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Impact of Content-Rich Interventions on Reading Outcomes in Grades K–3: A Systematic Literature Review

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Abstract

This systematic review examined 17 studies on building knowledge through literacy interventions for students in kindergarten through third grade. Studies were included if they evaluated interventions designed to build knowledge and reported effects on literacy-related outcomes. Most interventions combined explicit vocabulary instruction, thematic text sets, structured discussions, and interactive read-alouds. Positive effects were most common for proximal measures tightly aligned with the taught content, such as science vocabulary or argument writing, while few studies reported gains on standardized measures. Tier 2 interventions—those delivered in small groups—showed somewhat stronger effects on standardized measures than Tier 1 or Tier 3 interventions. Findings highlight that content-rich literacy instruction can meaningfully boost knowledge and vocabulary acquisition, but that these gains may not immediately generalize to standardized reading comprehension. Future research should investigate instructional approaches that foster the flexible application of knowledge and strategies for independent knowledge activation.

Introduction

Scholars have used terms such as prior knowledge, background knowledge, content knowledge, and domain-specific knowledge with limited clarity or consistency in their definitions and distinctions (Dochy & Alexander, 1995; Hattan et al., 2024). This review adopts the definitions proposed by Dochy and Alexander's (1995) conceptual analysis of prior knowledge. They defined prior knowledge as a dynamic and structured body of knowledge that exists before a learning task. It includes both explicit and implicit knowledge, various types of knowledge, and involves conceptual as well as metacognitive components. Although Dochy and Alexander (1995) include procedural and conditional knowledge as part of the reservoir of prior knowledge, the literature on prior knowledge in reading research mostly refers to factual knowledge that supports readers' learning of new information from a text.

Previous Reviews on the Topic

Three recent literature reviews and one meta-analysis have addressed the issue of prior knowledge as relevant for reading. Hwang et al. (2022) conducted a meta-analysis to evaluate the effects of integrated literacy and content-area instruction—specifically in science and social studies—on vocabulary and comprehension outcomes for students in kindergarten through fifth grade. The authors systematically identified 35 (quasi-)experimental studies, encompassing over 13,000 students. These studies compared integrated literacy and content-area instruction with traditional, separate instruction. To estimate the magnitude of instructional effects, the authors calculated effect sizes using random-effects models and adjusted for clustered data where appropriate. They also examined the influence of research design quality, instructional features, and publication bias through multiple methods.

Their results revealed that integrated instruction produced significant positive effects on vocabulary (g = 0.91) and comprehension (g = 0.40). For comprehension, both researcher-developed (g = 0.54) and standardized measures (g = 0.25) showed significant gains. Vocabulary gains, however, were significant only for researcher-developed assessments (g = 0.86); standardized outcomes showed no significant effect. A supplementary analysis also showed a large positive effect on content knowledge (g = 0.89), again only when measured with researcher-developed tools. Hwang et al. (2022) concluded that integrated literacy and content-area instruction improved both vocabulary and comprehension outcomes in the elementary years, particularly when outcomes closely aligned with intervention content.

Smith et al. (2021) conducted a critical review to examine how background knowledge influenced reading comprehension among children aged 6 to 12 in mainstream English-speaking classrooms. The review focused on empirical studies published between 1950 and 2020. Studies qualified for inclusion if they measured either pre-existing knowledge or the effects of knowledge-building interventions and reported objective, passage-level reading comprehension assessments. A total of 23 studies met these criteria. Most used quasi-

experimental designs and included typically achieving students from a variety of socioeconomic backgrounds.

The authors aimed to evaluate the compensatory effects of background knowledge on reading comprehension across different levels of reading skill, and to explore the interaction between background knowledge and text features such as cohesion. Although the studies employed diverse comprehension measures (e.g., recall, cloze, multiple choice), a consistent pattern emerged: background knowledge improved comprehension. This benefit appeared most prominently among low-skilled readers, who showed stronger performance when building a basic understanding of the text. However, the benefit was less pronounced in tasks that required inferential thinking.

Smith et al.'s (2021) review also showed that text cohesion moderated the effect of background knowledge. Readers with limited knowledge performed better when reading highly cohesive texts, while readers with substantial knowledge demonstrated stronger comprehension with texts that had lower cohesion. The authors concluded that background knowledge partially compensated for weaker reading skills but did not fully eliminate comprehension difficulties, particularly for tasks involving inference.

Another review was conducted by Hwang et al. (2023). Their purpose was to examine the effects of building content knowledge in English Language Arts (ELA) instruction for students in kindergarten through fifth grade on vocabulary and comprehension outcomes. They included both quasi-experimental and experimental designs drawn from peer-reviewed journal articles and unpublished dissertations. A total of eight studies (seven peer-reviewed articles and one dissertation) met the inclusion criteria. Meta-analytic results for standardized measures of vocabulary revealed no significant overall effect of background knowledge, but a significant effect emerged for researcher-developed measures (g = 0.29). For reading comprehension, the average effect size across standardized and researcher-developed measures was g = 0.24, although considerable heterogeneity was observed across studies. Instructional components varied widely in dosage—from a single session to two weeks of instruction—and most studies provided students with multiple informational texts on the same concept. Typical activities included read-alouds, guided discussion with questioning and brainstorming, explicit instruction in word meanings and semantic relations, and hands on experiences involving the observation or manipulation of concrete materials related to key concepts.

A third systematic review, conducted by Hattan et al. (2024), sought to catalog and evaluate empirical studies of prior knowledge activation in text-based learning tasks. This review was restricted to peer reviewed empirical articles in English involving student participants in grades K–16. Each study required an academic task with connected text (i.e., more than one sentence), an explicit activation technique, and sufficient procedural and outcome detail to support systematic analysis.

Across the 54 articles, Hattan et al. (2024) identified 88 distinct activation techniques, which they organized into eight categories (e.g., open-ended prompts, visual representation,

analogical reasoning). Nearly half of all techniques (48%) were studied with undergraduate samples, whereas only two techniques targeted lower elementary students. Domain coverage was broad—science, language arts, social studies, psychology/statistics/economics, and technology—but notably absent for mathematics and the arts. Activation overwhelmingly occurred before reading: 47 techniques focused solely on prereading prompts, and 65 included prereading as at least one phase of activation. Some studies specifically addressed students' misconceptions—primarily in science—using augmented activation, refutation texts, or analogical reasoning to correct false beliefs. Hattan et al. concluded that, although a wide variety of activation strategies exists, most rely on prereading prompts and are differentially effective depending on students' age, prior knowledge accuracy and completeness, and the level of scaffolding provided. They urged future research to extend activation approaches across reading phases and to better support younger learners and those with limited domain knowledge.

These three recent reviews and meta-analyses provide related but distinct evidence on how background knowledge supports reading. Hwang et al. (2022) found that integrating literacy with science and social studies instruction improved vocabulary and comprehension in elementary students. Gains were strongest when assessments matched the content taught. Smith et al. (2021) also showed that background knowledge improved comprehension, especially for low-skilled readers, but it did not eliminate difficulties with inference. Hwang et al. (2023) found weaker and more inconsistent effects when content-building occurred within ELA instruction. Vocabulary gains appeared only on researcher-developed tests. Hattan et al. (2024) reviewed studies on knowledge activation and found that most techniques occurred before reading and worked better for older students with accurate prior knowledge. Together, these studies confirm that background knowledge can support reading, but its impact depends on how instruction builds or activates it, who the learners are, and how outcomes are measured.

Factors Affecting Knowledge Building

Researchers have identified key variables that influence knowledge development, including the conceptual coherence and cohesion of texts, vocabulary, integration of content-rich instruction, and activation techniques.

- **Conceptual Coherence of Text Sets.** The coherence of reading materials plays a crucial role in building knowledge. Cervetti et al. (2016) found that students who read conceptually related texts—texts organized around a unified topic—developed stronger conceptual understanding and vocabulary than those reading unrelated materials. These coherent texts support the formation of structured semantic networks, making it easier for students to infer and retain new information. When ideas are interconnected, learners

can more easily integrate new content into existing knowledge frameworks, which in turn enhances comprehension of both familiar and novel texts.

- **Cohesion and Coherence of Texts.** The internal cohesion and coherence of a text also play a critical role in facilitating knowledge building. Texts that clearly signal relationships among ideas—using transitions, causal connectors, and referential clarity—reduce the inferencing burden on working memory. Smith et al. (2021) reported that low-skilled readers especially benefit from texts with high cohesion, as these reduce the cognitive demands of building a coherent text base and situation model. Well-structured texts help all readers, but especially those with limited prior knowledge, to form more complete mental representations of the content, enhancing both learning and retention.

- **Vocabulary.** Vocabulary plays a pivotal role in the development of knowledge, serving both as a gateway to comprehension and as a product of meaningful learning experiences. When students encounter and learn new words in context—especially within thematically connected texts—they not only expand their lexicons but also deepen their understanding of underlying concepts (Cervetti et al., 2016; Hwang et al., 2023). Instruction that explicitly supports word learning—by introducing key terms, exploring word relationships, and revisiting words across multiple texts—helps students form robust semantic networks. These networks, in turn, support fast and accurate retrieval of information, promote inferencing, and facilitate the integration of new ideas into long-term memory (Neuman et al., 2014).

  Additionally, students with richer vocabulary knowledge are better positioned to comprehend complex texts and make meaning from unfamiliar content (Wright & Cervetti, 2016). Conversely, a limited vocabulary can hinder comprehension and restrict access to new knowledge. Thus, vocabulary instruction that is intentionally connected to content not only improves language skills but also strengthens students' capacity to acquire and organize academic knowledge.

- **Content-Rich Literacy Instruction.** Embedding content-area knowledge in literacy instruction is another important factor. Hwang et al.'s review (2023) showed that integrating science or social studies content during ELA instruction significantly enhanced both vocabulary ($g = .29$) and comprehension ($g = .24$). Instructional designs that include discussion, writing, and repeated exposure to texts on the same topic provide multiple entry points for learning. These approaches can compensate for the limited time typically allocated to content-area instruction in the elementary grades.

- **Activation of Prior Knowledge.** The way in which prior knowledge is activated affects how well students build and apply new information. Hattan et al. (2024) identified 88 different activation techniques, including open-ended prompts, analogies, and visual supports. They found that the quality—not just the quantity—of prior knowledge activation matters. Relational reasoning prompts, for example, encourage students to identify similarities, differences, or contradictions between their existing knowledge and

new information. These deeper cognitive comparisons support comprehension more effectively than surface-level mobilization strategies.

Barriers to Knowledge Building

Despite growing recognition of the role that background knowledge plays in reading comprehension, various barriers hinder students from effectively building and using knowledge.

- **Limited Instructional Time for Content Learning.** One barrier is the reduced time allocated to content-area instruction in the early grades. Hwang et al. (2023) reported that elementary students in the United States typically receive only 2.5 hours per week of science and social studies instruction, compared to over 11 hours focused on ELA. This imbalance limits students' exposure to disciplinary knowledge that supports vocabulary growth and reading comprehension. Particularly for students from low-socioeconomic backgrounds, this reduced access can contribute to long-term disparities in academic knowledge.

- **Weak Integration of Content into Literacy Instruction.** A second barrier lies in the way literacy instruction is typically designed. Many ELA programs emphasize general reading skills—such as decoding or strategy use—without connecting these skills to substantive content (Cervetti et al., 2016; Hwang et al., 2023). When texts are not selected to build domain knowledge, students miss opportunities to develop interconnected concepts and deep understanding. Fragmented or shallow instructional designs fail to leverage reading as a tool for building knowledge and can hinder comprehension, especially for informational texts.

- **Misconceptions and Inaccurate Knowledge.** Students do not always bring accurate or complete knowledge to the reading process. Misconceptions can interfere with the construction of coherent mental models, leading to confusion or misinterpretation of text content. Smith et al. (2021) emphasized that faulty knowledge structures may lead students to draw incorrect inferences or overlook key ideas. Instruction that activates knowledge but fails to address these misconceptions may inadvertently reinforce them. Therefore, knowledge activation must also include opportunities to refine or replace incorrect understandings.

