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Article

Spelling success in students with SLD: The role of initial morphological awareness and vocabulary versus intervention strategies

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Abstract: Teaching spelling is particularly challenging for children with, or at risk for, Specific Learning Disabilities (SLD). The present study examined the effectiveness of a structured instructional intervention designed to improve spelling skills, vocabulary knowledge, and morphological awareness (MA) in Greek third-grade students receiving special education support. A pretest–intervention–posttest experimental design was implemented, with a total of 72 students randomly assigned to either an experimental group (n = 39) or a control group (n = 33). The four-week intervention was based on principles of Direct Instruction with systematic scaffolding and incorporated a modified version of the Morphological Processing Spelling Approach (MPSA). Standardized measures of spelling, MA and vocabulary knowledge were administered before and after the intervention to assess students' progress. Results from repeated-measures ANOVAs showed that students in the experimental group demonstrated significantly greater improvement than those in the control group in text-level spelling, grammatical and historical spelling. Improvements in isolated word spelling were comparable across groups. Regression analyses further indicated that neither MA nor vocabulary knowledge predicted spelling performance at the baseline level. Overall, the findings provide strong support for the effectiveness of structured and direct instruction for enhancing spelling development among children at risk for or with SLD, highlighting its value regardless of their initial competence.

Keywords: intervention; spelling; specific learning disabilities; vocabulary knowledge; morphological awareness

1. Introduction

Students with Specific Learning Disabilities (SLD) or those at risk for SLD experience a range of learning challenges, one of the most prominent being spelling. Spelling can be defined as the written representation of language through the accurate use of graphemes in accordance with the rules and conventions of a given linguistic system (Mouzaki, 2010). It is a comprehensive process that depends on the correlation of cognitive and linguistic skills (Giazitzidou et al., 2024). Since spelling mistakes reveal the complexity of writing, they can be categorized accordingly. Phonological, orthographic and morphological errors are among the most common types of errors spotted (Bahr et al., 2012). International research indicates that learners with SLD have lower performance in spelling tasks than their peers (de Bree et al., 2022; Schurig et al., 2022), a finding that also reflects a below grade level performance in Greek SLD learners (Papadimitriou et al., 2026). The recurring errors in SLD learners accentuate

the significant role that cognitive and linguistic skills play in acquiring the spelling of the Greek writing system. However, limited research has examined how multiple linguistic skills (e.g., morphological awareness and vocabulary) can be integrated within structured interventions for students with or at risk for SLD, particularly in morphophonemic orthographies such as Greek.

Finnish and Greek are transparent languages, first and second in rank, respectively. Greek is cited as a transparent language in terms of its syllable structure. Research (Georgiou et al., 2020) indicates that grapheme–phoneme mappings in Greek demonstrate very high consistency in the feedforward direction (orthography to phonology; 95.1%), but substantially lower consistency in the feedback direction (phonology to orthography; 80.3%) (Protopapas and Vlahou, 2009). Consequently, spelling in Greek is considerably more challenging than reading. A substantial proportion of spelling errors arises from the incorrect use of inflectional morphemes, whose forms exhibit considerable variability, given that six of the ten parts of speech in Greek are inflected (Grigorakis and Manolitsis, 2016). Further errors stem from the semi-transparent nature of Greek orthography, where many phonemes correspond to more than one possible graphemic representation (e.g., the phoneme /o/ mapped to o or ω; Fragkouli et al., 2022). To account for this complexity, Protopapas and Skaloumbakas (2010) proposed a classification system distinguishing among (a) phonological errors, reflecting insufficient knowledge of phonological identities; (b) grammatical errors, involving incorrect selection of graphemes in inflected or uninflected suffixes; and (c) historical errors, arising from the misuse of graphemes within word stems. Consequently, the above linguistic features challenge learners and more specifically SLD learners, who are expected to acquire phonological, morphological and lexical information simultaneously in order to produce accurate spelling. Although the characteristics of Greek orthography are well classified, there is a lack of experimentally validated interventions tailored to these linguistic features, especially for students with SLD.

1.1. Morphological awareness and spelling

Morphological awareness (MA) is the ability to use, identify, and examine the morphological structure of words, understanding how words can be broken down into smaller units such as prefixes, suffixes, and roots (Carlisle, 1995). MA aids learners in understanding how morphemes are combined to form complex words and how these units produce meaning, grammatical function/purpose/use and word associations (Kuo and Anderson, 2006). As indicated by research, students who analyze and use morphological information show higher performance in reading, vocabulary development and spelling (Casalis et al., 2011; Papakostas et al., 2025).

Considering the morphophonemic nature of the Greek orthographic system, MA has a significant role for learners. Greek learners are faced with the challenge to encode phoneme-grapheme correspondences, morphological cues that help disambiguate graphemes with overlapping phonological values. Therefore, the production of correct spelling—especially inflectional endings and derivational forms—relies on a child's capability of identifying morphemes and applying morphological rules (Aidinis, 2010;

Diamanti et al., 2017). As stated in empirical studies in Greek, MA anticipates spelling accuracy and enhances a learner's ability to generalize spelling patterns across related words.

Morphological processing is a great challenge for students with SLD. Reduced knowledge of morpheme forms, limited understanding of the semantic and grammatical roles of affixes and difficulty in decomposing complex words are common weaknesses noticed in students with SLD (Nagy et al., 2006). As a result, students make frequent errors in both oral and written language, where areas, such as spelling of inflectional suffixes and morphological system stems are significantly affected. Therefore, in order for students with SLD to develop accurate spelling, especially within the Greek orthographic system, explicit instruction in morphological structure is essential. However, intervention studies examining the role of MA in improving spelling—particularly within structured instructional frameworks—remain limited, especially in transparent orthographies like Greek (Levesque et al., 2021).

1.2. Semantic awareness and spelling

Semantic awareness refers to the knowledge of concepts that people have acquired (Feldman, 2009). In literacy research, semantic awareness is implemented through receptive and expressive language vocabulary. On the one hand, receptive vocabulary is the understanding of words, on the other hand, expressive vocabulary is the production of words either orally or written (Laufer and Paribakht, 1998; Paul, 1991).

According to theoretical models of literacy, semantic knowledge is a key factor for spelling because it strengthens the quality of lexical representations. It is easier for students to infer meanings of unfamiliar words and to form orthographic presentations when they are able to comprehend how word meanings are structured and associated/ the structure and association of word meanings (Nagy and Genter, 1990). Considering the fact that spelling and vocabulary are mutually related, it is assumed that when students are exposed to correct spellings, they develop their memory skills for word forms, pronunciations, and meanings, and when exposed to richer semantic representations, learners enhance the accurate retrieval of orthographic information (Ehri and Rosenthal, 2007). Nevertheless, empirical findings regarding the relationship between vocabulary and spelling vary. For example, according to the findings of Kim et al. (2013), the associations between vocabulary and spelling in young primary school learners are insignificant, indicating that the contribution of vocabulary varies depending on the demands of a task, orthographic characteristics and developmental stage.

