion of the instruction was not delivered as intended or when substantial deviations were observed, which was rare. All fidelity observations were conducted in person.

Although there is substantial previous evidence on SRSD (e.g., Graham et al., 2018), this is only the second study involving the Plus instruction. Thus, evaluation of the Plus instruction focused on three additional key aspects: adherence to the lesson, quality of instructional delivery, and effectiveness of scaffolding. Each of these aspects was rated on a scale of 1 to 5. Regarding adherence to the lesson, a score of 1 represented implementation of 0–59% of the activities or lesson, a score of 2 indicated 60–69% implementation, a score of 3 reflected 70–79% implementation, a score of 4 meant 80–89% implementation, and a score of 5 denoted 90–99% implementation. For the quality of instructional delivery, a score of 1 represented unorganized and unprepared instruction, a score of 2 indicated relatively poor instruction, a score of 3 reflected somewhat prepared instruction, a score of 4 denoted adequately prepared instruction, and a score of 5 represented well-prepared instruction. Lastly, for effectiveness of scaffolding, a score of 1 indicated an absence of teacher checking for comprehension or providing scaffolding, a score of 2 suggested rare checking of comprehension or providing scaffolding, a score of 3 represented occasional checking of comprehension or providing scaffolding, a score of 4 denoted frequent checking of comprehension or providing scaffolding, and a score of 5 indicated consistent checking of comprehension or providing scaffolding. The average adherence rating was 4.68, the average score for the quality of instructional delivery was 4.57, and the average score for instructional monitoring and scaffolding was 4.75.

### **Measures**

Students were assessed on written composition, planning, discourse knowledge, vocabulary, sentence proficiency, spelling, handwriting fluency, and word reading immediately before (pretest) and after (posttest) SRSD Plus instruction. Written composition was measured in the writing to inform (expository) genre and opinion genre. Written composition in the expository genre was measured by a researcher-developed source-based writing assessment because no normed measures were available, whereas the opinion genre was measured using a normed test (i.e., the Essay Composition task of the Wechsler Individual Achievement Test-3rd Edition [WIAT-III, Wechsler, 2009]). The other skills were measured using researcher-developed proximal measures, except for word reading, which was

measured using a normed test (i.e., Test of Word Reading Efficiency-2nd Edition [TOWRE-2; Torgesen et al., 2012]).

Students' responses were scored dichotomously (1 = correct; 0 = incorrect) for each item, except for the written composition, planning, and discourse knowledge measures. Students were assessed by rigorously trained research assistants in a quiet space in the school. Assessors were blind to the students' treatment condition. Written composition, spelling, and handwriting fluency tasks were administered in a group setting (3–4 students), and all other tasks were individually administered.

### **Written composition**

Students were assessed in informative/expository essay writing from source text and opinion genres. Because no normed and standardized writing measures of informative essay writing from source text at these grade levels were available, we used previously designed researcher-developed source-based writing assessments (Harris, Kim et al., 2023). The source texts were as follows: Hair (136 words; Lexile = 410–600) and Animal Tails (136 words; Lexile = 410–600) in Grade 1, and Birds (130 words; Lexile = 610–800) and Cats (180 words; Lexile = 410–600) in Grade 2. In addition, Superman (151 words; Lexile = 410–600) and Arbor Day (145 words; Lexile = 610–800) were used in both grades.

Students were asked to use source text to write on two tasks at pretest and posttest, respectively, and these source texts and prompts were administered in a counter-balanced manner. Specifically, at pretest, randomly selected half of the Grade 1 students were given either Hair or Animal Tails as well as either Superman or Arbor Day, while the other half of the Grade 1 students were given the two other tasks. This was reversed at posttest. The assessor read aloud each text once while students read along on their copy of the informational text (e.g., Hair). Then, the student was asked to write about the given text (e.g., write about reasons why our bodies have hair). Students were provided with a blank sheet of paper for planning and two lined sheets of paper for writing. There was no time limit to complete their writing.

For the opinion genre, the Essay Composition task from the WIAT-III (Wechsler, 2009) was used. In this task, students were asked to write about their favorite game and provide three reasons why it was their favorite. There were no source texts for students to read.

Students' handwritten compositions were typed up in Microsoft Word, and typed-up versions were used for scoring in order to remove any extraneous influence of handwriting ability (Graham et al., 2011). Compositions based on reading to learn and writing to inform were evaluated on quality, productivity/text length, and planning.

**Writing quality:** Writing quality was evaluated for the extent and clarity of idea development and organization on a rating scale of 0 to 7, similar to previous studies (e.g., Hooper et al., 2002; Kim et al., 2015; Olinghouse, 2008). Compositions with clear and rich ideas that were logically organized were rated higher, and compositions that were clearly off-topic and illegible, or copied verbatim from source text (which rarely occurred) were given a 0. The writing quality rubric used in this study can be found in [Table A1](#) in Appendix.