- **Cognitive Load and Working Memory Constraints.** Knowledge building is also constrained by cognitive processing limits. According to Cognitive Load Theory, working memory has limited capacity for handling new information (Sweller et al., 2019). Smith et al. (2021) explained that when students lack accessible background knowledge, working memory becomes overloaded by the effort required to integrate new content. This impairs comprehension and prevents successful transfer to long-term memory.

Conversely, students with high prior knowledge can process information more efficiently, reducing cognitive load and increasing learning potential.

Research Questions

- **Research question 1:** What instructional and intervention characteristics and student characteristics have been tested as part of knowledge-building interventions?

- **Research question 2:** What does the research say about the effectiveness of knowledge-building instruction in improving foundational reading outcomes for readers in grades K-3?

- **Research question 3:** What features of instructional interventions are associated with improved outcomes? Do these features differ according to student characteristics?

Methods

Study Eligibility Criteria

Studies for this review were considered eligible if they focused on students in kindergarten through third grade (ages 5 years, 0 months to 9 years,11 months). Studies with broader samples were included only when at least 50% of participants were in that age range or when results were disaggregated for eligible students. Mean-age reporting was acceptable if it fell between 5 years, 0 months and 9 years, 6 months. Only research conducted in the United States (including its territories), Canada, Australia, Ireland, New Zealand, or the United Kingdom was included, in settings such as schools, classrooms, early childhood centers, homes, or clinics. Interventions had to be described in sufficient detail to ensure replicability, specifying targeted skills, instructional activities, materials, duration, intensity, and the individuals responsible for delivering the intervention. Both comprehensive and supplemental curricula, as well as branded or non-branded strategies, were acceptable, provided they were designed to improve knowledge-building or other literacy-related skills (for instance, phonics, vocabulary, or reading comprehension).

Studies were required to report at least one measure of reading achievement or related literacy outcomes and be published in English between 2014 and 2025. Peer-reviewed journal articles were the only publication type included, excluding dissertations, conference papers, and other gray literature. Quantitative or mixed-method designs were deemed acceptable if their methodology allowed for evaluation of the intervention's effect on student learning, including randomized controlled trials, quasi-experimental designs, single-case designs, or regression discontinuity approaches.

Search Strategy

On January 13, 2025, a systematic search was conducted in four electronic databases: Academic Search Complete, APA PsycInfo, ERIC, and Teacher Reference Center. The search terms aimed to capture studies on reading or literacy interventions focused on background knowledge and related concepts, while also targeting relevant study designs, grade levels, and outcome measures. The final query was constructed as follows: *(reading OR Literacy) AND ("Background knowledge" OR Schema* OR "Context-rich text" OR "knowledge building" OR "content-rich text" OR "topic knowledge" OR "content knowledge" OR fact* OR concept* OR "prior knowledge" OR "wide reading" OR "volume reading") AND (Control group* OR Comparison group* OR Matched group* OR Treatment* OR Random* OR Assign* OR Baseline OR Experiment* OR Evaluat* OR Impact* OR Effectiveness OR Causal* OR Post*test* OR Pre*test* OR Randomized controlled trial OR RCT OR Quasi*experiment* OR Regression discontinuity OR Changing criterion OR Intrasubject replication OR Multiple baseline OR Multi*element OR Single case OR Single subject OR ABAB OR Alternating treatment OR Simultaneous treatment OR Reversal design OR Withdrawal design) AND (Interven* OR Curricul* OR Program* OR Strateg* OR Instruct* OR Teach* OR Train* OR Approach* OR Monitor* OR Treat* OR Self-regulat* OR transfer) AND (K-3* OR Kindergart * OR Elementary OR "First*grade*" OR "Second*grade*" OR "Third*grade*" OR "Age*5" OR "Age*6" OR "Age*7" OR "Age*8" OR "Age*9" OR "5 year* old" OR "6 year* old" OR "7 year* old" OR "8 year* old" OR "9 year* old") AND (Achieve* OR Improve* OR "Instructional effectiveness" OR Outcome* OR Effect* OR Develop* OR Skill* OR Assess* OR Test* OR Progress OR Aquis*)*

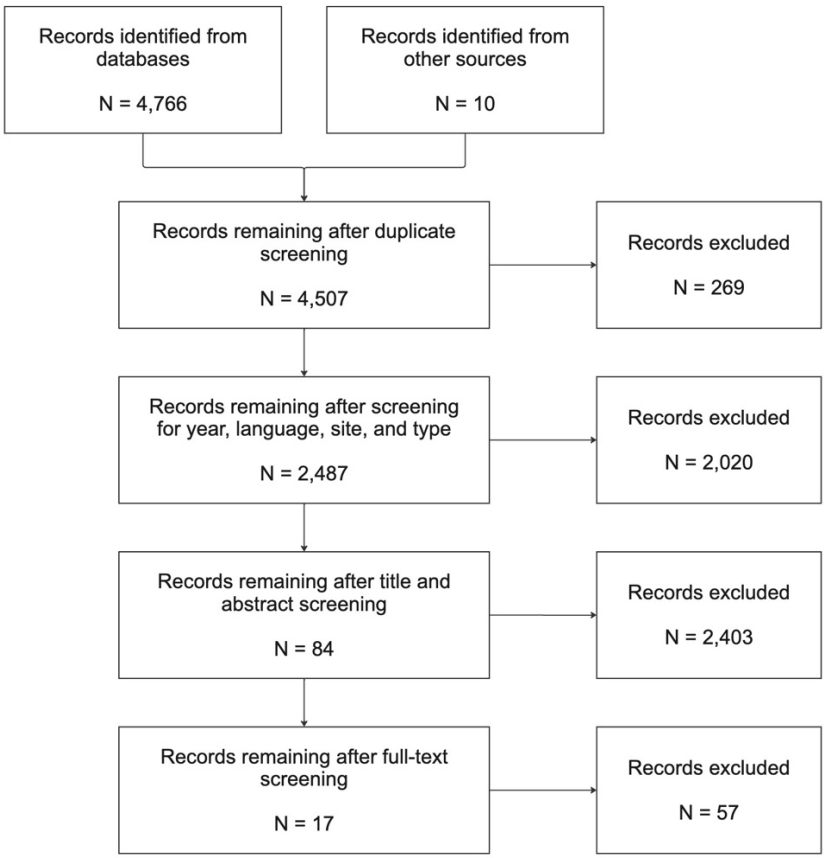
A total of 4,766 records were identified from these databases, and 10 additional records were identified from other sources, yielding 4,776 references in total. After removing 269 duplicates, 4,507 records remained. An initial screening for eligibility based on publication year, language, site, and study type excluded 2,020 records, reducing the pool to 2,487. Title and abstract screening then resulted in 2,403 additional exclusions, leaving 84 records for full-text review. Of those, 57 did not meet the inclusion criteria, leading to a final set of 17 articles that were included in the review.

Coding Procedure

A comprehensive coding protocol was developed to ensure systematic and replicable extraction of study characteristics. A spreadsheet was constructed, featuring fields for: study, design, participants (by grade or age band; including subgroups of multilingual and students with disabilities or special needs); implementation agent; intervention and comparison conditions as actually delivered; program origin (researcher-created vs. commercial curriculum, with curriculum name specified); dosage and delivery format (number of sessions, session length, and group size); tier intervened (1, 2 or 3), and outcomes.

Whenever possible, sample sizes were recorded as post-attrition figures as reported in the articles. In cases where only pre-attrition subgroup percentages (e.g., multilingual learners or students with disabilities or individualized education plans) were provided, equivalent post-attrition percentages were estimated based on available sample size. All such count estimations are denoted by "~" in the accompanying tables. Similarly, when exact dosage details were not specified but timing within the academic year was described, session counts or total intervention minutes were estimated using typical schoolyear calendars. These estimated values are likewise marked with "~" in the dosage column.

Figure 1. *PRISMA diagram*



Analysis

- **Synthesizing results.** A narrative synthesis was conducted to integrate findings across the 16 studies included in this review. The process began with the creation of summary tables of each study's main features, including participant characteristics, research

design, interventions examined, and reported outcomes. These summaries were then iteratively compared to identify consistent themes, patterns, and points of divergence.

- **Coding of Components.** A two-tiered coding approach, grounded in an a priori framework of six literacy "pillars" (Phonics, Vocabulary, Fluency, Writing, Comprehension, and Instructional Techniques), was used to capture the specific elements of each intervention. Each study's reported components were extracted and initially categorized under the most relevant pillar. During this process, interventions' subcomponents—such as explicit vocabulary instruction or interactive read-aloud sessions—were integrated into one of the established pillars. The most evident pillar match guided each assignment, though several subcomponents could logically fit more than one pillar (e.g., repeated reading can support fluency, comprehension, and vocabulary). All articles were coded by the main author, with any uncertainties resolved in consultation with the project supervisor. This systematic approach revealed how frequently each type of component was used, thereby clarifying patterns of instructional emphasis across the different literacy studies.

- **Subgroup and Tier Analysis.** Moderator analyses for subgroups of students were systematically coded for each study to capture whether and how treatment effects varied across key participant characteristics. For every article, the presence of explicit tests of moderation by multilingual status and special education designation were noted. Instances in which subgroup indicators were included only as control variables—without reported tests of moderation—were coded as covariate adjustments rather than true moderator analyses. Studies that made no mention of subgroup or moderator analyses were coded accordingly.

  A comparison of intervention effectiveness across different tiers was conducted. Effects were compared for interventions delivered at the whole-group level (Tier 1), small-group level (Tier 2), and individual level (Tier 3).

Results

Characteristics of Reviewed Studies

- **Research Design.** Details of the 17 studies in this review are displayed in Table 1. The studies included in this review employed a range of experimental methodologies. The majority utilized randomized controlled trial (RCT) designs, including efficacy studies (Connor et al., 2017), sequential multiple assignment randomization (Kim et al., 2019), and secondary analyses of RCT data (Relyea et al., 2024). Numerous studies employed cluster-level randomization, occurring at the school level (Cabell et al., 2025; Kim et al., 2023; Kim et al., 2021b; See et al., 2017) or classroom level (Kim et al., 2021a; Mosher et al., 2024; Neuman et al., 2018; Neuman et al., 2021; Williams et al., 2014; Williams et

al., 2016; Wright et al., 2022). Other designs included quasi-experimental approaches (Clark et al., 2024; Wright et al., 2017), experimental designs with wait-list controls (Neuman et al., 2018; Neuman et al., 2021), and a comparative interrupted time-series design (May et al., 2024).

- **Implementers.** Interventions were predominantly implemented by teachers, as indicated in 14 of the 17 studies. However, some studies utilized hired interventionists (Connor et al., 2017; May et al., 2024) or technology-based implementation (Kim et al., 2019). All the interventions examined were developed by the researchers involved in the studies, except two (Cabell et al., 2024; See et al., 2017).

- **Dosage.** Intervention dosage varied substantially across studies. Durations ranged from a single session (Mosher et al., 2024) or a few days (Wright et al., 2022) to a full school year (May et al., 2024; See et al., 2017) or specific periods like summer (Kim et al., 2019). The total number of sessions ranged from one (Mosher et al., 2024) to approximately 540 (May et al., 2024), though some were self-paced and thus varied across participants (Kim et al., 2019). Session lengths typically ranged from 12-15 minutes (Neuman et al., 2018; Neuman et al., 2021) to 80 minutes (Kim et al., 2021b; Relyea et al., 2024), with some studies not specifying session length (Clark et al., 2024; Wright et al., 2022) or having variable lengths depending on activity (Connor et al., 2017). Consequently, the approximate total intervention time varied immensely, from roughly 35 minutes (Mosher et al., 2024) to about 270 hours (May et al., 2024).