Students with SLD often showcase receptive and expressive language weaknesses, which is the outcome of low reading fluency and limited exposure to print (Diamanti et al., 2017). Contrary to skilled readers, who can decipher unfamiliar words and apply effective comprehension strategies, struggling readers lack reading opportunities and have limited access to lexical input (Grigorakis et al., 2022). Thus, difficulties in lexical and semantic processing may boost spelling issues, which lead to slower vocabulary development and less precise lexical representations (Cain et al., 2004). In conclusion, these factors emphasize the significance of studying vocabulary concurrently with spelling and morphological skills in intervention programs for students with SLD,

as its role remains unclear, particularly regarding its predictive contribution within intervention contexts (Elleman et al., 2009; Perfetti and Stafura, 2023).

1.3. Effective approaches for spelling, MA and vocabulary knowledge

Despite spelling fluency developing from exposure to print, converging evidence suggests that systematic and explicit instruction is valuable to learners with learning difficulties (Graham and Santangelo, 2014). Direct instruction (DI) is a well-known, effective and didactic framework for students with learning disabilities that supports phonological awareness, reading fluency, comprehension, vocabulary knowledge, and spelling (McLeskey and Waldron, 2011; Vaughn and Linan-Thompson, 2003). Four instructional stages compose the application of DI: (i) the presentation or modeling of the new concept, the teacher gives a precise explanation and demonstrates the steps required to acquire the new skill; (ii) structured practice, the learner practices with teacher supervision; (iii) guided practice, while the student works more independently, the teacher observes the learner's performance, provides feedback, and advocates accurate answers; (iv) independent practice encourages the learner to work autonomously and consolidate the targeted skill (Rosenshine, 1997).

Based on empirical evidence, DI-based spelling interventions have proven to be effective. A review by Wanzek et al. (2006) revealed that interventions featuring systematic practice and immediate corrective feedback were associated with considerable progress in spelling among learners with learning disabilities. As mentioned by more recent studies and meta-analyses, spelling approaches that incorporate phonological, orthographic, and morphological strategies within an explicit instructional framework are more productive than rote memorization methods (Galuschka et al., 2020; Robinson-Kooi and Hammond, 2020). In the teaching of spelling strategies, evidence supports the application of word sorting activities, which assist in pattern recognition, comparison, and generalization of spelling rules (Henderson, 1990). Consequently, research has proven that the Copy–Cover–Compare technique enhances spelling accuracy through systematic retrieval and self-monitoring (Bray et al., 2021). In conclusion, the Morphological Processing Spelling Approach (MPSA) is one morphology-based instructional framework that has been suggested to support spelling. This framework underlines the precise instruction of inflectional and derivational morphemes to improve the accurate spelling of morphologically complex words (Griva and Anastasiou, 2009).

Studies have demonstrated that MA and phonological awareness can be taught separately (Arnbak and Elbro, 1998), and MA is noticeably associated with the development of spelling skills (Apel, 2014). On the one hand, Apel and Diehm (2014) used the Direct Instruction approach to improve MA, providing major benefits. On the other hand, this instructional approach was implemented in a morphological and orthographic awareness intervention by Packard et al. (2006). The findings indicated that the experimental group's performance was remarkably better in accurate word writing compared to the control group, emphasizing the key role of MA in spelling skills. Nunes et al. (2003) researched and analyzed the contribution of morphology to spelling through the teaching of morphological and orthographic rules, demonstrating

a significant correspondence between MA and the correct spelling of word endings.

Regarding the lack of vocabulary, Fien et al. (2011) conducted an intervention to develop vocabulary in students with language difficulties, who were at risk of LD. The findings revealed that the experimental group significantly outperformed the control group in vocabulary comprehension (receptive) and word definition (expressive) after the intervention. A metanalysis conducted by Elleman et al. (2009), analyzed 37 studies on vocabulary interventions for students aged 6–12 years, and led to the conclusion that students with difficulties performed far better after the intervention.

1.4. The present study

Although international research has demonstrated the effectiveness of structured spelling interventions for students with learning difficulties, research focusing on non-English orthographies, such as Greek-speaking students with SLD, remains limited (Goodwin et al., 2020). Existing studies in Greek have primarily examined isolated instructional components, such as phonological or morphological training, rather than integrated, multi-component interventions that reflect the linguistic characteristics of the Greek orthographic system. Moreover, intervention studies rarely combine DI with evidence-based spelling practices such as word sorting (WS), the Copy–Cover–Compare (CCC) method, vocabulary knowledge instruction, and the Morphological Processing Spelling Approach (MPSA) within a single, systematically designed program.

In addition, while MA and vocabulary knowledge have been consistently associated with spelling development, their role in predicting spelling gains following intervention remains insufficiently explored, particularly in orthographies such as Greek. Previous findings regarding the contribution of vocabulary knowledge and MA to spelling outcomes are mixed, and few studies have examined whether these linguistic skills influence responsiveness to spelling intervention among students with or at risk for SLD.

The present study contributes to the international literature by examining the effects of a new, DI-based intervention program that comprises teaching practices including explicit spelling instruction, vocabulary knowledge, WS, CCC, and a modified version of the MPSA. Also, the study investigates the interplay between spelling, vocabulary knowledge and MA. The research questions of the study were the following:

i. Does the proposed DI-based intervention result in greater improvements in spelling, vocabulary knowledge, and MA compared to traditional instruction in students with or at risk for SLD?
ii. To what extent do baseline vocabulary knowledge and MA predict spelling gains in the experimental group students with or at risk for SLD?

2. Method

2.1. Participants and design

A total of 72 third graders at risk for or with SLD, attending 29 resource rooms in Greek public schools, participated in the study. Participants were identified as

students at risk for or with SLD, based on the following three criteria: (i) nonverbal intelligence index scores equal to or greater than 85 on the Greek version of the Raven's Colored Progressive Matrices (Sideridis et al., 2015), (ii) performance in decoding below the 25th percentile on the standardized Screening Tool for Reading Skills (STRS) (Padeliadu et al., 2019) and (iii) performance in spelling below the 10th percentile using The Spelling Test (TST; Mouzaki et al., 2007). Furthermore, bilingual children were included under the condition that they had attended Greek school from kindergarten age. This criterion was implemented to ensure sufficient exposure to the Greek orthographic and morphological system prior to the study. The languages represented in the sample were: Albanian, Romanian, Russian and Ukrainian. Participants with comorbid disorders such as autism spectrum disorder, intellectual disability, Attention-Deficit/Hyperactivity Disorder (ADHD), etc., were excluded.