Raters were trained using the rubric with anchor compositions, followed by independent practice sessions and meetings to discuss discrepancies. Reliability was estimated using 50 randomly selected compositions by three raters/scorers: one was a PhD student in language and literacy, another was a research staff member with a master's degree in literacy, and the other had a BA in education. The first two had extensive experience in coding primary grade students' written compositions. Inter-rater reliability, exact agreement, was .94 for the informative task and .96 for the opinion task.

**Writing productivity/text length:** Writing productivity was evaluated by the number of words written (Kim & Graham, 2022; Kim et al., 2015; Puranik et al., 2008; Wagner et al., 2011). Misspelled words that were reasonably decodable were counted as words. A research staffer with accumulated experience with children's writing double checked all the work.

**Planning:** Students' writing plan, which was completed on a blank sheet of paper, was evaluated for four aspects: (a) use of planning for composition, (b) the number of ideas relevant to the prompt, (c) organization of planning, and (d) organizational notes for text elements (see

Harris, Kim et al., 2023). The use of planning for composition evaluated the extent to which text on the planning sheet was related to the final product of written composition on a scale of 1 (no relation) to 4 (composition includes text from planning sheet as well as other information students added). The number of ideas was the total number of ideas on the planning sheet that were relevant to the prompt. The organization of planning evaluated structural organization of ideas, which was evaluated on a scale of 1 (ideas have no organizational structure—e.g., a string of words) to 7 (ideas have a clear macro [beginning, middle, and end] and micro structure [ideas within each macro structure are logically sequenced]). Lastly, organizational notes for text elements evaluated how effectively students used organizational supports such as numbering, arrows, symbols, or mnemonics for text structural elements (e.g., topic sentence, big ideas, details, conclusion) on a scale of 1 (no structural elements are found in planning) to 5 (all structural elements are found). Blank planning sheets were given a zero on all four aspects. Exact agreement was .95, using 40 randomly selected planning sheets that excluded blank sheets.

### **Discourse knowledge**

The student was asked the following 10 open-ended questions, which were adapted from previous work (e.g., Olinghouse et al., 2015): 1) What do good writers do when they write? 2) Why do you think some kids have trouble writing? 3) When asked to write a paper for class or homework, what kinds of things can you do that help you plan and write your paper? 4) When you write, do you think about whether your teacher can understand your writing? 5) When you write, do you think about whether your friend can understand your writing? 6) Why do kids write? 7) Why do grown-ups write? 8) When you write, do you reread your writing? If you do, why do you reread your writing? 9) Imagine your friend has to write an informational essay for a class. What would you tell him or her the parts of an informational essay are? 10) What else would you tell your friend is important when you write an informational essay?

Each question was read aloud to individual students. Students' oral responses to each question were transcribed verbatim, and the number of relevant ideas in different aspects (such as the writing process, productive procedure, structural elements, appeal to the reader, motivation as described by Olinghouse et al., 2015) were counted. Interrater exact percent agreement was .98.

### **Oral language, transcription, and word reading skills**

**Vocabulary:** A researcher-developed proximal task included words that were taught in SRSD Plus. The student was orally presented with a target word (e.g., survive, surface) and was asked to define the word. Student responses were scored on a scale of 0 to 2: 0 for an incorrect response, 1 for a partially correct response, and 2 for an accurate response. There were 16 test items and one practice item. Cronbach's alpha estimates across the 16 items were as follows: .77 for pretest and .84 for posttest for first graders, and .71 for pretest and .82 for posttest for second graders.

**Sentence proficiency:** A researcher-developed proximal task was used to measure sentence proficiency (Harris, Kim et al., 2023). The student heard two sentences and was asked to combine them into one sentence. There were 10 test items. In the first part of the task (six items), students were provided with a target connective to use (e.g., *I am happy. I can't stop smiling. Combine these two sentences using "so-that."*) whereas in the second part (four items), students were required to combine the sentences without using a connective (e.g., *I saw a dog. It is cute. → I saw a cute dog*). There was an example provided as part of the directions for the first part and second part, respectively. Cronbach's alpha estimates were .74 for pretest and .82 for posttest for first graders, and .76 for pretest and .81 for posttest for second graders.

**Spelling:** A researcher-developed dictation task was used. The items included a total of 30 words that were proximal words (taught words; e.g., *speed* in Grade 1), near-distal words (taught pattern but not taught words; e.g., *sweep* in Grade 1), and distal words (words or patterns not taught). Target words were presented in isolation, in a sentence, and in isolation again. Cronbach's alpha estimates ranged from .93 to .96.

**Handwriting fluency:** A sentence copying task was used, following previous studies (e.g., Connelly et al., 2007; Kim et al., 2015; Wagner et al., 2011). In this task, the child was asked to accurately copy a pangram sentence, *The quick brown fox jumps over the lazy dog*, as many times as possible in 1 minute. Students' responses were scored by counting the number of letters copied correctly. Interrater reliability, exact agreement, was .94, using data from 35 students.

**Word reading:** The Sight Word Reading Efficiency subtask of the Test of Word Reading Efficiency-2<sup>nd</sup> Edition (TOWRE-2; Torgesen et al., 2012) was used. In this task, the student was presented with a list of words ordered by increasing difficulty and asked to read them accurately with speed. The number of correctly read words in 45 seconds was their score. Test-retest reliability was reported to range from .92 to .93 for 6- to 7-year-olds (Torgesen et al., 2012).