- **Programs.** Named interventions included Science-Infused Literacy Instruction (SILI; Clark et al., 2024), Content-Area Literacy Instruction (CALI; Connor et al., 2017), the Model of Reading Engagement (MORE; Kim et al., 2023; Kim et al., 2021a; Kim et al., 2021b; Relyea et al., 2024), Bookworms (May et al., 2024), World of Words (WOW; Neuman & Kaefer, 2018; Neuman et al., 2021), the Word and World Reading Programme (WWR; See et al., 2017), Science, Oral Language, and Literacy Development from the Start of School (SOLID Start; Wright & Gotwals, 2017), and Core Knowledge Language Arts: Knowledge Strand (Cabell et al., 2025). In two studies (Williams et al., 2014, 2016), the primary focus was to assess the impact of the Close Analysis of Texts with Structure (CATS) intervention compared to two other conditions. For the purposes of this review, the Content Instruction condition from those studies was considered, as it aligned with the research questions and the articles had provided sufficiently detailed information about its implementation.

- **Demographics.** Studies exhibited considerable variation in sample size, ranging from N = 77 (Clark et al., 2024) to N = 8,806 (May et al., 2024). Although collectively the studies included participants from pre-kindergarten through fifth grade, most of the sample fell within kindergarten through third grade, meeting the inclusion criteria. Among the articles that reported fully disaggregated, post-attrition grade-level data, there were 1,958 Kindergarteners, 3,214 first graders, 17,419 second graders, and 3,049 third graders. These grade levels correspond directly to the eligibility criteria specified for

inclusion in this review. The substantially larger number of second graders reflects three largescale, districtwide intervention studies—Kim et al. (2021b), May et al. (2024), and Relyea et al. (2024)—each of which included several thousand second-grade participants. The aggregated participant counts likely overestimate the number of unique students, since several studies drew on overlapping datasets. For example, Kim et al. (2021a), Kim et al. (2021b), and Relyea et al. (2024) all seem to have analyzed data from the same urban district; similarly, Williams et al. (2014) and Williams et al. (2016).

Several studies provided specific counts or percentages for multilingual learners and students with disabilities or special education plans. Among the studies reporting these figures, the proportion of multilingual learners ranged from approximately 9.5% to 35% of the sample, with the highest percentages reported in See et al. (2017) and Relyea et al. (2024). Students with disabilities constituted approximately 7% to 21% of the sample, also highest in See et al. (2017). While many studies included these student populations, only one study conducted a secondary analysis specifically comparing outcomes for English learners (ELs) to non-ELs (Relyea et al., 2024). Only one study reported including students classified as "at-risk": the sample from Williams et al.'s (2014) study included only students in this subgroup. Demographic information for subgroups of participants was not reported for some studies (Clark et al., 2024; Connor et al., 2017; Mosher et al., 2024; Wright et al., 2017; Wright et al., 2022).

Table 1. Overview and Demographics

Study	Design	Students sample	Implementer	Dosage	Researcher Developed (*)	Name of Curriculum
Cabell et al., 2025	Cluster randomized controlled trial (school-level)	K = 1,191 (ML = 169; Dis = 120)	TI	Total Sessions: 77 Number of Weeks: ~23 (December – May, minus breaks) Sessions/Week: ~3.35 Minutes/Session: 60 Approx. Total Hours: 77	No	Core-Knowledge Language Arts: Knowledge (CKLA: Knowledge)
Clark et al., 2024	Quasi-experimental study	2nd = 77 (ML = NR; Dis = NR)	TI	Total Sessions: 12 (3 per week × 4 weeks) Number of Weeks: 4 Sessions/Week: 3 Minutes/Session: Not specified Approx. Total Hours: Not specified (lack of session length)	Yes	Science-Infused Literacy Instruction (SILI)
Connor et al., 2017	Randomized controlled trial (efficacy study)	K = 83 1st = 109 2nd = 75 3rd = 76 4th = 75 (ML = NR, Dis = NR)	HI	Total Sessions: 12 (4 per week × 3 weeks) Number of Weeks: 3 Sessions/Week: 4 Minutes/Session: ~30 (whole class) + 15–20 (small groups) Approx. Total Hours: If each session includes both whole-class and small-group for the same students, ~9–10 hours total	Yes	Content-Area Literacy Instruction (CALI)
Kim et al., 2019	Sequential multiple assignment randomized trial (SMART)	K - 2nd = 273 (ML = 26; Dis = 23)	Tech	Total Sessions: Self-paced (varies by participant) Number of Weeks: Summer period (duration varies) Sessions/Week: On-demand (not fixed) Minutes/Session: Not specified (app use varied) Approx. Total Hours: Varies widely (no fixed schedule)	Yes	Sub-intervention within Model of Reading Engagement (MORE)
Kim et al., 2023	Longitudinal cluster randomized controlled trial (school-level)	1st = 2,156 (ML = 517; Dis = 172)	TI	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 5–10 (flexible pacing) Sessions/Week: ~2–4 Minutes/Session: 40 Approx. Total Hours: 20 × 40 min = 800 min ≈ 13.3 hours	Yes	Model of Reading Engagement (MORE)
Kim et al., 2021b	Cluster randomized controlled trial	1st = 645 (ML = 136; Dis = 45)	TI	Total Sessions: 10 (10 lessons per unit × 1 unit) Number of Weeks: ~3 Sessions/Week: ~3–4 Minutes/Session: ~60 Approx. Total Hours: 10 × 60 min = 600 min = 10 hours	Yes	Model of Reading Engagement (MORE)
Kim et al., 2021a	Cluster randomized controlled trial (school-level)	1st - 2nd = 5,494 (ML = 22; Dis = 8)	TI	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 5–10 (flexible pacing) Sessions/Week: ~2–4 Minutes/Session: 80 Approx. Total Hours: 20 × 80 min = 1,600 min ≈ 26.7 hours	Yes	Model of Reading Engagement (MORE)
May et al., 2024	Comparative interrupted time-series design	2nd = 4,925 3rd = 1,395 4th = 1,270 5th = 1,216 (ML = NR; Dis = 1,074)	HI	Total Sessions: ~540 (3 per day × 5 days/week × ~36 weeks) Number of Weeks: ~36 (full school year) Sessions/Week: ~15 Minutes/Session: 30 Approx. Total Hours: 540 sessions × 30 min = 16,200 min ≈ 270 hours	Yes	Bookworms

Study	Design	Students sample	Implementer	Dosage	Researcher Developed (*)	Name of Curriculum
Mosher & Kim, 2024	Cluster randomized controlled trial	3rd = 965 (ML = NR; Dis = NR)	TI	Total Sessions: 1 Number of Weeks: 1 day Sessions/Week: 1 Minutes/Session: ~35 Approx. Total Hours: 1 × 35 min = 35 min ≈ 0.6 hours	Yes	Sub-intervention within Model of Reading Engagement (MORE)
Neuman & Kaefer, 2018	Randomized controlled trial (classroom-level, waitlist control)	PreK - K = 265 (ML = 35; Dis = 37)	TI	Total Sessions: 100 (Daily x 20 weeks) Number of Weeks: 20 Sessions/Week: 5 Minutes/Session: 12-15 Approx. Total Hours: ~20–25 hours total	Yes	World of Words (WOW)
Neuman et al., 2021	Randomized controlled trial (classroom-level, waitlist control)	PreK = 238 K = 272 1st = 221 (ML = NR; Dis = 109)	TI	Total Sessions: ~105 (5 per week × 21 weeks) Number of Weeks: 21 Sessions/Week: 5 Minutes/Session: 12–15 Approx. Total Hours: ~21–26 hours total	Yes	World of Words (WOW)
Relyea et al., 2024	Secondary analysis of randomized controlled trial (EL vs. non-EL)	1st - 2nd = 5,397 (ML = 1,236; Dis = 432)	TI	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 10 Sessions/Week: 2 Minutes/Session: 80 Approx. Total Hours: 20 × 80 min = 1,600 min ≈ 26.7 hours	Yes	Model of Reading Engagement (MORE)
See et al., 2017	Cluster randomized controlled trial (school-level, two-group waitlist design)	2nd = 611 3rd = 613 (ML ~428 , Dis ~257)	TI	Total Sessions: 69 (34 geography + 35 history) Number of Weeks: ~35 (full school year) Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 69 × 45 min = 3,105 min ≈ 51.8 hours	No	Word and World Reading Programme (WWR)
Williams et al., 2014	Cluster randomized controlled trial (classroom-level)	2nd = 197 (ML = NR; Dis = 41; At-risk = 197)	TI	Total Sessions: 22 Number of Weeks: 11 Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 22 × 45 min = 990 min ≈ 16.5 hours	Yes	*Article describes CATS (Close Analysis of Texts with Structure), but this analysis considered control group "Content Instruction"
Williams et al., 2016	Cluster randomized controlled trial (classroom-level)	2nd = 258 (ML = NR, Dis = 37)	TI	Total Sessions: 50 (9 lessons per unit × 5 units, plus 5 review) Number of Weeks: ~25 Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 50 × 45 min = 2,250 min ≈ 37.5 hours	Yes	*Article describes CATS (Close Analysis of Texts with Structure), but this analysis considered control group "Content Instruction"
Wright & Gotwals, 2017	Quasi-experimental study	K = 147 (ML = NR, Dis = NR)	TI	Total Sessions: 40 (20 lessons per unit × 2 units) Number of Weeks: 8 (4 weeks per unit) Sessions/Week: 5 Minutes/Session: ~45 Approx. Total Hours: 40 × 45 min = 1,800 min ≈ 30 hours	Yes	Science, Oral Language, and Literacy Development from the Start of School (SOLID Start)
Wright et al., 2022	Cluster randomized controlled trial (classroom-level)	1st = 83 2nd = 112 (ML = NR, Dis = NR)	TI	Total Sessions: 3 days total Number of Weeks: unclear whether days were consecutive or not Sessions/Week: ~3 (one per day) Minutes/Session: Not specified Approx. Total Hours: Not specified	Yes	Unnamed

Note. NR= not reported. ML = number of multilingual students. Dis = number of students with disability or individualized education plans. RI = researcher implemented, Tech = technology implemented, TI = teacher implemented, Para = paraprofessional implemented, HI = hired interventionist implemented. *Research-developed interventions refer to programs designed by the same researchers who conducted the evaluation study.

Independent Variables: Components of Interventions Examined in Synthesis

This section describes the instructional components that constituted the independent variables within the reviewed interventions. Details are displayed in Table 2. The interventions included in this review were typically multi-component, integrating various instructional practices across literacy domains.

- **Components Related to Phonics or Phonemic Awareness.**

  Only one of the included interventions explicitly addressed phonics or phonemic awareness. The Bookworms curriculum (May et al., 2024) implemented a systematic and explicit approach to foundational reading skills. The program included scripted lessons focused on phonemic awareness, word recognition, and fluency. Instructional routines were fully integrated into the daily structure of instruction and were sustained over an entire academic year. They included oral sound manipulation activities, printed letter-sound sorting tasks, and guided decoding with feedback.

  While not explicitly focused on phonics, other interventions included some components that could foment students' phonetic understanding. For example, Kim et al. (2019) incorporated a word study component within a broader vocabulary-focused intervention. This component included structured tasks designed to help students identify patterns across word families. In the study's decoding assessment, students were asked to match unfamiliar words to phonetic components found in target words, reflecting the program's emphasis on sound-symbol patterns and decoding by analogy (Kim et al., 2019).

  Connor et al. (2017) also included a minimal phonics component within the Content Area Literacy Instruction (CALI) intervention. While primarily focused on vocabulary and comprehension, the authors noted that the program provided some instruction on decoding words to students with weaker decoding skills.

- **Components Related to Vocabulary.**

  Explicit vocabulary instruction was a core component across nearly all reviewed interventions, with the exception of Clark et al. (2024). In that study, vocabulary support was embedded directly within the reading materials: texts were adapted to include in-text definitions and contextual cues, thereby reducing the need for teacher-delivered instruction. In all other studies, teachers actively defined, modeled, and reinforced target vocabulary that was central to comprehension and content learning.