The design of the study was organized as follows: pretest (Time 1, T1), intervention and posttest (Time 2, T2). Schools (resource rooms) were randomly assigned to experimental and control groups, each consisting of at least 3 participating students. Power analysis was conducted to determine the power of the omnibus 2 × 2 *F*-test for a given configuration of sample size and effect sizes. Using a medium effect size (semi partial correlation = 0.25), power levels equal to 80%, an alpha level of 5%, a two-tailed test and a correlation between time observations equal to 0.5, results indicated that 28 participants per group would suffice to identify medium level effects (actual power levels were equal to 81.2%). Consequently, the proposed sample size was associated with ample levels of power. All participating students came from different regions of the Attica municipality in Greece, representing variable socioeconomic strata (see **Table 1**). The intervention was implemented by the special education teachers of the resource rooms for 16 h (4 teaching hours per week for 4 weeks; each teaching hour lasted 40 min).

Table 1. Demographic characteristics of participants.

Group	Age *MS* (*SD*)	Gender		Language	
		Boys	Girls	Greek	Another
Experimental (N = 39)	8.54 (0.42)	22	17	27	12
Comparison (N = 33)	8.70 (0.40)	22	11	20	13
Total (N = 72)	8.62 (0.57)	44	28	47	25

Note: MS = mean score, SD = standard deviation.

T-tests for independent groups were utilized and showed equivalence between experimental and control groups on age [F (1, 65) = 1.58, $p > 0.10$], non-verbal intelligence [F (1,70) = −1.79, $p > 0.10$], decoding [F (1, 70) = 0.137, $p > 0.10$] and spelling [F (1, 70) = −0.222, $p > 0.10$] (see **Table 2**). Chi-square analyses also yielded non-statistically significant differences between groups in terms of gender [22 boys in experimental and 23 boys in control, (χ^2 (1) = 0.67, $p > 0.10$], or in bilingualism [12 bilinguals in experimental and 13 in control, χ^2 (1) = 0.58, $p > 0.10$]. The schools were randomly selected from regions characterized by varying socio-economic statuses.

Table 2. Characteristics of participants at the onset of the study.

Group	*M Age*	*M* (*SD*) Intelligence Quotient (IQ) [a]	*M* (*SD*) Decoding	*M* (*SD*) Spelling
Experimental	8.54	97.08	32.02	14.41
	(0.42)	(4.04)	(11.09)	(4.18)
Control	8.70	92.83	32.36	14.18
	(0.40)	(3.15)	(9.49)	(4.53)
	F (2, 65) =1.585, $p > 0.10$	F (2,70) = −1.797 $p > 0.10$	F (2, 70) =0.137, $p > 0.10$	F (2,70) = −0.222 $p > 0.10$

Note: Age = age in years; standard deviations are presented in parentheses. [a] = mean raw scores for IQ using Raven's Colored Progressive Matrices (Sideridis et al., 2015).

2.2. Measures

2.2.1. Raven's colored progressive matrices

The Greek adaptation of the Raven's Colored Progressive Matrices (Sideridis et al., 2015) was used to assess nonverbal intelligence. The test includes three subscales of 12 items each. Every item presents a pattern with a missing component and six possible choices, and students must select the option that completes the pattern. The assessment was administered individually and required approximately 10–20 min. The internal consistency index (McDonald's omega) was 0.68.

2.2.2. Screening tool for reading skills

The decoding of words was assessed via the Screening Tool for Reading Skills (STRS) (Padeliadu et al., 2019). STRS is a reading test, standardized in the Greek student population, aiming at the early detection of reading difficulties. The subtest for decoding 57 words in order of ascending difficulty, which children have to read aloud. Regarding words' decoding, the test includes words of 1–6 syllables on CVCV (Consonant-Vowel Consonant-Vowel) patterns (e.g., lasi /mati/"eye"), words with one and more consonant clusters (e.g., *αφρός*/afros/"foam") and words with digraphs (e.g., *έρευνα*/erevna/"research"; in this case, the digraph refers to *ευ*). Children's responses were scored with 0 (1) for an inaccurate (accurate) reading of a word, referring to phonological or stress errors. Five consecutive errors were the ceiling rule for discontinuing the subtest. Administration required approximately 5–10 min. The internal consistency reliability (McDonald's omega) for reading words was 0.93.

2.2.3. The spelling test (word-level spelling)

Single-word spelling ability was assessed with the standardized psychometric test, the Spelling Test (Mouzaki et al., 2007). This test consisted of 60 words. The student heard a word, followed by a sentence containing that word. The word was then repeated, and the student was finally asked to write it. Words are arranged in increasing difficulty, and testing was terminated after six consecutive errors. Administration required about 15 min, and scoring reflected the total number of correctly spelled words, later converted to percentile ranks. The internal consistency index (McDonald's omega) was 0.73.

2.2.4. The spelling skills test (text-level spelling)

The Spelling Skills Test (Sideridis, 1997) evaluates the spelling performance in dictated text writing for students in Grades 1–6. During administration, students write a

dictated text containing common orthographic patterns and rule-based exceptions. The text includes various parts of speech (nouns, verbs, adjectives, adverbs, prepositions). Testing was conducted individually and required 12–15 min. The internal consistency index (McDonald's omega) was 0.84.

2.2.5. Software for screening learning skills and difficulties

The Software for Screening Learning Skills and Difficulties (Skaloumbakas and Protopapas, 2007) was used to evaluate vocabulary knowledge, MA and historical and grammatical spelling. This standardized screening instrument is designed to detect learning difficulties in both written and oral language. Vocabulary knowledge was assessed through a picture-selection task: a spoken word was presented, and students chose the corresponding picture from four options. This exercise evaluated receptive vocabulary, with an internal consistency reliability coefficient (McDonald's omega) of 0.61.

MA was evaluated through an exercise, based on proportions, testing the student's ability in productive and clitic morphology without a supporting phrase. The student was asked to choose one of the four words given. The internal consistency reliability coefficient (McDonald's omega) for this exercise was 0.75.

Historical spelling was measured using multiple-choice items requiring students to identify the correctly spelled word from four options, focusing on stored lexical representations. This task examined the identity of the word itself, independent of grammatical and phonological rules. Historical (or orthographic) type of mistakes refers to misspellings in which the written word is pronounced correctly but the word's theme is written inaccurately (according to conventional spelling rules). Phonology is maintained (phonological spelling) while orthographic conventions are violated.

Similarly, grammatical spelling was examined by asking students to choose the correct word from four options, based on the context of a sentence, focusing on misspellings of grammatical suffixes. The internal consistency reliability coefficient from both spelling exercises (McDonald's omega) was 0.56. Morphological spelling mistakes affect the use or formation of morphemes, including roots, prefixes, or suffixes. Such errors may change the grammatical or semantic parts of a word even when its pronunciation seems unaffected. The entire procedure was conducted individually and required approximately 40 min.

2.3. Procedure

The study was conducted in 29 resource rooms across public primary schools in the Attica region of Greece. The research process began with permission from the Ministry of Education to implement the intervention program. Informed consent for children's participation in the study was granted by their legal guardians. The participation of all involved parties was voluntary, and children could withdraw at any time during the study. All tests took place in quiet classrooms during regular school hours.

