Effects of SRSD writing interventions in grade 3: examining the added value of attention vs. transcription training components

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Abstract

Children's writing depends on strategic and self-regulated behaviors as well as on attention and transcription skills. Despite the well-established effectiveness of interventions based on the self-regulated strategy development model (SRSD), little is known about their effects when combined with the explicit teaching and systematic training of attention or transcription. This study compared the effects of SRSD interventions that taught students a planning strategy and how to use it compose text, with additional components of attention (via focused meditation exercises) or transcription (via copy and alphabet exercises). We used a quasi-experimental design with three groups of Portuguese third graders: SRSD+attention ($n=42$), SRSD+transcription ($n=37$), and wait list ($n=34$). Measures of transcription, executive functions, motivation, written production, and academic achievement were collected before and after the interventions. Analyses of co-variance revealed that the SRSD+transcription group surpassed the others in terms of handwriting fluency as well as in terms of spelling accuracy, though only among the weakest spellers at pretest. Moreover, in comparison to the wait list group, both SRSD groups showed better planning skills, wrote more complete texts, and displayed better executive functioning at posttest. After the intervention, though the SRSD+transcription group produced better texts than their peers, the SRSD+attention group achieved better academic performance, but only among those with poorer grades at pretest. Regarding motivation, we only found an effect of the SRSD+transcription intervention on self-efficacy for ideation, among students with lower self-efficacy at pretest. These findings suggest the importance of articulating writing and self-regulation strategies with attention and transcription training in early schooling.

Keywords Writing · Self-regulation · Transcription · Attention · Meditation · Intervention

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Given the importance of writing in contemporary knowledge-based societies, it is crucial to establish evidence-based tools to enhance the skill and will of young writers (Graham et al., 2012). One of those tools is the Self-Regulated Strategy Development model (SRSD; Graham et al., 2012), whose effectiveness to improve primary grade students' writing skills and motivation-related variables is well established (Harris et al., 2012). Yet, only a couple of studies in primary school have combined SRSD interventions with the explicit training of core skills underlying writing proficiency (viz., attention and transcription), and examined SRSD effects beyond writing skills and motivation. Limpo and Alves (2018) showed that adding a transcription component to an SRSD intervention increased writing ability above an SRSD-only intervention. Moreover, Lane et al. (2011) found that an SRSD intervention, though failed to impact behavioral problems and social skills, did improve engagement during opinion essay writing, assessed through observational methods.

Stemming from these encouraging findings, we designed the present study in Grade 3 with a twofold goal: (a) to test the effects of two SRSD interventions with additional components targeting core skills in writing, which, in grounded on the Writer(s)-Within-Community (WWC) model (Graham, 2018), included attention and transcription; and (b) to evaluate the effects of these interventions on a comprehensive set of measures. As for the first goal, we combined an SRSD program - teaching students a planning strategy and how to use it compose text - with attention and transcription training components. Attention is not only among the most influential factors in learning and school success (Posner et al., 2014) but also a fundamental capability for the acquisition and development of writing (Engle, 2002; Kellogg, 2008). Likewise, the achievement of efficient and automatic transcription (viz., handwriting and spelling) is a cornerstone of good writing (Graham & Harris, 2000). Thus, we intended to scrutinize the effects of improving either attention or transcription within a SRSD training. As for the second goal, besides examining the effects of these interventions on measures of writing and writing motivation, we also targeted executive functions and transcription – which are outcomes directly related to the attention and transcription training added to SRSD – as well as school grades – which are a key indicator of academic success largely dependent on students' writing-related abilities.

Development of writing processes in children

A recent and illustrative approach to the diversity of components involved in writing is the Writer(s)-Within-Community (WWC) model (Graham, 2018). According to this model, writing is a social activity that results from the interaction between the context in which writing takes place and the writer's cognitive abilities (Graham, 2018). These latter include not only mental operations, such as transcription, but also control mechanisms, such as executive functions including attention, which rely on writers' motivation.

Transcription is the process of transforming oral language into written text, which includes handwriting/typing and spelling (Limpo et al., 2020). Handwriting integrates orthographic and motor skills. It refers to the combination of accuracy

and speed and is typically measured by the number of clear and precise letters or words that can be produced within a specified period of time (Berninger et al., 1992). Spelling is a multifaceted skill that requires the use of various skills and knowledge sources, including awareness of letter-sound correspondence, morphology, phonology, and orthography (Wood & Connelly, 2009). Spelling entails the ability to recall, recognize, and transcribe orthographic symbols and is typically assessed based on its precision, as indicated by the number of correctly spelled words in isolation or within context (Graham et al., 1997; Limpo & Alves, 2013). At the beginning of schooling, these transcription skills are not yet automatized. This means that primary graders struggle with the correct drawing of letters and spelling of words. Therefore, from very early on, it is essential to promote the training of transcription skills, so that they become increasingly automatic. This automatization is important because it releases attentional resources that can then be devoted to more complex cognitive processes, such as executive functions (Berninger & Winn, 2006).

Executive functions are cognitive mechanisms that play a crucial role in regulating and coordinating human behavior, facilitating rapid and flexible adjustments to environmental demands (Diamond, 2013). As described by Feifer and De Fina (2002), high levels of executive functioning are needed for children to achieve proficiency in writing. For example, writing requires cognitive planning skills for developing an action plan; switching skills for alternating between topics; inhibition skills for interrupting an irrelevant thought; and attentional skills for focusing attention on the writing task. Unfortunately, there is little evidence on the most important executive functions for young writers (see also Limpo & Olive, 2021). Yet, Cordeiro et al. (2020) found that attention played a key role in Grade 2, above and beyond transcription and other executive functions. Attention can be defined as the ability to focus on the relevant attributes of a task, while inhibiting interfering and irrelevant ones (Lutz et al., 2008). This process is at the base of other cognitive mechanisms (Diamond, 2013; Hilton et al., 2017) and has a key influence on learning and writing (Berninger et al., 2016), turning it into a relevant candidate for promotion in early grades.

In addition to the cognitive processes described above, research has shown the relevance of motivational aspects in young writers. Motivation translates into students' willingness to engage in writing and includes a set of beliefs they have about writing and themselves as writers (Limpo & Alves, 2013). According to the WWC model, key motivational beliefs include attitudes towards writing and self-efficacy. Students' attitudes towards writing are commonly defined as their level of enjoyment when engaging in writing. Past studies found that more positive attitudes are associated with better writing (Graham et al., 2017; Rocha et al., 2019). Similar findings have been found for writing self-efficacy (Pajares, 2003), which comprises students' beliefs about their ability to successfully perform writing-related tasks (Bandura, 1997). Contemporary approaches to self-efficacy showed the benefits of considering this construct as multidimensional (Bruning et al., 2013), including the domains of conventions (e.g., spelling), ideation (e.g., generating ideas), and self-regulation (e.g., managing emotions and behavior during writing). As most past studies addressed self-efficacy as a unitary construct, research is not particularly consistent regarding the relationship between these specific self-efficacy domains and writing

performance (Limpo & Alves, 2017; Rocha et al., 2019; Zumbrunn et al., 2020), including how they may be influenced by SRSD training.

Writing instruction via SRSD

Given the multitude of cognitive and motivational processes involved in writing, the development of self-regulation has been considered an effective practice to promote children's writing. One of the practices that has stood out for its effectiveness is the SRSD model (Harris & Graham, 2009). This model encompasses guided, situated, and scaffolded instructional practices implemented in six steps: (1) develop and activate background knowledge, (2) discuss and describe the writing and self-regulated strategies, (3) model the strategies, (4) memorize the strategies, (5) support the strategies, and (6) independent performance (Harris et al., 2008). Along these steps, students are provided with explicit teaching and systematic practice for carrying out not only specific writing processes but also self-regulation strategies, which allow them to optimize their performance and self-reflection. According to meta-analyses, SRSD is effective in teaching writing from elementary to high school (Graham et al., 2012; Graham & Perin, 2007).