  Across interventions, vocabulary instruction was integrated into thematic or content-based units. A common strategy involved the use of concept mapping, where students organized new vocabulary into visual webs that highlighted semantic relationships among terms. These concept maps often grew throughout the unit as new words were introduced and linked to prior knowledge (Kim et al., 2021a; Kim et al., 2021b; Neuman

& Kaefer, 2018). For example, in Kim et al. (2021a), students traced key words, copied child-friendly definitions, generated examples, and added them to a collaborative map that visually represented the science concepts under study. The use of conceptually coherent texts in many studies (Kim et al., 2023; Wright et al., 2022) increased students' exposure to target words and allowed them to revisit vocabulary across texts and genres.

The selection of target words was guided by instructional goals. In some cases, vocabulary was deliberately sequenced from general to specific or from concrete to abstract to reflect cognitive development (Neuman et al., 2021; Kim et al., 2021b). Several studies focused on discipline-specific vocabulary that was essential for grasping content in science and social studies (Cabell et al., 2025; Kim et al., 2021b; Wright et al., 2017). In other cases, words were selected for their role in text structure comprehension—such as signal words like "first", "next", or "finally"—to support students' understanding of cause-effect or chronological relationships in expository texts (Williams et al., 2014, 2016). Some interventions also prioritized versatile academic vocabulary, including verbs like "observe," "compare," or "explain," which could useful across subject areas and aligned with Common Core (Kim et al., 2023; Wright et al., 2017).

In many cases, writing tasks were used to reinforce vocabulary. For example, students were asked to incorporate target words into written summaries, science explanations, or opinion pieces (Kim et al., 2019; See et al., 2017). These tasks supported expressive vocabulary use and promoted integration of language and content learning. Oral language also played a role: some studies prompted students to use academic vocabulary in classroom discussions, often through structured activities like think-pair-share, partner discussions, or teacher-facilitated whole-group conversations (Mosher & Kim, 2024; Wright et al., 2017). Teachers modeled academic language during these exchanges and prompted students to adopt it in their responses.

A number of interventions included metalinguistic instruction to deepen word learning. These components focused on morphology, teaching students to analyze roots, prefixes, and suffixes to understand how words are formed and how their meanings change (Kim et al., 2021b; May et al., 2024). In May et al. (2024), for example, students learned how word families and morphemes could help them infer the meaning of new academic words they encountered in science and social studies texts.

Timing and delivery of vocabulary instruction also varied across studies. Some interventions introduced vocabulary prior to reading, using explicit definition, examples, and discussion routines to prepare students for unfamiliar terms in the upcoming text (Connor et al., 2017; Kim et al., 2021a). Other interventions introduced vocabulary during reading through teacher think-alouds or brief pauses to explain word meanings in context (Williams et al., 2016; Mosher & Kim, 2024), while others combined vocabulary work during and after reading (Cabell et al., 2025). Some studies relied on repeated

readings, introducing vocabulary before the first reading and revisiting it after each rereading to support gradual internalization (May et al., 2024; Neuman & Kaefer, 2018). For example, in Neuman and Kaefer (2018), vocabulary was introduced across a sequence of thematically connected read-alouds, allowing students to encounter and apply the same words in varied but related contexts.

- **Components Related to Fluency**

  While fluency development was not the central aim of most interventions in this review, several incorporated instructional elements that support oral reading fluency, including repeated reading, choral reading, and the use of leveled or simplified texts matched to students' reading abilities.

  The most intentional and comprehensive fluency component was observed in the Bookworms intervention (May et al., 2024). This program included structured routines where students engaged in choral reading of new text segments followed by immediate paired rereading. These sessions were part of daily shared reading lessons, which aimed to increase reading automaticity. Additionally, Bookworms provided decodable texts for early readers and opportunities for repeated oral reading of both decodable and authentic texts. Fluency and comprehension lessons incorporated multisyllabic word decoding paired with oral reading and inferential discussion.

  In the CALI intervention (Connor et al., 2017), fluency support was embedded in the design of leveled texts that aligned with content-area instruction. These books were tailored to different reading proficiency levels and used throughout science and social studies units. Although fluency was not explicitly targeted as an outcome, the repeated exposure to appropriately leveled and familiar texts within meaningful learning contexts may have supported the development of reading fluency.

  Kim et al. (2023) provided students with two types of texts to support fluency: grade-level texts thematically connected to prior classroom instruction, and reader-level texts selected based on students' assessed reading ability. Students were grouped by reading proficiency and allowed to choose from curated sets of informational texts related to science and social studies themes. This approach combined repeated exposure with moderate reading challenge.

  In a similar vein, the intervention described by See et al. (2017) relied on simplified texts designed to be appropriate for the targeted age group. These texts were integrated into structured units and used consistently throughout the intervention to support content learning. Although fluency was not a stated focus, the repeated use of accessible, content-linked texts may have contributed to students' fluency gains.

- **Components Related to Writing**

Writing instruction was incorporated into many of the reviewed interventions, often as a means of deepening students' content understanding, reinforcing vocabulary, or fostering argumentation skills. A common approach across interventions involved text-based written responses. In these cases, students were prompted to write about what they had read, often in response to comprehension questions or content-related prompts. For example, in studies by Williams et al. (2014, 2016), students engaged in written responses following read-alouds and informational text discussions, using the opportunity to apply vocabulary and demonstrate understanding of science-related content. Similarly, Wright et al. (2017) incorporated short writing tasks following guided reading and discussion, where students synthesized their learning into brief informational or explanatory responses. In both interventions, graphic organizers were used to scaffold students' ideas and structure their writing. These written tasks were not isolated exercises but integrated into content instruction, allowing students to articulate connections between vocabulary, concepts, and text structure.

Other interventions went further by incorporating explicit instruction in writing strategies, particularly those aligned with genre-specific goals. May et al. (2024), for instance, included daily writing instruction that targeted narrative, informative, and persuasive genres. Students were taught to plan, draft, and revise using genre-specific checklists and visual tools, such as semantic webs and graphic organizers. Grammar instruction was embedded through sentence-combining, unscrambling, and expansion activities based on mentor sentences drawn from the texts students were reading.

A notable emphasis on argumentative writing appeared in the MORE intervention (Kim et al., 2021a, 2021b; Relyea et al., 2024). In this program, students were taught to construct written arguments using the TREE strategy—Topic sentence, Reasons, Examination of reasons, and Ending. Instruction included modeling, graphic organizers, guided practice, and peer collaboration. For example, students debated questions such as whether people should be allowed to hunt seals in the Arctic, using evidence from their reading to support their claims.

- **Components Related to Comprehension**

All reviewed interventions included comprehension-oriented strategies that aimed to deepen students' understanding of texts and concepts. A strategy found across multiple studies involved activating students' prior knowledge before reading. This was typically accomplished through graphic organizers, brainstorming discussions, or charts such as KWL templates (Know, Want to Know, Learned), which encouraged students to reflect on what they already knew about a topic and what they hoped to learn (Clark et al., 2024; Mosher & Kim, 2024; Neuman & Kaefer, 2018). In some cases, such as in Neuman and Kaefer (2018) and Wright et al. (2017), these pre-reading activities extended beyond retrieval of prior knowledge and incorporated explicit knowledge building, whereby students were introduced to a set of concepts before encountering the texts. In the studies reported by Cabell et al. (2025), each read-aloud text served as a

building block in knowledge-buildings, which gradually prepared students to understand the following text.

Another ubiquitous element across interventions was the use of teacher-facilitated discussions around pre-planned, open-ended questions related to the content of the text. These questions were often designed to increase in cognitive demand over the course of the discussion, beginning with literal recall and moving toward inference, synthesis, or application. In Williams et al.'s (2014, 2016) studies, open-ended discussions were scaffolded with visual aids and graphic organizers to help students identify and apply rhetorical structures.

Several interventions aimed to enhance comprehension by including hands-on experiences. For instance, in Wright et al. (2017), kindergartners manipulated real-world materials (e.g., plants, seeds, scientific tools) prior to engaging in science texts, which served to ground abstract concepts in direct observation and experience. These experiences were often followed by teacher-led discussions using academic vocabulary, supporting both conceptual understanding and oral language development.

Another recurring design principle across the interventions was the use of content-oriented reading goals, often framed as guiding questions or big ideas that unified entire units (Kim et al., 2021a; Kim et al., 2021b; May et al., 2024; Wright et al., 2022). In some cases, these guiding questions were prescribed in the curriculum (e.g., “What do scientists do to learn about the world?” in Wright et al., 2017), while in others, students co-constructed questions through collaborative inquiry (Kim et al., 2021b). These goals-oriented students’ attention during reading and fostered coherence across multiple texts.

Other comprehension-oriented components included text-structure instruction, often supported by the use of graphic organizers. In Williams et al. (2016) and May et al. (2024), students learned to identify and represent common expository structures such as sequence, cause-effect, and comparison. Teachers used anchor charts and sentence frames to reinforce signal words and helped students complete organizers that mapped the logic of the text. Analysis of text features—such as headings, captions, diagrams, and bolded vocabulary—was also explicitly taught in studies like Kim et al. (2021b), where students were encouraged to preview texts and make predictions based on these non-narrative cues.

Several interventions promoted reading and integration of conceptually coherent texts across a unit to reinforce learning and promote deeper comprehension (Neuman et al., 2021; Wright et al., 2022). These sequences of texts allowed students to revisit core ideas and vocabulary in varied contexts, which supported generalization and inferencing. Some studies also included text-dependent questions that required students to draw directly from the text for evidence (May et al., 2024; Kim et al., 2019).

Finally, many studies emphasized the role of teacher modeling of a mental model for comprehension, where instructors demonstrated not only what to think, but how to think about texts (Mosher & Kim, 2024; May et al., 2024). These models often included meta-language and reflective questioning. Teachers modeled comprehension strategies through think-alouds, demonstrating how to summarize, visualize, infer, or clarify during reading (May et al., 2024; Kim et al., 2023).

- **Components Related to Instructional Techniques**

  Most interventions reviewed incorporated interactive read-aloud sessions as a central instructional strategy (Cabell et al., 2025; Kim et al., 2021a, 2021b, 2023; May, 2024; Mosher & Kim, 2024; Neuman, 2021; Neuman & Kaefer, 2018; Relyea et al., 2024; See et al., 2017; Williams et al., 2014, 2016; Wright, 2017, 2022). Across these studies, teachers read aloud from complex or thematically related informational texts and engaged students in structured discussions intended to deepen vocabulary knowledge, support comprehension, and build content knowledge. In Cabell et al. (2025), teachers paused during read-alouds to define target words and engaged students in discussion through questions. In Kim et al. (2021a), the MORE intervention used read-alouds anchored to science content, during which teachers introduced vocabulary and posed questions. Similarly, Wright (2017) embedded daily read-alouds within the SOLID Start curriculum and included explicit questioning during discussions to scaffold the construction of scientific explanations.

  Several interventions incorporated the use of trade books as part of their instructional design (Clark, 2024; Connor, 2017; Kim, 2019, 2021a, 2021b, 2023; May, 2024; Williams, 2014, 2016; Wright, 2017). In Clark's (2024) study, students engaged with multiple trade books, referred to as mentor texts, to support the development of science content knowledge and text structure awareness. Connor's (2017) CALI intervention used leveled trade books alongside original historical documents to facilitate content-area learning across flexible small groups. In Kim's series of interventions (2019, 2021a, 2021b, 2023), students selected thematically related trade books to deepen domain knowledge in science and social studies. The Bookworms curriculum described by May (2024) required the purchase and daily use of trade books for Shared Reading and ELA blocks. Williams (2014, 2016) incorporated trade books in both the text structure and content programs to anchor lessons on historical communities. Similarly, Wright's (2017) SOLID Start curriculum involved daily interactive read-alouds of informational trade books to build vocabulary and conceptual understanding in science topics. Across these interventions, trade books served as a primary medium for introducing complex vocabulary, supporting conceptual development, and fostering student engagement with informational texts.