### Data analysis strategy

Multilevel modeling in SPSS 28 was used to account for students being nested within schools. Hedges' *g* effect sizes (ES; What Works Clearinghouse, 2022) were estimated for writing outcomes (writing quality and writing productivity [number of words] for the researcher-developed informative essay and the normed opinion essay, planning, elements), transcription skills (spelling, handwriting fluency), oral language skills (vocabulary, grammatical knowledge), and discourse knowledge. Students' pretest performance in each outcome, gender (female = 1), grade (Grade 2 = 1), English learner status (English learner = 1), racial background (White = 1, 0 = others), and free and reduced lunch status (eligible = 1) were included as control variables. Potential moderation was examined systematically one by one by grade, gender, racial background, English learner status, and free and reduced lunch status, but none of them were statistically significant moderators. Lastly, as teachers in School 4 (Teachers 9 and 10) taught both treatment and comparison conditions, we carried out a post-hoc sensitivity analysis excluding the data from School 4, using Mplus 8.6 using TYPE = COMPLEX.

### Results

At pretest, missingness ranged from 3.6% in the sentence copying task to 6.5% in the experimental vocabulary task; Little's Missing Completely at Random (MCAR) test was not rejected ( $\chi^2 = 80.58$ ,  $df = 69$ ,  $p = .16$ ). At posttest, missingness ranged from 6.5% in writing planning, productivity, discourse knowledge, word reading, and spelling to 6.9% in experimental vocabulary, sentence proficiency, and writing quality; Little's MCAR test was not rejected ( $\chi^2 = 30.31$ ,  $df = 24$ ,  $p = .18$ ).

Table 1 displays descriptive statistics by treatment status. It is notable that there were substantial floor effects in planning both at pretest and posttest across the conditions. A multivariate analysis of covariance, controlling for grade level, indicated that there were no statistically significant differences at pretest by treatment status: Wilks's  $\lambda = 0.94$ ,  $F(9, 218) = 1.47$ ,  $p = .16$ . Post-hoc analysis, however, revealed that the mean performance on the planning task was statistically significantly higher for those in the SRSD Plus condition than those in the BAU condition ( $p = .01$ ). In addition, not surprisingly, mean performances for Grade 2 students were statistically higher on all the tasks than for Grade 1 students ( $ps \leq .02$ ). Bivariate correlations among variables are included in the online supplemental materials.

Table 2 summarizes the results of multilevel models for written composition outcomes, controlling for students' performance on the pretest and students' demographic characteristics (grade, gender, race/ethnicity, English learner status, and eligibility for the free and reduced lunch program) as covariates in all the models. Students in the SRSD Plus condition outperformed those in the BAU condition on all outcomes for the expository essays: writing quality (effect sizes [ES] = .59,  $p < .001$ ), writing productivity (ES = .57,  $p < .001$ ), and planning (ES = .30,  $p = .03$ ). For example, the average writing quality score for students in the SRSD Plus condition was 1.62 points higher than those in the BAU condition. Furthermore, statistically significant positive effects were found in the opinion genre (far generalization; source text was not

**Table 1.** Descriptive statistics.

Variable	Control Condition						Treatment Condition					
	N	M	SD	Min-Max	Skew	Kurtosis	N	M	SD	Min-Max	Skew	Kurtosis
<b>Pretest</b>												
Writing Quality	121	4.30	2.22	0–11	0.20	0.06	116	4.28	2.17	0–9	-0.40	-0.34
Writing Productivity	121	45.90	33.31	0–187	1.34	2.35	116	46.50	28.48	2–140	0.62	0.15
Planning	121	0.50	1.91	0–14	4.64	24.39	116	1.03	2.49	0–12	2.47	5.38
WIAT Quality	121	2.44	0.97	0–5	-0.64	0.09	116	2.28	1.03	0–4	-0.82	-0.66
WIAT Productivity	121	24.12	16.58	0–89	1.27	1.90	116	24.23	18.28	0–90	1.29	1.78
Discourse Knowledge	121	7.45	3.76	0–25	1.14	4.15	116	7.19	3.74	0–22	0.75	1.83
Vocabulary	117	3.47	3.88	0–15	1.16	0.56	115	3.01	3.29	0–17	1.50	2.63
Sentence Proficiency	119	3.23	2.52	0–10	0.42	-0.56	114	2.62	2.20	0–9	0.55	-0.51
Spelling	121	10.07	6.85	0–28	0.72	-0.26	116	10.15	7.50	0–29	0.66	-0.38
Sentence Copying	123	31.31	16.76	0–95	0.89	1.40	116	31.18	16.57	3–85	0.76	0.48
Sight Word Efficiency	120	44.05	20.51	0–84	-0.39	-1.1	115	44.1	21.01	0–79	-0.48	-0.98
Sight Word Efficiency SS	120	105.89	19.6	57–139	-0.51	-0.82	115	106.35	19.43	68–138	-0.37	-0.98
<b>Posttest</b>												
Writing Quality	116	5.19	2.73	0–12	0.34	0.18	115	6.70	2.80	0–12	-0.20	-0.28
Writing Productivity	117	64.18	52.54	0–227	1.36	1.34	115	95.57	72.62	16–544	2.61	11.96
Planning	117	0.94	2.82	0–17	3.86	15.56	115	1.90	5.97	0–42	4.53	23.12
WIAT Quality	117	2.80	0.86	0–6	-1.16	4.24	115	3.05	0.91	0–6	-0.39	1.89
WIAT Productivity	117	34.05	22.95	0–124	1.17	1.71	115	37.86	23.20	0–105	1.06	0.67
Discourse Knowledge	118	8.34	3.84	0–20	0.46	0.38	114	9.58	4.21	0–27	1.02	2.79
Vocabulary	117	4.48	4.75	0–19	1.05	0.26	114	8.17	5.99	0–29	0.76	0.41
Sentence Proficiency	117	4.30	2.64	0–10	-0.02	-0.80	114	5.16	2.77	0–10	-0.30	-0.92
Spelling	117	13.52	9.01	0–30	0.28	-1.21	115	15.21	8.73	0–30	0.03	-1.11
Sentence Copying	117	43.36	23.31	0–117	0.55	0.28	115	38.92	13.72	11–87	0.50	0.42
Sight Word Efficiency	117	49.85	20.53	0–86	-0.72	-0.06	115	51.29	19.51	0–84	-1.08	0.75
Sight Word Efficiency SS	117	101.95	20.96	55–136	-0.53	-0.48	115	103.63	19.41	56–141	-0.64	0.13