For example, Lane et al. (2011) demonstrated that an SRSD intervention of three to four 30-min weekly sessions during 12 weeks increased second graders' opinion essay and story quality and structure as well as opinion essay engagement. Similarly, Harris et al. (2012) found that an SRSD intervention of three 30-min weekly sessions during 6 to 8 weeks improved second- and third-grade students writing (viz., number and quality of story and opinion essay elements). One of the few studies that combined SRSD with transcription training showed that an SRSD intervention of 10 60-min weekly sessions in Grade 2, with or without transcription training, resulted in more complex plans as well as longer, better, and fuller stories. Sawyer et al. (1992) further expanded these findings confirming the importance of implementing the full SRSD model including explicit self-regulation instruction: After three 20-to-56-min weekly sessions during 3 weeks, there was an increase in text structure and learning generalization in Grade 5 and 6. Despite scarce and mixed results on the effects of SRSD on motivation (Camacho e al., 2020), Zumbrunn (2010) showed that an SRSD intervention of three 30-min weekly sessions during one semester improved first graders' self-efficacy for writing stories. In most of the above studies, SRSD instruction targeted students' written planning skills, which seems to be among the most effective approach to improve the texts of developing writers (Graham et al., 2012; Graham & Perin, 2007).

Promoting written planning

Written planning is particularly beneficial in developing writers (Graham et al., 2012; Graham & Perin, 2007), as it directs attention to specific objectives and facilitates the generation and organization of ideas ahead of writing (Limpo & Alves, 2013). As proposed by Georgiou (2021), this type of planning differs from cognitive planning. Deemed a component of executive functions (e.g., Diamond 2013), cognitive

planning consists of the ability to anticipate actions and carry out a task in a methodical, well-organized, and efficient manner. Following this proposal, the current study addressed both written and cognitive planning, considered components of writing and executive functioning, respectively.

Past research demonstrated that written planning can be effectively promoted by teaching students' strategies to identify the key elements of a particular genre and to apply appropriate discourse knowledge (Graham & Harris, 2007). Among the several teaching practices designed to promote the learning of these strategies and their use in writing (e.g., modeling, collaborative work), SRSD relies on the use of mnemonics for enhancing students' ability to remember strategy steps when building their plans (Harris et al., 2008, 2011). An example, is the mnemonic "TREE" developed by Harris et al. (2008) for opinion essay writing (T - Topic; R - Reasons; E - Explain; E - Ending). Typically, these mnemonics are complemented with graphic organizers, which include empty boxes for the genre elements to be included in the plan (for graphic examples, see Harris et al., 2008). The use of this form of structure-based written planning was found to be associated with enhanced writing at the discourse, sentence, and word levels (Limpo & Alves, 2013). The combination of these teaching methods (i.e., mnemonics and graphic organizers) help students to internalize, implement, and generalize the strategy. The teaching of written planning strategies is even more effective when coupled with self-regulatory training (Zumbrunn & Bruning, 2013).

Promoting self-regulation

Fundamental self-regulation strategies used in SRSD are goal setting, self-monitoring combined with self-assessment, and self-instructions. Goal setting helps students establish goals before writing, indicating what is expected or required for the task and guiding the production of the text (Hayes & Flower, 1986). In addition, it promotes students' motivation and effort, and gives them a basis for self-monitoring and self-assessment (Harris et al., 2008). Whereas self-monitoring refers to a process of examining an expected behavior has occurred (e.g., to check if all planning steps were followed), self-assessment refers to the process of comparing the information collected in self-monitoring with previous situations followed by appropriate reinforcement (Harris et al., 2011). These strategies allow students to monitor their own progress, thereby fostering not only self-efficacy but also motivation (Graham & Harris, 2000). The use of goal setting as well as of self-monitoring plus self-assessment strategies can be facilitated through self-instruction strategies. These are verbalizations that students direct to themselves to increase focus, control automatic and impulsive responses, and guide writing behavior (Zimmerman, 2000). The strategies of goal setting, self-monitoring plus self- assessment, and self-instructions are critical in SRSD, as they seem to magnify the impact of writing-specific strategies (Graham et al., 2013).

Promotion of attention via meditation training

Recent research suggested that an effective practice to improve attention is meditation (Lutz et al., 2008; Matko et al., 2021). Meditation includes a set of self-regulation practices that put mental processes under voluntary control through attention and awareness training, with the goal of developing a sense of calm, clarity, and concentration (Walsh & Shapiro, 2006). An effective style of meditation in children is focused attention meditation (Napoli et al., 2005), which involves the maintenance of the attentional focus on a chosen stimulus, such as breathing (Malinowski, 2013). During breathing meditation, attention is directed to the sensations that arise during inhalation and exhalation in different body parts (e.g., nose, chest, and stomach). This technique is highly recommended for beginners not only because it is simple and easy to learn but also because it was found to develop their attention skills (Willis & Dinehart, 2014). Prior research showed that engaging in meditation practice increased children's attention gauged with performance-based measures, such as the Attention Network Task (ANT; Rueda et al., 2004), which evaluates three fundamental attention subsystems: conflict monitoring, orientation, and alertness (Posner & Petersen, 1990). For example, Felver et al. (2017) showed that meditation training improved children's abilities to resolve conflict, direct and constrain attention to specific topics, and to maintain a state of alertness to environmental stimuli.

Given the importance of these attentional skills in writing (Berninger et al., 2016), as also highlighted by the WWC model (Graham, 2018), it seems plausible that increasing attention by means of meditation may have a positive impact on writing-related variables as well as school grades, which largely depend on both attention and writing abilities. Preliminary evidence supporting this proposition was already found. Authors (Limpo et al., 2023) showed that an intervention including meditation practice improved third-graders opinion essay writing ability and math grades. Also in Grade 3, Magalhães et al. (2022) found that a meditation-based intervention led to attentional improvements as well as to better grades in Portuguese, Mathematics and Social Studies (see also Bakosh et al., 2018; and Cordeiro et al., 2021).

Promotion of handwriting and spelling via transcription training

Several intervention studies confirmed the importance of promoting either handwriting fluency or spelling accuracy in young children (for meta-analyses, see Graham & Santangelo, 2014; Santangelo & Graham, 2016). Explicit teaching and systematic practice of transcription appear to be particularly effective in promoting these competences (Graham et al., 2002; Limpo & Graham, 2020). Alphabet and copying activities are among the best practices to promote handwriting skills (Graham, 2009). Spelling programs that incorporate elements of explicit instruction through phonemic, morphemic, and whole-word approaches, have also been shown to be highly successful in improving spelling skills (Treiman, 2018). Besides systematic instruction, spelling development also benefits from natural learning approaches that rely on incidental and informal teaching procedures (Graham, 2000).

While most studies show the effectiveness of teaching explicit handwriting and spelling together (e.g., Graham et al., 2018), there is also evidence to support the

effectiveness of transcription programs combining explicit handwriting and implicit spelling training. Through the inclusion of carefully selected words, copying activities may also provide students with implicit spelling practice (for a discussion about this, see Limpo & Graham 2020). In Grade 2, Limpo and Alves (2018) examined the effects of an SRSD intervention coupled with transcription training including explicit teaching of handwriting and implicit teaching of spelling. The goal of this implicit instruction was to make it easier for students to automatically use the correct spelling of words containing alternations (i.e., different ways to represent a single phoneme) and, thus, posing challenging for Portuguese-speaking children. The implicit practice was provided by including those words in the copying activities used for handwriting instruction, without explicit instruction on how to spell those words. Findings showed that the inclusion of this type of transcription training in the SRSD intervention increased both handwriting fluency and spelling accuracy for inconsistent words, as well as written planning completeness, story completeness, and several composing fluency measures. The SRSD + transcription intervention was particularly effective in increasing the writing quality among the weakest writers. Limpo et al. (2020) further showed the effectiveness of this transcription program without the SRSD component. After participating in the transcription intervention combining explicit and implicit teaching of handwriting and spelling, respectively, third graders showed greater handwriting fluency as well as spelling accuracy than their peers participating in a drawing intervention (active control group). All in all, despite the well-established need of explicit spelling instruction (Graham & Harris, 2000), selecting specific words to be copied in handwriting practice exercises seems to be a useful complementary – but not a replacement – practice to aid students correctly spelling some Portuguese words.

