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Effects of Tier 1 Content Literacy Intervention on Early-Grade English Learners' Reading and Writing: Exploring the Mediating Roles of Domain-Specific Vocabulary and Oral Language Proficiency

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Abstract

This exploratory follow-up study to a randomized controlled trial examined (a) the differential impact of classroom-based (Tier 1) content literacy intervention on reading and argumentative writing outcomes among Grades 1 and 2 English learners (ELs; *n* = 1,236) and their English-proficient peers (EPs; *n* = 4,161) and (b) the mechanisms determining how the intervention yielded effects on ELs. The study was conducted across 30 elementary schools in an urban U.S. school district. The 10-week intervention, comprised of 20 lessons in science and social studies thematic units, was delivered by classroom teachers. The core components were designed to build students' content and vocabulary knowledge through informational texts and concept mapping and to transfer their schema to argumentative writing and research collaboration. Results show that while the intervention did not significantly improve reading proficiency (effect size [ES] = .01 for ELs and ES = -.02 for EPs) and basic literacy skills (ES = .04 for ELs and ES = -.02 for EPs), it significantly bolstered argumentative writing in science (ES = .25 for ELs and ES = .24 for EPs) and social studies (ES = .42 for ELs and ES = .44 for EPs). The treatment effect on reading proficiency among ELs was fully mediated by their improved domain-specific vocabulary knowledge and English oral proficiency. A significant indirect effect on social studies argumentative writing through domain-specific vocabulary knowledge was also evident. These findings corroborate the effectiveness of the content literacy intervention, providing insights into *for whom* and *how* the intervention was effective.

Keywords: content literacy intervention, English learners, reading, argumentative writing, domain-specific vocabulary knowledge, English oral proficiency

Educational Impact and Implications Statement

This exploratory study shows the positive effects of classroom-based content literacy instruction for Grades 1 and 2 English learners (ELs), with benefits similar to those seen in English-proficient peers in science and social studies vocabulary and argumentative writing. In thematic units, students actively built content and vocabulary knowledge through interactive read-alouds and concept mapping, which were applied in writing and collaborative research activities. Importantly, this instructional approach did not negatively affect basic literacy skills and reading proficiency and even improved ELs' domain-specific vocabulary knowledge and English oral proficiency, which in turn positively predicted their reading proficiency. These findings highlight the value of content literacy instruction in promoting ELs' English language and literacy competencies through active engagement in content knowledge building and its application in a content- and language-rich classroom setting.

Effects of Tier 1 Content Literacy Intervention on Early-Grade English Learners' Reading and Writing: Exploring the Mediating Roles of Domain-Specific Vocabulary and Oral Language Proficiency

With the increasing number of English learners (ELs) in U.S. public schools, now representing 10.4% of the school-age population (National Center for Education Statistics, 2022), various stakeholders are collaborating to foster improvements in academic content and English language and literacy development of elementary-grade ELs (Goldenberg & Cárdenas-Hagan, 2023). Many ELs, especially in English-only classroom environments, face challenges in navigating academic content and developing literacy skills in a language that they are still acquiring (August et al., 2009; Lesaux, 2012).

These challenges are more pronounced in high-poverty urban schools, where educational resources are often inadequate and unevenly distributed (Callahan et al., 2022; Umansky, 2016). In many school settings, ELs experience limited opportunities for comprehensive academic content learning and development. This disparity is exacerbated by the prevalent practice of removing them from mainstream content-subject classes for specialized English-as-a-second-language (ESL) instruction, which primarily focuses on oral language proficiency (Hopkins et al., 2015). The COVID-19 pandemic has further intensified these challenges, significantly curtailing their access to essential learning opportunities and instructional support (Relyea et al., 2023; Sugarman & Lazarin, 2020); therefore, there is a pressing need for educators and leaders to develop and implement effective classroom instructional strategies and curricular resources. These resources must be strategically designed to ensure equitable access to ELs' academic content while supporting and enhancing their English language and literacy development (Baker et al., 2014).

Emerging research evidence has highlighted promising instructional approaches for integrating literacy instruction with academic content learning (e.g., science, social studies) (Hwang et al., 2022). Well-designed and implemented content literacy instruction has shown potential benefits for elementary-grade students by building background and conceptual knowledge in content-area subjects while simultaneously enhancing language and literacy skills (e.g., Concept-Oriented Reading Instruction [CORI; Guthrie et al., 2004], Content-Area Literacy Instruction [CALI; Connor et al., 2017], In-Depth Expanded Applications of Science [IDEAS; Romance & Vitale, 2001]). Content literacy instruction is broadly defined as a pedagogical framework wherein language and literacy activities serve as a primary vehicle for accessing, cultivating, and communicating subject-area content knowledge. At the same time, knowledge-building instructional approaches can foster the enhancement and advancement of reading and writing as students engage in disciplinary learning (Cervetti & Hiebert, 2015; Cervetti & Wright, 2020).

Despite the promising potential of content literacy instruction, rigorous evaluation of its impact on the young EL population is limited. Recent findings from studies with EL adolescents (i.e., Vaughn et al., 2017, 2022) suggest that content literacy instruction may benefit ELs and their English-proficient (EP) peers equally. However, a considerable gap remains in our understanding of the efficacy of this approach for primary-grade ELs. Notably, writing outcomes—a vital component of literacy development—have been largely overlooked in previous research. The current study represents an important step toward addressing this gap, aiming to assess the impact of the general classroom (Tier 1) content literacy intervention, called Model of Reading Engagement (MORE), for Grades 1 and 2 ELs in comparison to their EP peers, and to explore the mechanisms that may contribute to ELs' reading and writing abilities.

Theoretical Position of Content Literacy Instruction

The conceptualization of content literacy instruction may vary across contexts. Yet, its common ground involves an instructional approach designed to capitalize on interconnections among content knowledge acquisition, reading comprehension, and writing (e.g., Connor et al., 2017; Guthrie et al., 2004; Kim, Burkhauser, et al., 2021; Kim, Relyea, et al., 2021; Vaughn et al., 2017, 2022). This approach is rooted in, and enacts, a theoretical perspective that views the instantiation and development of knowledge as reciprocally tied to reading and writing. Content knowledge is dynamically accessed and applied during the interactive acts of reading, writing, speaking, or listening, with each modality informing and enriching the others. In this framework, reading and writing are not isolated activities but are instead seen as mutually reinforcing cognitions and mechanisms that can influence content and language knowledge processes (Fitzgerald & Shanahan, 2000).

Contemporary cognitive perspectives on reading comprehension processes further explain this reciprocal influence (e.g., Kendeou & van den Broek, 2005; Kintsch, 1988; Perfetti & Stafura, 2014). Reading comprehension is not merely about decoding the surface code provided in print; it involves constructing a coherent mental textbase representation. Through this process, text content and relevant background knowledge are integrated into the reader's knowledge system, resulting in building a mental situation model that forms an enriched content knowledge network of semantically meaningful information (Kintsch, 1988). Establishing and maintaining this coherent situational model are crucial for a deeper understanding of text and for enhancing the capacity to learn from text.

Constructing situational models may be particularly critical for ELs, who are simultaneously developing literacy in a new language and building content knowledge. This

process transcends basic reading comprehension to become a complex act of activating cross-linguistic strategies, applying metacognitive and metalinguistic skills, and drawing upon existing schema to interpret and integrate new information and concepts (Morishima, 2013; Zwaan & Brown, 1996). Like EPs, ELs are engaged in an active, multidimensional interaction with content through reading and writing, which involves making connections and conceptualizing ideas in linguistically and cognitively demanding ways (August et al., 2014; Coyle et al., 2010; Crandall, 2012; Snow, 2005). With its structured approach, content literacy instruction provides ELs with the essential tools and opportunities to engage with text at multiple levels—linguistically, conceptually, and contextually—fostering the development of a rich and nuanced situational model that supports language development and academic progress.

It is evident in contemporary academic discourse that cognitive engagement in reading comprehension, especially in the instantiation of mental situation models, is paralleled in the act of writing. Prior content knowledge and knowledge of language stored in long-term memory, as well as knowledge acquired and extended during the act of composing, play significant roles in retrieval and construction during writing (e.g., Galbraith & Baaijen, 2018; Kim & Graham, 2022; Kim & Park, 2019). Researchers have predicated their stances on composing by considering similar mental representations for both discourse comprehension and production (e.g., Fletcher & Chrysler, 1990; Kim & Schatschneider, 2017; Kintsch, 1988). When composing, students may either have a predefined idea of what they aim to express in writing or, as part of the composing process, engage in a knowledge-constituting process that helps to formulate and refine their ideas for their written work (e.g., Galbraith & Baaijen, 2018; Kim & Schatschneider, 2017).

Empirical support exists for the connection between knowledge and reading comprehension and, to a lesser extent, between knowledge and writing (e.g., Burgoyne et al.,

2009; Fincher-Kiefer et al., 1988; Yekovich et al., 1990). Students with extensive background knowledge tend to exhibit enhanced reading comprehension and writing abilities (Kim & Graham, 2022). The efficiency with which students retrieve knowledge when constructing situation models may be a contributing factor. Those with a rich knowledge base can more effectively access and retrieve relevant background and conceptual knowledge from long-term memory. In contrast, their counterparts with less knowledge face the challenge of starting their mental model construction from scratch (Kurby & Zacks, 2012).

The reciprocal relationship between reading and writing within the content literacy instruction framework solidifies the notion that the reciprocal relationship fosters deeper engagement with content. This connection is instrumental in enabling students to develop the analysis and critical thinking skills crucial for knowledge acquisition and transfer (e.g., Graham & Hebert, 2011). Writing, like reading, acts as a reflective tool, empowering students to organize and clarify their thoughts, thus promoting the application of knowledge in novel contexts beyond the immediate learning context (e.g., Langer & Applebee, 1987; Pearson & Duke, 2002). Therefore, the symbiotic relationship between reading and writing in content literacy instruction is crucial, as it cultivates an environment where knowledge is actively constructed, applied, and extended.

Why Might Content Literacy Instruction be Especially Beneficial for ELs?

Content literacy instruction emerges as a critical pedagogical approach for ELs due to its integrated focus on disciplinary content learning and academic language and literacy development (Cabell & Hwang, 2020). While many primary-grade literacy interventions for ELs target their constrained, code-based skills (e.g., Baker et al., 2016; Ehri et al., 2007; Foorman et al., 2018; see review by Roberts et al., 2022), studies show that ELs can develop these skills at

rates comparable to their EP peers when provided with all-English instruction (Lesaux & Geva, 2006; Mancilla-Martinez & Lesaux, 2011). As ELs progress to higher grades, the role of vocabulary knowledge and language comprehension becomes increasingly salient, accounting for greater variability in reading comprehension, particularly when engaging with complex texts (García & Cain, 2014; Language and Reading Research Consortium [LARRC], 2015).

The early introduction of content literacy instruction is crucial for ELs' cognitive and linguistic development. The Reading for Understanding initiative research has underscored the importance of a content-rich instructional environment in fostering word and world knowledge and shaping listening and reading comprehension from the earliest years of schooling (Pearson et al., 2020). By integrating academic content from science and social studies with informational text comprehension and argumentative writing skills, content literacy instruction aligns with the initiative's emphasis on enhancing background knowledge acquisition, deep comprehension, and critical thinking. These early literacy experiences, integrating rigorous academic content, establish a foundation for young ELs, preparing them to meet the complex cognitive and linguistic demands of later schooling (Dickinson & Porche, 2011; Elleman et al., 2017; Truckenmiller & Petscher, 2020).

Cummins' (1979) Cognitive Academic Language Proficiency (CALP) framework further substantiates the significance of content literacy instruction for ELs, highlighting the essentiality of robust vocabulary-concept knowledge and sophisticated academic language skills in fostering the development of content knowledge and advanced literacy (Snow & Uccelli, 2009). Instruction aligned with CALP principles has been evidenced to substantially improve reading and writing competencies among upper-elementary ELs (e.g., Proctor et al., 2019; Silverman et al., 2021), underscoring the importance of early integration of these principles. This foundational

preparation equips young learners for the increasingly complex language demands of higher grades, bridging their conversational language skills with the academic language needed to engage with abstract concepts and gain and apply deep conceptual knowledge across academic disciplines (Volodina et al., 2020).

Core Instructional Components to Foster Content Knowledge and Literacy Development

The core instructional components of the intervention, designed to optimize the effectiveness of the instructional process, were: (a) the use of conceptually coherent, complex informational texts in a thematic unit facilitated through interactive read-aloud activities, (b) domain-specific vocabulary network building for deeper exploration and understanding of complex concepts and vocabulary, and (c) argumentative writing and research collaboration, providing students with the opportunity to apply their vocabulary and content knowledge in an engaging and practical context. This multifaceted approach, taken together, was designed to allow ELs to engage with academic content and literacy and to participate in a continuous process of knowledge construction and transfer.

These strategies were also aligned with the research-based instructional guidelines from the Institute of Education Sciences (IES) What Works Clearinghouse (WWC) Educators' Practice Guide for teaching academic content and literacy to ELs (Baker et al., 2014). This Guide offers four key recommendations for educators of ELs: (a) Recommendation 1: provide intensive instruction of academic vocabulary words across several days using various instructional activities; (b) Recommendation 2: integrate oral and written English language instruction into content-area teaching; (c) Recommendation 3: provide regular, structured opportunities to develop their written language skills; and (d) Recommendation 4: provide small-group intervention to students experiencing difficulties in literacy and English language development.