Note. SS = Standard Score.

**Table 2.** Coefficients of multilevel model results for writing outcomes.

Effects	Exp prompt writing quality	Exp prompt productivity	Exp prompt Planning	WIAT writing quality	WIAT productivity	Discourse knowledge
<i>Fixed effects</i>						
Intercept	2.82 (.56)	6.64 (12.06)	.27 (.70)	2.11 (.18) ***	16.63 (3.85) ***	7.03 (.73)***
Pretest	.39 (.09)***	.77 (.12)***	.11 (.16)	.30 (.11)**	.37 (.08)***	.14 (.08)~
Grade 2	1.28 (.37)***	25.97 (6.86)***	1.37 (.63) *	-.07 (.12)	17.51 (2.89) ***	.71 (.57)
Female	.39 (.30)	9.89 (5.53)	.07 (.63)	.10 (.11)	2.35 (2.38)	1.48 (.51)**
White	-.10 (.47)*	-26.26 (8.73)**	-2.06 (.91)*	-.01 (.16)	-5.22 (3.67)	.20 (.73)
English Learner	-.53 (.36)	-7.97 (6.57)	.71 (.73)	.03 (.13)	-5.73 (2.80)*	-1.56*
Free and reduced lunch	-.41 (.43)	8.20 (7.83)	-.93 (.77)	-.33 (.14)*	-5.53 (3.25)	-1.11 (.63)~
SRSD Plus	1.62 (.31)***	32.02 (5.63)***	1.38 (.64) *	.30 (.11)**	4.98 (2.43)*	.93 (.52)~
<i>Random effects</i>						
Level 1: Child	4.82 (.46)***	1644.96 (158.00)***	21.25 (2.02)	.66 (.06)***	308.36 (29.58) ***	7.00 (1.32)***
Level 2: School	.43 (.41)	371.19 (295.18)	0	0	23.02 (22.53)	0
Effect size (g)	.59***	.57***	.30*	.34*	.22*	.23~

Note. Standard errors are in parentheses. Exp = Expository or informational writing.

\*\*\* $p < .001$ . \*\* $p < .01$ . \* $p < .05$ . ~ $p < .10$ .

provided), both in writing quality ( $ES = .34, p = .008$ ) and writing productivity ( $ES = .22, p = .04$ ). Students in the SRSD Plus condition outperformed those in the BAU condition in the discourse knowledge ( $ES = .23$ ) although the statistical significance was just shy of the conventional .05 level ( $p = .07$ ).

**Table 3.** Coefficients of multilevel model results for transcription and language skills, word reading, and discourse knowledge.