Present study

SRSD is an effective instructional writing model, directly targeting writing and self-regulation strategies (Harris et al., 2008; Harris & Graham, 2009). Yet, this model does not include specific components to train transcription and attention skills. To test the adequacy of including those components into SRSD interventions, we conducted the present study. We compared the effects of SRSD interventions with additional training components addressing attention via focused meditation exercises (SRSD + attention group) or transcription skills via letter and word copying plus alphabet exercises (SRSD + transcription group) with wait list control group. The SRSD intervention was implemented in line with the guidelines provided by the authors (Graham et al., 2005). Following the six steps of instruction and using core teaching techniques (e.g., modeling, collaborative writing, feedback), we taught a written planning strategy together with self-regulation strategies to help students plan and write argumentative essays. Prior the examination of interventions' effectiveness, we assured all sessions were implemented as planned. Before and after the interventions, we measured a comprehensive set of outcomes.

To test the specific effects of the additional components focused on transcription and attention, respectively, we assessed students transcription skills (i.e., handwriting fluency and spelling accuracy) and executive functions (i.e., cognitive planning,

working memory, inhibition, and regulation). Following past studies and aiming to replicate their findings (Harris et al., 2012; Zumbrunn, 2010), we assessed motivation (attitudes towards writing and self-efficacy for writing) and writing (written planning as well as text structure, quality, and length). Since few studies verified whether SRSD training impacted academic achievement, we also measured students' school grades. These latter represent a quantitative indicator of students' abilities to face the multiplicity of daily academic-related activities, largely dependent on writing, given its importance for the transmission, acquisition, and assessment of contents across most study areas (Prata et al., 2019). In what follows, we present the expected group differences at posttest only.

Past studies showed the benefits of SRSD interventions on students' written planning abilities, structure, length and quality of their argumentative texts, and motivation-related beliefs (Prata et al., 2019). Grounded on this evidence, we expected that, in comparison to the wait list group, both SRSD groups would display more complex plans, as well as more complete, longer, and better texts along with more positive attitudes and stronger self-efficacy.

Moreover, though to the best of our knowledge no study tested the effects of SRSD interventions on executive functions and academic achievement as defined above, we also predicted that both SRSD groups would surpass the control group in terms of these outcomes. On the one hand, SRSD instruction may enhance executive functions by promoting students' abilities to analyze, plan, and make decisions towards goals; to coordinate cognitive and affective resources; and to focus and maintain attention in the tasks at hands (Harris et al., 2018). On the other hand, SRSD writing interventions are likely to improve academic achievement due to its expected impact on writing and self-regulation (Harris et al., 2018), which are fundamental skills to perform well at school (Salas et al., 2020).

Despite the overall benefits of the two SRSD interventions, given the key differences between the attention or transcription groups, we foresaw the following differential effects. Based on studies showing that transcription intervention with explicit teaching of handwriting and implicit teaching of spelling improved handwriting and spelling skills (Limpo & Alves, 2018; Limpo et al., 2020), we anticipated that the SRSD + transcription group would show greater handwriting fluency and spelling accuracy than the other two groups. Grounded on evidence supporting the effectiveness of meditation to promote children's attentional skills (Schonert-Reichl et al., 2015), which are at the root of executive functions (Garon et al., 2008), we hypothesized that the SRSD + attention group would display higher teacher-reported executive functioning than the SRSD + transcription group.

Method

Participants and design

The study involved a pretest-posttest quasi-experimental design and included 113 third graders from seven classes within a school in the North of Portugal. As the number of classes was odd, we created three clusters of classes (two composed by

two classes plus another one composed by three classes) with the most equivalent number of students in each. These clusters were then randomly assigned to the three conditions: SRSD+attention (3 classes), SRSD+transcription (2 classes) and wait list (2 classes). Due to the small number of classes per condition, students rather than classes were used as the unit of analyses.

We set the following exclusion criteria to define the data-analytic sample: lack of authorization to be involved in the study by the legal guardian ($n=9$), special education needs ($n=6$), lack of one or two assessment moments ($n=3$), and absence in more than 25% of the intervention sessions ($n=1$). The final sample included 97 students: 34 in the SRSD+attention group ($M_{age} = 8.30$, $SD=0.39$; 20% girls), 31 in the SRSD+transcription group ($M_{age} = 8.20$, $SD=0.30$; 17% girls), and 32 in the wait list group ($M_{age} = 8.34$ years, $SD=0.30$; 17% girls). Table 1 presents the sociodemographic characterization of these groups, which did not differ in terms of age $t=0.29$, $p=.28$, gender $\chi^2=0.25$, $p=.88$., and socio-economic status $\chi^2=7.49$, $p=.28$.

Interventions programs

Whereas students on the wait list group received standard writing instruction from their teachers, all others participated in a SRSD intervention program with either transcription or attention training. Both programs of these programs were implemented in classroom groups for five weeks at the same time. Each week included two 60-minutes-long sessions on Monday and Tuesday, followed by three 5-minutes-short sessions delivered on Wednesday, Thursday, and Friday.

The 60-minutes-long sessions were implemented by five psychologists (one per class), among which three worked in the school where the study took place, and two worked in the research project in which the study was conducted. All psychologists were female, aged between 26 and 45 years, and registered in the Order of Portuguese Psychologists. These long sessions aimed to implement the SRSD program combined with either the transcription or attention training. In total, students participated in 5 h of SRSD instruction, in line with the directions followed in the field (Harris & Graham, 2009) and described in the SRSD interventions presented in the introduction.

Table 1 Demographic Data for the Participating Students by Condition

		SRSD+Attention ($n=34$)	SRSD+Transcription ($n=31$)	Wait list ($n=32$)
Gender				
	Boys	15	15	16
	Girls	19	16	16
Age (in years)				
	M (SD)	8.30 (0.30)	8.21 (0.30)	8.34 (0.30)
	Min-Max	7.83–9.50	7.83–8.83	7.92–8.92
Mother educational level (n)				
	Grade 4	0	0	1
	Grade 9	8	4	10
	Highschool	10	6	8
	College or above	13	19	12
	Unknown	3	2	1

The 5-minutes-short sessions were implemented by the respective schoolteacher of the class. In total, participated five teachers (one per class), including four females and one male, aged between 40 and 55 years. Long sessions were supported by PowerPoint files with the key topics to be presented. Short sessions were also supported by a PowerPoint file, but the schoolteacher's task was only to open the file and either play an audio (SRSD+attention group) or read the transcription tasks' instructions (SRSD+transcription group). These 5-minutes sessions aimed to introduce regular and systematic practice of breathing meditation or sentence copying into the daily classroom routine. The best dosage of meditation and copying practice at the end of primary school is still unknown. However, past studies showed benefits of 8-week mindfulness interventions in children and adolescents with only 5 min of daily meditation (Saltzman & Goldin, 2008; Zylowska et al., 2008). Moreover, it has been suggested that brief, but regular copying activities are among the best practices to enhance the learning of handwriting skills (Graham, 2009).

Following the SRSD model (Harris et al., 2018), the writing program taught students a written planning strategy combined with self-regulation strategies (viz., self-instructions, goal setting, and self-monitoring plus self-assessment) in line with the SRSD instructional steps and features. In what follows, we present, first, the taught strategies, and then, the operationalization of the SRSD steps and features (further detail can be found on Table 1 of Supplementary materials).

As a first step, students learned to set their goal for the program (i.e., writing complete 6-part texts). Then, it was explained that to achieve this goal, they were going to learn two strategies. At this point, two mnemonics were presented to facilitate the learning and memorization of those strategies: SETA (arrow) and 2P2EAcaba! (2P2Eend!). SETA was the mnemonic used to represent a self-instruction strategy, aimed to guide students throughout the main steps involved in the process of writing an argumentative text: Silêncio (silence); Esquema (plan); Texto (text); Avaliar (evaluate). To implement this strategy, they were asked to use covert (in their heads) or overt (out loud) self-talk to follow those four steps and complete the writing assignment. Imbedded within the E of SETA, students learn the mnemonic 2P2EAcaba!, which represented a written planning strategy aimed to help students in generating content accordingly to the major parts of an argumentative text. These two strategies are described below.