The subsequent section details the instructional components and how they align with the WWC recommendations (see Figure 1), highlighting the tailored pedagogical strategies suitable for ELs.

Use of Conceptually Coherent Informational Texts in a Thematic Unit

In developing the current content literacy intervention, we structured the lessons into thematic units in science and social studies and involved students engaging with conceptually coherent, complex informational texts in each unit. A thematic unit approach provides students with a framework for "discoveries of the connections," fostering the development of an integrated knowledge base (Roser & Hoffman, 1992, p. 45). Integrating conceptually coherent informational texts in a thematic unit was designed to cultivate students' broader and deeper understanding of connected concepts and facilitate their ability to construct, apply, and articulate world knowledge (Pearson et al., 2020; Snow et al., 2009). This cohesive set of texts enhances substantive understanding of semantically associated words and concepts by providing repeated exposure, in-depth elaboration, and diverse examples across the texts. (Cervetti et al., 2016; Kim, Relyea, et al., 2021). Those content-rich, complex texts can also foster areas of expertise and domain knowledge that motivate further engagement in reading and writing (Duke, 2000; Duke et al., 2021; Graham et al., 2018). This strategy aligns with the WWC Practice Guide Recommendation 2, aiming to enhance students' language and literacy skills in academic content learning.

A key focus of this core component is to ensure that ELs have the opportunity to engage with content-rich informational texts at an appropriate level of rigor. Informational texts pose unique challenges for ELs, such as navigating technical vocabulary and complex text structures and bridging gaps in background knowledge on specific topics (Martin & Duke, 2011; Williams

et al., 2016). To mitigate these barriers and enhance ELs' comprehension and content knowledge acquisition, the MORE intervention embraced an interactive read-aloud strategy that involves teachers providing scaffolding through active and dialogic reading. During the interactive read-aloud activities, teachers demonstrated their mental models of the comprehension process and encouraged students to engage in text-based discussions. This strategy created an authentic, language-rich context that made complex texts more accessible and meaningful to ELs, providing a framework to deepen their understanding of abstract academic words and bolster oral language proficiency, allowing for more nuanced learning experiences (Wiseman, 2010; Zuckerman & Needlman, 2020).

Domain-Specific Academic Vocabulary Network Building

In accordance with the WWC Practice Guide Recommendation 1, our intervention emphasized domain-specific vocabulary instruction through the use of concept mapping activities. Concept mapping refers to the visualization process wherein semantically related words are organized in a manner that helps students develop high-quality mental semantic representations (Novak et al., 1984). This approach facilitates acquiring and retrieving knowledge from semantic long-term memory (Fitzgerald et al., 2020; Perfetti, 2007). The process of building a cognitive network involves integrating new words that represent specific concepts into the mental lexicon and expanding existing knowledge through the creation of linkages in a network structure (Murphy, 2003; Steyvers & Tenenbaum, 2005). As children progress and engage with more complex disciplinary content, the practice of mapping and constructing mental networks becomes increasingly important. It ensures cognitive accessibility to the depth and quality of lexical and conceptual knowledge that forms the foundation of their learning (Anderson & Freebody, 1981; Kintsch, 1998).

Importantly, given the distinct knowledge structures in science and social studies (Marzano, 2004), we arranged the selected target words accordingly. Specifically, science words were organized hierarchically, progressing from general concepts related to animal survival in Grade 1 (e.g., *survive, habitat, physical features*) to more specific, nuanced concepts associated with dinosaur survival and mass extinctions in Grade 2 (e.g., *extinct, evidence, paleontologist*). In contrast, social studies words were taxonomically arranged, highlighting shared characteristics and essential properties from explorers in Grade 1 (e.g., *navigation, expedition, discovery*) to inventors in Grade 2 (e.g., *prototype, manufacture, laboratory*). This tailored organization of target vocabulary in our intervention lessons, aligning with the cognitive development needs of the students, was crucial for building a robust and interconnected knowledge base that supports advanced thinking and learning in these domains (Schleppegrell, 2004).

Concept mapping activities are particularly beneficial for ELs, who often encounter additional cognitive challenges when reading and comprehending content in a less familiar language. This is even more pronounced in content area subjects, which typically involve complex systems and processes, such that ELs may find it particularly difficult to grasp concepts through text alone. Concept maps have been shown to assist students in visualizing and understanding these complex relationships between concepts in texts, aiding in constructing a coherent and cumulative conceptual framework (Blunt & Karpicke, 2014; Schroeder et al., 2018). The strategy not only alleviates cognitive demands for EL but also fosters organization and integration of new information with existing knowledge, enhancing language acquisition, deepening engagement with academic content presented in text, and improving overall text comprehension (Chang et al., 2002; Guastello et al., 2000; Nesbit & Adesope, 2006).

Argumentative Writing and Research Collaboration

In addition to the components designed to build students' domain knowledge structure or schema, the MORE intervention integrated two additional components to facilitate schema transfer to varied contexts and tasks: argumentative writing and research collaboration.

Argumentative Writing. The first component was an argumentative writing task aligned with the WWC Practice Guide Recommendation 3. In this task, students were guided to write arguments and support their claims with reasons and textual evidence in science and social studies topics. Writing instruction and practices occur infrequently in many conventional elementary school environments (Brindle et al., 2016; Coker et al., 2016; Cutler & Graham, 2008). Our intervention provided students with sustained opportunities to compose argumentative texts.

In content-focused writing, novice writers can learn and apply self-regulated strategies (Graham et al., 2019). These strategies facilitate the production of academic texts that require concise and persuasive communication, drawing upon various facets of linguistic resources (e.g., vocabulary knowledge, syntactic knowledge), topic knowledge, and text organizational structures (Ferretti et al., 2009; Phillips Galloway & Uccelli, 2015). For young ELs composing a demanding topic in a new language, working memory capacity might not be sufficient to simultaneously address linguistic and content demands. Nevertheless, with repeated writing opportunities and relevant content and vocabulary knowledge reinforcement, cognitive overload can be alleviated during writing (Galbraith & Baaijen, 2018; McCutchen, 2000). This, in turn, enables ELs to heighten their awareness of crucial writing features, leading to higher-quality text production.

Research Collaboration. The second component involved research collaboration, allowing students to participate in small-group discussions around complex texts presenting the

unit topics (Blumenfeld et al., 1996; Murphy et al., 2009; Reznitskaya et al., 2009). Through active collaboration with their peers, students conducted research using authentic sources such as newspaper and magazine articles. They also engaged in critical, collaborative dialogues and writing exercises with their peers. The principal goal of the research collaboration was to enable students to build, expand, and deepen their content knowledge in science and social studies (Scardamalia & Bereiter, 2006) and improve high-level text comprehension (Murphy et al., 2009). Furthermore, this collaborative process was designed to create a classroom environment where ELs could engage in challenging academic conversations and tasks with their linguistically diverse peers, strengthening their oral language skills.

Conceptual Model of the MORE Intervention

Figure 1 displays the hypothesized logic model illustrating how our MORE intervention could enhance ELs' reading and argumentative writing abilities. This model focuses on action theory for how the intervention affects mediators (i.e., domain-specific vocabulary knowledge and English oral proficiency) and conceptual theory for how these mediators relate to student outcomes (Chen, 1990; MacKinnon et al., 2002).

The action theory underpinning our multi-component content literacy intervention suggests that its emphasis on building domain knowledge and schema transfer has immediate, positive effects on two mediators: domain-specific vocabulary knowledge and English oral proficiency. This structured approach enriches ELs' domain-specific vocabulary knowledge, equipping them with the lexical resources needed to access and engage with academic content (Nagy & Townsend, 2012) while also strengthening their oral proficiency, thereby cultivating the linguistic and cognitive competencies essential for navigating academic discourse.

The conceptual theory underlying our intervention elucidates the relationship between the mediators and outcomes for ELs in reading and argumentative writing. Domain-specific vocabulary knowledge is essential for the mental instantiation of content knowledge, serving as labels for concepts and forming the substance of the content. Semantic networks in long-term memory embody conceptual content knowledge (Borovsky et al., 2016; Verhoeven et al., 2011). More extensive vocabulary networks are associated with improved vocabulary learning and text comprehension (Crosson et al., 2021; Lesaux & Kieffer, 2010), and a higher-quality lexical representation aids in understanding complex or abstract texts (Perfetti & Stafura, 2014). These networks and representations enhance the speed and quality of meaning retrieval, facilitating reading comprehension and influencing word choice in writing (Dobbs & Kearns, 2016; Mancilla-Martinez, 2010).

While the role of ELs' English oral proficiency in reading comprehension is well-established (e.g., Babayiğit, 2014; Kieffer, 2008), its relationship with writing competence, particularly argumentative writing, is less explored. Studies in general or monolingual student populations highlight the importance of oral language skills (e.g., syntactic knowledge) in writing (e.g., Kim et al., 2015). The Direct and Indirect Effects Model of Writing (Kim, 2020) posits that oral language skills, encompassing higher-order cognitive skills like perspective-taking and inference-making, contribute to written composition (Kim & Graham, 2022). Our study sought to broaden this understanding by exploring whether enhancing ELs' oral proficiency through content literacy instruction predicted their argumentative writing abilities.

Previous Research on the MORE Intervention and the Current Study

This study aimed to assess the effects of a Tier 1 content literacy intervention on improving the reading and argumentative writing abilities of Grades 1 and 2 ELs and their EP

peers. Implemented in 30 elementary schools, this 20-lesson intervention was delivered by teachers in the MORE treatment classrooms over 10 weeks. Previous evaluations have confirmed the overall effectiveness of the intervention in enhancing domain-specific vocabulary knowledge and argumentative writing among all participants (ELs and EPs combined) in the treatment group (Kim, Burkhauser, et al., 2021; Kim, Relyea, et al., 2021). Further exploring the differential benefits of the intervention for ELs compared to their EP peers and their outcomes relative to peers in business-as-usual (BAU) curricular practices can inform the refinement of our intervention approach. This comparative analysis can help clarify the specific impact of the intervention and assess its effectiveness across various student groups, ensuring that the Tier 1 intervention was equitable and addressed the unique needs of ELs in classroom environments.

Expanding on our initial studies that examined the overall impacts of the MORE intervention on student outcomes, this exploratory follow-up study to a randomized controlled trial (RCT) was designed to examine (a) the differential impacts by language status and (b) the underlying mechanisms determining how the intervention yielded meaningful effects on ELs (e.g., Reardon & Stuart, 2017). Two research questions (RQ) guiding this study were:

1. Does the MORE intervention in Grades 1 and 2 have a differential impact on reading proficiency, basic literacy skills, and argumentative writing in science and social studies based on students' language status?
2. Within the EL subgroup, do domain-specific vocabulary knowledge and English oral proficiency (speaking and listening) mediate the MORE intervention effects on reading proficiency, basic literacy skills, and argumentative writing outcomes?

Method

Study Design

This exploratory study was based on a cluster RCT with a randomized block design, conducted across 30 elementary schools (307 classrooms) within a large urban school district in the southeastern U.S. These elementary schools were stratified into seven blocks based on their demographic characteristics and academic performance. Within each block, half the schools were randomly assigned to the Grade 1 treatment group (with Grade 2 as the control group), and the other half were assigned to the Grade 2 treatment group (with Grade 1 as the control group). Consequently, Grade 1 treatment schools acted as valid counterfactuals for Grade 2 schools and vice versa. Students in the treatment group participated in the MORE intervention curriculum, while those in the control group received BAU instruction. In this study, RQ1 involved conducting moderation analyses with all students—ELs and EPs—to explore the interaction effects between the treatment and language status on reading proficiency, basic literacy skills, and science and social studies argumentative writing outcomes. RQ2 was to examine the mediation effects of the treatment on these outcomes within the EL subgroup through two latent factor mediators: domain-specific vocabulary knowledge and English oral proficiency.

Study Participants

The study involved a total of 5,397 students, including 1,236 ELs (n = 639 in the treatment group; n = 597 in the control group) and 4,161 EPs (n = 2,209 in the treatment group; n = 1,952 in the control group). Initially, we recruited 5,735 students, comprising 1,314 ELs (n = 681 in the treatment group; n = 633 in the control group) and 4,421 EPs (n = 2,369 in the treatment group; n = 2,052 in the control group). However, post-randomization attrition occurred due to student absences during the post-test sessions. The overall attrition rate was 5.89% (5.94% for ELs; 5.88% for EPs), with the treatment group experiencing a 6.62% attrition rate compared to 5.07% in the control group. The differences between the initial and final analytic samples,

based on baseline Measures of Academic Progress (MAP) reading and Dynamic Indicators of Basic Early Literacy Skills (DIBELS) tests, were negligible. Effect sizes were .00 and .01 for ELs and .01 and .02 for EPs, respectively.

The determination of students' language status (i.e., ELs or otherwise) was conducted by the school district. Upon the initial enrollment of students in public schools, a home language survey was completed by their parents or guardians. Students identified from this survey as primarily using a language other than English at home were further assessed using the World-Class Instructional Design and Assessment (WIDA) ACCESS for ELLs® 2.0 screener to determine their EL status. Students who scored below a proficiency level of 5.0 in any language domain (listening, speaking, reading, or writing) on the WIDA test, administered in the spring of kindergarten, were classified as ELs and became eligible for the district's language support services.

Table 1 presents the descriptive characteristics of the student participants at baseline, categorized by treatment condition and language status. The student sample was 50% male, and approximately 59% of ELs and 35% of EPs participating in the study came from low socio-economic status (SES) backgrounds. Among ELs, 76-77% identified as Hispanic/Latinx, 15% as Asian, 5% as White, and 3-4% as Black/African American.