  Many interventions incorporated the use of multimedia elements such as drawings, videos, picture cards, visual aids, globes, and atlases to support vocabulary learning and content comprehension (Cabell et al., 2025; Clark et al., 2024; Connor et al., 2017; Kim

et al., 2023; Neuman & Kaefer, 2018; Neuman et al., 2021; Relyea et al., 2024; See et al., 2017; Williams et al., 2014, 2016; Wright & Gotwals, 2017). Several interventions incorporated images, visual aids, or picture cards during read-alouds to scaffold students' understanding of complex vocabulary and concepts (Cabell et al., 2025; Kim et al., 2023; Neuman & Kaefer, 2018; Neuman et al., 2021; Relyea et al., 2024). Other studies focused on students' active creation of visual representations to deepen engagement with content. For example, Clark et al. (2024) and Williams et al. (2014, 2016) prompted students to produce drawings that illustrated scientific processes or historical features discussed during lessons. Similarly, Connor et al. (2017) integrated graphic organizers and science notebooks as tools for students to record observations and organize information during content-rich instruction. In addition, some interventions paired multimedia with tangible materials to enhance real-world understanding: See et al. (2017) distributed globes and atlases for hands-on exploration of geographical concepts, and Wright and Gotwals (2017) combined multimodal activities, including direct observation and dramatization, to make scientific phenomena accessible to students.

Several interventions incorporated instructional strategies that aimed to promote student engagement with content through real-world connections, collaborative work, student agency, and the use of authentic materials. For example, Connor et al. (2017) emphasized connections between the content of texts and students' lives or current news. Collaborative activities in small groups were also common (Cabell et al., 2025; Clark et al., 2024; Connor et al., 2017; Kim et al., 2021a, 2021b, 2023; Mosher & Kim, 2024; Relyea et al., 2024; Wright & Gotwals, 2017; Wright et al., 2022), like Cabell et al.'s (2025) incorporation of think-pair-share routines during read-alouds and Relyea et al.'s (2024) use of structured peer dialogues to promote thinking and understanding new words.

Opportunities for student choice were less frequently reported but appeared in several interventions (Kim et al., 2019, 2021a, 2021b, 2023), often related to book selection. In Kim et al. (2019), students chose from a curated set of informational books about Arctic animals, while Kim et al. (2023) allowed students to select thematically related science and social studies books to read independently over the summer. Collaborative research activities were integrated into some interventions (Clark et al., 2024; Connor et al., 2017; Kim et al., 2021a, 2021b, 2023; Relyea et al., 2024). Finally, several interventions incorporated reading of authentic or primary source materials (Connor et al., 2017; May et al., 2024; Relyea et al., 2024). For instance, Connor et al. (2017) had students read historical documents such as facsimiles of the Bill of Rights.

Linking Components to Intervention Effectiveness

It is challenging to attribute outcomes to specific instructional components, given that all reviewed interventions included multiple elements. Among the reviewed studies, interactive

read-aloud sessions regularly appeared in interventions that yielded positive standardized outcomes. For example, Clark et al. (2024) utilized interactive read-alouds combined with hands-on science activities and reported significant gains in standardized reading comprehension scores (η_p^2 = 0.10). Likewise, Connor et al. (2017) included interactive read-alouds and found standardized effects in oral comprehension (*d* = 0.47) and picture vocabulary (*d* = 1.20).

Explicit vocabulary instruction, often combined with semantic and conceptual mapping strategies, also regularly aligned with positive outcomes. For instance, Wright and Gotwals (2017) focused on vocabulary within coherent thematic units, reporting non-standardized effect sizes greater than 1.0 for receptive and science-context vocabulary, thus highlighting the possible benefits of structured vocabulary instruction for comprehension and knowledge acquisition.

Integration of thematically related text sets also emerged as an influential factor potentially supporting comprehension and content-specific knowledge. Cabell et al. (2025), despite not reporting significant standardized gains, found robust non-standardized effects for proximal social studies (ES = 0.93) and science knowledge (ES = 0.26). Their curriculum involved strategically ordered thematic units, gradually introducing related content across multiple texts, which may have assisted students in forming coherent schemas and possibly improved vocabulary retention and comprehension.

Writing activities, particularly argumentative writing and text-based responses, similarly appeared associated with student outcomes. Relyea et al. (2024) found significant non-standardized effects on argumentative writing performance (ES range = 0.24–0.44). Kim et al. (2021b) also reported considerable gains in argumentative writing (ES = 0.24–0.44).

Finally, the use of multimedia resources (e.g., images, videos, picture cards) was often included in intervention with positive outcomes, particularly regarding vocabulary and comprehension. Neuman and Kaefer (2018) integrated multimedia picture cards to visually reinforce key concepts, observing substantial vocabulary gains (pre-K; *d* = 1.14). Wright and Gotwals (2017) also employed multimedia resources during interactive read-alouds, reporting significant vocabulary gains (*g* ranging from 1.10 to 1.76).

Table 2. ***Intervention Components***

		Cabell et al., 2025	Clark et al., 2024	Connor et al., 2017	Kim et al., 2019	Kim et al., 2023	Kim et al., 2021a	Kim, et al., 2021b	May et al., 2024	Mosher & Kim, 2024	Neuman & Kaefer, 2018	Neuman et al., 2021	Relyea et al., 2024	See et al., 2017	Williams et al., 2014	Williams et al., 2016	Wright & Gotwals, 2017	Wright et al., 2022
Phonics	Letter sound and letter name drills								✓									
	Phonemic segmentation and blending								✓									
	Decoding by analogy								✓									
	Differentiated foundational skills instruction								✓									
	Explicit spelling instruction								✓									
Vocabulary	Explicit vocabulary instruction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Word study to build metalinguistic or morphological awareness				✓	✓			✓									
	Concept mapping of semantically-related words				✓	✓	✓	✓	✓	✓			✓		✓	✓		
	Organizing target words into categories or conceptual structures	✓			✓	✓	✓	✓		✓	✓	✓	✓					
	Asking students to use target words in writing and/or discussions								✓									
Fluency	Repeated reading of same text across several days								✓		✓	✓						
	Choral reading								✓									
	Use of leveled, adapted or decodable texts			✓		✓			✓					✓				✓
Writing	Writing reflections			✓														
	Peer revision and editing								✓									
	Planning writing (e.g. using graphic organizer planner)								✓									
	Text-based written response to content of text	✓							✓					✓	✓	✓	✓	
	Explicit grammar instruction (e.g. on sentence composing grammar)								✓									

		Cabell et al., 2025	Clark et al., 2024	Connor et al., 2017	Kim et al., 2019	Kim et al., 2023	Kim et al., 2021a	Kim, et al., 2021b	May et al., 2024	Mosher & Kim, 2024	Neuman & Kaefer, 2018	Neuman et al., 2021	Relyea et al., 2024	See et al., 2017	Williams et al., 2014	Williams et al., 2016	Wright & Gotwals, 2017	Wright et al., 2022
	Argumentative writing					✓	✓	✓					✓					
Comprehension	Teachers modeling comprehension strategies								✓				✓					
	Instruction and reading oriented towards a content question or goal	✓				✓	✓	✓	✓								✓	
	Instruction on text structures or features					✓	✓	✓	✓									
	Sentence-level comprehension-oriented activities				✓													
	Modeling metacognitive processes while reading								✓									
	Activating background knowledge	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓		
	Reading and integrating thematically-related text sets	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓					✓
	Explicit content instruction prior to reading				✓						✓	✓		✓	✓	✓		
	Use of conceptually-coherent texts					✓	✓	✓					✓					✓
	Discussions around pre-planned open-ended questions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Instructional Techniques	Interactive read-aloud sessions	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Connect content to students' lives or news			✓														
	Students handling concrete content-related material in hands-on activities		✓														✓	
	Reading primary sources or authentic texts			✓					✓				✓					
	Student collaboration activities in small groups		✓				✓											
	Use of multimedia materials (e.g. drawings, videos, picture cards, globe)	✓	✓	✓							✓	✓		✓	✓	✓	✓	
	Reading trade books		✓		✓	✓	✓	✓	✓				✓		✓	✓	✓	
	Opportunity for student choice				✓	✓	✓	✓	✓									
	Student collaborative research on content related to texts		✓			✓	✓	✓					✓					

Description of Results Distinguishing Between Standardized or Non-Standardized Dependent Variables

The studies in this review used both standardized tests and researcher-developed measures to assess intervention effects. All outcomes are displayed in Table 2. Outcome domains frequently assessed included reading comprehension, vocabulary, writing, content knowledge, foundational skills, and motivation/attitude. Effect sizes were reported using different metrics, including Cohen's *d*, Hedges' *g*, Eta-Squared (η^2), and effect sizes (ES) not otherwise specified.

Positive results varied widely depending on the type of assessment. Three out of 24 standardized outcomes showed an advantage for the intervention, compared to 23 out of 62 non-standardized outcomes.

- **Standardized Assessments.** Positive standardized effects were found in a few of the studies. Two Tier-2 programs—Bookworms (May et al., 2024) and CALI for fourth graders (Connor et al., 2017)—and the quasi-experimental SILI study (Clark et al., 2024) each reported gains on comprehension or growth in reading measure. One Tier-1 trial of MORE also produced a modest advantage on a comprehension test (Kim et al., 2021a). The remaining large-scale Tier-1 evaluations of MORE (Kim et al., 2021b; Kim et al., 2023) and CKLA-Knowledge (Cabell et al., 2025) did not outperform business-as-usual on any standardized measure.

- ***Researcher-Developed or Proximal Measures.*** By contrast, most interventions produced clear benefits on proximal measures that mirrored the lessons' vocabulary, concepts, or writing tasks. CKLA-Knowledge (Cabell et al., 2025) improved all three proximal outcomes it reported, and the brief Structured Read-Aloud lesson (Mosher & Kim, 2024) showed advantages on four comprehension and content measures taken minutes after instruction. Likewise, every non-standardized outcome favored treatment in MORE's large Tier-1 study (Kim et al., 2021b) and its smaller classroom-level study (Kim et al., 2021a). SOLID Start (Wright & Gotwals, 2017) also achieved uniformly large effects on vocabulary and evidence-based explanation.

- ***Programs with Mixed or Null Findings.*** A few interventions produced limited or no positive change. Word and World Reading (See et al., 2017) did not raise scores on the single standardized comprehension measure it employed, perhaps due to the large portion of their sample corresponding to multilingual students and students with special education plans. The two content instruction conditions from Williams and colleagues yielded gains only for vocabulary and content posttests, with no significant differences in other comprehension measures (Williams et al., 2014, 2016). The app-based Tier-3

study (Kim et al., 2019) showed a small edge on science vocabulary but no significant effects on a word-study task.

Description of Results by Dependent Variable

- **Reading Comprehension**

  Findings regarding reading comprehension were mixed and depended heavily on the type of measure used. Most studies used both researcher-developed and standardized measures of reading comprehension. Regarding standardized, domain-general reading comprehension measures, several interventions showed no significant advantage over comparison conditions, including Model of Reading Engagement (MORE) in two large studies (Kim et al., 2023; Kim et al., 2021b), Word and World Reading (WWR; See et al., 2017), Content-Area Literacy Instruction (CALI; Connor et al., 2017), and a brief intervention (Mosher et al., 2024). However, three studies found that students in the intervention group outperformed their peers in other conditions in standardized measures of reading comprehension: one MORE study (Kim et al., 2021a; ES = 0.11), the Science-Infused Literacy Instruction (SILI) program compared to Content-Area Literacy Instruction (CALI; Clark et al., 2024; η_p^2 = 0.10), and the Bookworms condition outperformed peers in control group (May et al. 2024; ES = 0.26).

  In contrast, positive effects emerged more frequently on researcher-developed comprehension measures, particularly those tied to specific content domains. MORE demonstrated positive effects on science content reading comprehension (Kim et al., 2023; ES = 0.18). Mosher et al. (2024) found their structured read-aloud intervention improved researcher-developed recall and transfer measures of comprehension (ES = 0.17 – 0.18) compared to unstructured read-alouds. Similarly, Wright et al. (2022) found conceptually-coherent texts improved listening comprehension concepts for 1st graders (ES = 0.68) compared to non-coherent texts, though not for 2nd graders. Williams et al. (2014) found no difference on immediate comprehension questions for their Content Instruction intervention versus BAU.