The screening process followed a standard sequence for all students. First, the students were assessed on non-verbal intelligence via the Raven's Colored Progressive Matrices (Sideridis et al., 2015). Those who scored lower than 85 were excluded. The rest of those who remained continued the evaluation process with the decoding subtest

of the Screening Tool for Reading Skills (Padeliadu et al., 2019). Those who performed below the 25th percentile were assessed on spelling with The Spelling Test (Mouzaki et al., 2007). Those of them scoring below the 10th percentile on spelling were included in the final sample. By the completion of the screening phase, all participating students continued with the rest of the pre-intervention assessments, including the Software for Screening Learning Skills and Difficulties (Skaloumbakas and Protopapas, 2007) and the Spelling Skills Test (Sideridis, 1997). All assessment tools were administered individually, following standardized testing protocols.

One week before the beginning of the intervention program, teachers assigned to the experimental group participated in a two-hour training session by the authors, including theoretical guidelines about DI and detailed information about the instructional material. It should be noted that the teachers had already received the material before the meeting for reasons of their individual preparation. The intervention lasted four weeks, for a total of 16 instructional hours (four hours per week). Teachers of the experimental group implemented the intervention program as part of their instructional schedule. On the other hand, teachers of the control group continued using traditional instructional practices that they routinely employed in the resource room setting. Following the completion of the intervention, i.e., within up to 7 days after the last session, both groups were assessed (post-test) by the research team.

2.4. Experimental and control group teachers' characteristics and training

To avoid potential teachers' effects, each one of them was asked to provide information about their educational level, years of teaching experience, and possible previous participation in other intervention programs. Chi-square analyses indicated no statistically significant differences between the experimental (n = 14) and control (n = 15) groups on these variables.

Teachers assigned to the experimental group followed a 2-h training session, including theoretical guidelines about DI and detailed information about the instructional material (teacher's handbook & the student activity book) and the intervention. No additional training was provided to teachers since it is considered that the short training suffices to affect their daily practice (Antoniou, 2009) and the program was fully scripted, providing the exact wording they had to use. On the contrary, teachers in the control group did not attend the training session and were not given any guidance material, in order to prevent contamination. This procedure ensured that the control-group teachers remained unaware of the intervention.

2.5. The intervention program

The intervention program aimed at improving students; spelling performance. The intervention was based on the principles of DI and scaffolding (Rosenshine, 1997). Instruction was organized into four sequential units, each delivered across one week (4 h per week).

During Week 1, the teacher introduced the instructional goal, explained the steps and provided explicit modeling of each task, while students followed the demonstrated

steps. During Week 2, the teacher had the roles of supporter and assistant while providing guided practice, corrective feedback, and support. In Week 3, the teacher did not provide direct guidance, requiring students to complete tasks independently. In Week 4, the teacher withdrew all instructional support, allowing students to perform the activities fully autonomously.

Each instructional unit began with a story that introduced a protagonist and students' role was to help the character in overcoming literacy-related challenges. To address phonological, historical, and grammatical spelling, each unit included five consistent activity types: (i) word sorting, (ii) word building: producing words following the target rule, (iii) word hunting, (iv) grapheme–phoneme correspondence activities, and (v) copy-cover-compare. All these instructional formats have proven to be effective in previous research (Bear et al., 1996; Graham et al., 2002; Murphy et al., 1990).

To improve phonological spelling, students matched each phoneme to its corresponding grapheme. In Week 1, the teacher explained the importance of accurate spelling, read the word aloud, and clarified its meaning. Afterwards, he/she modeled the task by segmenting each phoneme while pointing to its grapheme. Students had to write the word while pronouncing the phonemes. Support was gradually withdrawn so that students would be able to perform independently.

Regarding historical spelling, students sorted 20 words into two categories based on their roots. The steps for completing the activity were: (a) say the word aloud, (b) visualize it with eyes closed, (c) write it, (d) check and correct each letter, (e) rewrite it from memory, and (f) produce words of the same root while highlighting common letters. Independent work was again the ultimate goal.

To enhance grammatical spelling and MA, a modified Morphological Processing approach was used. Activities included: (a) sorting words to introduce grammatical rules, (b) producing rule-based words, (c) re-sorting all words, including student-generated examples, (d) locating examples in books, and (e) completing a final comprehensive sorting task. Support was gradually withdrawn, encouraging students to apply morphological rules independently.

For vocabulary instruction, each unit contained a short text with three target words (e.g., homeless, refugees, desperate). In Week 1, the teacher explained the relevance of learning new words, read the text aloud, and introduced the Κ.Λ.Ε.Ι.Δ.Ι. (KLEIDI) Strategy: (a) look and write the word, (b) identify the context, (c) examine clues in the text, (d) identify a similar word when possible, and (e) ask the teacher if needed. In Week 2, students practiced the strategy with partial teacher support; in Week 3, teacher guidance was minimized; and in Week 4, students worked fully independently, also reviewing previously learned words.

During the same period, students in the control group continued receiving instruction in the resource rooms using their teachers' traditional methods, with no exposure to the materials or procedures used in the intervention.

2.6. Control group condition

The control group students received their ongoing, scheduled resource room instruction (traditional instruction), provided by the remaining 15 resource room teachers. The following guidelines were given to these teachers: (i) teaching spelling and vocabulary using their preferred practices and methods for the same total time (16 h); (ii) teaching the general rules and core Greek word features as in the experimental group to ensure content matching; and (iii) taking notes of their instructional activities. Analysis of their notes and supplemental questionnaire responses showed that 57.1% of them reported utilizing elements of systematic instruction or practices similar to DI, while the remaining teachers employed cooperative learning or indirect instruction methods. Overall, their lessons were short and based on grouping.

2.7. Treatment fidelity

To ensure the accuracy and consistency of the intervention, two trained members of the research team observed each teacher's instruction twice during the intervention's implementation. Each observer was called to fill in a form (Likert scale questionnaires) while observing a teacher's instruction, by putting checkmarks to the boxes that corresponded to the DI steps successfully executed according to the teaching manual. It needs to be mentioned that the observers were obliged to work individually, so they were not allowed to interact during the observation of teachers' instruction. Results showed that 87.5% of the participating teachers demonstrated high fidelity, as they followed exactly the directions provided by their manual. The level of agreement between the two examiners is indicated by the pairwise correlation coefficient of $r = 0.81$, $p < 0.001$. As for the reliability of data, all spelling and vocabulary tests collected and were first scored by the examiner and then rescored by the primary investigator. There were only four discrepancies that were settled through discussion.

3. Results

All statistical analyses were conducted using IBM SPSS Statistics v.25. To evaluate the effectiveness of the intervention, a series of 2 (Time: T1, T2) × 2 (Group: experimental, control) repeated-measures analyses of variance (RM-ANOVAs) were performed. Time was treated as a within-subjects factor and Group as a between-subjects factor. Because the design included only two measurement occasions, the assumption of sphericity was inherently satisfied. The effect size measure, partial eta squared (η_p^2), was used to quantify the magnitude of effects. The significance level for all tests was set at $\alpha = 0.05$. Means and standard deviations for all measures are presented in **Table 3**.