We conducted a post hoc power analysis using the semPower package in R (Moshagen & Erdfelder, 2016) to determine the statistical power of mediation analyses with the reduced EL subgroup sample for RQ2. This analysis was performed based on a sample size of 1,257, with an RMSEA of .05 and an alpha level set to .05. The results indicated a power exceeding 99% to correctly reject a false null hypothesis (Cohen, 1982), thus minimizing the risk of Type II errors while maintaining the Type I error rate at the standard 5%.

The MORE Intervention Program

Intervention Unit Lessons

The MORE curriculum in Grades 1 and 2 included two thematic units each: one focused on science and the other on social studies. Each unit was organized around a single theme guided by a specific question. In Grade 1, the science unit was guided by the question, "*How do animals survive in their habitat?*" while the social studies unit explored "*How do explorers overcome obstacles?*". For Grade 2, the guiding questions were "*How do scientists study mass extinctions?*" for science and "*How do inventors solve problems?*" for social studies. During the 10-week intervention period, teachers in the treatment group implemented a total of 20 lessons, each 80 minutes long, divided equally between the science and social studies units, with each unit comprising 10 lessons delivered over five weeks in content-area blocks. Teachers in the treatment group were provided with a pacing calendar to guide the instructional sequence, but they were also granted the flexibility to adjust lesson pacing to accommodate the unique contexts of their local schools.

Each lesson in each unit was divided into two sections. The first section (40 minutes) was designed to build domain and topic knowledge through an interactive read-aloud of conceptually and thematically connected informational texts. Teachers initiated the lesson by outlining the learning goals and leading the interactive read-aloud activity (20 minutes). During this activity, teachers introduced a segment of an informational text along with target concept words pertinent to themes in each unit. While reading aloud, teachers provided child-friendly definitions of the target words, supplemented by visual aids and illustrations to enhance comprehension. After reading, students participated in the Elbow Exchange activity (Bondie & Zusho, 2018), which offered a structured, equitable exchange of dialogic discussion (10 minutes). With an elbow

partner, students alternated the roles of speaker and listener, either repeating or adding to their partner's response to questions from teachers. Teachers timed each partner to ensure equal sharing time. After teachers' explicit modeling, students were encouraged to include the word *because* and apply the target vocabulary learned while sharing ideas, questions, and feedback with their elbow partner to deepen their understanding and thought process. Teachers offered personalized feedback and restated responses in more complex language to model advanced structures for ELs. Following this, teachers guided the class in a concept mapping activity, where students and teachers collaboratively organized the key domain-specific academic words into a concept map displayed on the classroom wall (5 minutes). Students were engaged in discussions to categorize and link words based on their relationships, constructing a visual and relational understanding of the vocabulary. Teachers used sentence frames and explicit language cues to support ELs' contributions during the discussions. The first segment concluded with a reflection on the learning goals (5 minutes).

The second section (40 minutes) was designed to encourage students to apply their newly gained knowledge and transfer it to novel reading and writing tasks. Students first engaged in a more expanded and detailed concept mapping activity, utilizing resources from the texts and supplementary materials (15 minutes). This was followed by a collaborative research activity in which students focused on text features and structures to gain additional information on the given concepts. Teachers supported ELs by pre-teaching target words from the materials and providing graphic organizers to help them gather information. This section also facilitated in-depth academic group discussions, during which students used pertinent details and evidence from their research (20 minutes). Lessons 5 and 10 in each unit in this section (a total of 80 minutes across the two units) were modified to equip students with a self-regulated writing strategy

known as "TREE" (**T**opic sentence, **R**easons, **E**xplain reasons, and **E**nding; Graham & Harris, 2005, 2018). The goal was to enable students to write an argumentative response to an open-ended prompt related to the guiding question for the unit. Teachers explicitly modeled each strategy step, providing clear examples to support students in understanding and applying these concepts. Finally, each lesson concluded with a reflection session where students shared what they had learned from the lesson, aspects they enjoyed, and areas they were interested in exploring further (5 minutes).

Professional Development

Before implementing the intervention, classroom teachers and literacy facilitators assigned to the treatment condition participated in a half-day, in-person professional development workshop. Literacy facilitators, specialists in supporting and enhancing literacy instruction within schools, collaborated closely with teachers in the project to facilitate the implementation of the intervention and the administration of assessments. The initial workshop was divided into three distinctive sessions. The first session, conducted by the research team, was dedicated to developing the teachers' understanding of the principles and conceptual framework of the intervention, its research-based core instructional components, and the scope and sequence of the curriculum. The second session was more interactive, involving teachers in role-play and group discussion activities designed to solidify their grasp of the instructional components and routines. The third session created space for teachers from the same school to collaboratively strategize on classroom implementation methods.

After the workshop, the research team scheduled four monthly virtual meetings over the implementation period. These meetings served to maintain open communication with the MORE-group teachers, offering continuous support, guidance on lesson materials, and assistance

in implementing the program. At each school, literacy facilitators worked closely with the research team to address any logistical and instructional queries raised by the teachers. Moreover, the research team created daily video clips, each lasting between 5 to 10 minutes, as supplementary aids for the MORE teachers. These clips provided further guidance on instructional practices and approaches specific to each lesson.

Control Condition

In the BAU control condition, teachers utilized standard resources and traditional pedagogical practices aligned with state-standard core competencies and learning objectives. In reading/English Language Arts (ELA) classes, the instructional focus was on foundational reading skills, integrating vocabulary and reading comprehension strategies. The pedagogical approach adopted a balanced literacy framework that combined teacher-led direct instruction and student-centered activities, including guided reading groups, literacy centers, storytelling, reading aloud, and writing workshop exercises. In science classes, the instructional emphasis was on hands-on experiments and observational activities to facilitate understanding of fundamental scientific concepts and the natural environment. Social Studies classes were designed to build a foundational understanding of communities, history, and geography, using diverse instructional strategies like storytelling, role-playing, and applying maps and globes.

Fidelity of Implementation

We assessed fidelity of implementation (FOI) on four dimensions suggested by Dane and Schneider (1998): (a) adherence to the core components, (b) instructional time allocation, and (c) treatment differentiation. Descriptive statistics of these measures are presented in Table 2.

Adherence to Core Components

The assessment of the MORE teachers' adherence to the core components of the intervention was conducted through the analysis of audio-recorded class sessions. The process for gathering and evaluating these recordings involved several steps. Initially, from a stratified sample based on poverty levels (low, middle, and high), two schools were randomly chosen from each stratum, resulting in six schools for data collection. In these schools, 25 MORE classrooms were selected, where intervention lessons were audio-recorded during the site visit. Subsequently, an adherence checklist was developed, comprising 11 essential indicators aligned with the core components of the intervention (see Supplemental Online Material [SOM] Appendix S1 for the sample adherence checklist). A research assistant then reviewed the 25 audio recordings from these classrooms, marking each indicator's presence (1 point) or absence (0 point). The adherence score for each teacher was derived by totaling the points for the observed indicators and normalizing this total against the possible maximum. This score was then converted into a percentage to quantify each teacher's adherence level. The mean adherence rate among the 25 teachers was high at 98% (with a range of 80–100%), indicating substantial fidelity to the intervention components. After an initial coding work, a second research assistant independently re-coded 44% of the lessons, selected at random, to assess inter-rater reliability, which yielded a substantial agreement of 91% (Cohen's $\kappa = 0.63$).

Instructional Time Allocation

Both treatment and control groups adhered to the same total school hours. The self-reported teacher survey indicated that treatment-group teachers dedicated an average of 486 minutes per week to reading/ELA instruction within these allocated hours—approximately 20 minutes less than their counterparts in the control group. Conversely, treatment-group teachers allocated additional time to science and social studies, dedicating approximately 165 and 162

minutes per week to each subject. This represents an increase of nearly 60 minutes for each subject compared to the control group.

The treatment group's intensified focus on science and social studies was facilitated by reallocating instructional time. Periods typically reserved for less structured activities were repurposed into content-area blocks. This adjustment was implemented within the existing school hours, ensuring that the total instructional time remained unchanged and that the core curriculum was maintained without any core curricular elements being omitted.

Treatment Differentiation

Dane and Schneider (1998) defined treatment differentiation as a "manipulation check," ensuring that participants in each experimental condition received only intended interventions (p. 23). To examine the treatment differentiation between the treatment and control groups, we compared (a) the proportion of informational texts and (b) the complexity levels of texts utilized in interactive read-aloud activities. In our study, these text evaluations were crucial indicators of treatment differentiation. Notably, the treatment-group students' engagement with highly complex and challenging informational texts was our intervention's critical and distinct feature.

Teachers in the control group reported the titles of books used, revealing a stark difference: 100% of books in the treatment group were informational texts, compared to only 27% for Grade 1 and 9% for Grade 2 in the control group (see SOM Appendix S2 for the title of books). Moreover, the treatment group's books had higher complexity levels, with average Lexile levels at 738.67L for science and 876.92L for social studies, compared to 534.29L and 439.09L in the control group, respectively. These differences indicate that treatment-group students encountered texts with higher linguistic and conceptual complexity.

Measures

Reading Proficiency

The MAP reading test (Northwest Evaluation Association [NWEA], 2011) assessed students' overall reading proficiency. This test was a computerized adaptive assessment, in which the difficulty of each question was adjusted based on a student's previous responses (Thum & Kuhfeld, 2020). The test items were calibrated to the Rasch unit (RIT) scale grounded in Item Response Theory (IRT). The test was administered to all students before and after the implementation of the intervention. Each student received a unique set of 43 test items. The untimed assessment typically took 25 to 40 minutes to complete. The MAP score was a composite of four strands: narrative and informational text comprehension, vocabulary use and functions, foundational skills, and language and writing. An overall RIT score was computed based on performance on the four strands. The test-retest reliabilities of the composite test scores for the state ranged from .90 to .91 (NWEA, 2019).

Basic Literacy Skills

The DIBELS test was administered to evaluate students' basic literacy skills such as sound fluency, phoneme segmentation fluency, letter naming fluency, nonsense word fluency, oral reading fluency, and retell abilities (Good & Kaminski, 2002). We utilized a composite score combining subtest scores to assess a student's proficiency in fluently reading nonsense words (correct letter sounds and whole words read), oral reading fluency, and retelling ability. The assessment was conducted one-on-one with each student.

The predictive validity of DIBELS is evidenced by moderate correlations with standardized reading tests (e.g., Group Reading Assessment and Diagnostic Evaluation). Test-retest and inter-rater reliabilities of the composite scores ranged from .88 to .98 across grades. The concurrent and predictive validity, sensitivity, and specificity of DIBELS scores in relation

to end-of-year district and state standardized assessments are moderate to strong (Goffreda et al., 2009), underscoring its effectiveness as a tool for early literacy assessment.

Science and Social Studies Argumentative Writing

The proficiency of students' argumentative writing was evaluated in both science and social studies domains. This researcher-developed assessment aimed to evaluate their understanding and application of the structure and elements of argumentative composition. Each student was provided with an open-ended writing prompt for each domain, accompanied by a short source passage for contextual background pertinent to a given topic designed to stimulate argument construction. Both the writing prompts and source passages (see SOM Appendix S3) were delivered in written form and through oral reading.

In the science domain, the prompts were "*Should people be allowed to cut down trees in the rainforest?*" for Grade 1 and "*Do you think that an asteroid resulted in the extinction of dinosaurs? Why or why not?*" for Grade 2. The social studies writing prompts were "*Both Amelia Earhart and Sally Ride deserve to be celebrated. But, if you had to pick just one of these women explorers to celebrate, which one would you choose - Amelia Earhart or Sally Ride? Why?*" for Grade 1 and "*If you had to pick just one of the young inventors to celebrate, which one would you choose - Leonardo da Vinci or Henry Ford? Why?*" for Grade 2. Students were then encouraged to form an argument, explain their reasoning, and include a conclusion statement.

To evaluate the students' argumentative writing, we employed a genre-specific rubric (Graham et al., 2011), focusing on three key dimensions: claim, evidence, and conclusion. Each dimension was scored separately. The claim dimension was scored on a 0-2 scale, with 0 indicating no discernable claim, 1 suggesting a vague or unclear claim, and 2 reflecting a clear, appropriate, and well-articulated claim. The evidence dimension was evaluated on a 0-4 scale,

where 0 denoted the absence of supportive evidence or pertinent background knowledge, 1 represented the inclusion of textual evidence that was irrelevant to the claim, 2 meant the use of relevant background knowledge not found in the source text, 3 indicated the incorporation of at least one relevant piece of textual evidence from the source text, and 4 pointed to the use of at least two pieces of relevant textual evidence. Lastly, the conclusion was scored as either 0 or 1, contingent on the presence (1) or absence (0) of an appropriately articulated concluding statement. The summation of the scores from these three dimensions formed the total score, ranging from 0 to 7.

The evaluation of students' writing involved two raters, who were research assistants and our research team members. Initially, they underwent extensive training and practical exercises facilitated by the first author, using a scoring manual and anchor writing samples as essential resources. These raters were blinded to the experimental conditions and students' demographic information, including language status, to maintain objectivity and eliminate potential bias during the scoring process. In the initial scoring phase, any discrepancies observed were addressed through constructive discussions between the raters and the first author, aiming to reach a consensus on the final scores for objectivity and precision of the evaluation. This approach resulted in an inter-rater agreement of 90% or higher, a benchmark established after appraising approximately 14% of the randomly selected total writing samples. After this phase, the raters independently evaluated the remaining writing samples.