- **Vocabulary**

  Vocabulary outcomes also showed divergence between general, standardized measures and those developed by researchers. The World of Words (WOW) intervention generally showed no significant effect on standardized general vocabulary measures compared to business-as-usual (Neuman et al., 2018; Neuman et al., 2021), with one exception for PreK expressive vocabulary (Neuman et al., 2018; *d* = 0.94). However, WOW consistently demonstrated large effects on researcher-developed, science-related or curriculum-based vocabulary measures (Neuman et al., 2018: d = 0.48–1.14; Neuman et al., 2021: *d* = 0.55 – 0.65).

Similarly, the SOLID Start intervention showed large effects on researcher-developed receptive vocabulary and science context vocabulary (Wright et al., 2017; *g* = 1.10–1.76). MORE also showed positive effects on researcher-developed measures of vocabulary depth (Kim et al., 2021a; ES = 0.30) and networks of vocabulary knowledge in science and social studies (Kim et al., 2021b; ES = 0.50–0.56), though one MORE study found no difference on a similar measure (Kim et al., 2023). A Content Instruction approach likewise yielded large effects on researcher-developed vocabulary measures (Williams et al., 2016; *d* = 1.64 – 1.78). Conversely, Wright et al. (2022) found mixed results for conceptually-coherent texts on listening comprehension vocabulary, with 2nd graders in the non-coherent condition scoring higher (ES = 0.50).

- **Writing.** Several studies assessed writing outcomes, primarily using researcher-developed measures focused on argumentation and evidence use. Multiple studies found positive effects for MORE on argumentative writing in science and social studies compared to BAU, with small to medium effect sizes (Kim et al., 2021a: ES = 0.24; Kim et al., 2021b: ES = 0.24–0.44; Relyea et al., 2024: ES = 0.24–0.44 for ELL subgroup). The SOLID Start intervention also demonstrated medium to large effects on students' ability to make claims (g = 0.76–1.86) and provide evidence-based support (g = 0.83–1.23) in kindergarten science contexts (Wright et al., 2017). In contrast, Clark et al. (2024) found that CALI yielded slightly better results than SILI on a researcher-developed writing assessment (η_p^2= 0.06). Studies by Williams et al. (2014; 2016) focusing on Content Instruction or CATS generally found no significant effects on sentence-level writing or identification of main ideas/structure statements compared to BAU or Content Instruction alone.

  Thus, interventions like MORE and SOLID Start, which integrate content learning with literacy, showed potential for improving specific aspects of argumentative or evidence-based writing, while other approaches showed less impact on the writing measures used.

- **Content Knowledge.** Interventions that explicitly integrated content learning often led to gains on researcher-developed measures of that content. WOW resulted in greater knowledge of science-related concepts compared to control condition (Neuman et al., 2018; Neuman et al., 2021, d = 0.37–0.40 reported in 2021). Mosher et al. (2024) found their structured read-aloud approach led to better content comprehension than unstructured read-alouds (ES = 0.18). Williams et al. (2014) reported a very large effect (ES = 10.00) for Content Instruction over control condition on immediate content knowledge posttests, though this effect was not sustained on delayed tests.

- **Foundational Skills.** Three studies involving the MORE intervention consistently found no significant difference between MORE and business-as-usual on standardized

measures of basic literacy skills (Kim et al., 2021a; Kim et al., 2021b; Relyea et al., 2024).

- **Motivation/Attitude/Interest.** Few studies reported on motivation, attitude, or interest outcomes. Clark et al. (2024) found no difference between SILI and CALI in reading attitude and motivation. Similarly, Kim et al. (2021a) found no difference between MORE and BAU on situational interest or reading motivation.

Treatment Effects for Subgroups of Students

Several investigations probed whether multilingual students derived similar or differential benefits from background-knowledge interventions compared to native English speakers. Neuman and Kaefer (2018) reported a significant interaction between treatment and multilingual status: English learner (EL) students in the intervention condition exhibited greater vocabulary growth and expressive language gains than their native-speaker peers, whereas no moderation was observed for science-related concept knowledge or global receptive language.

Similarly, Neuman et al. (2021) found that prekindergarten EL children made significantly larger improvements in both expressive vocabulary and curriculum-specific vocabulary than non-EL treatment peers, although gains in concept knowledge and categorical property knowledge did not differ by language status. By contrast, Relyea et al. (2024) and May et al. (2024) tested EL by treatment interactions for outcomes including argumentative writing performance, reading growth, basic literacy scores, and overall achievement trajectories, and none reached statistical significance.

Cabell et al. (2025) also examined EL moderation across multiple outcomes and identified a single significant effect—favoring native speakers—on a proximal, non-standardized measure of social-studies knowledge; all other EL by treatment interactions proved nonsignificant. Together, these mixed findings suggested that EL students sometimes experienced relatively greater vocabulary and expressive-language gains from content-rich interventions, but that moderation by language status was less consistent for comprehension and broader achievement measures.

Evidence regarding special-education status as a moderator was sparse but suggestive. May et al. (2024) conducted explicit tests of treatment by special-education interactions and observed a marginally significant effect: students qualifying for special education services showed an accelerated reading growth compared to peers without special-education designations. No other reviewed studies reported formal moderation analyses by special-education status.

Effectiveness of Intervention by Tier

Linking tier classification to intervention effectiveness reveals several trends, although caution is warranted because all interventions included multiple instructional components and outcomes were assessed using a variety of measures. Among Tier 1 interventions, positive effects were observed primarily in non-standardized measures. For instance, Cabell et al. (2025) found that their Core Knowledge Language Arts intervention significantly outperformed the business-as-usual condition on proximal vocabulary (ES = 0.63), proximal science knowledge (ES = 0.26), and proximal social studies knowledge (ES = 0.93), despite no differences in standardized vocabulary or comprehension scores. Similarly, Kim et al. (2021a) reported positive results for vocabulary depth (ES = 0.30), listening comprehension (ES = 0.40), and argumentative writing (ES = 0.24) on non-standardized measures, even though standardized reading comprehension showed only a modest advantage (ES = 0.11). Thus, Tier 1 interventions tended to yield stronger impacts on content-specific or proximal non-standardized outcomes.

In Tier 1, standardized outcomes were less consistently positive. Clark et al. (2024) found a statistically significant improvement in standardized reading comprehension for the Science-Infused Literacy Instruction group compared to the Content-Area Literacy Instruction group (η_p^2 = 0.10), although the magnitude was modest. In contrast, large-scale Tier 1 trials such as Kim et al. (2021b) and Kim et al. (2023) reported no statistically significant gains in standardized reading or vocabulary measures when comparing the Model of Reading Engagement to business-as-usual, despite detecting improvements in more proximal, non-standardized indices like networks of vocabulary knowledge depth.

Tier 2 interventions produced somewhat stronger effects on standardized outcomes. May et al. (2024) found that Bookworms students demonstrated significantly greater gains than business-as-usual students in MAP Growth Reading assessments (ES = 0.26), a standardized measure. Connor et al. (2017) also observed gains for fourth graders in the Content-Area Literacy Instruction group relative to the business-as-usual group in oral comprehension (*d* = 0.47), picture vocabulary (*d* = 1.20), and passage comprehension (*d* = 0.22), although these effects were limited to a single grade level.

Tier 3, represented only by Kim et al. (2019), showed relatively weaker outcomes overall. Although a small positive effect was found for non-standardized measures of science vocabulary knowledge (ES = 0.10) and for listening comprehension (ES = 0.14), no significant differences emerged in broader measures like the MAP score or DIBELS composite score. This pattern might reflect the more individualized, app-based and self-paced nature of the Tier 3 intervention, which differed markedly from the more structured and teacher-directed approaches seen in Tiers 1 and 2.

In sum, Tier 1 interventions demonstrated robust impacts on proximal, non-standardized outcomes, particularly in vocabulary knowledge, science and social studies comprehension, and

writing. Tier 2 interventions appeared more successful at affecting standardized reading and vocabulary outcomes, while the single Tier 3 intervention showed more limited effects overall. However, given the multicomponent nature of all interventions, attributing outcomes solely to Tier classification remains tentative.

Table 3. ***Tiered Support and Outcomes***

Study and design	Participants	Tier	Intervention condition	Comparison condition	Outcome domain and reported findings	Dosage
Cabell et al., 2025; Cluster randomized controlled trial (school-level)	K = 1,191 (ML = 169; Dis = 120)	1	Core Knowledge Language Arts: Knowledge Strand (CKLA: Knowledge)	Business as Usual (BAU)	**Standardized** 1) Receptive Vocabulary (PPVT-IV): CKLA = BAU 2) Expressive Vocabulary (WJ Picture Vocabulary Test): CKLA = BAU (when words explicitly taught excluded) 3) Listening Comprehension (CELF SS & TNL): CKLA = BAU 4) Science Knowledge (Science subtest of the Academic Knowledge test of the WJ-III Tests of Achievement): CKLA = BAU 5) Social Studies Knowledge (Social Studies subtest of the Academic Knowledge test of the WJ-III Tests of Achievement): CKLA = BAU **Non-Standardized** 1) Proximal Vocabulary: CKLA > BAU (ES = 0.63) 2) Proximal Science Knowledge: CKLA > BAU (ES = 0.26) 3) Proximal Social Studies Knowledge: CKLA > BAU (ES = 0.93)	Total Sessions: 77 Number of Weeks: ~23 (December – May, minus breaks) Sessions/Week: ~3.35 Minutes/Session: 60 Approx. Total Hours: 77
Clark et al., 2024; Quasi-experimental study	2nd = 77 (ML = NR; Dis = NR)	1	Science-Infused Literacy Instruction (SILI)	Content-Area Literacy Instruction (CALI)	**Standardized** 1) Reading Comprehension (Subtest of Gates MacGinitie Reading Assessment): SILI > CALI (Partial Eta-Squared = 0.10) **Non-Standardized** 1) Writing Assessment: CALI > SILI (Partial Eta-Squared = 0.06) 2) Reading Attitude and Motivation (Garfield Reading Attitude Survey): SILI = CALI	Total Sessions: 12 (3 per week × 4 weeks) Number of Weeks: 4 Sessions/Week: 3 Minutes/Session: Not specified Approx. Total Hours: Not specified (lack of session length)
Kim et al., 2021a; Cluster randomized controlled trial	1st = 645 (ML = 136; Dis = 45)	1	Model of Reading Engagement (MORE)	Business as Usual (BAU)	**Standardized** 1) Reading Comprehension (MAP): MORE > BAU (ES = 0.11) 2) Basic Literacy Skills (DIBELS): MORE = BAU **Non-Standardized** 1) Vocabulary Depth: MORE > BAU (ES = 0.30) 2) Listening Comprehension: MORE > BAU (ES = 0.40) 3) Argumentative Writing: MORE > BAU (ES = 0.24) 4) Situational Interest: MORE = BAU 5) Reading Motivation: MORE = BAU	Total Sessions: 10 (10 lessons per unit × 1 unit) Number of Weeks: ~3 Sessions/Week: ~3–4 Minutes/Session: ~60 Approx. Total Hours: 10 × 60 min = 600 min = 10 hours
Kim et al., 2021b; Cluster randomized controlled trial (school-level)	1st - 2nd = 5,494 (ML = 22; Dis = 8)	1	Model of Reading Engagement (MORE)	Business as Usual (BAU)	**Standardized** 1) Reading Comprehension (MAP): MORE = BAU 2) Basic Literacy Skills (DIBELS): MORE = BAU **Non-Standardized** 1) Networks of Vocabulary Knowledge Depths in Science: MORE > BAU (ES = 0.50) 2) Networks of Vocabulary Knowledge Depths in Social Sciences: MORE > BAU (ES = 0.56) 3) Argumentative Writing in Science: MORE > BAU (ES = 0.24) 4) Argumentative Writing in Social Sciences: MORE > BAU (ES = 0.44)	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 5–10 (flexible pacing) Sessions/Week: ~2–4 Minutes/Session: 80 Approx. Total Hours: 20 × 80 min = 1,600 min ≈ 26.7 hours