Effects	Vocabulary	Sentence proficiency	Spelling	Sentence copying	Sight Word efficiency
<i>Fixed effects</i>					
Intercept	2.11 (.76)*	2.04 (.48)***	3.46 (.75)***	21.10 (2.77)***	19.26 (2.71)***
Pretest	.96 (.08)***	.67 (.06)***	1.07 (.04)***	.55 (.07)***	.73 (.05)***
Grade 2	.21 (.56)	-.13 (.26)	-.36 (.58)	8.55 (2.22)***	-.09 (1.81)
Female	-.37 (.52)	.06 (.26)	-.24 (.55)	3.14 (1.97)	-.38 (1.63)
White	.48 (.78)	-.17 (.40)	.17 (.81)	-7.33 (2.83)	.58 (2.31)
English Learner	-1.85 (.63)**	-.13 (.31)	-.47 (.66)	.78 (2.30)	-3.27 (1.95)
Free and reduced lunch	-.78 (.72)	.04 (.36)	-1.05 (.73)	-3.12 (2.46)	-1.11 (2.16)
SRSD Plus	3.88 (.54)***	1.21 (.27)***	1.27 (.57)*	-3.25 (2.02)	.91 (1.67)
<i>Random effects</i>					
Level 1: Child	3.47 (.56)***	3.51 (.34)***	16.74 (1.59)***	215.39 (20.40)***	144.01 (13.76)
Level 2: School	.26 (.33)	.42 (.35)	0	0	0
Effect size ( <i>g</i> )	.72***	.45***	.14*	-.16+	.05+

Note. Standard errors are in parentheses. FRL = eligible for the free and reduced lunch program.

\*\*\*  $p < .001$ . \*\*  $p < .01$ . \*  $p < .05$ .

Table 3 summarizes multilevel model results for oral language skills, transcription skills, and word reading. Students in the SRSD Plus condition had higher mean scores in vocabulary ( $ES = .72$ ,  $p < .001$ ) and sentence proficiency ( $ES = .45$ ,  $p < .001$ ) after controlling for pretest and demographic variables. In addition, there was a small but statistically significant positive effect of SRSD Plus on spelling ( $ES = .14$ ,  $p = .03$ ). When analysis was conducted only for the words that were taught in SRSD Plus, results differed by grade such that  $ES$  was .33 ( $p = .055$ ) in Grade 1 whereas  $ES$  was .05 ( $p = .58$ ) in Grade 2. See Appendix Table A2 for details. There was no statistically significant difference between SRSD Plus and BAU in handwriting fluency as measured by sentence copying ( $ES = -.16$ ,  $p = .11$ ). There was also no difference in word reading, as measured by Sight Word Efficiency ( $ES = .05$ ,  $p = .59$ ).

Sensitivity analysis without teachers in School 4 (Teachers 9 and 10) included a substantially reduced sample size of 133 students (with  $n = 70$  in the control condition, comprising 38 Grade 2 students and 35 females, and  $n = 63$  in the treatment condition, including 30 Grade 2 students and 35 females). Results are reported in the online supplemental materials. Unsurprisingly, the results differed from those obtained when utilizing the complete dataset. For example, the effect sizes in the informative genre were .41 in writing quality, .27 in writing productivity, and .49 in planning. In contrast, there was a small negative effect size in the WIAT quality ( $-.13$ ). However, it is highly important to exercise caution when interpreting these results as the reduced sample does not adequately reflect the study as a whole.

## Discussion

In the present study, we investigated the impact of teacher implemented SRSD Plus on the development of writing (including planning), discourse knowledge, word reading, spelling, handwriting, and oral language skills among students in Grades 1 and 2. Our investigation was guided by the interactive dynamic literacy model (Kim, 2020, 2022), comprehensive reviews of the literature on the relations between reading and writing (Kim et al., 2024), and research on professional development (Harris, Camping et al., 2023). The SRSD Plus instructional approach employed in this study is designed to provide explicit and active learning on a range of essential skills, knowledge, and strategies crucial to the development of reading and writing. These include but are not limited to discourse knowledge (including genre knowledge), content knowledge, self-regulation strategies, oral language proficiency, reading, spelling, and handwriting fluency.

An important aspect of SRSD Plus is the emphasis on the integrated teaching of reading and writing. Students were provided with opportunities to engage in close reading activities in order to learn about science topics that served as foundational sources for their writing tasks. Students were

also instructed and supported to use what they were learning about handwriting, spelling, vocabulary, and sentence construction during the SRSD instruction. Moreover, SRSD instruction addressed the structural elements of texts and self-regulatory strategies within the context of comprehension of source texts, establishing a direct connection between reading and writing. This integrated approach enables students to effectively structure their written work and develop a deeper understanding of the relation between reading and writing.

Overall, we found that teacher implemented SRSD Plus improved targeted skills such as writing, planning, oral language, spelling, and discourse knowledge, compared to the counterfactual condition. These results indicate that teaching reading and writing together along with instruction on multiple skills is effective in improving children's literacy skills. These results are in line with a previous study of SRSD Plus (Harris, Kim et al., 2023). The current findings are also in line with the literature on vocabulary instruction and sentence instruction (Biemiller & Boote, 2006, Coyne et al., 2007; Saddler & Graham, 2005) and spelling instruction (Apel et al., 2004; Graham & Santangelo, 2014; Graham et al., 2002). Results on writing are also convergent with the literature on SRSD (e.g., Graham et al., 2018). Note, however, that we refrained from comparing effect sizes in the present study with previous SRSD research for two reasons. First, the vast majority of SRSD research has been conducted with upper elementary grade students. Second, the present study was conducted during the pandemic whereas previous SRSD studies were conducted prior to the pandemic.