To validate the reliability of their independent assessments, an inter-rater reliability test was conducted on a subset comprising 20% of the randomly selected writing samples. Cohen's κ values for the total scores ranged from .92 to .99, reflecting the high consistency and dependability of the raters' independent evaluations.

Domain-Specific Vocabulary Knowledge

We employed a researcher-developed semantic association task to evaluate students' domain-specific vocabulary knowledge (Read, 2004; see SOM Appendix S4). This task assessed students' understanding of science and social studies academic words explicitly taught or incidentally encountered during the lesson units. It also evaluated their ability to identify and establish connections between semantically related words. The task comprised 24 items, divided equally between the science and social studies domains. For each domain, seven target words were explicitly taught during the interactive read-aloud and concept mapping activities, while the remaining five words were incidentally encountered through reading, listening, writing, and discussions.

In the semantic association task, each item presented a target word and four options. Students were guided to select two semantically connected words to the target word. In constructing the distractors for this task, we deliberately selected words as options that were either (a) phonetically similar to the target word in their beginning or ending sounds or (b) semantically contrasting with the target word. This design aimed to assess students' ability to discern words based on their meaning rather than phonetic similarities and to test their understanding of the target words' meanings. To prevent word decoding skills from interfering with the assessment of vocabulary knowledge, all questions and options in the semantic association task were read aloud to the students. Each item scored from 0 to 4 (see SOM Table S1 for the detailed scoring system). The task demonstrated a high internal consistency with a Cronbach's alpha (α) of .91.

English Oral Proficiency

English oral proficiency for ELs was assessed using the WIDA speaking and listening tests, administered toward the end of the intervention implementation. The WIDA test assessed ELs' English language proficiency based on WIDA's English language development standards (WIDA Consortium, 2020) that reflect the social and academic language needed and used in a K-12 school context. Both speaking and listening test components were computer-delivered, with trained teachers providing individualized support during test administration.

Speaking. Students interacted with pre-recorded speaking prompts from the computer and responded through headsets. The duration of the speaking test was approximately 30 minutes. Students' responses were automatically recorded and subsequently forwarded to the Data Recognition Corporation for evaluation. Students' speaking proficiency was assessed using a rubric for three criteria: linguistic complexity, language control, and vocabulary usage.

Listening. Students listened to pre-recorded passages via a computer interface and responded to multiple-choice questions displayed on the computer screen, all within a 40-minute timeframe. This computer-based listening test utilized a multi-stage adaptive test design, routing students to a low, middle, or high tier based on their proficiency level. Students were then presented with listening test items and tasks that matched their determined level of difficulty.

Control Variables

The analytic models accounted for several control variables, including students' demographic information (i.e., gender, race/ethnicity, socioeconomic status [SES], and grade) and randomization of school blocks. To adjust for baseline reading abilities, two pre-intervention reading scores—MAP reading and DIBELS—were factored into the statistical analyses.

Analysis Plan

RQ1: Impact Analysis

To investigate whether the MORE intervention treatment effects on the four separate outcomes of reading proficiency (MAP reading), basic literacy skills (DIBELS), and science and social studies argumentative writing measures varied according to students' language status, we employed hierarchical linear models (HLM; Raudenbush & Bryk, 2002) outlined as follows:

$$Y_{ij} = \beta_{00} + \beta_{01}(TREATMENT)_j + \beta_{10}(EL)_{ij} + \beta_{11}(TREATMENT)_j \times (EL)_i +$$

$$\sum_{m=2}^{3} \beta_{m0}(PRETEST)_{ij} + \sum_{p=4}^{14} \beta_{p0}(COV)_{ij} + \sum_{q=2}^{7} \beta_{0q}(BLOCK)_j + \varepsilon_{ij} + \zeta_{0j},$$

where Y_{ij} denotes the post-test outcomes for student *i* in school *j*. *TREATMENT* is a dichotomous variable indicating the treatment condition (0 = control; 1 = MORE treatment); *EL* corresponds to a dummy-coded variable representing language status (0 = EP; 1 = EL); *TREATMENT* × *EL* is the interaction term between treatment and language status; *PRETEST* corresponds to students' pretest (baseline) MAP reading and DIBELS scores; *COV* represents student-level demographic covariates; and *BLOCK* refers to dummy-coded randomization school blocks. The model included random effects at the student (ε_{ij}) and school (ζ_{0j}) levels, which are assumed to be normally distributed. The outcome variables were standardized across the sample by grade.

We further conducted a series of subgroup analyses for EL and EP students separately to estimate the treatment effect within each subgroup. This approach was taken to complement the interaction analysis, ensuring reliable results despite smaller sample sizes in each subgroup. We calculated effect sizes for each subgroup using the same post-test outcome measures as in the interaction analysis. The results from these subgroup analyses were then compared to those from the interaction analysis to evaluate consistency in the treatment effects observed across ELs and EPs.

RQ2: Mediation Analysis

We specified four mediation models to investigate the effects of the MORE intervention treatment on the post-test outcomes mediated by domain-specific vocabulary knowledge and English oral proficiency.

Measurement Models. We first examined the measurement portion of the final models by conducting confirmatory factor analysis (CFA) models. This was to determine whether the two latent mediator constructs were well represented by their respective observed measures. The domain-specific vocabulary knowledge factor comprised four observed measures: vocabulary knowledge of taught and untaught words in science and social studies. The English oral proficiency factor included the measures from WIDA speaking and listening. We assessed the fit of these models to our data using the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and root mean square error of approximation (RMSEA). Adequate or excellent model fit is suggested by CFI and TLI values above .95 and RMSEA values less than .06 (Hu & Bentler, 1999).

Structural Models. We fitted four structural models to evaluate the direct and indirect treatment effects on four observed post-test outcomes mediated by the two latent factors. For our mediation analyses, we employed the bootstrapping method to derive bias-corrected confidence intervals that were based on empirical estimations of the sampling distribution rather than imposing the assumption of normality of the sampling distribution (Cheung & Lau, 2008; MacKinnon et al., 2004). Given the smaller sample size of ELs in our mediation analysis, bias correction to confidence interval boundaries was applied to adjust for asymmetry in the distribution of bootstrap estimates (Efron & Tibshirani, 1993). We constructed 95% confidence intervals for the direct and indirect effects using bias-corrected bootstrapped standard errors with 1,000 draws in *Mplus* version 8 (Muthén & Muthén, 2017).

Transparency and Openness

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study, and we follow Journal Article Reporting Standards (Kazak, 2018). The dataset is available at https://doi.org/10.7910/DVN/HQEMN6, and the analysis code and research materials can be obtained by contacting the corresponding author. Data were analyzed using Stata version 17 (StataCorp, 2021) and *Mplus* version 8 (Muthén & Muthén, 2017). The original RCT study, pre-registered (https://doi.org/10.1257/rct.2746-2.1) and focused on predefined hypotheses and research questions, is detailed in our confirmatory analyses (Kim, Relyea, et al., 2021). The current study built upon that framework by exploring new research questions using the same dataset that was not covered in the initial pre-registration.

Results

Baseline Equivalence and Preliminary Analysis

We conducted a pre-intervention baseline equivalence assessment between the treatment and control groups, separately for each language status, using HLM to account for school-level clustering. For ELs, no statistically significant differences were observed between the groups in MAP reading and DIBELS scores (*ps* > .05), with effect sizes (Cohen's *d*) of .09 and .05, respectively. For EPs, there was a statistically significant difference in baseline MAP reading scores between the groups ($p < .05$), with an effect size of .12, while no significant difference was noted in DIBELS scores ($p > .05$), with an effect size of .07. Considering the effect sizes greater than .05, we statistically adjusted for both baseline MAP reading and DIBELS scores in the impact analyses to adhere to the baseline equivalence standard (What Works Clearinghouse, 2022).

Table 3 presents descriptive statistics for pre- and post-test measures, categorized by groups and language status. As illustrated in Figure 2, in the post-test assessments of domain-specific vocabulary knowledge, ELs in the treatment group outperformed ELs in the control group with a statistically significant difference ($p < .05$) in both science (ES = .49) and social studies (ES = .52). Notably, ELs in the treatment group even scored comparably to EPs in the control group in both science and social studies vocabulary knowledge. Likewise, for the argumentative writing outcomes, ELs in the treatment group scored higher than ELs in the control group with a statistically significant difference ($p < .05$) in science (ES = .25) and social studies (ES = .42). Moreover, in the social studies argumentative writing, ELs in the treatment group slightly outperformed EPs in the control group.

Table S2 in SOM displays a correlation matrix for all measures by language status. For both ELs and EPs, domain-specific vocabulary knowledge exhibited stronger correlations with reading post-test scores (*rs* = .48 to .61) than the argumentative writing scores (*rs* = .28 to .41). Among ELs, WIDA speaking and listening scores were more strongly correlated with reading post-test scores (*rs* = .32 to .58) than with the argumentative writing scores (*rs* = .16 to .34).

RQ1: Intervention Impact Variation by Language Status

Table 4 displays the results from the fitted HLMs, which assess the main effects of treatment and language status, as well as their interaction effects on reading and argumentative writing outcomes. For the MAP reading outcome, there were no significant main treatment effects and interaction effects between treatment and language status (*ps* > .05). Effect sizes for MAP reading were .01 for ELs and -.02 for EPs. The main effect of language status was significant ($p < .001$), indicating that, on average, EPs achieved higher scores than ELs in MAP

reading. For DIBELS, both main and interaction effects were not statistically significant (*ps* > .05), with effect sizes of .04 for ELs and -.02 for EPs.

As for the argumentative writing outcomes, the interaction effects for both argumentative writing outcomes were not statistically significant (*ps* > .05), suggesting that the treatment effects were generally similar for both ELs and EPs. Students in the treatment condition outperformed those in the control condition with effect sizes of .25 for ELs and .24 for EPs in science argumentative writing, and .42 for ELs and .44 for EPs in social studies argumentative writing.

The results from our subgroup analyses, conducted to assess the treatment effect within each group of ELs and EPs, showed findings consistent with those of the interaction analyses (see SOM Table S3 for ELs and Table S4 for EPs). These analyses revealed that the significance of the treatment effect was similar in both groups. Notably, the discrepancies in effect sizes between the subgroup and interaction approaches were minimal, ranging only from .01 to .02.

RQ2: Mediation Effects among English Learners

Measurement Model Testing

We assessed the validity of the two measurement models using Confirmatory Factor Analysis (CFA). The goodness-of-fit statistics indicated that all four measurement models satisfactorily fit the data. The loadings of the measured variables on the latent factors were statistically significant (*ps* < .001), with standardized factors exceeding .61 (see SOM Table S5). These findings suggest that all latent factors were adequately represented by their respective indicators. Hence, the satisfactory fit of the measurement models warranted the subsequent examination of the structural mediation models.

Structural Mediation Models

Table 5 presents the estimates for the direct, indirect, total indirect, and total effects of the four mediation models. Figures 3 and 4 illustrate the path estimates for the reading and argumentative writing outcome models, respectively.

Reading Proficiency. The model for the reading proficiency outcome (MAP reading) in Figure 3 (a) demonstrated an excellent fit with the data (CFI = .976, TLI = .957, RMSEA = .034 [90% CI = .028 to .039]). After accounting for the mediators and covariates, the direct effect of the treatment on MAP reading was not statistically significant ($p > .05$). However, the indirect effects through domain-specific vocabulary knowledge and English oral proficiency were significant ($ps < .05$). The treatment had a statistically significant effect on domain-specific vocabulary knowledge ($p < .001$) and English oral proficiency ($p < .05$), which in turn significantly predicted MAP reading ($ps < .001$). The total indirect effect through both mediators was statistically significant ($p < .05$), indicating that the intervention effect on MAP reading was fully mediated by these two mediators. Effect sizes for all observed mediator variables are presented in Table S6 in SOM.

Basic Literacy Skills. The model for the basic literacy skills (DIBELS) outcome in Figure 3 (b) also exhibited an excellent fit with the data (CFI = .976, TLI = .958, RMSEA = .034 [90% CI = .028 to .039]). The direct effect on DIBELS was not significant, and neither were the indirect effects through domain-specific vocabulary knowledge and English oral proficiency ($ps > .05$).

Science Argumentative Writing. The model for science argumentative writing in Figure 4 (a) demonstrated an excellent fit with the data (CFI = .955, TLI = .922, RMSEA = .035 [90% CI = .029 to .041]). Neither the direct effect on science argumentative writing nor the indirect

effects through domain-specific vocabulary knowledge and English oral proficiency were significant (*ps* < .05).

Social Studies Argumentative Writing. The model for the social studies argumentative writing outcome in Figure 4 (b) showed an excellent fit with the data (CFI = .960, TLI = .931, RMSEA = .034 [90% CI = .028 to .039]). Statistically significant effects were observed for both the direct treatment effect on this outcome and the indirect effect mediated by domain-specific vocabulary knowledge (*ps* < .05). While the indirect effect mediated by English oral proficiency was not significant (*p* > .05), the total indirect effect was significant (*p* < .05). Notably, the intervention effect on ELs' social studies argumentative writing was partially mediated by domain-specific vocabulary knowledge.

Statistical Power Analysis

A post hoc power analysis was conducted using the Monte Carlo simulation method (Thoemmes et al., 2010) with *Mplus* to determine the statistical power of the mediation effects. This analysis involved simulating 10,000 random samples based on the model parameters. Findings reveal that while the direct effects in all four models were underpowered (ranging from .05 to .66), the total indirect effects achieved adequate statistical power (ranging from .82 to 1.00) (Cohen, 1982). The results substantiate the validity of our mediation models and highlight the mediators' role in elucidating the mechanism through which the MORE treatment could influence the dependent variables.