Step 1 of SETA: silence Students learned that the first step to write a good argumentative text was to be quiet, in silence. The implementation of this step was the only difference in the long sessions between SRSD+attention and SRSD+transcription groups.

SRSD+attention program Students were asked to be silent as a way to focus their attention. For this, they performed a 5-minutes age-appropriate audio guided meditation. All meditations focused on breathing, but they varied across sessions in terms of the body part to attend (nose, chest, stomach, or free choice) and the breathing rhythm (provided or not). The meditations trained in the long lessons were further trained in the short lessons. Students completed these meditations daily.

SRSD + transcription program Students were asked to be in silence and train their transcription abilities during 5 min, through quick copying activities. In the 5-minutes-short sessions, they performed alphabet and quick sentence copying activities. These activities were taken from the evidence-based transcription program developed and tested by Limpo and Alves (2018), then cross-validated by Limpo et al. (2020). As validated by these authors, the copying activities include specific words that allow the implicit practice of spelling, without any kind of explicit instruction. Students were exposed to 40 target words containing alternations (i.e., different ways of representing a single phoneme) that are a struggle for children learning the Portuguese spelling system (for example alternative spelling units s and z for the phoneme [z] "pesado" vs. "amizade"). Based on the findings reported by Limpo and Alves (2018), showing that this implicit practice improved accuracy in writing inconsistent but not consistent words, in the present study, students only completed activities targeting inconsistent words, assessed using the instrument developed by Limpo and Alves (2018).

Step 2 of SETA: plan All students learned the importance of written planning and how to do it using the 2P2EAcaba! strategy. This mnemonic helped students to remember the major parts of an argumentative text: "2P" - *"Diz o que **p**ensas e **p**orquê" (Say what you think and why)*; "2E" - **E**xplain each reason with **e**xamples; and "**A**caba!" (*End*) - Finish your text with a new sentence. To facilitate its implementation, students received graphic organizers. These graphic organizers are made up of six text boxes corresponding to the major parts of the argumentative text taught through the 2P2EAcaba! mnemonic, organized as a structured outline.

Step 3 of SETA: text After finishing the plan, students were taught to use this plan to write the final text. They were instructed to follow the ideas in the plan and, if possible, to develop them a little further and write complete sentences.

Step 4 of SETA: evaluate Finally, students self-monitored their performance. For this, after finishing the first version of their text, they were asked to read it and identify if each of the six parts of the 2P2EAcaba! strategy was present in the text. For each part that was present, students made a written record on a target-shaped chart. This chart contained one small box for each strategy part to be checked off as identified as being present. It also included a big box to write the total number of parts included. This activity allowed students to self-assess their work, by confirming whether their texts were complete or not and revising them accordingly. To register their progress on each individual writing task throughout the program, students additionally had a sheet with five rockets, each with six parts, to be colored according to the essay parts included.

As noted before, in addition to teaching a written planning strategy combined with three self-regulation procedures (viz., goal setting, self-instructions, self-monitoring), the writing program was in line the SRSD steps and features. Specifically, all main constructs addressed in the program (e.g., argumentative essays, meditation, written planning, self-regulation strategies) were presented and discussed with

students (SRSD Steps 1 and 2: Development of background knowledge and Discussion). In addition, the main tasks associated with writing (viz., carrying out the plan, writing the text, self-monitoring, and self-assessment) were first modeled by the teacher (SRSD Step 3: Modeling). Since Lesson 1, the memorization of strategies' key concepts and steps was encouraged through question-and-answer group activities, regular restating of lessons' main points, and systematic practice (SRSD Step 4: Memorization). After modeling, collaborative writing and individual writing activities were carried out, with increasingly less support from the psychologist and materials (SRSD Step 5: Support). Together, the flexible implementation of these steps aimed at providing students with progressive autonomy in relation to the process of argumentative writing argumentative (SRSD Step 6: Independent performance).

Other features of SRSD were also present in the program: students were seen as active collaborators who worked together with their colleagues and with the psychologist; there was a long-term goal to promote their motivation, that of selecting the best text of each student to be assembled in book; after the writing of each text, students were given the opportunity to read their texts aloud and share their ideas with the group; all sessions included specific, challenging, and achievable short-term goals that were flexibly adjusted to each student's progress (e.g., once a student was able to provide two reasons, he/she was stimulated to try to include a third one); three lessons before the end of the program, students received a "progress certificate" with specific and individualized feedback along with reinforcement statements to encourage them using the strategies; during the program, the psychologist promoted the generalization of the taught skills to other contexts through examples and dares (e.g., try to use the strategy to convince your parents to do something you want).

Intervention fidelity

To ensure that both interventions were implemented as planned, we applied the following procedures. First, we developed a 25-hour course composed of three modules. The first module included an introductory, pre-intervention workshop of 9 h aimed to: (a) discuss research contributions to the teaching and learning of writing; (b) share the effectiveness of teaching written planning strategies to promote writing; (c) introduce the theoretical and empirical bases of the intervention programs; (d) present the SRSD instructional model and underlying didactic practices (viz., coupling of writing and self-regulation strategies and the six SRSD stages). The second module included a set of five 2-hour weekly monitoring sessions, which were interspersed with classroom program implementation sessions. In the monitoring sessions, there was a reflection about the program's sessions implementation in the previous week, including what went as planned as well as unexpected situations and solutions to resolve them. After this, the contents of the following week's sessions were presented and practiced. The third module of the course included a 3-hour session to wrap up. In this last session, psychologists reflected on the experience of implementing the programs in the classroom and on their impact on students' behavior and academic skills. All sessions were co-led by the first and last authors and attended by all instructors involved (i.e., psychologists).

Second, long lessons were organized into 12 main steps detailed in a checklist to be completed by psychologists. There were rare deviations from instructional plans that usually involved missed steps covered in the next lesson. At the end, all instructors reported to have implemented 100% of the planned steps. Third, three lessons (out of ten) in both SRSD conditions were audio-recorded and examined by a trained research assistant, who confirmed that 100% of the planned steps were completed. Fourth, the same researcher evaluated the quality of the observed lessons in terms of teacher performance; teacher/student interaction; and efficiency and pacing of instruction (based on Limpo & Alves 2013). The average quality of the SRSD+attention and SRSD+transcription program was 4.7 and 4.8, respectively (1=*very low*, 5=*very high*). Fifth, for short lessons, we gave teachers a checklist to be filled in at the end of the week, indicating whether the exercises were completed or not. The 15 lessons planned were implemented in both SRSD+transcription classes, but only 10 and 9 lessons out of 15, were implemented in the SRSD+attention classes. Finally, we confirmed that the main activities of both programs were successfully understood and completed. For that, the first author analyzed all the notebooks to see if students failed to complete any writing assignment. No such case was found. All students attending the classes completed all proposed tasks.

This study was conducted from November to December 2021, during the pandemic. Regrettably, the worsening of the situation at the end of 2021 affected two SRSD+attention classes. Several students in these classes, but not in the SRSD+transcription classes, got COVID and, following governmental rules, the entire classes were put in quarantine. Although we managed to implement all the long lessons, in one of the SRSD+attention classes, two weekly units were implemented online. These implementations were carefully followed by the research team, who assured treatment fidelity. However, in another class, due to technical constraints, it was not possible to adopt the online format, which ended up being reflected in a high number of student absences in face-to-face classes. The mandatory quarantine of these classes also affected the implementation of the short lessons in the SRSD+attention classes. The lack of face-to-face classes caused significant delays in the transmission of syllabus contents. Consequently, schoolteachers prioritized the recovery of learnings rather than the complete implementation of the program, reason why some short lessons were not implemented.