Table 3. Means (M) and standard deviations (SD) before and after the DI intervention.

	Time	**Experimental group (*n* = 39)**		**Control group (*n* = 33)**	
		M/[C.I.$_{95\%}$]	***SD***	***M/[C.I.$_{95\%}$]***	***SD***
Spelling-word	T1	14.14/[12.96–15.55]	4.17	14.18/[12.86–15.60]	4.53
	T2	18.30/[16.34–20.28]	6.42	16.88/[14.81–18.97]	5.87
Spelling-text	T1	71.51/[69.91–79.23]	15.23	74.48/[68.63–78.08]	14.83
	T2	81.62/[77.17–86.09]	12.28	76.64/[74.12–83.17]	14.02

Table 3. *Cont.*

	Time	Experimental group (n = 39)		Control group (n = 33)	
		M/[C.I.$_{95\%}$]	***SD***	***M/[C.I.$_{95\%}$]***	***SD***
Grammatical spelling	T1	2.79/[2.30–3.28]	1.62	3.03/[2.55–3.57]	1.38
	T2	3.94/[3.18–4.71]	2.81	2.82/[2.03–3.63]	1.77
Historical spelling	T1	3.33/[2.83–3.85]	1.62	3.21/[2.68–3.73]	1.49
	T2	4.05/[2.97–4.35]	2.91	3.08/[2.36–3.81]	1.46
Vocabulary	T1	9.10/[8.22–9.88]	2.55	8.27/[7.38–9.16]	2.55
	T2	9.86/[8.91–10.83]	3.23	8.45/[7.43-9.48]	2.59
MA	T1	3.53/[2.93–4.22]	2.11	2.81/[2.13–3.51]	1.82
	T2	4.28/[3.44–5.14]	2.88	3.06/[2.15–3.97]	2.30

Baseline comparisons: Independent-samples t tests were conducted to examine possible initial differences between the experimental (n = 39) and control (n = 33) groups at T1. The analyses confirmed that the two groups did not differ significantly at baseline in word-level spelling, $t(70) = -0.04$, $p = 0.97$; text spelling, $t(70) = -0.84$, $p = 0.40$; grammatical spelling, $t(70) = -0.68$, $p = 0.50$; or historical spelling, $t(70) = 0.33$, $p = 0.74$. Similarly, there were no statistically significant differences in the mean scores for receptive vocabulary [t (70) = −1.37, $p = 0.17$] and MA [t (70) = −1.53, $p = 0.34$] between the groups before the intervention. These results indicate that prior to the intervention, the groups were well matched, providing a sound basis for interpreting any subsequent differences as attributable to the instructional methods implemented during the study.

Word-level spelling: The RM-ANOVAs for word-level spelling showed a significant main effect of Time, F (1, 70) = 24.10, $p < 0.001$, $\eta_p^2 = 0.26$, indicating that students' accuracy in spelling isolated words improved from T1 to T2 across groups. The main effect of Group was not significant, F (1, 70) = 1.02, $p = 0.32$, $\eta_p^2 = 0.01$, suggesting that overall performance levels were comparable between the experimental and control groups. The Time × Group interaction was not significant, F (1, 70) = 2.15, $p = 0.15$, $\eta_p^2 = 0.03$. Although the progress of the experimental group was numerically higher (from 14.14 to 18.30) compared to the control group (from 14.18 to 16.88), this difference between groups was not significant (see **Figure 1**). This finding may indicate that enhancements in word-level spelling reflect general developmental progress over time rather than intervention-specific effects. The relatively transparent orthography may have reduced variability in performance, making it more difficult to detect statistically significant differences between groups.

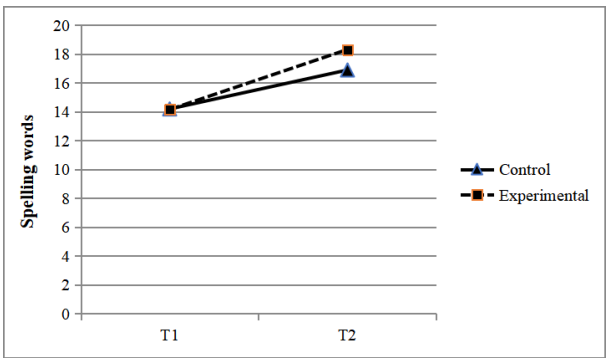

Figure 1. Word-level spelling performance prior to the treatment and at post-test.

Text-level spelling: A more differentiated pattern emerged for text-level spelling. There was a significant main effect of Time, F (1, 70) = 14.25, $p < 0.001$, $\eta_p^2 = 0.17$, indicating that students improved their ability to spell words within connected text from pretest to posttest. The main effect of Group was not significant, F (1, 70) = 0.95, $p = 0.33$, $\eta_p^2 = 0.01$, reflecting comparable overall performance levels between groups. Crucially, the Time × Group interaction was significant, F (1, 70) = 6.45, $p = 0.013$, $\eta_p^2 = 0.08$. Students in the experimental group improved in higher means (from 71.51 to 81.62) compared to the students in the control group (from 74.48 to 76.64). This depicts that the structured and explicit instructional approach was comparatively more effective in supporting students' ability to transfer spelling skills to authentic writing contexts (see **Figure 2**).

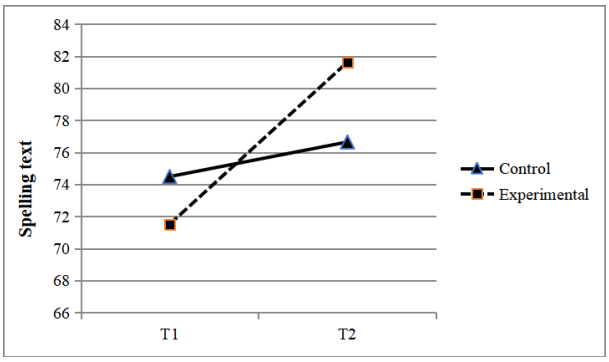

Figure 2. Text-level spelling performance prior to the intervention and at post-test.

Grammatical/Morphological spelling: For grammatical/morphological spelling, no significant main effect of group was observed, F (1, 70) = 2.30, $p = 0.13$, $\eta_p^2 = 0.03$. The main effect of Time approached significance, F (1, 70) = 3.45, $p = 0.067$, $\eta_p^2 = 0.05$, suggesting a trend toward general improvement across students. Importantly, the Time × Group interaction was significant, F (1, 70) = 14.10, $p < 0.001$, $\eta_p^2 = 0.17$. Students in the experimental group improved in significantly higher means from T1 (M = 2.79) to T2 (M = 3.94) compared to the control group from T1 to T2 (from 3.03 to 2.82). This shows that the intervention program was particularly effective in applying grammatical rules and selecting correct inflectional suffixes in spelling tasks (see **Figure 3**).