Moreover, the total indirect effects exhibited stronger statistical power than the total effects of the outcome models (see Table 5), indicating that the inclusion of the mediators increased statistical power to detect the total indirect effects (Kenny & Judd, 2014; Shrout & Bolger, 2002). This counterintuitive result can be attributed to the combination of small effect

sizes and a large sample size in our study. Small standardized coefficients, when combined with a large sample size, enhance the precision of the estimates and increase the likelihood of detecting significant total indirect effects (O'Rourke & Mackinnon, 2015).

The discrepancy in statistical power between the total indirect effect and the total effect was apparent in the MAP reading (.99 and .09, respectively) and DIBELS (.82 and .15, respectively) models. For the MAP reading model, this discrepancy may have occurred because the total indirect and direct effects had opposite signs (i.e., positive total indirect effect and negative direct effect), leading to a near-zero total effect while the total indirect effect was statistically significant (MacKinnon, 2008; Taylor et al., 2008). In the DIBELS model, the total indirect effect and the total effect were equal, as the direct effect was near zero, resulting in higher power to detect the total indirect effect (O'Rourke & Mackinnon, 2018).

Discussion

Building upon the findings from the previous content literacy intervention study (i.e., Kim, Relyea, et al., 2021), this study further explored (a) the differential impacts on reading and argumentative writing outcomes among ELs and EPs in Grades 1 and 2 and (b) the underlying mechanisms behind the intervention's effects on the EL subgroup. Four key findings emerged. First, the classroom-based content literacy intervention was equally beneficial for both ELs and EPs in enhancing argumentative writing in science (ES = .25 for ELs and ES = .24 for EPs) and social studies (ES = .42 for ELs and ES = .44 for EPs). Second, while the intervention did not significantly impact MAP reading and DIBELS for both ELs and EPs, the effect sizes were slightly higher for ELs (ES = .01 and .04, respectively) than for EPs (ES = -.02 and -.02, respectively). Third, the exploratory mediational analyses indicate that for ELs, the intervention effect on MAP reading was fully mediated by domain-specific vocabulary knowledge and

English oral proficiency. Fourth, the intervention effect on ELs' social studies argumentative writing was partially mediated by domain-specific vocabulary knowledge. This study shed light on the varying impacts of the intervention on ELs and EPs and identified potential mechanisms responsible for the intervention's effects on ELs' reading and argumentative writing outcomes.

Comparable Intervention Benefits for ELs and EPs

The first finding from RQ1 indicates that the intervention yielded strong and similar effects on the argumentative writing performance in science and social studies for ELs and EPs. This result not only aligns with recent research by Vaughn et al. (2022), which found comparable benefits in social studies vocabulary knowledge for adolescent ELs and EPs, but also extends previous research (e.g., Connor et al., 2017; Guthrie et al., 2004; Kim, Relyea, et al., 2021) by exploring how the MORE intervention effects vary across language status groups. This deepens our understanding of the effectiveness of content literacy instruction, especially in complex tasks like argumentative writing and domain-specific vocabulary knowledge.

The intervention's impact on students' argumentative writing exemplified the mutually reinforcing nature of reading and writing. Despite only 80 minutes allocated to writing activities across four lessons, the substantial effect likely derives from integrating writing tasks into the broader context of reading and language activities, affirming literacy skill interconnectedness (Fitzgerald & Shanahan, 2000). Engaging with informational texts, text-based discussions, and concept mapping using domain-specific vocabulary likely enriched students' disciplinary knowledge and cognitive networks, aiding critical processes in information retrieval and composition (Borovsky et al., 2016; Fitzgerald et al., 2021, 2022; Perfetti, 2007; Steyvers & Tenenbaum, 2005). Furthermore, explicit self-regulated strategy instruction and structured writing tasks may have eased cognitive demands, fostering the development of a mental structure

for essential writing elements (Galbraith & Baaijen, 2018; Graham & Harris, 2018; McCutchen, 2000). This approach is particularly beneficial for ELs who face additional cognitive challenges in reading and writing in a second language (Zwaan & Brown, 1996)

Interestingly, this study unveiled a distinct variation in the intervention impact on argumentative writing and vocabulary knowledge, with more pronounced effect sizes in social studies than in science. This divergence may be attributed to the social studies curriculum's emphasis on critical thinking, argument development, and complex academic vocabulary (Newmann, 1991)—skills targeted by the intervention. In particular, ELs in the MORE treatment group exhibited better performance in social studies argumentative writing and a deeper understanding of vocabulary than their EP counterparts in the control group, suggesting the potential of the intervention to narrow the achievement gap in the social studies domain.

Furthermore, the current study complements Tyner and Kabourek's (2020) findings on the positive effects of extended social studies instruction on literacy outcomes. The increased instructional time in social studies in the intervention is presumed to have contributed to enhanced proficiency in argumentative writing and vocabulary knowledge. Importantly, the intensified focus on social studies did not compromise reading proficiency and basic literacy skills; instead, it appears to have facilitated the transfer of content and vocabulary knowledge to more complex literacy tasks. This result implies that strategically extending instructional time in social studies for early elementary grades can catalyze literacy development, especially for ELs simultaneously learning content and literacy in a new language.

Another plausible explanation for the greater impact on social studies outcomes relative to science may be the higher complexity of social studies texts used in the treatment group. These texts are usually rich in sophisticated vocabulary and abstract concepts that require a

deeper contextual understanding (Schleppegrell, 2004). The higher Lexile levels in social studies texts in our study reflect intricate expository structures, such as chronologically, comparatively, and thematically arranged historical narratives (Williams et al., 2007). This demands logical connections between events and ideas, enhancing comprehension and engagement. Moreover, the thematic content in social studies—explorers (Grade 1) and inventors (Grade 2)—along with collaborative discussion, provides a rich context for argumentation and in-depth exploration of perspectives and historical events (Wissinger & De La Paz, 2016).

The selection of target vocabulary within each domain also likely influenced students' argumentative writing outcomes. Science vocabulary in semantic networks typically follows a hierarchical structure, with concepts building progressively from general (e.g., *animal survival*) to specific (e.g., *physical features*), facilitating systematic idea exploration (Shanahan & Shanahan, 2012; Snow, 2010). On the other hand, social studies vocabulary is often taxonomically organized, categorizing words by common traits or properties (Schleppegrell, 2004). This taxonomic structure of social studies vocabulary may enhance argumentative writing by enabling effective categorization and connection of concepts in networks, fostering coherent idea presentation. Such organization likely aided in vocabulary retention and recall, supporting argument construction (Neuman et al., 2011).

Content Literacy Intervention Impact on Reading

Despite the significant effects on the researcher-developed argumentative writing measures, there was a lack of significant impact on the standardized reading assessments. This aligns with previous studies (e.g., Connor et al., 2017; Lesaux et al., 2014; Proctor et al., 2011) that reported non-significant effects on standardized reading comprehension outcome. One possible interpretation is that these assessments, primarily focusing on domain-general reading,

may not sensitively capture the specific improvements targeted by our intervention. This suggests the need for more nuanced assessment tools to detect specific gains in content learning and literacy skills, particularly for ELs navigating academic language complexities (Goldenberg, 2020; Snow & Uccelli, 2009).

Additionally, the nature of the MAP reading test, which assesses unconstrained, complex reading skills that typically develop over extended periods (Paris, 2005; Snow & Matthews, 2016), suggests that the 10-week duration of our intervention may not have been sufficient to produce significant changes in this measure. For ELs, acquiring these unconstrained skills in a second language may present additional challenges, requiring even more time and support. A more sustained, possibly multi-year, intervention might be necessary to achieve notable effects on unconstrained reading outcomes (Kim et al., 2023, 2024).

The second key finding of our study is nuanced yet holds practical significance: ELs exhibited slightly larger effect sizes in MAP reading and DIBELS compared to EPs, suggesting a potential, albeit modest, advantage from the intervention. This subtle difference indicates that instructional core elements aligned with the WWC Practice Guide Recommendations may offer incremental reading benefits to ELs when provided with equal educational opportunities despite the absence of statistical significance. Although the effect sizes were small, this finding is meaningful in the context of ELs' educational experiences, highlighting the intervention's potential for positive change. The development of content and vocabulary knowledge and the opportunity to apply this knowledge in an interactive and inclusive classroom setting may have contributed to these gains. This underscores the importance of sustained evidence-based, inclusive instructional practices, suggesting that well-structured instructional strategies can yield positive reading outcomes for ELs.

Unpacking the Mediating Mechanisms of the Intervention for ELs

The current study aimed to validate the hypothesized logic model for our intervention by exploring the mechanisms through which it influenced ELs' reading and argumentative writing outcomes. While direct effects were not statistically significant, except for the social studies argumentative writing outcome model, theoretical considerations justified further exploration of the mediators (Baron & Kenny, 1986; Hayes, 2013; O'Rourke & MacKinnon, 2018). Mediation analyses are increasingly recommended in intervention research to identify and examine the mechanisms as active ingredients of an intervention program even when overall and direct effects do not reach statistical significance (Fritz et al., 2015; MacKinnon, 2008).

Our mediation analysis provided insights into the action theory, focusing on how the intervention affected the mediators, and the conceptual theory, elucidating how these mediators influenced the targeted outcomes (MacKinnon, 2008). We tested replicable mediators and identified specific pathways through which the intervention affected ELs. This approach was crucial for refining the theoretical framework and instructional core components and enhancing the measures used, thereby providing a more nuanced evaluation of the effectiveness of the intervention (Maxwell & Cole, 2007).

Mediators of the Indirect Intervention Effect on Reading Proficiency

The third finding from the exploratory mediational analysis reveals that ELs' domain-specific vocabulary knowledge and English oral proficiency fully mediated the intervention effect on MAP reading. This full mediation in the absence of a significant direct intervention effect on MAP reading is a counterintuitive yet critical finding, underscoring the crucial role of domain-specific vocabulary knowledge and English oral proficiency in reading proficiency for ELs. These components were likely more sensitive to the aspects targeted by the intervention,

capturing subtle yet meaningful changes in language skills that were positively related to reading proficiency, even though these changes were not immediately evident in the domain-general reading outcome. In other words, enhancing domain-specific vocabulary knowledge and English oral proficiency is the fundamental mechanism of the intervention affecting ELs' reading proficiency. The absence of a direct intervention effect reinforces the critical role of these language skills in reading proficiency and highlights the importance of targeting them in interventions designed to improve reading outcomes for ELs.

The findings, aligned with the action theory underpinning the intervention, suggest that the significant effect on ELs' domain-specific vocabulary knowledge can be attributed to the implementation of academic vocabulary instruction through concept mapping, which fosters the development of high-quality mental semantic representations (Fitzgerald et al., 2021; Perfetti, 2007). ELs particularly benefited from explicit visualization and discussions of textual and semantic networks during concept mapping activities, facilitating the learning of meanings of content-area academic words (e.g., Borovsky et al., 2016; Bravo & Cervetti, 2008; Pollard-Durodola et al., 2011; Stahl & Nagy, 2006). For example, in the Grade 1 social studies unit, as students constructed a mental network around the word *explorer*, they gradually integrated related concepts like *expedition, obstacle, persistent*, and *discovery*, each adding breadth and depth to their conceptual understanding of *explorer*. This expanding network, linking to preexisting networks, led to a broader and stronger academic vocabulary repertoire, enhanced automaticity in retrieving academic meanings, and advanced acquisition of disciplinary knowledge and schema (Fitzgerald et al., 2020; Hirsch, 2006; Newman et al., 2006; Palincsar & Duke, 2004; Perfetti, 2007; Steyvers & Tenenbaum, 2005).

Additionally, the results demonstrate the positive effect on ELs' English oral proficiency, which is particularly noteworthy for its substantial predictive power on reading proficiency, as supported by various studies with second language learners (e.g., Babayiğit, 2014; Berninger & Abbott, 2010; Cho et al., 2019; Droop & Verhoeven, 2003; Verhoeven & van Leeuwe, 2012). The findings underscore the crucial role of a classroom environment enriched with content knowledge, linguistic development, and peer collaboration in fostering ELs' English speaking and listening competencies. Academic language proficiency, as measured by the WIDA test and characterized by specific register features in the schooling context (Biber & Conrad, 2009; Schleppegrell, 2001; Truckenmiller & Petscher, 2020), is essential for understanding and utilizing the complex vocabulary, sentence structures, and discourse formats prevalent in academic texts (Nagy & Townsend, 2012; Snow & Uccelli, 2009). The study emphasizes the importance of actively engaging in content knowledge building and its application in content- and language-rich classroom settings to support young ELs' linguistic and academic development.

Our study highlights the significant relationship between ELs' domain-specific vocabulary knowledge and domain-general reading proficiency, partially supporting the conceptual theory of the intervention. In essence, our exploratory mediation analyses suggest that measures matter when it comes to assessment impacts on early reading outcomes. On one hand, we found a significant predictive association between domain-specific vocabulary knowledge and MAP reading. On the other hand, this relationship was not mirrored in the DIBELS results, indicating that the predictive power of domain-specific vocabulary may vary between these two reading assessments. This distinction is particularly salient given the nature of the MAP reading assessment—a personalized, computer-adaptive tool that evaluates higher-order reading

abilities—contrasted with DIBELS's focus on foundational code-related skills. The exploratory mediation analyses clearly suggest that the core components are necessary but not sufficient to improve code-related skills that are assessed on outcomes like DIBELS.