Testing sessions

All students were evaluated before and after the interventions in a 60-minutes group session, organized in three parts. Firstly, students were presented with the essay writing topic: "Do you think teachers should give students homework every day?" at pretest, and "Do you think there should be more field trips?" at posttest. These prompts have already been used in past studies (Cordeiro et al., 2020; Limpo et al., 2020) and were selected by an experienced team of primary-grade schoolteachers. They are considered equivalent in terms difficulty and interest value, as they are directly related to the children's routine, thus maximizing task involvement and productivity (Limpo & Alves, 2013). We used different prompts instead of a counterbalancing procedure to prevent students from knowing the writing prompt in advance, as they

attend the same school and would be able to discuss it. After the topic presentation, students had 10 min to plan the essay, namely, to think about what they wanted to say and to organize their ideas. Then, they had 15 min to compose the essay, based on the ideas they wrote in the plan. Secondly, students performed three transcription tasks, in which they were asked to (a) copy a 9-word sentence as quickly as possible without making mistakes during 90 s (Limpo & Alves, 2018), (b) write the lowercase letters of the alphabet as quickly as possible without making mistakes during 15 s (Berninger et al., 1992), and (c) spell a set of 16 words dictated to them at intervals of 6-to-10 s (Limpo & Alves, 2018). Thirdly, students filled in the writing attitudes and writing self-efficacy questionnaires. The experimenter indicated that, for both questionnaires, there were no right or wrong answers and explained the overall procedure. Items were read aloud to students, who completed the instruments simultaneously and one item at a time. Moreover, schoolteachers completed an executive function questionnaire about each student and provided their school grades.

Measures

Transcription

Handwriting fluency In the copy task, the final score was the number of words accurately copied, with higher scores indicating greater fluency (Alves et al., 2015) In the alphabet task, the final score was the number of correct letters written. A letter was counted correct when it was legible out of context and in the right alphabetical order (Berninger et al., 1992).

Spelling accuracy We relied on students' performance on a dictation task composed of 16 words that were targeted in the SRSD + transcription intervention. The test included eight inconsistent words, whose correct spelling could be resolved only through rote learning (Limpo & Alves, 2018). For the corresponding set of words, we counted the number of words correctly spelled. As noted above, we only assessed inconsistent words because Limpo and Alves (2018), who developed and validated the transcription activities as well as the task to evaluate their impact on spelling accuracy, found training benefits on inconsistent but not consistent words.

One quarter of all transcription tasks were assessed by a second rater. For all measures and testing moments, inter-rater reliability, computed through the intra-class correlation coefficient (ICC), was above 0.99.

Executive functions

We used the Children's Executive Functioning Inventory (CHEXI), validated to Portuguese by Moura et al. (2019). This is a rating instrument through which teachers assess children's executive functioning (Thorell & Nyberg, 2008). Supporting the use of CHEXI among different respondents, cultures, and age groups, previous studies have been gathering strong evidence on the construct and predictive validity of CHEXI among various European and Asian cultures (Thorell et al., 2013), including

on its capacity to discriminate with good sensitivity and specificity between children with ADHD and typically developing controls (Catale et al., 2015).

CHEXI contains 26 items, divided into four subscales: cognitive planning (4 items), working memory (11 items), inhibition (6 items) and regulation (5 items) (further detail can be found on Table 2 of Supplementary materials). For each student, teachers were asked to indicate their level of agreement with the set of statements, using a 5-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Because the internal consistency of the five subscales in the two testing moments was very high (αs > 0.91) and because we wanted to implement a thorough assessment of SRSD programs' impact on executive functions, we opted to examine each factor separately, instead of combining these factors into two dimensions (Thorell & Nyberg, 2008).

Motivation

Attitudes towards writing scale We used a self-report instrument evaluating students' attitudes towards writing in and out of school (Graham et al., 2017), adapted to Portuguese by Rocha et al. (2019). Students indicated their level of agreement with a set of five statements (e.g., "I enjoy writing"), using a 5-point Likert scale (1 = *strongly disagree*; 5 = *strongly agree*). Cronbach's alpha was 0.84 at pretest and 0.90 at posttest.

Self-efficacy for writing We used the 9 items of the reduced version of the Self-Efficacy for Writing Scale (SEWS; Bruning et al., 2013), whose long Portuguese version was validated to Portuguese by Limpo and Alves (2017). This scale measured students' perceived confidence in their ability concerning three dimensions, with three items per each: ideation, that is, generating ideas; conventions, that is, expressing these ideas through writing; and self-regulation, that is, managing writing behaviors. Participants rated their self-efficacy on each item (e.g., "I can avoid distractions while I write") on a 0 to 100 scale ranging from no confidence to complete confidence. Internal consistency was high for conventions and ideation (αs > 0.74) and moderate for self-regulation (α = 0.64 at both testing times).

Writing

Written planning We assessed planning complexity using a scale ranging from 1 (*no planning*) to 7 (*structural relationships*). This scale was an updated version of the one used by Limpo and Alves (2013), who used a 6-point scale. In this study, we opted to split the original score 2 (reduced written planning) into two (minimal and moderated written planning) to allow a better discrimination of young students' written planning skills. The scores 1, 2 and 3 were attributed to plans that represent no written planning (i.e., the sheet is blank, with drawings, or with one or two words written, sometimes illegible), minimal written planning (i.e., plan is exactly the same as the text or with minimal changes) or moderated written planning (i.e., plan corresponds to the text with only minor changes regarding content, structure or order of sentences), respectively; plans summarizing the text received a score of 4; plans presented in

Table 2 Means and Standard Deviations for All Measures in Each Condition by Testing Time

	Pretest M (SD)			Posttest M (SD)			Posttest M_adjusted		
	Attention	Transcription	Wait list	Attention	Transcription	Wait list	Attention	Transcription	Wait list
Transcription									
Handwriting fluency (copy)	18.09 (4.59)	17.35 (4.68)	17.81 (3.51)	21.28 (4.77)	21.42 (5.19)	20.39 (4.19)	21.02	21.75	20.33
Handwriting fluency (alphabet)	14.25 (4.47)	11.87 (4.83)	12.72 (4.06)	15.23 (5.62)	16.10 (6.18)	15.00 (4.39)	13.86	16.99	15.09
Spelling	3.85 (3.13)	3.32 (2.85)	3.94 (2.91)	3.75 (3.65)	2.35 (2.30)	3.19 (2.80)	12.39	13.31	12.99
Executive functions									
Cognitive Planning	1.63 (0.90)	1.68 (0.76)	2.33 (0.97)	1.64 (0.91)	1.79 (0.79)	1.98 (0.94)	1.85	1.97	1.59
Working memory	1.70 (0.91)	1.79 (0.85)	2.23 (0.88)	1.70 (0.86)	1.81 (0.67)	1.92 (0.87)	1.87	1.91	1.66
Inhibition	1.80 (0.93)	1.67 (0.86)	2.55 (1.09)	1.76 (0.79)	1.68 (0.76)	2.04 (0.89)	1.92	1.93	1.64
Regulation	1.70 (0.86)	2.05 (1.24)	2.14 (0.98)	1.63 (0.76)	2.00 (1.12)	1.94 (0.92)	1.84	1.92	1.79
Motivation									
Attitudes	4.01 (0.84)	3.74 (0.98)	3.91 (0.98)	3.84 (0.97)	3.79 (1.05)	3.77 (1.08)	3.73	3.91	3.71
Self-efficacy for conventions	81.16 (21.39)	84.82 (14.13)	76.76 (17.80)	85.29 (19.29)	86.73 (11.76)	76.27 (24.99)	85.54	84.28	78.90
Self-efficacy for self-regulation	74.85 (21.04)	79.09 (19.27)	68.88 (22.81)	78.74 (23.88)	79.56 (23.68)	71.40 (26.08)	78.28	76.75	74.68
Self-efficacy for ideation	84.64 (17.49)	80.41 (19.28)	73.07 (24.26)	85.92 (20.94)	92.12 (9.41)	82.44 (25.22)	83.06	91.35	86.17
Writing									
Written Planning	2.62 (0.65)	2.55 (1.20)	2.56 (0.72)	4.41 (1.92)	5.61 (1.59)	2.35 (0.76)	4.41	5.62	2.36
Text structure	4.07 (1.78)	4.04 (1.52)	3.66 (1.51)	4.88 (1.84)	5.61 (1.56)	3.45 (1.57)	4.92	5.47	3.66
Text quality	4.45 (1.23)	4.49 (1.32)	4.22 (1.30)	4.66 (1.38)	5.08 (1.27)	4.07 (1.42)	4.50	4.93	4.15
Text length	51.37 (25.75)	48.43 (22.65)	54.41 (19.75)	60.61 (17.83)	60.46 (22.06)	46.14 (29.29)	60.70	61.75	44.81
Academic achievement	3.56 (0.71)	3.53 (0.58)	3.38 (0.52)	3.55 (0.58)	3.29 (0.76)	3.25 (0.60)	3.49	3.26	3.35

a list format or with slightly elaborated topics received a score of 5; scores 6 and 7 were assigned to plans with emergent subordination (i.e., explicit macrostructure) and structural relationships (e.g., graphic organizers), respectively. Additionally, for SRSD students at posttest, we counted the number of 2P2EAcaba! Parts included in the plan. As with transcription measures, 25% of the written plans were assessed by a second rater. ICC at pretest and posttest was 0.74 and 0.96, respectively.