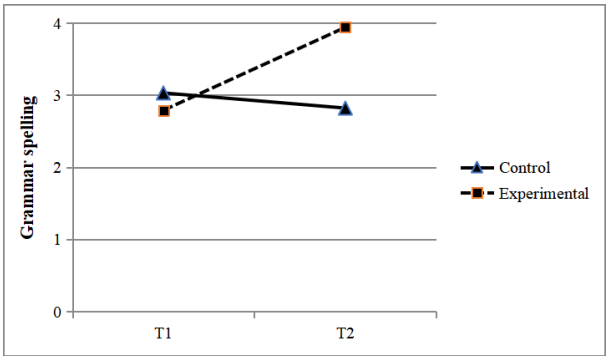

Figure 3. Grammar spelling performance prior to the intervention and at post-test.

Historical spelling: A significant main effect of time was observed for historical spelling, F (1, 70) = 9.20, $p = 0.003$, $\eta_p^2 = 0.12$, suggesting that students improved

their performance from T1 to T2 regardless of group. The main effect of Group was not significant, F (1, 70) = 1.10, p = 0.30, η_p^2 = 0.02. However, the Time × Group interaction was significant, F (1, 70) = 7.05, p = 0.010, η_p^2 = 0.09. The experimental group exhibited a higher average performance after the intervention (from 3.33 to 4.05) compared to the control group (from 3.21 to 3.08) (see **Figure 4**). This result shows that because historical spelling in Greek consists of phonologically opaque graphemes, the intervention was successful in supporting students to consolidate and recall historically determined spelling forms more effectively than the practices used in the control group.

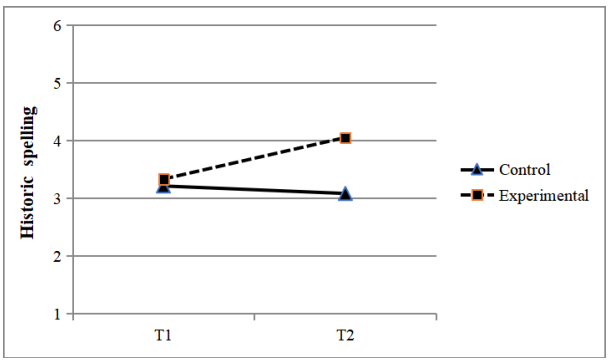

Figure 4. Historic spelling performance prior to the intervention and at post-test.

Vocabulary knowledge: The experimental group demonstrated a higher average performance after intervention (M = 9.86, SD = 3.23) compared to the control group (M = 8.45, SD = 2.59). Nevertheless, the RM-ANOVAs did not indicate statistically significant main effects for time, F (1, 69) = 3.12, p > 0.05, η_p^2 = 0.04, or for group, F (1, 69) = 3.39, p > 0.05, η_p^2 = 0.05. Additionally, the interaction between group and time was not significant, F (1, 69) = 1.26, p > 0.10, η_p^2 = 0.02, (see **Figure 5**). These findings indicate that vocabulary gains did not differ significantly between groups (see **Figure 5**).

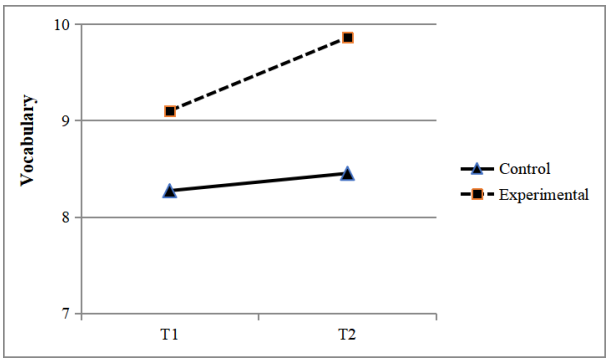

Figure 5. Vocabulary knowledge performance prior to the intervention and at post-test.

Morphological awareness: The experimental group exhibited a higher average performance after the intervention (M = 4.28, SD = 2.88) compared to the control group (M = 3.06, SD = 2.30) after the intervention (T2). The RM-ANOVAs revealed no significant effect of time, F (1, 69) = 2.82, p > 0.05, η_p^2 = 0.04, but a significant effect of group, F (1, 69) = 4.33, p < 0.05, η_p^2 = 0.06, suggesting that the experimental group performed significantly better than the control group. Furthermore, the interaction between group and time (pretest, posttest) was not significant, F (1, 69) = 0.68, p >

0.10, $\eta_p^2 = 0.01$, indicating that the change in performance over time did not differ significantly between the groups (see **Figure 6**).

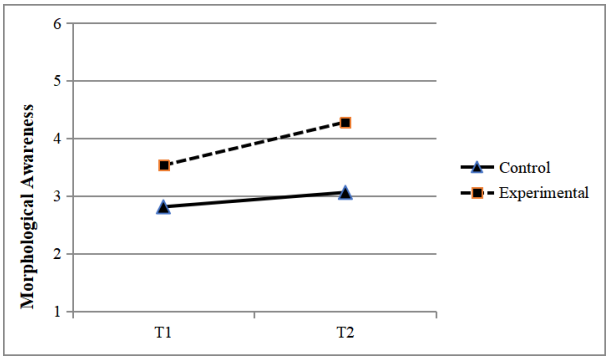

Figure 6. Morphological awareness performance prior to the intervention and at post-test.

For the second research question, analyses were conducted using the multiple linear regression model, in order to determine whether experimental group students' vocabulary knowledge and morphological awareness competence at the beginning of the study (T1) significantly predicted gains at spelling at T2. Specifically, separate analyses were performed to assess whether these two independent variables predicted spelling skills at the word-level, text-level, as well as in grammatical and historical spelling, respectively. MA was measured as a unified construct, and individual metamorphological tests were not utilized. Additionally, in the regression analyses, vocabulary was not treated as a composite variable, as only receptive vocabulary was evaluated. **Tables 4** and **5** present detailed information on the correlations, regression coefficients (B), and the total values (R^2) derived from the results of the linear regression analyses.

Table 4. Correlations between vocabulary and morphological awareness with the spelling skills of the students in the experimental group.

Spelling assessment variables	**Vocabulary/MA**
Spelling-words	0.306
Spelling-text	0.037
Grammatical spelling	0.211
Historical spelling	0.300

Table 5. Results of the linear regression analyses for the prediction of the spelling skills of the students of the experimental group.