Domain-Specific Vocabulary Knowledge as a Mediator in Social Studies Argumentative Writing

The fourth finding is that domain-specific vocabulary knowledge partially mediated the intervention effect on social studies argumentative writing, demonstrating the complex mechanisms at play. The significant indirect effect suggests that the intervention enhances ELs' domain-specific vocabulary knowledge, which is positively and significantly associated with their argumentative writing in social studies. The relationship between domain-specific vocabulary knowledge and argumentative writing is likely rooted in the cognitive processes involved in writing. Access to a mental lexicon of semantic relationships and knowledge of word forms and meanings is essential for effective writing (Legacy et al., 2018; Olinghouse & Wilson, 2013). Enriched academic vocabulary may help ELs navigate the complexities of argumentative writing, transferring their expanded lexical knowledge to advanced composition tasks (Kimball & Holyoak, 2000). This transfer of knowledge might be evident as word forms and meanings in their mental networks could facilitate coherent argument formation and effective evidence integration (Nagy & Townsend, 2012), which supports the notion of a link between domain-specific vocabulary knowledge and argumentative writing (e.g., Dobbs & Kearns, 2016; Graham, 2020; Kim & Schatschneider, 2017). Furthermore, mapping academic vocabulary networks might enhance cognitive accessibility and facilitate the retrieval of lexical and conceptual knowledge, resolving semantic ambiguities in the writing process (Andrew, 1997).

Interestingly, the observed relationship between domain-specific vocabulary knowledge and argumentative writing appears to be domain-specific, as statistical significance ($p < .05$) was found with social studies argumentative writing but not in science. This distinction is further supported by stronger correlations observed in social studies ($r = .41$ for both ELs and EPs) compared to science ($rs = .30$ for ELs and .28 for EPs). Additionally, as illustrated in SOM Figure S1, social studies vocabulary knowledge significantly predicted social studies argumentative writing, unlike in science. For ELs in the treatment group, acquiring social studies vocabulary knowledge proved to be a robust mechanism for transferring knowledge to argumentative writing that was not observed in science. This suggests that the taxonomical structure of social studies vocabulary may serve as a bootstrapping mechanism, facilitating more effective induction of word meanings (Neuman et al., 2011) and underscoring the importance of the nature and structure of domain-specific vocabulary in enhancing students' writing performance.

However, it is essential to note that the presence of partial mediation in social studies argumentative writing also indicates a direct effect of the intervention on this outcome that is not accounted for solely by domain-specific vocabulary knowledge. This suggests that the intervention directly enhances aspects of social studies argumentative writing, independent of this mediator. Given this significant direct effect, it is likely that there are other factors or mechanisms contributing to the intervention's effect on social studies argumentative writing. These could include elements related to content knowledge, critical thinking skills, or specific writing strategies (Giroux, 1978; Wissinger et al., 2021). Further research is needed to identify and explore these additional factors to fully understand the multifaceted nature of the intervention effect on social studies argumentative writing.

Taken together, our findings indicate that ELs can benefit from equitable educational opportunities provided by classroom-based content literacy instruction. This instruction, characterized by a rigorous and content-rich curriculum coupled with systematic pedagogical approaches, produced positive effects on their language and literacy. This positive outcome was evident as the intervention notably narrowed gaps between ELs and EPs in domain-specific vocabulary and argumentative writing. Remarkably, in social studies argumentative writing, ELs in the treatment group even outperformed EPs in the control group. These outcomes underscore the transformative potential of equitable, targeted, and robust educational support in empowering ELs to experience significant growth and deeper engagement with the curriculum.

However, it is important to acknowledge that post-test performance gaps between ELs and EPs within the treatment condition, while reduced, persisted. This highlights the complexities of addressing all aspects of literacy development within a limited timeframe and underscores the need for continuous research and development of interventions tailored to the specific needs of ELs, particularly in reading. Future efforts should focus on targeted approaches to further narrow and ultimately eliminate these gaps, ensuring that ELs keep pace and excel beyond their EP peers in various language and literacy facets. This study contributes to the growing evidence supporting the effectiveness of research-based literacy interventions for ELs. It emphasizes the importance of refining educational strategies to meet the diverse needs of all students, especially those acquiring English as an additional language.

Limitations and Future Directions

Despite the valuable insights gained from this study, it is essential to acknowledge its limitations, warranting further exploration in future research. First, a crucial caveat in interpreting our findings is the differential allocation of instructional time between the treatment

and control groups. Both adhered to the same total school hours, yet the treatment group received about 100 additional minutes across reading/ELA, science, and social studies. This extra time was redistributed within the school day, favoring science and social studies without extending the overall hours or omitting core curricular components. Notably, the treatment group's reduced reading/ELA instruction hours did not negatively affect reading outcomes, suggesting that the effectiveness of the intervention is due to the quality and integration of content literacy instruction rather than increased time on task alone.

Second, our mediation analyses imply that content literacy interventions targeting both constrained and unconstrained skills could positively influence ELs' literacy development. Specifically, ELs' domain-specific vocabulary knowledge and English oral proficiency showed a significant link with MAP reading, which measures language and text comprehension skills. To reduce decoding demands on students, complex informational texts were read aloud during MORE lessons, and assessments of domain-specific vocabulary knowledge and argumentative writing were conducted orally. Despite these accommodations, the associations of domain-specific vocabulary knowledge and English oral proficiency with DIBELS were not apparent. This lack of linkage indicates that content literacy interventions that address both the constrained (code-based) and unconstrained (meaning-based) literacy skills might more effectively enhance ELs' language and literacy skills (Cho et al., 2019; Mancilla-Martinez et al., 2020). Furthermore, large-scale evaluations of language-based interventions from kindergarten to Grade 3 have shown limited direct effects on reading comprehension (e.g., LARRC et al., 2019), underlining the need for sustained, multi-year interventions designed to support the full range of language and literacy skills critical for ELs' literacy development.

Third, future research could explore integrating tailored Tier 2 small-group supplemental instruction for ELs, particularly benefiting those needing additional support beyond Tier 1 lessons (Baker et al., 2014). A systematic and cohesive approach tailored to ELs' unique code- and language-related skills may offer complementary and synergistic advantages, strengthening their reading comprehension.

Finally, further investigation is needed to understand how ELs' native language moderates the effects of content literacy interventions on their English reading and writing outcomes. The role of primary language literacy skills in shaping academic language and literacy development among young multilingual students is well documented (e.g., Cheung et al., 2019; Relyea & Amendum, 2020). Applying moderated mediation models (Preacher et al., 2007) could provide a deeper insight into the interplay among students' home language experiences, literacy competencies, and the effects of content literacy instruction on student outcomes.

Implications and Conclusion

The results of the study have important implications for educational practice and policy. Importantly, they provide crucial insights into the capacity of young ELs to navigate and engage meaningfully with complex, content-rich informational texts through various activities in general classrooms. This interaction expands their content knowledge and facilitates the transfer of schema to English language and literacy. These findings challenge the widely held assumptions about ELs' academic capabilities due to still-developing English proficiency, highlighting their readiness and potential to immerse themselves in rigorous academic content.

Results from this study also call for a recalibration of EL instructional strategies. The study suggests that engaging ELs with intricate science and social studies content and their interactions with peers can be an effective strategy for English language acquisition and

academic content learning. This finding challenges pedagogical tendencies to delay the introduction of complex content until ELs reach an optimal English language proficiency level. With the growing need to incorporate content literacy principles in curriculum design (Baker et al., 2014; Lee, 2020), teachers should integrate content literacy instructional strategies into their reading/ELA curricula, ensuring that ELs receive consistent exposure to and actively participate in rich content, informational texts, and collaborative activities with their linguistically diverse peers.

Finally, our findings suggest that teacher training programs should emphasize equipping educators with the skills and tools necessary to effectively support ELs' engagement with content knowledge building and application processes. It is crucial for teacher training to ensure that teachers can deliver content in a manner that is linguistically accessible and educationally enriching for ELs (Lesaux et al., 2014; Proctor et al., 2019). From a policy perspective, there is a need to underscore the dual pedagogical value of content-rich instruction for ELs in language-rich classroom environments, emphasizing its crucial role in bolstering content knowledge and schema and fostering English language proficiency (Goldenberg, 2020).

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Table 1

*Baseline Demographic Characteristics of Students (*N = *5,397) by Intervention Treatment Condition and Language Status*

	Treatment			Control		
Characteristics	All	EL	EP	All	EL	EP
N	2,848	639	2,209	2,549	597	1,952
Gender						
Male	50%	50%	51%	50%	44%	51%
Race/Ethnicity						
White	18%	5%	22%	19%	5%	23%
Black/African American	39%	3%	49%	37%	4%	47%
Asian	8%	15%	5%	8%	15%	6%
Hispanic/Latinx	32%	77%	19%	32%	76%	19%
Other	4%	0.3%	4%	3%	0.3%	4%
Individualized education plan	7%	8%	7%	%	9%	8%
Low SES status	41%	59%	35%	40%	59%	35%
Middle SES status	38%	33%	39%	39%	34%	40%
High SES status	21%	8%	25%	20%	7%	25%

Note. SES = socioeconomic status. EL = English learners. EP = English-proficient students

Table 2

Descriptive Statistics of Fidelity of Implementation

	Treatment		Control		
FOI components	*M*	*SD*	*M*	*SD*	*t*
Adherence to core instructional components	98.00%	5.70	n/a	n/a	
Instructional time allocation[a]					
Reading/ELA instruction	485.94	244.02	505.30	258.91	-0.42
Science instruction	164.51	126.84	103.25	88.50	4.97***
Social studies instruction	161.68	123.44	103.69	90.62	4.83***
Program differentiation: Complexity of interactive read-aloud texts					
Science texts	738.67L	120.35L	534.29L	137.10L	4.63***
Social studies texts	876.92L	128.67L	439.09L	100.64L	9.15***

Note. [a]minutes per week. ELA = English Language Arts.
***$p < .001$.

Table 3

Descriptive Statistics of Student-Level Measures for English Learners (EL) and English-Proficient (EP) Peers by Treatment and Control Condition

	Treatment						Control					
	EL			EP			EL			EP		
Measures	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Pre-tests												
MAP reading	166.49	16.90	639	177.73	17.84	2,209	168.90	17.06	597	179.45	16.71	1,952
DIBELS	152.18	106.85	634	219.69	110.84	2,201	159.97	115.68	596	227.07	111.43	1,946
Post-tests												
Reading												
MAP reading	172.18	16.80	639	182.34	17.17	2,209	173.94	16.81	597	184.31	16.16	1,952
DIBELS	173.80	115.66	636	234.23	113.60	2,196	180.53	117.17	596	244.01	109.83	1,946
Argumentative writing												
Science arg. writing	3.08	1.82	296	3.67	1.78	1,075	2.55	1.78	304	3.23	1.69	1,050
SS arg. writing	3.63	2.16	264	4.15	1.98	1,002	2.82	1.89	285	3.36	1.88	981
Domain-specific vocabulary knowledge												
Science vocab. total	34.37	6.89	578	37.54	6.72	2,007	31.30	6.80	547	34.62	6.40	1,787
Science vocab. taught	20.15	4.36	578	22.20	4.27	2,007	18.56	4.49	547	20.44	4.14	1,787
Science vocab. untaught	14.59	3.46	578	15.83	3.31	2,007	13.19	3.42	547	14.52	3.42	1,787
SS vocab. total	33.33	6.81	536	37.33	6.85	1,914	30.17	6.58	530	33.76	6.55	1,739
SS vocab. taught	20.46	4.53	536	22.59	4.22	1,914	18.13	4.29	530	19.73	4.04	1,792
SS vocab. untaught	12.87	3.54	536	14.73	3.61	1,914	12.04	3.57	530	14.04	3.51	1,792
English oral proficiency												
WIDA speaking	253.84	51.19	631	--	--	--	254.20	53.08	595	--	--	--
WIDA listening	329.63	54.34	631	--	--	--	322.61	58.25	595	--	--	--

Note. MAP = Measure of Academic Progress. DIBELS = Dynamic Indicators of Basic Early Literacy Skills. arg. = argumentative. vocab. = vocabulary. SS = social studies. WIDA = World-Class Instructional Design and Assessment.

Table 4

Hierarchical Linear Modeling (HLM) Results of Main Effects of Treatment and Language Status and their Interaction Effects (Treatment by Language Status) on Reading and Argumentative Writing Outcomes

Sources	Reading		Argumentative writing	
	Reading proficiency (MAP reading)	Basic literacy skills (DIBELS)	Science	Social studies
Fixed effects				
Intercept, β_{00}	.02 (.05)	-.01 (.04)	-.21 (.12)†	-.36 (.12)**
Treatment, β_{01}	-.02 (.02)	-.02 (.02)	.24 (.06)***	.44 (.06)***
ELs, β_{10}	-.08 (.02)**	-.03 (.02)	-.04 (.07)	.07 (.07)
Treatment × ELs, β_{11}	.04 (.03)	.05 (.03)†	.01 (.08)	-.02 (.08)
MAP pretest, β_{20}	.68 (.01)***	.14 (.01)***	.32 (.03)***	.32 (.03)***
DIBELS pretest, β_{30}	.22 (.01)***	.79 (.01)***	.12 (.03)***	.18 (.03)***
Variance				
Level 1, ε_{ij}	.19	.14	.72	.68
Level 2, ζ_{0j}	.01	.01	.03	.03
N	5,377	5,354	2,718	2,522
Treatment effect size				
EL	.01	.04	.25	.42
EP	-.02	-.02	.24	.44

Note. Student-level demographic characteristics (i.e., gender, race/ethnicity, socioeconomic status, grade) and school randomization blocks were included in HLM analyses as covariates but suppressed in Table 4. MAP = Measure of Academic Progress. DIBELS = Dynamic Indicators of Basic Early Literacy Skills. EL = English learners. EP = English-proficient students.
†$p < .10$, **$p < .01$, ***$p < .001$.