Study and design	Participants	Tier	Intervention condition	Comparison condition	Outcome domain and reported findings	Dosage
Kim et al., 2023; Longitudinal cluster randomized controlled trial (school-level)	1st = 2,156 (ML = 517; Dis = 172)	1	Model of Reading Engagement (MORE)	Business as Usual (BAU)	**Standardized** 1) Domain General Reading Comprehension and Vocabulary (MAP): MORE = BAU **Non-Standardized** 1) Science Content Reading Comprehension: MORE > BAU (ES = 0.18) 2) Networks of Vocabulary Knowledge Depth in Grade 2 Science: MORE = BAU	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 5–10 (flexible pacing) Sessions/Week: ~2–4 Minutes/Session: 40 Approx. Total Hours: 20 × 40 min = 800 min ≈ 13.3 hours
Mosher & Kim, 2024; Cluster randomized controlled trial	3rd = 965 (ML = NR; Dis = NR)	1	Read Aloud with Structured Supplements (INT)	Read Aloud without Structured Supplements (CON)	**Standardized** 1) End-of-Grade Domain General Reading Comprehension (North Carolina): INT = CON **Non-Standardized** 1) Reading Comprehension / Recall: INT > CON (ES = 0.17) 2) Reading Comprehension / Near Transfer: INT > CON (ES = 0.18) 3) Reading Comprehension / Mid Transfer: INT > CON (ES = 0.18) 4) Content Comprehension: INT > CON (ES = 0.18)	Total Sessions: 1 Number of Weeks: 1 day Sessions/Week: 1 Minutes/Session: ~35 Approx. Total Hours: 1 × 35 min = 35 min ≈ 0.6 hours
Neuman & Kaefer., 2018; Randomized controlled trial (classroom-level, waitlist control)	PreK - K = 265 (ML = 35; Dis = 37)	1	World of Words (WOW)	Business as Usual (BAU)	**Standardized** 1) General Receptive Vocabulary (Peabody Picture Vocabulary Test-IV): WOW = BAU 2) General Expressive Vocabulary (Expressive One-word Picture Vocabulary Test- IV): WOW = BAU (except for PreK, d = 0.94) **Non-Standardized** 1) Science-Related Vocabulary: WOW > BAU (PreK d = 1.14; K d = 0.48) 2) Knowledge of Science-Related Concepts: WOW > BAU (no ES reported)	Total Sessions: 100 (Daily x 20 weeks) Number of Weeks: 20 Sessions/Week: 5 Minutes/Session: 12-15 Approx. Total Hours: ~20–25 hours total
Neuman et al., 2021; Randomized controlled trial (classroom-level, waitlist control)	PreK = 238 K = 272 1st = 221 (ML = NR; Dis = 109)	1	World of Words (WOW)	Business as Usual (BAU)	**Standardized** 1) General Expressive Vocabulary (Expressive One-Word Picture Vocabulary Test-IV): WOW = BAU **Non-Standardized** 1) Curriculum-Based Vocabulary: WOW > BAU (K, d = 0.65; 1st, d = 0.55) 2) Concept Knowledge: WOW > BAU (K, d = 0.37; 1st, d = 0.40) 3) Categorical Property Knowledge: WOW = BAU	Total Sessions: ~105 (5 per week × 21 weeks) Number of Weeks: 21 Sessions/Week: 5 Minutes/Session: 12–15 Approx. Total Hours: ~21–26 hours total
Relyea et al., 2024; Secondary analysis of randomized controlled trial (EL vs. non-EL comparison)	1st - 2nd = 5,397 (ML = 1,236; Dis = 432)	1	Model of Reading Engagement (MORE)	Business as Usual (BAU)	**Standardized** 1) Reading Comprehension (MAP): MORE = BAU 2) Basic Literacy Skills (DIBELS): MORE = BAU **Non-Standardized** 1) Science Argumentative Writing: MORE > BAU (ML, ES = 0.25; Dis, ES = 0.24) 2) Social Sciences Argumentative Writing: MORE > BAU (ML, ES = 0.42; Dis, ES = 0.44)	Total Sessions: 20 (10 lessons per unit × 2 units) Number of Weeks: 10 Sessions/Week: 2 Minutes/Session: 80 Approx. Total Hours: 20 × 80 min = 1,600 min ≈ 26.7 hours
See et al., 2017; Cluster randomized controlled trial (school-level, two-group waitlist design)	2nd = 611 3rd = 613 (ML ~428 , Dis ~257)	1	Word and World Reading (WWR)	Business as Usual (BAU)	**Standardized** 1) Reading Comprehension (Progress in English Test): WWR = BAU	Total Sessions: 69 (34 geography + 35 history) Number of Weeks: ~35 (full school year) Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 69 × 45 min = 3,105 min ≈ 51.8 hours

Study and design	Participants	Tier	Intervention condition	Comparison condition	Outcome domain and reported findings	Dosage
Williams et al., 2014; Cluster randomized controlled trial (classroom-level)	2nd = 197 (ML = NR; Dis = 41)	1	Content Instruction (CI)	Business as Usual (BAU)	**Non-Standardized** 1) Immediate Posttest Strategy Measures: CI = BAU 2) Immediate Posttest Content Measures: CI > BAU (ES = 10.00) 3) Immediate Posttest Sentence Combination: CI = BAU 4) Immediate Posttest Comprehension Questions: CI = BAU 5) Delayed Posttest Strategy Measures: CI = BAU 6) Delayed Posttest Content Measures: CI = BAU 7) Delayed Posttest Sentence Combination: CI = BAU	Total Sessions: 22 Number of Weeks: 11 Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 22 × 45 min = 990 min ≈ 16.5 hours
Williams et al., 2016; Cluster randomized controlled trial (classroom-level)	2nd = 258 (ML = NR, Dis = 37)	1	Content Instruction (CI)	Business as Usual (BAU)	**Non-Standardized** 1) End-of-Unit Test Main Idea: CI = BAU 2) End-of-Unit Test Structure Statement: CI = BAU 3) End-of-Unit Test Sentence Completion: CI = BAU 4) End-of-Unit Test Main Idea Questions: CI = BAU 5) End-of-Unit Test Structure Questions: CI = BAU 6) End-of-Unit Test Non-Structure Questions: CI = BAU 7) End-of-Unit Test Vocabulary: CI > BAU (d_tw = 1.64)7) 8) Posttest Clue Words Identification: CI = BAU 9) Posttest Strategy Questions Identification: CI = BAU 10) Posttest Graphic Organizer Identification: CI = BAU 11) Posttest Main Idea: CI = BAU 12) Posttest Structure Statements: CI = BAU 13) Posttest Paragraph Structure Identification: CI = BAU 14) Posttest Sentence Completion: CI = BAU 15) Posttest Structure Questions (Natural Text): CI = BAU 16) Posttest Paragraph Structure Identification (Natural Text): CI = BAU 17) Posttest Vocabulary: CI > BAU (dw = 1.78) 18) Posttest Features: CI > BAU (dw = 1.68)	Total Sessions: 50 (9 lessons per unit × 5 units, plus 5 review) Number of Weeks: ~25 Sessions/Week: 2 Minutes/Session: 45 Approx. Total Hours: 50 × 45 min = 2,250 min ≈ 37.5 hours
Wright & Gotwals, 2017; Quasi-experimental study	K = 147 (ML = NR, Dis = NR)	1	Science, Oral Language, and Literacy Development from the Start of School (SOLID Start)	Business as Usual (BAU)	**Non-Standardized** 1) Receptive Vocabulary: for unit on weather SOLID > BAU (g = 1.10); for unit on plants, SOLID > BAU (g = 1.76) 2) Claim: for weather unit, SOLID > BAU (g = 0.76); for plants unit, SOLID > BAU (g = 1.86) 3) Evidence-Based Support: for weather unit, SOLID > BAU (g = 0.83); for plants unit, SOLID > BAU (g = 1.23) 4) Vocabulary Science Context: for weather unit, SOLID > BAU (g = 1.30); for plants unit, SOLID > BAU (g = 1.51)	Total Sessions: 40 (20 lessons per unit × 2 units) Number of Weeks: 8 (4 weeks per unit) Sessions/Week: 5 Minutes/Session: ~45 Approx. Total Hours: 40 × 45 min = 1,800 min ≈ 30 hours
Wright et al., 2022; Cluster randomized controlled trial (classroom-level)	1st = 83 2nd = 112 (ML = NR, Dis = NR)	1	Conceptually-Coherent Texts (CC)	Non-Conceptually Coherent (NCC)	**Non-Standardized** 1) Incremental Word Knowledge: CC = NCC 2) Listening Comprehension Concepts: 1st grade CC > NCC (ES = 0.68); 2nd grade, CC = NCC; 3) Listening Comprehension Vocabulary: 1st grade CC = NCC; 2nd grade, NCC > CC (ES = 0.50);	Total Sessions: 3 days total Number of Weeks: unclear whether days were consecutive or not Sessions/Week: ~3 (one per day) Minutes/Session: Not specified Approx. Total Hours: Not specified

Study and design	Participants	Tier	Intervention condition	Comparison condition	Outcome domain and reported findings	Dosage
Connor et al., 2017; Randomized controlled trial (efficacy study)	K = 83 1st = 109 2nd = 75 3rd = 76 4th = 75 (ML = NR, Dis = NR)	2	Content-Area Literacy Instruction (CALI)	Business as Usual (BAU)	**Standardized** 1) Oral Comprehension (WJ-III): CALI = BAU (except for 4th graders, d = 0.47) 2) Picture Vocabulary (WJ-III): CALI = BAU (except for 4th graders, d = 1.20) 3) Passage Comprehension (WJ-III): CALI = BAU (except for 4th graders, d = 0.22)	Total Sessions: 12 (4 per week × 3 weeks) Number of Weeks: 3 Sessions/Week: 4 Minutes/Session: ~30 (whole class) + 15–20 (small groups) Approx. Total Hours: If each session includes both whole-class and small-group for the same students, ~9–10 hours total
May et al., 2024; Comparative interrupted time-series design	2nd = 4,925 3rd = 1,395 4th = 1,270 5th = 1,216 (ML = NR; Dis = 1,074)	2	Bookworms (BW)	Business as Usual (BAU)	**Standardized** 1) Reading Comprehension (MAP): BW > BAU (ES = 0.26)	Total Sessions: ~540 (3 per day × 5 days/week × ~36 weeks) Number of Weeks: ~36 (full school year) Sessions/Week: ~15 Minutes/Session: 30 Approx. Total Hours: 540 sessions × 30 min = 16,200 min ≈ 270 hours
Kim et al., 2019; Sequential multiple assignment randomized trial (SMART)	K - 2nd = 273 (ML = 26; Dis = 23)	3	Coherent and Connected Texts (CCT) + Use of App	Leveled Texts (LL) + Use of App	**Standardized** 1) Reading Comprehension (MAP): CCT = LL 2) Basic Literacy Skills (DIBELS): CCT = LL **Non-Standardized** 1) Science Vocabulary Knowledge: CCT > LL (ES = 0.10) 2) Word Study: CCT < LL (ES = -0.06) 3) Listening Comprehension: CCT > LL (ES = 0.14)	Total Sessions: Self-paced (varies by participant) Number of Weeks: Summer period (duration varies) Sessions/Week: On-demand (not fixed) Minutes/Session: Not specified (app use varied) Approx. Total Hours: Varies widely (no fixed schedule)

Discussion

Discussion of Overall Independent Variable Effectiveness

Results from this review align with earlier meta-analyses showing that content-rich instruction has the strongest effects on tests closely tied to the taught material (Hwang et al., 2022). Overall, the findings confirmed that the closer the match between instruction and assessment, the more likely it was to detect an effect. The clearest gains emerged from interventions that paired tightly sequenced informational texts with explicit language work and that assessed outcomes close to the taught content. SOLID Start (Wright & Gotwals, 2017) registered positive effects on every non-standardized indicator—receptive science vocabulary, conceptual vocabulary, and evidence-based explanation. CKLA-Knowledge (Cabell et al., 2025) and the two MORE classroom trials (Kim et al., 2021a, 2021b) also posted large proportions of positive findings, but almost all of their success occurred on proximal measures that sampled the very words, concepts, and writing tasks embedded in the lessons.