Text structure Argumentative texts were evaluated for the presence and elaboration of four essay elements: premise, reasons, elaborations, and conclusion (Graham et al., 2005; Limpo & Alves, 2013). One point was assigned if the premise and conclusion were explicit, and two points were given if they were presented and elaborated. For reasons, one point was assigned for each reason that justified the premise. For elaborations, one point was assigned for each reason explained in depth. The final scores resulted from the sum of all points awarded. All texts were evaluated by two raters and ICC at pretest and posttest was 0.96 and 0.97, respectively.

Text quality To avoid biases in quality assessments, all texts were typed and corrected for spelling and punctuation errors (Graham et al., 2011). Afterwards, all texts were randomized and gathered in a single document. All texts were assessed by two research assistants, blind to study purposes and groups, trained by the first author. Raters used a scale ranging from 1 (*low quality*) to 7 (*high quality*) to rate each text with a single value, considering the following criteria: creativity (ideas originality and significance), coherence (text clarity and organization), syntax (sentences correctness and diversity) and vocabulary (word diversity and adequacy). The validity of this procedure to assess writing quality of school-age children was consistently proven by previous studies (Cordeiro et al., 2020; Limpo et al., 2020; Rocha et al., 2022). The final score was the average among judges, higher scores indicating better quality. ICC at pretest and posttest was 0.91 and 0.92, respectively.

Text length Using the word count function of Microsoft Word, we calculated the number of words of each text.

Academic achievement

We averaged students' school grades in three main subjects, namely, Portuguese, Mathematics, and Social Studies. In Grade 4, these grades range between 1 (*insufficient*) and 4 (*very good*). For this study, we collected the last grades given before the interventions and the first grades given right after the interventions.

Data-analytic strategy

All analyses were conducted using SPSS (version 27). As a first step, we examined the distribution of all variables to determine the appropriateness of using parametric procedures. Specifically, skewness and kurtosis absolute values below 3.0. and 10.0, respectively, were deemed indicative of no severe deviations from the normal

distribution (Kline, 2005). Then, to test for differences between groups on posttest variables, and aiming to increase statistical power by reducing error variance, we conducted a set of analyses of covariance (ANCOVAs). Given our pretest-posttest quasi-experimental design with three groups (SRSD+attention, SRSD+transcription, wait list), we introduced the respective pretest score of the (posttest) dependent variable as covariate and group as a fixed factor. Statistically significant group effects ($\alpha=0.05$) were followed up with pairwise comparisons, using Bonferroni adjustments. Before conducting the main ANCOVAs, we examined the homogeneity of the regression slopes across groups by testing the interaction between group and pretest scores. Significant interactions were decomposed with the Johnson Neyman (JN) technique using the PROCESS macro for SPSS, version 3 (Hayes, 2018). This technique allowed us to determine the range of pretest scores where the group effect on posttest scores was statistically significant.

Results

Table 2 provides means and standard deviations for all variables by group and testing time. Descriptive statistics showed that no variable had severe deviations from the normal distribution, as skewness and kurtosis were below |1.67| and |5.84|, respectively.

Transcription

Handwriting fluency For the copy task, we found no evidence of an interaction between group and pretest scores, $F(2, 88)=1.25$, $p=.29$, $\eta^2_p=0.03$. The ANCOVA revealed a main effect of pretest scores, $F(1, 90)=65.05$, $p<.001$, $\eta^2_p=0.42$, but no condition effect, $F(2, 90)=1.19$, $p=.31$, $\eta^2_p=0.03$. For the alphabet task, there was no interaction between group and pretest scores, $F(2, 85)=0.39$, $p=.68$, $\eta^2_p=0.01$. The ANCOVA revealed a main effect of pretest scores, $F(1, 87)=46.34$, $p<.001$, $\eta^2_p=0.35$, as well as of group, $F(2, 87)=3.76$, $p=.03$, $\eta^2_p=0.08$. Pairwise comparisons revealed that, at posttest, SRSD+transcription students correctly wrote more alphabet letters than their peers in the SRSD+attention group ($p=.01$, $d=0.54$). There were no other significant differences between groups.

Spelling accuracy Results showed an interaction between group and pretest scores, $F(2, 88)=4.21$, $p=.02$, $\eta^2_p=0.09$, indicating that the effects of the interventions were moderated by spelling scores before the intervention. The JN technique revealed that among students with spelling pretest scores of 12.38 or below (i.e., 46% of the sample), after the intervention, SRSD+transcription students produced less misspellings than students in the SRSD+attention, $B = -0.92$, $t = -2.00$, $p=.05$.

Executive functions

There were no pretest x condition interactions for all CHEXI dimensions, namely, cognitive planning, $F(2, 91)=0.52$, $p=.60$, $\eta^2_p=0.01$, working memory, $F(2, 91)=2.25$, $p=.11$, $\eta^2_p=0.05$, inhibition, $F(2, 91)=0.73$, $p=.48$, $\eta^2_p=0.02$, and regulation, $F(2, 91)=0.66$, $p=.52$, $\eta^2_p=0.01$. We then proceeded with the ANCOVAs. For each post-test variable, analyses revealed a main effect of the correspondent pretest score: cognitive planning, $F(1, 93)=288.44$, $p<.001$, $\eta^2_p=0.76$, working memory, $F(1, 93)=355.73$, $p<.001$, $\eta^2_p=0.79$, inhibition, $F(1, 93)=278.68$, $p<.001$, $\eta^2_p=0.75$, and regulation, $F(1, 93)=346.83$, $p<.001$, $\eta^2_p=0.79$. Moreover, results showed significant group effects for cognitive planning, $F(2, 93)=5.39$, $p=.01$, $\eta^2_p=0.10$, working memory, $F(2, 93)=4.02$, $p=.02$, $\eta^2_p=0.08$, and inhibition, $F(2, 93)=4.24$, $p=.02$, $\eta^2_p=0.08$.

Pairwise comparisons indicated that, in comparison to the wait list group, both the SRSD+transcription and SRSD+attention groups demonstrated greater cognitive planning ability, (respectively, $p=.002$, $d=0.44$; $p=.03$, $d=0.28$), better working memory (respectively, $p=.009$, $d=0.32$; $p=.03$, $d=0.24$) and greater inhibition (respectively, $p=.012$, $d=0, 35$; $p=.012$, $d=0.33$) at posttest. There was no group effect for regulation, $F(2, 93)=0.79$, $p=.46$, $\eta^2_p=0.02$.

Motivation

Attitudes We found no interaction between condition and pretest scores, $F(2, 84)=1.97$, $p=.15$, $\eta^2_p=0.05$. Although the ANCOVA revealed a main effect of pretest attitudes, $F(1, 86)=118.24$, $p<.001$, $\eta^2_p=0.58$, no posttest differences between groups were observed, $F(2, 86)=0.75$, $p=.48$, $\eta^2_p=0.02$.