When comparing the present effect sizes to those in the previous study of SRSD Plus (Harris, Kim et al., 2023), the present effect sizes were generally smaller. In the present study, the effect sizes were .59 in writing quality, .57 in productivity/text length, .30 in planning, .23 in discourse knowledge, .72 in vocabulary, .45 in sentence proficiency, and .14 in spelling, and there were no significant effects in handwriting fluency (sentence copying) and a normed measure of word reading. In the previous study, effect sizes were 1.02 in writing quality, .21 to .94 in productivity depending on grade levels, 1.40 in planning, .43 in discourse knowledge, 1.18 in spelling, 2.29 in vocabulary, and .29 in sentence proficiency; there were no effects in handwriting fluency.

We believe that several differences between the present study and the previous study might account for these discrepancies. The first important difference is challenges associated with COVID-19. The negative impact of COVID-19 on student achievement has been widely reported (Skar et al., 2023). Although instruction was delivered in person during the 2021–2022 academic year, there were quite a few challenges, such as COVID-associated teacher and student absences. For example, one teacher in SRSD Plus had to miss quite a few days of school due to COVID-19 and therefore, the implementation took longer than the anticipated 12 weeks. Second, instruction in the present study was delivered by classroom teachers to a whole class whereas instruction in the previous study was conducted in small groups by former teachers as interventionists. Third, teachers in the previous study reported not having an official curriculum for writing (although they reported using the writer's workshop approach and not using any commercial programs) whereas in the present study, there were official literacy (reading and writing) curricula.

We do not know which of these aspects (COVID-19, instructional group size, instructional agent, having an official writing curriculum, or the combination of these), explain the discrepancy in effect sizes. It seems reasonable, however, to speculate that COVID-19 and instructional group size may have played a large role in the results. Studies have shown the negative impact of COVID-19 on student learning (e.g., Skar et al., 2023) and the positive impact of small-group instruction compared to whole-class instruction (Sørensen & Hallinan, 1986). Despite the challenges posed by COVID-19, however, it is noteworthy that the effect sizes, though small to medium, indicate the promise of SRSD Plus in improving primary grade students' writing skills and skills and knowledge that are important to writing skills.

In addition, the nature of instruction in the counterfactual condition in the present study may contribute to the differences in the effect sizes. The previous study did not include observations of the comparison classrooms (Harris, Kim et al., 2023). Therefore, there was no information about the extent and nature of literacy instruction in the comparison condition beyond the fact that teachers

reported using the writer's workshop approach and no commercial programs. In the present study, we conducted classroom observations and documented classroom instruction in the comparison condition. Our observations revealed meaningful variation across the counterfactual classrooms; with some practices important to note.

Some counterfactual classroom teachers used the word study approach as part of spelling instruction, which is similar to the spelling instruction in SRSD Plus. This likely helps explain the small effect of SRSD Plus on spelling in the present study. As reported in the Results section, there was a meaningful effect on spelling of *taught* words in Grade 1 but not Grade 2. Although there was variation in spelling instruction in the counterfactual classrooms in both Grade 1 and Grade 2, Grade 1 classrooms showed less systematic spelling instruction compared to in Grade 2 classrooms.

In addition, there was large variability in reading comprehension and composition instruction across counterfactual classrooms. Some classrooms had less focused and structured instruction particularly in the expository genre, whereas other classrooms had highly systematic literacy instruction somewhat similar to SRSD Plus. As noted previously, teachers in School 4 (Teachers 9 and 10) taught both treatment and comparison conditions. Both teachers taught their SRSD Plus class followed by teaching their BAU class. Teacher 9's BAU observations did not show highly structured instruction similar to SRSD Plus, but Teacher 10's instructional content in the BAU class was structured and explicit as described previously in the Method section. Sensitivity analysis without these two teachers was conducted and similar results were found in some outcomes (e.g., planning, writing productivity), but not other outcomes (e.g., writing quality). However, these results should be interpreted with great caution because there was no systematic evidence of contamination based on classroom observations, and the significantly reduced sample size— 12 to 8 classrooms and from 248 to 133 students – does not adequately represent the study as a whole.

A notable finding in the present study is positive generalization and transfer effect of SRSD Plus to the opinion writing genre (writing quality  $ES = .34$ ; writing productivity  $ES = .22$ ). SRSD Plus instruction focused on close reading of expository texts in preparation for writing to inform. The generalization effects might be due to several aspects of the SRSD Plus instruction that are generalizable across these two genres, such as consider the reader and your goals for writing, hook the reader, clear topic sentence, effective sentence writing, adding details, and a good ending (generalization across relatively near writing tasks has been found in SRSD research; e.g. Harris et al., 2015). Furthermore, use of self-regulation strategies, oral language, and transcription skills may have generalized. The text/genre structure, represented by the mnemonic TIDE, taught in the SRSD instruction might also have supported students' organization when writing in the opinion genre. Finally, spelling, vocabulary, and sentence proficiency taught in Plus are also expected to generalize to writing across genres. These are important questions for future research.