Dependent variables	**Independent variables**	***B***	***t***	***p***	***F***	***p***	R^2
					1.853	0.171	0.093
Spelling words	Morf. Awar.	0.764	1.631	0.112			
	Vocabulary	0.180	0.465	0.645			
					00.024	0.976	0.001
Spelling text	Morf. Awar.	0.283	0.213	0.833			
	Vocabulary	−0.109	−0.104	0.918			
					0.815	0.451	0.045
Grammatical spelling	Morf. Awar.	0.137	0.689	0.495			
	Vocabulary	0.129	0.787	0.437			

Table 5. *Cont.*

Dependent variables	Independent variables	*B*	*t*	*p*	*F*	*p*	R^2
					2.198	0.126	0.112
Historical spelling	Morf. Awar.	0.281	1.458	0.154			
	Vocabulary	0.150	0.939	0.354			

More specifically, it was found that vocabulary knowledge and MA were not significantly associated with spelling performance at the level of words, as there was no correlation ($r = 0.30$, $p = 0.17$) of the variables. According to the results, only 9.3% ($r^2 = 0.093$) of word-level spelling was due to MA and vocabulary. This may indicate that these skills contribute in combination with other linguistic processes, limiting their independent predictive effect. Similarly, in text-level spelling these two independent variables did not contribute statistically significantly, showing no correlation ($r = 0.03$, $p = 0.97$) with only 0.1% ($r^2 = 0.001$) contributing to the improvement, accounting for a negligible proportion of the variance. This likely reflects the increased complexity of text-level spelling, where multiple processes are involved. The same was observed with grammatical and historical spelling. Vocabulary knowledge and MA did not appear to be predictive indicators for either. There was no correlation in grammatical spelling ($r = 0.21$, $p = 0.45$), with only 4.5% ($r^2 = 0.045$) of the variance attributed to these two variables, nor in the historical spelling ($r = 0.33$, $p = 0.12$), with only 11.2% contributing. This may be due to the greater reliance of these spelling types on rule-based and orthographic knowledge.

4. Discussion

The aim of this study was the development of an intervention based on DI for students with or at risk for SLD and examined whether receptive vocabulary knowledge and MA at the beginning of the intervention predicted spelling performance gains. A variety of measures were used for different dimensions of spelling (word, text, grammatical, and historical), strengthening the validity of the findings. The data analysis showed improvements in spelling performance, particularly in text-level spelling, grammatical spelling, and historical spelling. However, vocabulary knowledge and MA at baseline did not predict significantly the experimental group's spelling gain, a finding that proves the importance of teaching spelling strategies regardless of the SLD student's initial knowledge. This finding depicts that the contribution of linguistic skills varies across orthographies such as English and French (opaque), German and Dutch (intermediate), and Greek, Italian, or Finnish (transparent) (Georgiou et al., 2020). In more transparent systems, spelling development tends to rely more on explicit rule-based instruction, particularly in the early stages.

In line with previous research (Ardanouy et al., 2024; Colenbrander et al., 2024; Papakostas et al., 2025), the deployment of the proposed research-based practices within the framework of DI for teaching grammatical and historical spelling was proven to be beneficial to children at risk of SLD. These findings confirm the preexisting studies supporting that DI is an effective instructional method for improving spelling accuracy in these students (Fragkouli et al., 2022; McLeskey and Waldron, 2011;

Vaughn and Linan-Thompson, 2003). The intervention also led to improvements in word- and text-level spelling; however, only text-level spelling showed a significant statistically advantage for the experimental group. These domain-specific differences are consistent with earlier work suggesting that contextualized spelling tasks (e.g., dictation or connected text) may be more sensitive to instructional effects than isolated-word tasks (Graham and Santangelo, 2014). Similar instructional effects have been documented across different orthographic systems (e.g., English, German), suggesting that DI constitutes a cross-linguistically effective approach for students with SLD, despite structural differences between writing systems (Goodwin et al., 2020).

Although improvements in historical and grammatical spelling reached statistical significance and yielded medium to large effects, the relatively short duration of the intervention (four weeks) the relatively short duration of the intervention (four weeks) limited the extent to which larger gains could be observed. Various effective spelling interventions—particularly those focusing on orthographically opaque or historically determined spelling patterns—have a duration of over 8 to 12 weeks (Alber and Walshe, 2004; Galuschka et al., 2020; Kinney et al., 2013; Owens et al., 2004). Notably, the proposed study exploited multiple standardized tools rather than researcher-developed assessments, which, albeit more responsive to instructional effects, may have limited generalizability (Zielinski et al., 2012). Given that progress in spelling is typically incremental and nonlinear (Richardson, 2008), the gains observed within this short time frame are educationally relevant. This finding is also supported by cross-linguistic findings from languages such as English and Spanish, where spelling performance in text reflects deeper morphological and lexical processing compared to isolated word tasks (Wolters and Kim, 2023).

Regarding receptive vocabulary, both groups showed a degree of improvement over time, but with no statistically significance between them. Although DI has been found to benefit vocabulary acquisition in some studies (Fien et al., 2011; Lubliner and Smetana, 2005), other research has reported no significant effects on receptive vocabulary specifically (Coyne et al., 2010; Hutchinson and Clegg, 2011). Several factors may explain the non-significant findings in the present study. First, interventions producing robust vocabulary gains often provide multiple exposures to the same target words across varied contexts (Beck et al., 2013), whereas the current intervention introduced new words in each unit. Second, studies reporting strong vocabulary outcomes frequently use researcher-designed assessments containing target words taught during intervention (Coyne et al., 2010; Justice et al., 2005). In contrast, our use of a standardized receptive vocabulary measure ensured that only generalized knowledge was assessed, which is typically harder to influence through short-term instructional programs.

A modified version of the Morphological Processing Spelling Approach (MPSA) was integrated into grammatical spelling instruction. Although previous research suggests that morphological instruction can improve spelling and MA (Anastasiou and Griva, 2012; Apel and Diehm, 2014; Packard et al., 2006), the present study did not find statistically significant improvements in MA. Several factors may account for this discrepancy. First, our assessment measured MA broadly using analogy-based tasks,

requiring students to read and reason about morphologically related words without contextual cues. If one considers the difficulties in decoding and reading fluency that students with SLD present, this exercise may have influenced their ability to demonstrate morphological knowledge. In contrast, studies reporting stronger effects have used tasks more closely aligned with targeted instruction, such as generating words within families or identifying morphological variants (Anastasiou and Griva, 2012; Ardanouy et al., 2024). Such tasks capture specific skills but may not reflect generalized MA abilities.

An additional purpose of the study was to examine whether vocabulary knowledge and MA at baseline can be used as predictors for spelling performance gains. Contrary to extensive literature suggesting that both skills contribute to spelling development (Casalis et al., 2011; Ehri and Rosenthal, 2007; Grigorakis and Manolitsis, 2021; Görgen et al., 2021), the present study found no significant associations between vocabulary knowledge, MA and any spelling domain. This can be attributed to age and literacy development. More specifically, studies that resulted in strong vocabulary–spelling or morphology–spelling relationships include children in upper elementary grades whose orthographic and semantic representations are more developed (Ricketts et al., 2009; Rosenthal and Ehri, 2008). On the contrary, younger children with SLD may use phonological decoding strategies more extensively and have less consolidated morphological or semantic knowledge (Yinon and Shaul, 2025).