By contrast, only a handful of programs shifted performance on standardized indicators. Bookworms (May et al., 2024) raised MAP Growth Reading scores after a full-year, high-dosage implementation, and SILI (Clark et al., 2024) improved state-aligned comprehension after twelve science-infused lessons. One MORE study (Kim et al., 2021a) produced a small, standardized advantage, whereas large-scale studies of MORE and CKLA, despite sizeable samples, did not. Taken together, just 13% of standardized outcomes favored the treatment, compared with 37% of researcher-developed outcomes. This discrepancy re-affirms findings from prior syntheses (Hwang et al., 2022) that content-rich instruction yields its strongest effects when tests align closely with the taught knowledge, and it raises questions about the extent to which domain-specific gains generalize to the multifaceted passages sampled by norm-referenced batteries.

Discussion of Components Effectiveness

All interventions in this review included discussions built around open-ended questions. This emphasis on discussion practices aligns with decades of work showing that text-based dialogue supports comprehension (Murphy et al., 2009). Results from this review showed that learning gained from interventions with high dosage of discussions can impact students' scores in proximal measures of reading comprehension but will not necessarily transfer to standardized measures of reading comprehension.

Interventions in this review used word learning as the vehicle for knowledge growth, explicitly teaching key terms and then revisiting them as reading the other texts within semantically-coherent sets. The prevalence of vocabulary instruction aligns with meta-analytic evidence that show that word study and knowledge acquisition rise and fall together (Hwang et al., 2022). Yet variation emerged in how teachers supported this work. In some classrooms, lesson starters previewed words; in others, instruction appeared mid-text when students met an unfamiliar

concept. A few programs delayed direct teaching until after reading; or provided instruction at more than one moment. To keep new words from floating in isolation, teachers frequently asked students to map or sort them. Such practices echo schema theory's claim that knowledge becomes durable when ideas are linked (Dochy & Alexander, 1995). Despite some design differences, these studies show that explicit vocabulary instruction continues to be a cornerstone of knowledge-building interventions.

Another thread that ran through the interventions was the deliberate sequencing of texts and a strong reliance on informational material. Rather than one-off readings, teachers assembled clusters of books and articles on a single topic—a design choice linked to deeper conceptual growth (Cervetti et al., 2016). Interactive read-alouds served as the common entry point: educators paused to model thinking, highlight text features, and probe understanding while children listened.

Prior research suggests that informational texts may support comprehension better than narratives (Cervetti et al., 2009), and the interventions in this review build on that evidence. However, the heavy use of informational texts in these studies contrasts with findings from U.S. preschool and elementary classrooms, where read-alouds still favor narratives (Pentimonti et al., 2010; Conradi et al., 2022). To expand knowledge-building approaches, both teacher practices and school libraries will need to shift toward greater inclusion of informational texts. Some studies suggest that teachers feel less comfortable reading informational texts aloud (Price et al., 2012). Still, the interventions reviewed here show that, with careful planning, teachers can use informational texts effectively to engage young learners—offering a hopeful counterpoint to these concerns.

Supporting this shift, many of the reviewed interventions also incorporated visual and multimodal aids to strengthen comprehension during read-alouds. Teachers used picture cards, illustrations, diagrams, real objects, and videos to help students grasp new concepts. The use of visual supports is consistent with recommendations to reduce cognitive load during content learning (Cervetti & Wright, 2020) and likely contributed to the effectiveness of informational text read-alouds in these studies.

Taken together, the pattern of components across studies—rich questioning, explicit and relational word work, strategic activation of prior knowledge, thematically connected text sets, well-scaffolded read-alouds, and visual supports—reflects a converging view of how young readers learn new content. Thus, while no single practice guarantees success, this constellation of features appears to set the stage for meaningful knowledge growth in the early elementary grades.

Discussion of Results for English Learners and Students with Disabilities

Evidence for multilingual learners painted a nuanced picture. Two studies that built science-related knowledge reported that English learners outperformed their English-speaking classmates on expressive and curriculum-specific vocabulary, whereas the same interventions produced similar gains for both groups in concept knowledge.

These findings align to Smith et al.'s (2021) conclusion that background knowledge can narrow language-based gaps on tasks that rely on precise word meanings, yet does not fully erase disparities on more conceptually demanding assessments. In contrast, large elementary trials of content-rich curricula detected no reliable moderation by language status on standardized comprehension or achievement measures, even when the programs improved proximal vocabulary or writing. One interpretation is that vocabulary advantages for multilingual students did not translate into the broader reading constructs captured by norm-referenced tests, a pattern that Hwang et al. (2022) also observed in their meta-analysis.

Special-education status received far less attention. Only one year-long Tier 2 program reported a modest interaction, with students who received special-education services showing steeper growth on a curriculum-embedded reading index. Although encouraging, the result remains tentative because other studies either lacked power or omitted formal tests. The limited evidence leaves open the question of whether knowledge-building instruction needs additional scaffolds to benefit learners with identified disabilities—a gap that future research should address.

Discussion of Results for Interventions at Tiers 1, 2, and 3

When interventions were delivered whole-class (Tier 1), effects surfaced most often on proximal measures tightly aligned to lesson content—particularly vocabulary depth, topic knowledge, and argument writing. For example, core-curriculum units that sequenced thematically related texts and explicit word work yielded large gains on researcher-developed social-studies and science assessments, yet showed little effect on standardized vocabulary or comprehension tests. This pattern matches Cervetti, Wright, and Hwang's (2016) finding that conceptually coherent text sets strengthen local networks of knowledge before influencing distal outcomes.

Tier 2 programs, which supplemented regular instruction in small-group format, demonstrated a somewhat different profile. The few studies in this category reported statistically significant advantages on standardized reading comprehension or growth metrics. More targeted instruction, and additional practice opportunities may have helped students consolidate newly acquired knowledge into skills detectable by norm-referenced instruments.

The single Tier 3 study—an individualized, app-based summer intervention—produced only small effects on domain vocabulary and listening comprehension and none on broader literacy indices. Its self-paced design may have limited sustained exposure to the shared discussions

and teacher mediation that other research identifies as central to knowledge construction (Neuman & Wright, 2013).

Implications for Practice

Teachers who aim to build knowledge in the primary grades should organize literacy instruction around conceptually coherent units rather than isolated lessons. Selecting three to five high-quality informational texts that address a single science or social-studies topic allows students to encounter the same ideas, facts, and technical language across multiple readings. Sequencing the texts from simple to complex and re-using anchor questions across the set deepens conceptual networks and prepares children to explain the topic in writing or discussion.

Within each unit, practitioners should make explicit and systematic vocabulary work a daily routine. Previewing key terms before reading, pausing briefly to revisit them in context, and adding extension activities like concept mapping, sorting tasks, and morphological analyses seem like effective ways to learn new words and connect them to prior knowledge. These instructional practices provide children with opportunities for repeated encounters with unfamiliar language, highlighting semantic relationships, and promoting long-term retention. Pairing word work with open-ended discussion prompts can also help turn vocabulary into a tool for reasoning, not just recall.

A successful knowledge-building classroom also relies on informational read-alouds supported by visuals and hands-on materials. Teachers can reinforce key ideas with photographs, picture cards, real objects, or brief video clips. These multimodal supports lighten cognitive load and make abstract content accessible to young learners. Because many classrooms still favor narrative texts, district leaders should allocate funds to expand nonfiction collections that align with grade-level science and social-studies standards.

Finally, schools could benefit from adopting a two-tiered approach to support students who are falling behind. When multilingual learners or students who receive special-education services show slower acquisition of skills, additional Tier 2 small-group sessions show promise of being effective in accelerating their growth.

Limitations

Several features of the search strategy narrow both the scope and the generalizability of the current synthesis. The review drew only on English-language, peer-reviewed articles published between 2014 and 2024 and conducted in six majority-English nations. Although these restrictions promote methodological transparency and curricular relevance to U.S. schools, they exclude research released in other languages, unpublished dissertations, conference papers, and studies completed before 2014. Consequently, promising programs implemented in

multilingual settings or evaluated through gray literature may be under-represented, and the evidence base may reflect a publication bias toward positive findings.

The eligibility rules further shaped the body of evidence. Each study was required to report at least one reading- or language-related outcome; interventions that built disciplinary knowledge without measuring literacy were therefore omitted. Studies in which fewer than 50% of participants were in kindergarten through Grade 3—unless disaggregated data were reported—were also excluded, limiting inferences about older or mixed-age classrooms. Because several included articles drew on overlapping district datasets, the number of unique interventions is smaller than the article count suggests, and the independence of findings is restricted.

Methodological heterogeneity constrained synthesis and interpretation. Outcome measures ranged from broad, standardized tests to narrow, researcher-developed measures; effect sizes were reported with different statistics; and intervention dosages varied widely.

Coding decisions introduce additional uncertainty. A single reviewer extracted study features and classified instructional components; although spot checks occurred, no independent double coding was completed. Sparse implementation details in several articles required inferences about the presence or absence of specific practices. In addition, moderator analyses were rare. These gaps weaken causal inferences and leave open questions about scalability, sustainability, and differential effects for students with disabilities or those learning English as an additional language.

Future Research

A first priority involves tracking whether early, domain-specific gains consolidate into the broader, transferable knowledge that can result in increased reading comprehension as students grow. Few trials in the present review followed students beyond the immediate post-test, and even fewer employed distal, standardized assessments. Longitudinal designs that combine delayed standardized testing with curriculum-embedded probes would clarify whether tightly sequenced science or social-studies units merely foster familiarity with taught material or, instead, enlarge the general knowledge base that later facilitates comprehension of unfamiliar texts.

A second line of inquiry should isolate the mechanisms that make knowledge instruction effective. Every program blended multiple elements, so causal attribution remains speculative. Future experiments could assign classrooms to single components or strategic combinations, revealing which features drive vocabulary growth, which foster durable knowledge gains, and which help students understanding of texts. Such work should also distinguish *building* knowledge from *activating* it, a boundary that becomes blurred when an activation prompt also seeds new learning (Hattan et al., 2024).

Researchers might also examine how students can learn to trigger relevant knowledge without continuous teacher scaffolding. Studies that teach and assess self-prompting routines could test whether metacognitive supports boost comprehension when prior knowledge is absent, partial, or tangential. Experiments could compare direct instruction in analogical reasoning, categorical mapping, or structural alignment to determine which strategies best transfer across domains, especially when content is genuinely novel.

Finally, equity questions remain largely unanswered. Evidence for multilingual learners and students with disabilities is thin. Future trials should oversample these groups, embed moderator analyses, and report disaggregated outcomes by language proficiency and disability classification.

Conclusion

Evidence from the past decade shows that primary-grade interventions fare best when they weave explicit vocabulary instruction, conceptually coherent sets of informational texts, and sustained, open-ended discussion into everyday literacy blocks. These elements reliably boost students' mastery of the words and concepts they are taught and, in some cases, strengthen standardized reading performance, especially when exposure is intensive and year-long. Yet the same pattern of results underscores a central takeaway: building background knowledge is indispensable for understanding content-aligned texts, but it does not automatically generalize to all measures of reading comprehension.

Future research could examine how to leverage students' prior knowledge to facilitate their comprehension of texts of any genre or topic. Despite this caveat, the present findings affirm that strategically sequenced, content-rich literacy instruction constitutes a powerful, practicable route to closing early knowledge gaps and laying a stronger foundation for later reading success.

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