Important differences, however, also existed in between these two writing genres and their assessment. Source text was provided and close reading taught in the SRSD instruction, but source text was not provided in the normed opinion essay writing task (i.e., Essay Composition task of WIAT III). With this measure, students are asked to write about their favorite game and are told to include at least 3 reasons why they like it. Future research is needed to fully understand generalization between these tasks. Overall, the present findings suggest that explicit, interactive, and discourse based instruction for reading to learn and writing to inform can support some development in opinion essay writing.

We hypothesized no effect in word reading, which was measured by a distal normed task, because impact on distal measures of reading would require sustained instruction of greater dosage. This hypothesis was confirmed. In addition, the lack of an effect on word reading could be attributed to the characteristics of our study sample. The mean word reading skill of the participating students was in the average range compared to the norm group, and it might be that effects on word reading may be found for a sample of students who struggle with word reading. Unlike our hypothesis, however, no discernable effects were found in handwriting fluency. These results are in contrast to previous work that focused on handwriting fluency for children (Santangelo & Graham, 2016; Wanzek et al., 2017). We believe that the current findings are due to dosage: In the current SRSD Plus program,



handwriting, word reading, and spelling are taught for a total of 525 minutes or 8.75 hours; of this time, the amount that was exclusively devoted to handwriting accuracy and fluency during the 12 weeks of instruction was approximately 8 to 10 minutes per unit for a total of 56 to 70 minutes (8–10 minutes \* 7 units). Therefore, the handwriting instruction in SRSD Plus may not have been of sufficient dosage or intensity to make a discernable effect. Future work is needed to shed light on this speculation.

The present study has shown that it is feasible for classroom teachers to implement integrated teaching of reading and writing in classroom settings in Grade 1 and Grade 2. Implementation fidelity was high across grade levels in terms of both adherence to the content and quality of delivery. As noted previously, theoretical models and evidence demonstrate that reading and writing skills draw on shared skills and resources, and therefore, high-quality instruction on the component skills facilitates development of both reading and writing. Although reading and writing merit instructional attention on their own, reading instruction that does not systematically incorporate writing opportunities and practices, and writing instruction that does not systematically embed reading opportunities and practices, likely disserve students and their development of reading and writing skills. The present findings, together with a large body of literature on reading-writing relations (see Kim et al., 2024 for a meta-analysis) and instruction (see Graham et al., 2017 for a meta-analysis), indicate that the Science of Teaching Reading (Kim & Snow, 2021) and the associated efforts in policies and research support should consider reading-writing connections (Graham, 2020; Kim et al., 2024).

### Limitations and future directions

Several limitations and associated future directions are notable. The first one is measurement of constructs. Ideally, all targeted skills would have been assessed using both proximal *and* distal measures. However, we did not anticipate significant effects on general reading and spelling skills, as measured by distal normed tasks. Achieving noticeable improvements in distal tasks would require a more intensive and extensive instructional dosage than the 36 sessions over a span of 12 weeks provided by the SRSD Plus program. Another issue is the practical constraints associated with working within school settings, where assessment time is often limited. Finally, norm-referenced measures in the early grade levels for reading to learn followed by a writing task do not yet exist, and are badly needed. Construction of reliable and valid norm-referenced writing tests beyond those available is badly needed. Consequently, the assessment battery focused primarily on the key constructs expected to be influenced by the SRSD Plus instruction.

These limitations suggest several potential directions for future research. First, future studies could explore the effectiveness of the SRSD Plus program with a more extended and intensive dosage and include a comprehensive assessment of both proximal and distal measures. Additionally, investigating the program's impact on general reading and spelling skills may provide valuable insights into its overall efficacy. Moreover, researchers could aim to identify alternative assessment methods that can capture a broader range of outcomes while accommodating the practical limitations of school environments. By addressing these limitations and exploring these avenues, future research can enhance our understanding of the SRSD Plus program's potential benefits and expand its applicability in educational settings.

Another notable weakness of this study pertains to the random assignment of teachers to the SRSD Plus and comparison conditions. While our initial plan was to randomly assign teachers within schools and grades to different conditions, we encountered recruitment challenges associated with the impact of COVID-19. Consequently, we had to adopt a flexible approach to our assignment strategy. As described in the Method section, different structures were implemented across various schools. Future replications that employ a consistent assignment design can strengthen the internal validity of the study and strengthen the generalizability of the findings.

When considering the reading-writing connections within the framework of the Science of Teaching Reading, several areas warrant further investigation. One such area pertains to the

exploration of the mechanisms through which reading development, experience, and instruction contribute to the development of writing skills, as well as the reciprocal influences of writing development on reading skills (Graham, 2020). Further, the impact of SRSD Plus on other important outcomes studied in SRSD research should be examined in future studies of SRSD Plus, including self-efficacy for writing, attitudes and beliefs about writing, motivation for writing, persistence, engagement, maintenance of outcomes, and social validity (Harris & Graham, 2018). Understanding underlying processes can shed light on the interplay between reading and writing, and inform instructional approaches that foster comprehensive literacy development. This can be addressed in a future larger study; the present dataset is less than ideal for examining the mechanisms for several reasons. First, a larger study with a more extensive representation of teachers and students will yield more robust and stable results. Second and importantly, we believe that a future study with greater methodological rigor is needed, involving the random assignment of teachers within a school to different conditions or the random allocation of schools to distinct conditions. As stated previously, we intended the former but had to be flexible (see Figure 1). Last, we acknowledge that we were unable to directly assess a crucial component in line with the interactive dynamic literacy model, which is reading comprehension.