Self-efficacy for writing Regarding the conventions and self-regulation dimensions, findings showed no interactions between condition and pretest scores: respectively, $F(2, 89)=0.28$, $p=.76$, $\eta^2_p=0.01$, and $F(2, 88)=0.50$, $p=.61$, $\eta^2_p=0.01$. The ANCOVAs showed a main effects of the respective pretest scores for both self-efficacy for conventions, $F(1, 91)=33.00$, $p<.001$, $\eta^2_p=0.28$, and for self-regulation, $F(1, 90)=33.66$, $p<.001$, $\eta^2_p=0.27$, but there was no group effects for conventions, $F(2, 91)=1.42$, $p=.25$, $\eta^2_p=0.03$, or self-regulation, $F(2,90)=0.23$, $p=.80$, $\eta^2_p=0.01$. Concerning self-efficacy for ideation, we found an interaction between group and pretest scores, $F(2, 88)=12.18$, $p<.001$, $\eta^2_p=0.21$, indicating that the effects of the interventions were moderated by ideation scores before the intervention. The JN technique showed that among students with ideation pretest scores of 74.62 or below (i.e., 37% of the sample), after the intervention, SRSD+transcription students surpassed wait list, $B=7.91$, $t = -2.00$, $p=.05$ and SRSD+attention students, $B=5.06$, $t = -2.00$, $p=.05$.

Writing

Written planning We found no interaction between group and pretest scores, $F(2, 88)=0.22$, $p=.80$, $\eta^2_p=0.01$. The ANCOVA revealed no link between pretest and posttest scores, $F(1, 90)=1.94$, $p=.17$, $\eta^2_p=0.02$, but a clear main effect of group, $F(2, 90)=37.48$, $p<.001$, $\eta^2_p=0.45$. Pairwise comparisons revealed that, in comparison to the wait list group, both SRSD groups showed better written planning skills at posttest ($p<.001$). Moreover, SRSD+transcription students produced better plans than their peers in the SRSD+attention group ($p=.002$, $d=0.69$).

Text structure After confirming the lack of interaction between group and pretest scores, $F(2, 79)=0.99$, $p=.38$, $\eta^2_p=0.02$, the ANCOVA revealed main effects of pretest scores, $F(1, 81)=6.76$, $p=.01$, $\eta^2_p=0.08$, and of group, $F(2, 81)=10.24$, $p<.001$, $\eta^2_p=0.20$. Pairwise comparisons indicated that, compared to the wait list group, both the SRSD+transcription and SRSD+attention groups wrote more complete texts at posttest (respectively, $p<.001$, $d=1.17$; $p=.003$, $d=0.79$). There was no other significant difference.

Text quality There was no interaction between group and pretest scores, $F(2, 79)=2.52$, $p=.09$, $\eta^2_p=0.06$. The ANCOVA revealed main effects of pretest scores, $F(1, 81)=29.27$, $p<.001$, $\eta^2_p=0.27$, and of group, $F(2, 81)=3.26$, $p=.04$, $\eta^2_p=0.07$. Pairwise comparisons revealed that, at posttest, SRSD+transcription students produced better texts than their SRSD+attention peers ($p=.01$, $d=0.34$). There were no other significant effects.

Text length We found no interaction between group and pretest scores, $F(2, 79)=1.53$, $p=.22$, $\eta^2_p=0.04$. The ANCOVA revealed main effects of pretest scores, $F(1, 81)=18.13$, $p<.001$, $\eta^2_p=0.18$, and of group, $F(2, 81)=5.54$, $p=.01$, $\eta^2_p=0.12$. Pairwise comparisons indicated that, compared to the wait list group, both the SRSD+transcription and SRSD+attention groups wrote longer texts at posttest (respectively, $p=.004$, $d=0.65$; $p=.007$, $d=0.66$).

Academic achievement

Preliminary findings showed an interaction between group and pretest scores, $F(2, 91)=12.93$, $p<.001$, $\eta^2_p=0.22$, indicating that the effects of the interventions were moderated by academic achievement before the intervention. The JN technique indicated that among students with poorer pretest grades (i.e., average grades of 3.62 or below; 38% of the sample), after the intervention, SRSD+attention students' grades surpassed those of SRSD+transcription grades, $B=0.19$, $t=2.00$, $p=.05$.

Discussion

This study compared the effects of SRSD interventions with additional training components of attention (via focused meditation exercises) or transcription (via copy and alphabet exercises) in Grade 3. In general, results showed that the SRSD+transcription intervention improved handwriting fluency in all students and spelling accuracy among poor spellers. Compared with the wait list group, both intervention groups improved executive functioning and produced better plans as well as larger and more complete texts. Besides the lack of consistent effects on motivation variables, we found that the SRSD+meditation intervention improved academic performance among weaker students. These findings are discussed next.

Effects on transcription skills

Contrary to our expectations and past findings (Limpo et al., 2020), the transcription training component added to the SRSD intervention did not improve students' copying skill. Considering the complexity of handwriting for beginning writers (Graham et al., 2000), we believe our training component devoted little time to practice handwriting. In total, students were only enrolled in transcription activities for ca. 2 h. This is considerably less practice time than that reported by Limpo et al. (2020), where transcription training lasted 10 h. In the future, it would be useful to determine the minimum amount of transcription practice needed to ensure benefits on students' ability to copy words fast.

Interestingly, though not being enough to improve copying skills, the 2 h of transcription training was sufficient to improve alphabet writing skills. After the intervention, the SRSD+transcription group wrote more correctly written alphabet letters than their peers in the other two groups, in line with previous studies providing transcription training (Limpo & Alves, 2018; Limpo et al., 2020). It seems that even with little training time, performing simple and quick tasks, such as copying words and doing alphabet games that start with different alphabet letters or writing the alphabet starting from varying letters, helped students to become faster and more accurate in writing ordered, isolated letters. This is an important result because there is now much evidence showing that students' ability to write the alphabet fast and accurately is an important predictor of composing skills (Graham et al., 1997; Santangelo & Graham, 2016).

The effects of transcription training on spelling skills were not clear-cut. Results revealed that the SRSD+transcription intervention improved students spelling skills, only among the weakest spellers as identified at pretest. This finding is partially aligned with the results of Limpo and Alves (2018) with second graders, who showed that SRSD coupled with transcription training increased spelling accuracy, albeit among all participants. It is worth recapping that both here and in Limpo and Alves (2018) students were provided with implicit spelling practice, through copying activities that included carefully selected words. In their study, Limpo and Alves raised the question of whether this kind of practice would benefit struggling spellers. The current work seems to provide a preliminary answer to that, by showing that the implicit spelling training helped the poorest spellers. This finding is encouraging

because with little effort for teachers, poor spellers may raise their ability to correctly spell words and catch up with their peers. A caveat should however be noted. Since the assessed and trained words were the same, this program with implicit spelling practice did not assess generalization. Additional studies scrutinizing the effectiveness and usefulness of this type of training is clearly needed.

Effects on executive functions

As anticipated, after the intervention, both SRSD groups showed enhanced teacher-reported executive functions compared to the wait list group. Likely due to the SRSD-based training, students improved their overall abilities to select and develop better action plans; to remember objectives, while working on tasks and linking them to prior knowledge; and to inhibit interfering behaviors and focus on important attributes of the task at hands. We believe that this increase in cognitive planning, working memory, and inhibition observed by teachers in the classroom was related to the explicit teaching of self-regulation procedures for writing (e.g., goal setting, self-monitoring, self-instructions), which can be easily transferred to other school tasks (Mason & Brady, 2021). Despite this claim, to the best of our knowledge, this is among the few studies showing SRSD benefits on executive functions, at least, gauged with the measures here used. Further research is however needed to replicate these findings with behavioral tasks.

Despite the observed growth in cognitive planning, working memory, and inhibition, SRSD interventions had no effects on the regulation CHEXI subscale. This dimension refers to children's ability to control their behaviors and emotions (example item: "Has clear difficulties in doing the things you find boring"), which seems related to emotional aspects of executive functioning, such as affect regulation, motivation, and reward/punishment experiences. In line with the general lack of effects on attitudes and self-efficacy (see discussion below), the absence of results on the CHEXI subscale of regulation is not particularly surprising. Indeed, a closer look at the items revealed a close proximity to general motivation (e.g., "Seldom seems to be able to motivate him-/herself to do something that he/she doesn't want to do").