Table 5

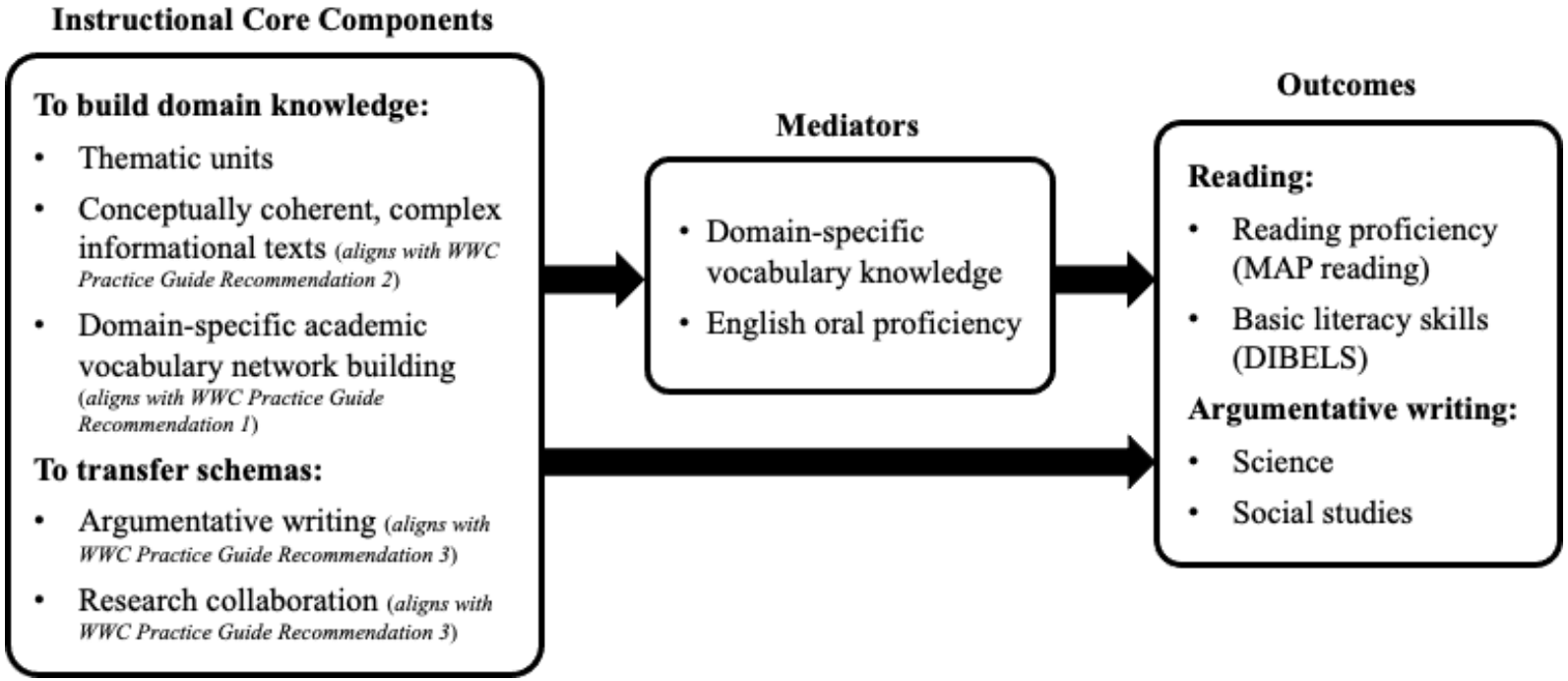
Results of Direct, Indirect, Total Indirect, and Total Effects of Mediation Models and Power Analysis for the English Learner Subgroup

Effects	Estimates			Power[a]
	β	*SE*	BC bootstrapped 95% CI	
Reading proficiency (MAP reading) outcome model				
Direct effect, *c'*	-.04	.02	[-0.08, 0.001]	.295
Indirect effect via M1, a_1b_1	.04	.01	[0.02, 0.06]	1.000
Indirect effect via M2, a_2b_2	.01	.01	[0.001, 0.03]	.434
Total indirect effect, $a_1b_1 + a_2b_2$	.05	.01	[0.03, 0.08]	.993
Total effect, *c*	.01	.02	[-0.02, 0.05]	.086
Basic literacy skills (DIBELS) outcome model				
Direct effect, *c'*	.002	.02	[-0.04, 0.04]	.051
Indirect effect via M1, a_1b_1	.02	.01	[-0.001, 0.04]	.653
Indirect effect via M2, a_2b_2	.003	.002	[-0.001, 0.01]	.070
Total indirect effect, $a_1b_1 + a_2b_2$	.02	.01	[0.002, 0.04]	.823
Total effect, *c*	.02	.02	[-0.01, 0.05]	.146
Science argumentative writing outcome model				
Direct effect, *c'*	.06	.07	[-0.07, 0.19]	.262
Indirect effect via M1, a_1b_1	.05	.03	[-0.01, 0.13]	.963
Indirect effect via M2, a_2b_2	.01	.01	[-0.003, 0.03]	.131
Total indirect effect, $a_1b_1 + a_2b_2$	.06	.03	[0.003, 0.13]	.985
Total effect, *c*	.12	.05	[0.02, 0.22]	.727
Social studies argumentative writing outcome model				
Direct effect, *c'*	.11	.06	[0.003, 0.22]	.661
Indirect effect via M1, a_1b_1	.08	.03	[0.03, 0.15]	1.000
Indirect effect via M2, a_2b_2	-.001	.01	[-0.02, 0.01]	.003
Total indirect effect, $a_1b_1 + a_2b_2$	.08	.03	[0.03, 0.14]	1.000
Total effect, *c*	.19	.05	[0.10, 0.28]	.985

Note. M1 = mediator 1: domain-specific vocabulary knowledge. M2 = mediator 2: English oral proficiency. *c* = the total effect, $a_1b_1 + a_2b_2 + c'$. MAP = Measure of Academic Progress. DIBELS = Dynamic Indicators of Basic Early Literacy Skills. BC = bias-corrected. CI = confidence interval.
[a]Power is equal to $1 - \beta$ (β is the probability of Type II error).

Figure 1

Hypothesized Logic Model for MORE Intervention: Instructional Core Components, Mediators, and Outcomes



Note. WWC Practice Guide refers to the Institute of Education Sciences (IES) What Works Clearinghouse's (WWC) *Teaching Academic Content and Literacy to English Learners in Elementary and Middle School* Practice Guide (Baker et al., 2014). Recommendation 1: teach a set of academic vocabulary words intensively across several days using a variety of instructional activities. Recommendation 2: integrate oral and written English language instruction into content-area teaching. Recommendation 3: provide regular, structured opportunities to develop written language skills. MORE = Model of Reading Engagement. MAP = Measure of Academic Progress. DIBELS = Dynamic Indicators of Basic Early Literacy Skills.

Figure 2

Bar Graph Comparisons of Mean Scores of Science and Social Studies Vocabulary Knowledge and Argumentative Writing Outcomes for English Learners (EL) and English-Proficient (EP) Students in Control and Treatment Groups

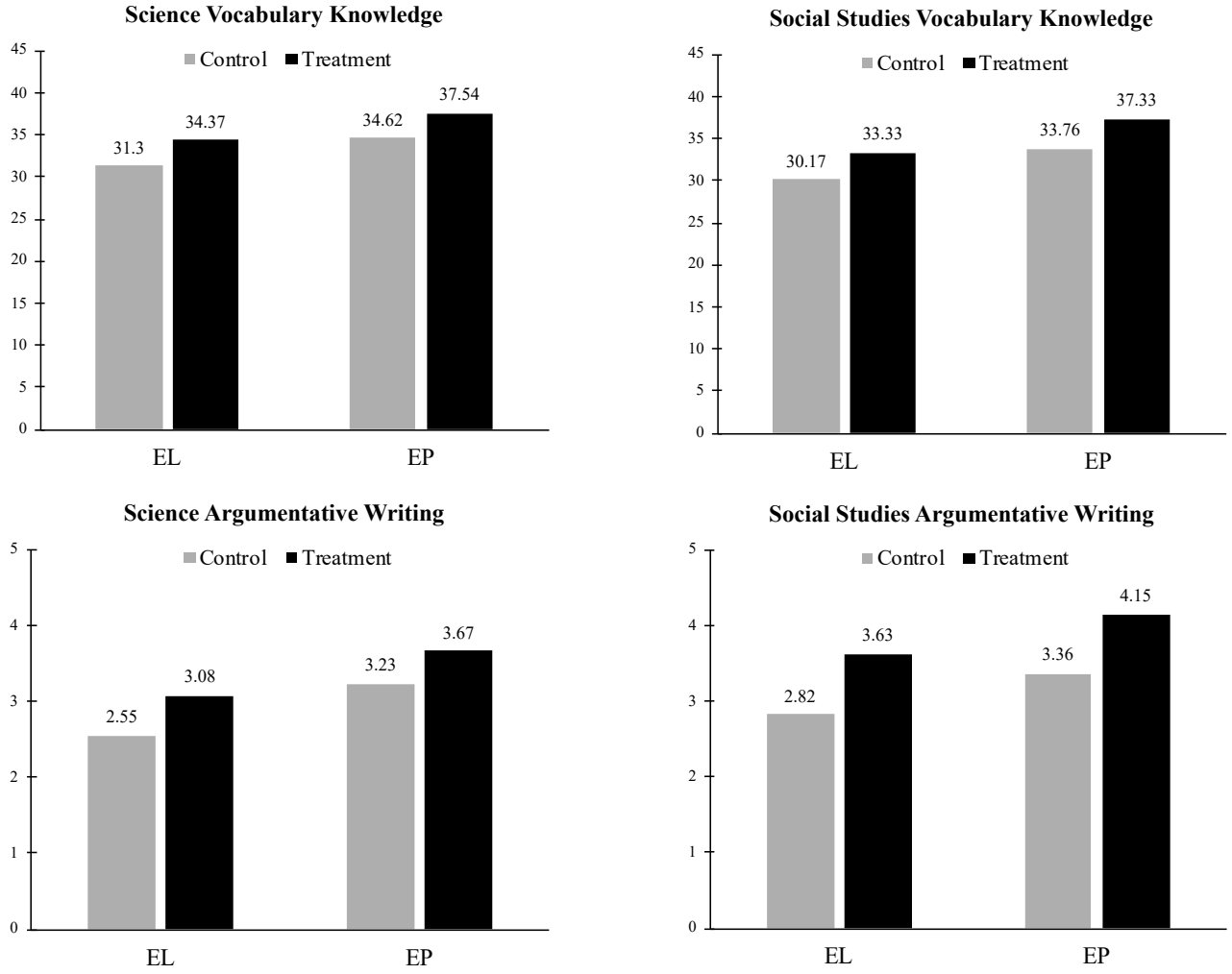
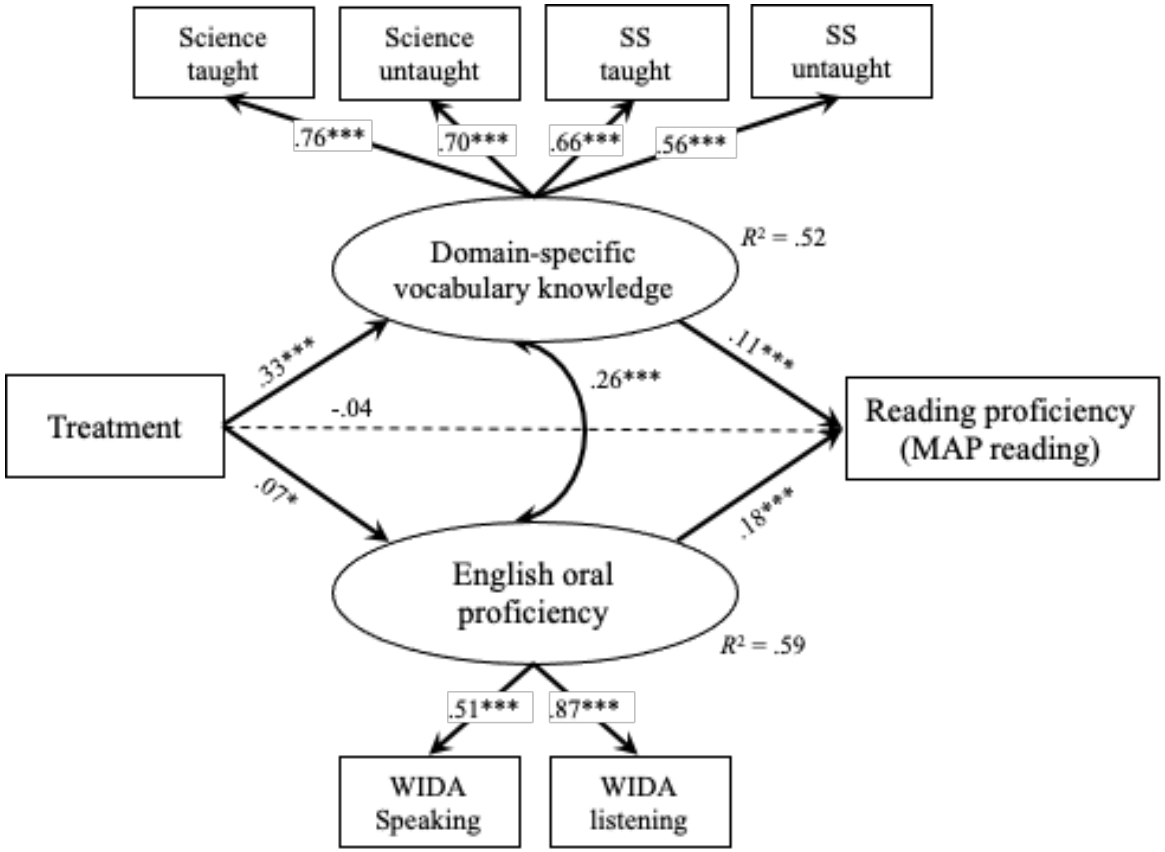