Another crucial direction for future research involves gaining a deeper understanding of classroom instructional practices. This includes investigating how teachers acquire the knowledge and skills necessary to effectively teach reading and writing. In the Science of Teaching Reading (Kim & Snow, 2021), the teacher and their instructional practices are seen as a key mechanism through which students' literacy improvements occur, and therefore teacher development, for example via teacher professional development, is an important aspect. As noted earlier, the present study included PBPD for the teachers. PBPD (Ball & Cohen, 1999) focuses on development of teacher knowledge (pedagogical and content), understanding, beliefs, and skills for teaching, with support for using what has been learned once classroom implementation begins.

All aspects of PBPD described earlier were included in this study. However, changes in teachers' knowledge of and beliefs about pedagogical approaches and teaching reading and writing, and integrated instruction for reading and writing, were not measured, nor were teachers' perceptions of the social validity of SRSD Plus. In future studies, this could assist in identifying strategies and approaches to enhance teacher buy-in and ultimately benefit student outcomes (Harris, Camping et al., 2023).

Future work should delve into the mechanisms underlying the reading-writing connections, investigate classroom instructional practices, and further develop supportive strategies for teachers and practice-based professional development. Addressing these areas will help us advance the Science of Teaching Reading that explicitly includes writing and our understanding of how to best cultivate competent readers and writers.

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## Appendix

**Table A1.** Writing quality rubric for informative essays.

7 points	The essay is on topic, logical, coherent, well stated, and organized. It has three or more ideas with a clear macro structure. All organizational parts are effective (e.g., attention-getting introduction or ending); sequencing of ideas is logical and smooth; advanced transition words are skillfully and precisely used. Each big idea has well-developed supporting details. Expression is effective, precise, and free of any problems. Does not contain illogical or irrelevant information. Overall, writing reads like a breeze.
6 points	The essay is on topic, has three or more ideas, and has a clear sense of macro structure; logical and smooth sequencing of ideas with effective use of transition words (beyond the rudimentary ones [e.g., first, second, third]). Most big ideas have supporting details. Expression is used effectively and efficiently for coherence. However, there may be minor problems in a few places (e.g., macro organization, a lapse in sequencing of ideas, or less skilled use of language). Does not contain illogical or irrelevant information.
5 points	The essay is on topic, has three or more ideas, and has a clear sense of macro structure with clear use of transition words; sequencing of ideas is logical and smooth. Big ideas may not have supporting details. Transition words tend to be rudimentary ones. Expression is overall appropriate and free from major problems. Extraneous information is minimal.
4 points	The essay is on topic and has three or more ideas that are presented with an emerging sense of macro organization though it is not perfect (e.g., missing introduction or conclusion). A sense of structure is a distinguishing feature between the scores 4 and 3 (below). Expression is overall appropriate and free from major problems but may not be varied. May include extraneous information or redundancy.
3 points	The essay is on topic but is not sufficiently developed. There is no macro organization nor coherence. There are three or more ideas but they are presented like a list or string of facts rather than as related. The ideas can be a variety of combinations (e.g., two big ideas and a detail; 1 big idea and two simple details; three big ideas with no supporting details; two sentences but with extended supporting details). Expression and sentence structure tend to be simple or have some noticeable problems. May include information that is vague, not supported, redundant, and illogical.
2 points	The essay is on topic, but it is characterized by two simple ideas regardless of the number of sentences (i.e., one sentence with two ideas or two sentences with two ideas or two phrases etc.). In addition, organization, logic, and transition words are not present. Expressions may be simple or incomplete. May contain extraneous information or repetition.
1 point	The essay is on topic, but it is characterized by only a single idea; therefore, organization, logic, and transition words are not present. Expressions are simple or incomplete. May contain extraneous information or repetition.
0 point	Off-topic (text that is completely irrelevant or does not address the prompt); illegible content; apparent verbatim copying from the text; single idea used as a hook without any contextualization.

**Table A2.** Coefficients of multilevel Model results for spelling of taught words.

Effects	Grade 1	Grade 2
<i>Fixed effects</i>		
Intercept	2.83 (.90)**	4.20 (.98)***
Pretest	1.03 (.07)***	1.01 (.05)***
Female	-.38 (.67)	-.59 (.90)
White	-.89 (1.15)	-.93 (.92)
English Learner	-.96 (.83)	-.58 (1.49)
Free and reduced lunch	-1.15 (.97)	-.33 (1.12)
SRSD Plus	7.27 (.94)~	.42 (.74)
<i>Random effects</i>		
Level 1: Child	11.53 (1.61)***	11.62 (1.62)***
Level 2: School	1.08 (1.55)	0
<i>Effect size (g)</i>	.33~	.05