Moreover, unlike studies measuring both expressive and receptive vocabulary (Ricketts et al., 2009; Rosenthal and Ehri, 2008), the present study assessed only receptive vocabulary, which may underrepresent the semantic skills relevant to spelling (Andrews et al., 2020). There is a difference between how many words students know and whether they can semantically represent them. This suggests that rich semantic connections required for accurate spelling cannot be acquired only by simply knowing the general meaning of a word (Protopapas et al., 2013; Ruberto et al., 2024).

Another potential explanation concerns orthographic transparency. Greek is characterized by relatively consistent phoneme–grapheme mappings in regular spelling patterns. Research with Korean-speaking children, a language similar to Greek, has similarly found limited contributions of vocabulary to spelling (Kim, 2010). In contrast, much of the literature supporting strong vocabulary–spelling associations is derived from English, a language with an opaque orthography. However, even within English, findings are mixed, with some studies reporting weak or moderate relationships (Sénéchal and LeFevre, 2002). Additionally, studies by Görgen et al. (2021) and Volkmer et al. (2019) examined typically developing German students in a phonologically based, but less transparent, spelling system than Greek, further complicating cross-study comparisons. Nevertheless, in orthographic transparent languages, rich vocabulary knowledge relates highly with accurate spelling, while this is not the case in opaque languages (Broc et al., 2021), as also confirmed in cross linguistic studies integrating languages with various orthographic depth (Papadopoulos et al., 2021). Consequently, spelling in more transparent systems such as Greek, Italian, or Finnish is more strongly supported by phonological and rule-based processes, reducing the immediate impact of vocabulary knowledge (Kuperman et al., 2021;

Perfetti and Stafura, 2023).

Similarly, prior studies reporting strong contributions of MA to spelling often employed tasks embedded in meaningful linguistic contexts, such as writing words within phrases or generating morphologically related words (Apel et al., 2012). The analogy-based measure used in the present study may have required a level of reading precision and linguistic inference that exceeded the students' reading and cognitive profiles, thereby attenuating the predictive relationship. In the early stages of literacy, spelling is primarily based on phonological strategies, while the automation of decoding and the stabilization of spelling representations gradually allow for the release of cognitive resources and the integration of more complex language skills, such as morphology and semantics (Kellenberger et al., 2024). Once this foundation is established, both morphological awareness and vocabulary begin to contribute more substantially to predicting spelling progress, particularly for words of increased structural and morphological complexity (Inoue et al., 2023). Longitudinal studies show that morphological awareness predicts future performance in reading and spelling even when powerful factors such as phonological awareness and spelling cognition are controlled, while its full automation appears to be achieved in later stages of reading development (Jöbstl et al., 2021). At the same time, interventional research documents the causal role of morphological teaching in improving spelling (de Bree et al., 2022; Colenbrander et al., 2024), while the application of morpho-spelling principles becomes more systematic at older ages (Limpo et al., 2021). Similarly, cross-linguistic studies in languages such as French and Italian indicate that the contribution of morphological awareness to spelling becomes stronger in upper stages of literacy development and varies depending on orthographic complexity and instructional alignment (Schöfl et al., 2024). To sum up, findings support a transition from phonological processing to a more comprehensive use of morphological and semantic information. This transition may be a slow but critical developmental process for advanced spelling proficiency (Iwao et al., 2025).

Regarding the vocabulary-spelling relationship, methodological differentiations seem to have a significant role. More specifically, the methods used to measure vocabulary and spelling seem to influence the findings since more detailed approaches that take into account partially accurate spellings or differentiated types of mistakes (Limpo et al., 2021) prove to be more responsive in comparison to traditional scoring (Andrews et al., 2020; Niolaki et al., 2023; Treiman et al., 2025).

Overall, by combining the findings from multiple orthographic systems—including opaque (e.g., English), intermediate (e.g., German), and transparent (e.g., Greek, Finnish, Italian) languages—the present study strengthens its theoretical generalizability and highlights the importance of cross-linguistically informed spelling instruction.

5. Limitations and Future Directions

Certain limitations of the present study and future directions are worth mentioning. Firstly, the short duration of the intervention (four weeks) may influence the performance of students, particularly for skills such as historical spelling and MA,

which often need continuous practice and guidance. Generally, interventions that last longer are more likely to lead to the achievement of above-average performance. Future research should therefore examine the effects of longer interventions to determine the required time needed for spelling improvement. A second limitation is that, due to practical difficulties, the participant children were not tested for a third time, after T2, a procedure that could provide more evidence concerning the further maintenance of the results. Third, the results of the non-significant findings for receptive vocabulary and the prediction analyses are limited. The low internal consistency (McDonald's omega = 0.61) observed in the receptive vocabulary may have reduced the statistical power necessary to detect genuine relationships or intervention effects in vocabulary. Future research must prioritize instruments with established high reliability in this population.

Interestingly, the findings of the study can be considered in the broader perspective of research regarding spelling. In this direction, future intervention could examine a broader range of cognitive and linguistic control variables, such as phonological awareness, working memory, rapid automatized naming, and non-verbal intelligence, all of which have been implicated in spelling development. Additionally, Future research should examine whether expressive vocabulary better predicts spelling performance in students with SLD. Given the limited research on spelling predictors within the Greek orthographic system, a more comprehensive modeling of these factors would provide deeper insight into the mechanisms underlying spelling acquisition and intervention responsiveness in this linguistic context.

Finally, the findings of this study have several implications for educators and policymakers. The proposed intervention appeared to be easy to implement into regular classroom practices. Specifically, teachers can integrate the proposed activities, or the whole program, into their daily classrooms in order to support students at risk for SLD. Additionally, policymakers might consider allocating resources and training for early literacy interventions that incorporate differentiated instruction, emphasizing the systematic teaching of spelling strategies even in languages with transparent orthographies like Greek. Likewise, in Greece, teaching spelling was neglected in favor of reading instruction to a great extent; in many cases, spelling errors were not even correct. This resulted in minimal to non-existent teaching hours dedicated to spelling instruction in the Greek educational system.

6. Conclusion

In conclusion, the findings of the present study demonstrate that a structured, research-based intervention based on the principles of DI and morphological processing can significantly improve the spelling performance of third-grade students with or at risk for SLD. These findings highlight that explicit instruction is particularly effective for improving grammatical, historical, and text-level spelling, regardless of a student's initial linguistic competence. While baseline morphological awareness and vocabulary did not emerge as significant predictors of spelling gains—likely due to the developmental transition from phonological to morphological strategies—the results underscore the educational value of strategy-based instruction in the Greek

orthographic system. To sum up, incorporating systematic, scaffolded spelling programs can successfully support students in overcoming persistent literacy challenges and mastering spelling.

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Informed consent statement: Informed consent was obtained from all subjects involved in the study.

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