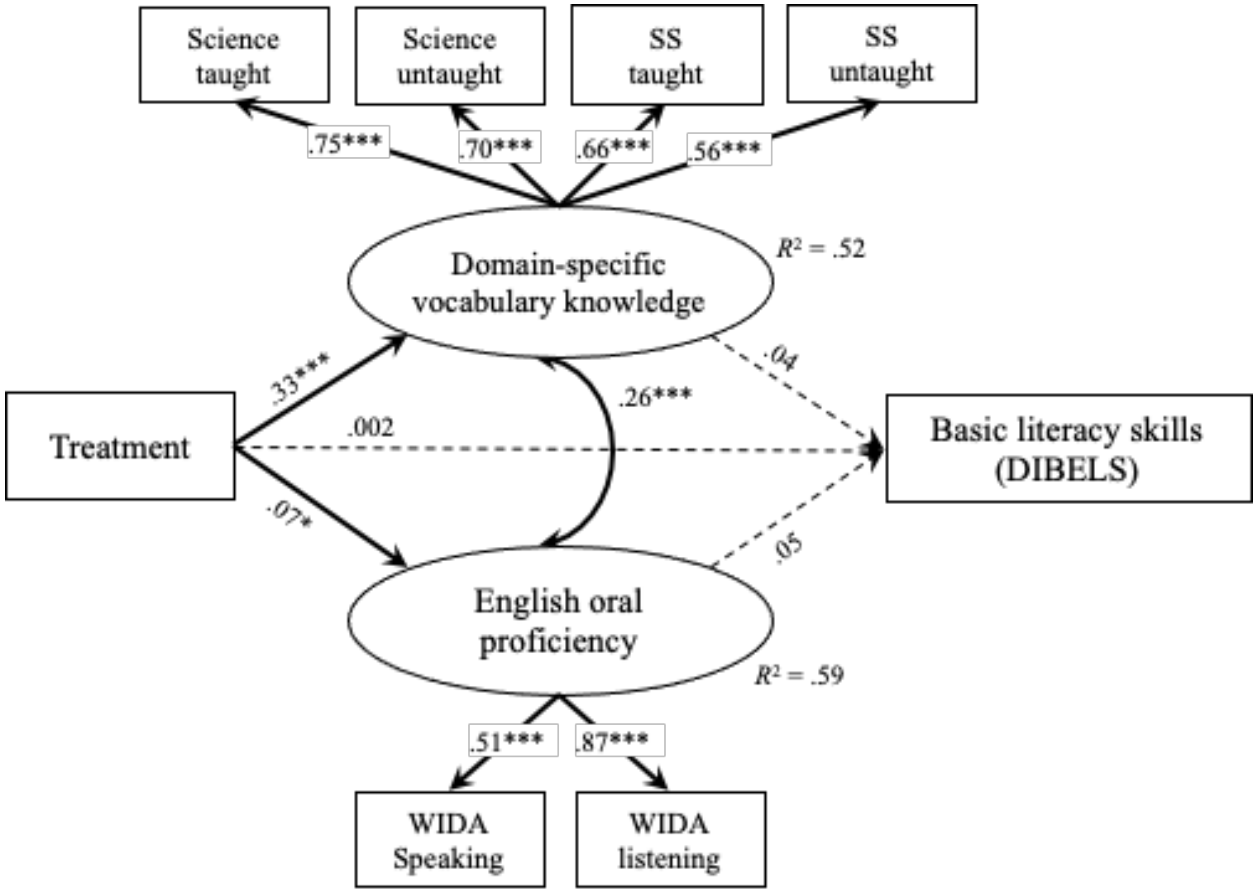
Figure 3

Results for the Structural Mediation Models of the Direct and Indirect Treatment Effects on (a) Reading Proficiency (MAP Reading) and (b) Basic Literacy Skills (DIBELS) Outcomes among English Learners

(a) Reading proficiency (MAP reading) outcome model



(b) Basic literacy skills (DIBELS) outcome model

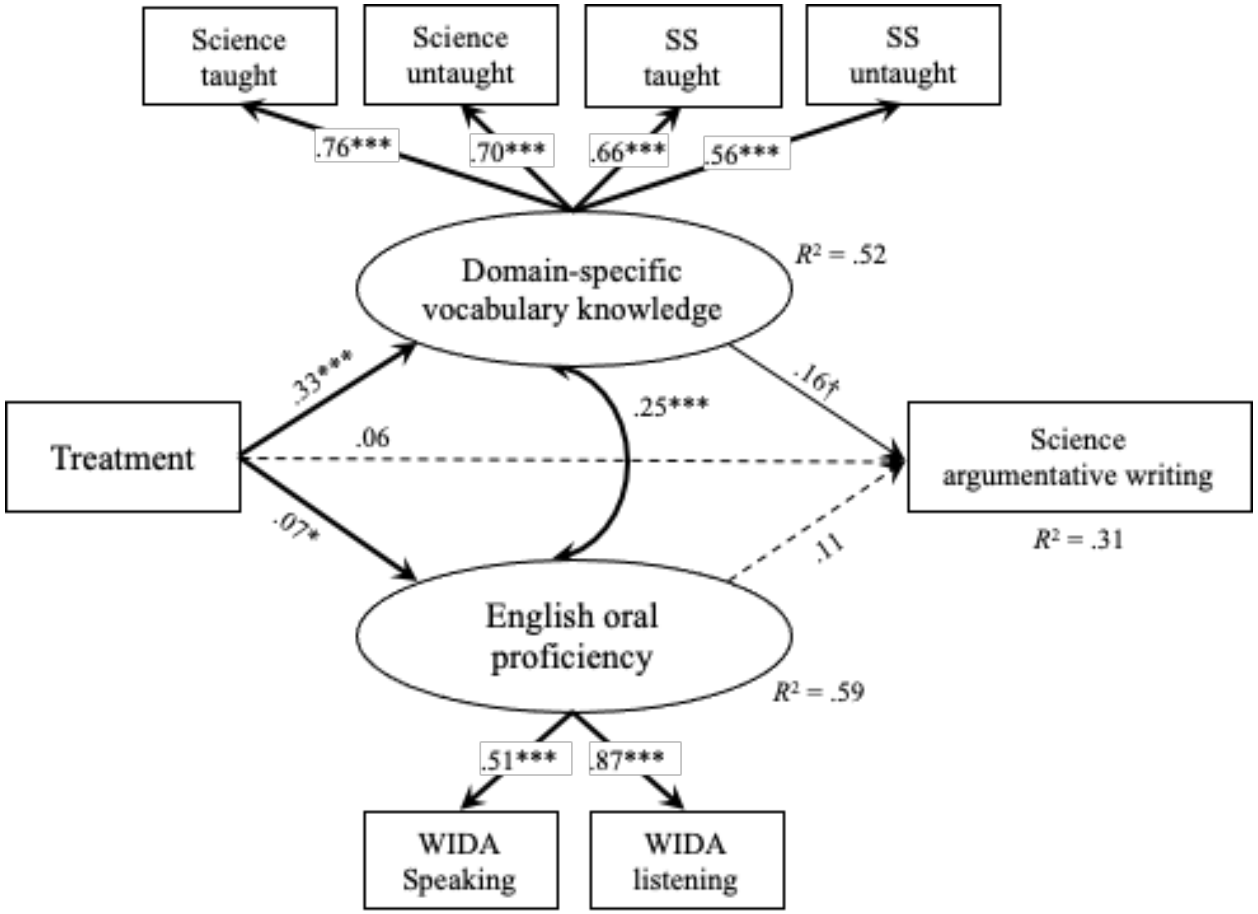


Note. Statistically significant path coefficients ($p < .05$) are shown as bold, straight lines. Dotted lines represent statistically non-significant coefficients ($p > .05$). All path estimates are standardized. Student-level demographic characteristics (i.e., gender, race/ethnicity, socioeconomic status, grade) and school randomization blocks, though included in the mediation analysis, are not shown in the path diagram. SS = social studies. MAP = Measure of Academic Progress. DIBELS = Dynamic Indicators of Basic Early Literacy Skills. WIDA = World-Class Instructional Design and Assessment.
*$p < .05$, ***$p < .001$.

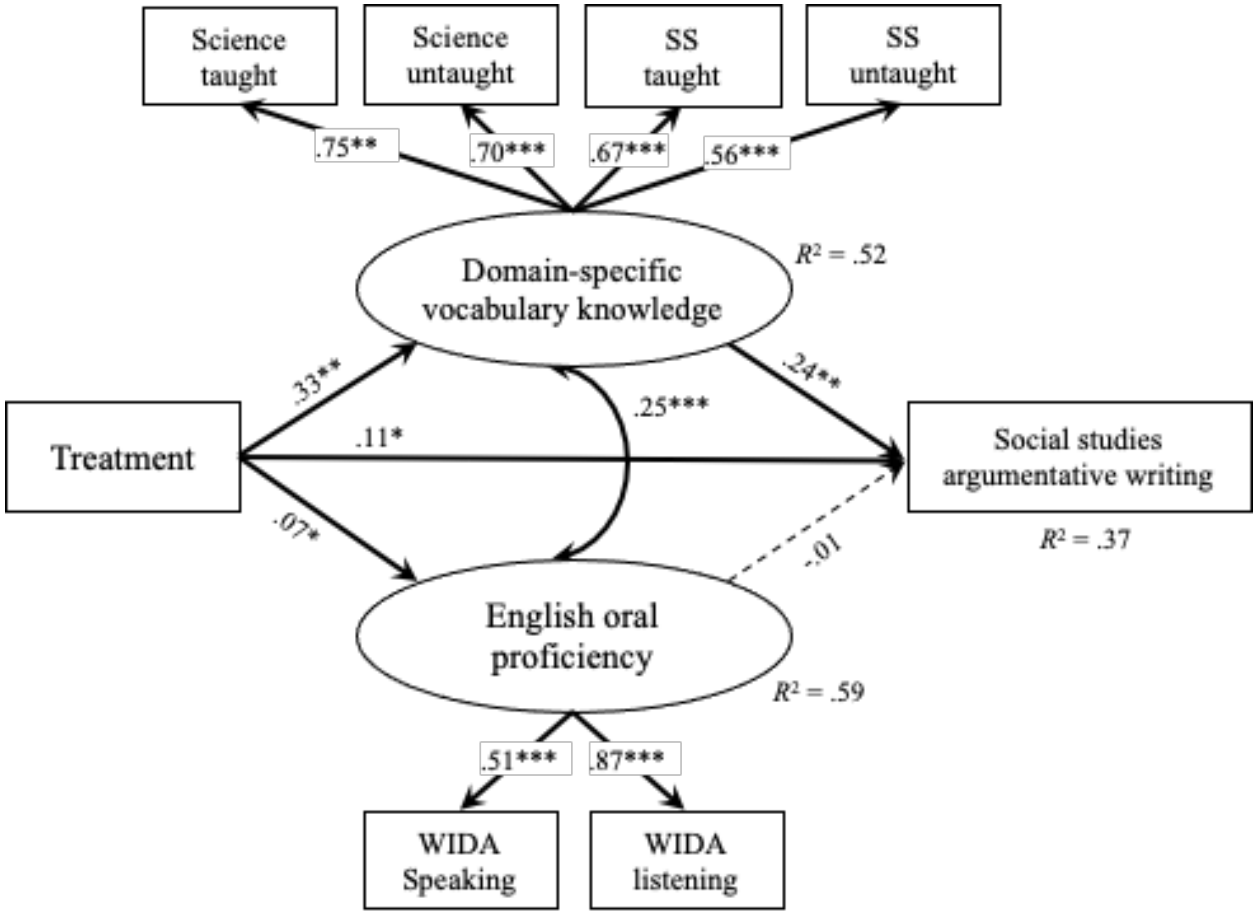
Figure 4

Results for the Structural Mediation Models of the Direct and Indirect Treatment Effects on (a) Science Argumentative Writing and (b) Social Studies Argumentative Writing among English Learners

(a) Science argumentative writing outcome model



(b) Social studies argumentative writing outcome model



Note. Statistically significant path coefficients ($p < .05$) are shown as bold, straight lines, while a single straight, non-bold line indicates marginal significance ($p < .10$). Dotted lines represent statistically non-significant coefficients ($p > .05$). All path estimates are standardized. Student-level demographic characteristics (i.e., gender, race/ethnicity, socioeconomic status, grade) and school randomization blocks, though included in the mediation analysis, are not shown in the path diagram. SS = social studies. arg. = argumentative. MAP = Measure of Academic Progress. WIDA = World-Class Instructional Design and Assessment.
†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.