Effects on motivation

Contrary to our expectations, we did not find any condition effects on students' attitudes towards writing. This finding is not easy to interpret, as only a few past studies have analyzed SRSD effects on attitudes. Yet, recently, Türkben (2021) found that 24 h of SRSD instruction did increase sixth graders' attitudes towards writing. At least three reasons may explain our different results. First, our study targeted younger participants (Grade 3 vs. 6). Second, our SRSD intervention lasted less than half of the time (10 vs. 24 h). Third, our study used a 5-item unidimensional measure to measure attitudes, whereas Türkben used a multidimensional approach. Given the importance of attitudes in writing performance (Rocha et al., 2019), it seems relevant to conduct additional research into the factors that may moderate the impact of SRSD on students' attitudes towards writing.

The SRSD interventions also failed to nurture students' self-efficacy for conventions and self-regulation. Although SRSD is aimed at improving students' self-efficacy, other studies targeting general self-efficacy also failed to support this claim (Graham et al., 2005; Limpo & Alves, 2013; Page-Voth & Graham, 1999). An exception to this was the study of Zumbrunn (2010), showing that SRSD instruction improved first graders self-efficacy for story writing. It seems premature to draw sound inferences from the reduced number of studies examining SRSD effects on specific dimensions of self-efficacy. Still, the study of Zumbrum and ours seems to indicate that SRSD interventions may influence training-related self-efficacy dimensions. Indeed, as here found, the SRSD + transcription intervention improved self-efficacy for ideation, though only among less confident at pretest. Likely, their improved abilities to plan and enhanced alphabet-related skills, made them feel more capable for generating good ideas.

Effects on writing

In line with our hypotheses, we found a clear condition effect on students' written planning. Compared to the wait list group, both SRSD groups produced more complex and structured written plans. Overall, they showed an enhanced ability to generate and list the main ideas as well as to organize them according to the structure of the opinion essay. This result replicated previous findings (Graham et al., 2005, 2012; Limpo & Alves, 2018) showing the benefits of SRSD on young students' written planning skills. Additionally, we found that SRSD + transcription group showed better written planning skills than the SRSD + attention group. The added value of transcription training in SRSD instruction is consistent with previous research. Limpo and Alves (2018) already showed that combining the teaching of written planning and self-regulation strategies with transcription training benefited second graders' ability to generate ideas for story writing. As claimed by these authors, transcription training may facilitate the implementation of written planning strategies by freeing up attentional resources for generating ideas and enabling their quick recording.

In line with written planning-related improvements, both SRSD interventions also had a positive impact on opinion essay structure and length. This finding agrees with prior studies, showing that SRSD instruction helps students to write longer texts complying with the genre structure (Glaser & Brunstein, 2007; Salas et al., 2020). These benefits of SRSD are assumed to result from the taught written planning strategy that may help young writers to store and organize their ideas into a written plan to be transposed and updated during text writing (Graham & Harris, 2007). Despite the added value of transcription training to written planning, this effect did not manifest in terms of text structure or length, as there were no differences between the two SRSD interventions. Future research is needed to understand if the attentional and transcription components have no effects on these variable, or similar effects with different mechanisms.

The results about the impact of SRSD interventions on text quality were less clear. We found one significant effect: At posttest, SRSD + transcription students produced better texts than wait list students. Yet, SRSD + attention students produced texts of similar quality to their peers. In other words, despite implementing two equivalent

SRSD interventions – which only differed concerning an extra component targeting either transcription or attention skills – only one of them improved argumentative writing quality. Currently, there is substantial evidence showing the benefits of SRSD instruction (without extra components) in primary graders' writing (Graham & Harris, 2017; Graham et al., 2012, 2013). This evidence aligns well with the text quality improvements found in response to the SRSD + transcription intervention.

The lack of effects of the SRSD + attention intervention on text quality was, however, striking, given that we were not able to find any previous study showing no improvements on quality measures after SRSD training, even though this can be due to publication bias (i.e., studies finding non-effective SRSD interventions were not published). Though a quick reading of our result could suggest that the meditation exercises may have hampered SRSD instruction, we believe this was not the case. Though there have been some indications that some types of meditation can trigger unpleasant sensations (e.g., discomfort, agitation, and anxiety) by prompting introspection (Pinto & Carvalho, 2019), there is no evidence showing that breath-focused attention meditation has negative effects on children. Indeed, a much more parsimonious explanation arises from the treatment fidelity results. Unfortunately, as SRSD + attention classes were especially affected by the pandemic, there were several changes in the implementation dynamics in this group, a major one being the use of online methods. Despite our best efforts to keep fidelity of implementation, these unusual conditions may have affected the implementation of the SRSD component. For example, online teaching may have impaired contents acquisition, interfered with performance, and limited instructional feedback. Clearly, a replication of this study without any crisis circumstances is warranted to fully ascertain the value of adding meditation exercises to SRSD writing instruction.

Effects on academic achievement

The hypothesis regarding the impact of SRSD interventions on academic achievement was partially confirmed. We found that students in the SRSD + attention group improved on academic achievement, but this only happened among students with lower grades at pretest. This result suggests that teachers may use meditation techniques with low-achieving students to complement the school curriculum and promote their school performance. Previous research has already shown that meditation facilitates learning and school achievement (Cordeiro et al., 2022; Magalhães et al., 2022; Schonert-Reichl et al., 2015).

The practice of breathing meditation may have help students to develop a sense of calm, allowing them to hold their attention for longer periods and turning them less prone to distractions (Fisher, 2006). Moreover, through explicit instructions on when and how to use these exercises, our SRSD + attention program may have also prompted children to use meditation in difficult times, such as those requiring greater emotional control and attentional focus, like writing a text. It is worth noting that this gain in academic achievement among weaker students occurred after a couple of hours of meditation training. Thus, this practice can be easily included in a classroom context with positive results within a few weeks.

Limitations and indications for future research

Current findings should be interpreted considering some limitations, which may.

guide future research. First, the SRSD, attention, and transcription training components were brief. As the development of writing is a long and demanding process (Kellogg, 2008), researchers may want to consider implementing longer interventions, at least to guarantee that lack of findings is not due to insufficient practice.

Second, this study used a small sample with a quasi-experimental design, constraining the power of the study and limiting findings' generalization. Moreover, the maintenance of the interventions' benefits was not assessed. Further randomized controlled trials with larger samples and follow-up assessments are needed to collect stronger evidence.

Third, to assure a more homogeneous sample and as proposed by schoolteachers, children with special educational needs were not included in the study. It is possible they could have benefited from the program, providing need information on the treatments' effectiveness with special populations.

Fourth, although we chose a written-planning task of 10 min in line with past studies (Limpo & Alves, 2018; Olinghouse & Graham, 2009) and some school activities, this amount of time may have been too short. In the future, researchers should consider using free-time written planning tasks and measure average duration time.

Fifth, executive functions were assessed through a questionnaire filed in by teachers. Despite the different findings between CHEXI factors, we cannot fully discard possible rating biases. Future studies should consider combining performance and reporting measures of executive functions, including of attention, which are not explicitly targeted by CHEXI.

Finally, our study design did not include a SRSD-only intervention, which impede us from making claims as to whether the additional components tested in this study bring added value to SRSD. Future studies should replicate the present one could include an SRSD-only group in order to make evidence-based claims about the added value of included attention or transcription training into SRSD.

Conclusion

A characteristic of expert writers is the strategic articulation of numerous writing processes (Graham & Harris, 2000). Yet, in the beginning of writing instruction, there is a greater focus on developing writing skills in isolation rather than on promoting their articulation. We believe that integrating additional components to SRSD programs may be an important path towards helping students to effectively articulate all the writing skills they are acquiring. This is the first study examining the empirical effect of coupling SRSD and meditation, with results supporting the inclusion of meditation practices as a complement to curricular activities. Though in need of further empirical support, we believe the findings of this study suggest the importance of articulating writing and self-regulation strategies with transcription and attention training in the early years of schooling.

Declarations

Competing interests No potential conflict of interest was reported by the author(s).

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