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# A Systematic Review of Disciplinary Literacy Research for Adolescent Readers from 2008-2024

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Heather Van Ness, Ph.D.

Associate Professor, Early Childhood, Multilingual, and Special Education

University of Nevada, Las Vegas


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UNIVERSITY OF LOUISVILLE. COLLEGE OF EDUCATION & HUMAN DEVELOPMENT

Kentucky Department of EDUCATION

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## Abstract

Despite the vital importance of developing proficiency in academic language and vocabulary for informed citizenship and the direct connection between education and increased workplace literacy, national and international assessments show a disturbing lack of improvement in adolescents' reading comprehension or science achievement over the past two decades. The purpose of this systematic literature review was to examine the intervention research focused on adolescent literacy. This review analyzed 31 experimental and quasi-experimental studies to identify effective intervention characteristics and student outcomes across grades 4-12. Findings revealed that most interventions (71%) were implemented by general education teachers in general education classrooms (55%). Nearly 90% of interventions focused on science or history. While vocabulary (53%) and comprehension (80%) were the most common reading components addressed, 57% of studies targeted only a single component, despite recommendations for multi-component interventions. Effective interventions demonstrated positive impacts on reading comprehension, vocabulary, and disciplinary thinking, particularly for emergent bilinguals and students with disabilities, often through integrated, explicit instruction. The review underscores the need for more comprehensive, multi-component interventions and improved reporting to better understand effective strategies for all adolescent learners.


A significant concern in education is the persistent struggle many students face with reading and writing, a challenge demonstrably linked to alarming dropout rates (National Center for Literacy, 2007). This stark reality underscores an urgent need to extend robust literacy instruction far beyond the elementary years, ensuring its continuous presence throughout the middle and high grades (Ferreira & Zygouris-Coe, 2013). Disturbingly, approximately eight million young people between fourth and twelfth grade struggle to read at grade level (Biancarosa & Snow, 2006; Shanahan & Shanahan, 2008), highlighting a profound societal challenge in equipping adolescents with the fundamental skills necessary for academic success and future participation in a global economy (Biancarosa & Snow, 2006).

## The Persistent Adolescent Literacy Crisis

The severity of this "literacy crisis" is particularly pronounced for adolescent emergent bilinguals, whose performance on literacy indicators is strikingly poor (Echevarria et al., 2011), and for students with learning disabilities, who consistently demonstrate lower reading and science scores compared to their non-disabled peers (National Center for Educational Statistics, 2009, 2011; Seifert & Espin, 2012). Despite the vital importance of developing proficiency in academic language and vocabulary for informed citizenship (Trefil & O'Brien-Trefil, 2009) and the direct connection between education and increased workplace literacy (Ferreira & Zygouris-Coe, 2013), national and international assessments show a disturbing lack of improvement in adolescents' reading comprehension or science achievement over the past two decades (Ferreira & Zygouris-Coe, 2013; Grigg et al., 2006; Lutkus et al., 2006; National Assessment of Educational Progress, 2009; National Center for Education Statistics, 2007). This ongoing stagnation implies that current reading comprehension instruction is insufficient for preparing citizens to fully participate in 21st-century society (National Assessment of Educational Progress, 2009).

## Challenges of Secondary Academic Texts and Teacher Preparedness

A major factor contributing to this literacy challenge is the nature of secondary academic texts themselves. Textbooks, which remain a primary instructional resource, frequently exceed students' reading comprehension levels, introduce an overwhelming volume of new vocabulary, and often suffer from disorganized presentation (Coulter & Lambert, 2015; Kroeger et al., 2009; Mastropieri et al., 2006; Seifert & Espin, 2012). High school science texts, for instance, can introduce up to 3,000 terms—a quantity exceeding what is typically expected in a foreign language class (Ferreira & Zygouris-Coe, 2013). The inherent density, abstraction, and technicality of academic language further exacerbate comprehension difficulties (Huerta et al., 2016; Irby et al., 2021; Lara-Alecio et al., 2018).

Compounding these textual challenges is the issue of teacher preparedness. Despite educational standards, including the Common Core State Standards (CCSS), explicitly requiring the integration of discipline-specific reading and writing objectives (Common Core State Standards Initiative, 2010; National Council for the Social Studies, 2013; O'Connor et al., 2017; Roberts et al., 2019; Wissinger et al., 2021), many content-area teachers report feeling inadequately prepared to integrate robust language-based activities into their instruction (Cawley et al., 2002; Irby et al., 2021; Lee, 2005; Mastropieri & Scruggs, 1992; Moin et al., 2009; Seifert & Espin, 2012; Swanson et al., 2016). This is particularly notable in social studies, where teachers often view their primary role as content delivery rather than literacy instruction (Irby et al., 2021). Without deliberate instruction in comprehending and synthesizing textual

information, students are unlikely to develop sophisticated content knowledge (Berkeley et al., 2011; Wanzek et al., 2015).

## Disciplinary Literacy: A Targeted Approach

To address these deficiencies, the concept of disciplinary literacy has emerged as a crucial approach. This involves teaching students to read, write, and think in the ways characteristic of experts within specific subject areas, thereby acknowledging each discipline's unique modes of discourse (Gee, 2001; Larson, 2014). This approach is widely recognized as essential for success in content-area classrooms (Carnegie Council on Advancing Adolescent Literacy, 2010) and for actively engaging students in the construction of knowledge (Larson, 2014). Comprehending printed materials necessitates that students connect new information with their existing prior knowledge to construct a coherent mental representation of the text's meaning (Romance & Vitale, 2017; Van den Broek, 2010).

### *Disciplinary Literacy in Science*

Science achievement among U.S. students demonstrates a persistent decline in proficiency from elementary to secondary grades (Romance & Vitale, 2017), with reading comprehension standing as a primary impediment (Donahue et al., 1999; Ferreira & Zygouris-Coe, 2013). This is exacerbated by science texts often featuring abstract topics that diverge from students' everyday experiences (Fang, 2005; Ferreira & Zygouris-Coe, 2013), and presenting information in a dense, technical manner (Armbruster & Anderson, 1998; Seifert & Espin, 2012). Students with limited reading skills, including those with, find science texts particularly challenging (Mason & Hedin, 2011; McDuffie et al., 2005; Roberts et al., 2019; Solis et al., 2016).

To overcome these challenges, researchers strongly recommend infusing language and literacy instruction directly into science teaching (Llosa et al., 2016; Maerten-Rivera et al., 2016; Tong et al., 2014). Effective interventions consistently involve explicit and targeted vocabulary instruction (Hayden et al., 2019; Larson, 2014), along with multi-component and integrated approaches within inquiry-based learning that cultivate deep comprehension by emphasizing evidence-based arguments from multiple sources (Goldman et al., 2019; Irby et al., 2021). Additionally, the use of structured tools and processes like graphic organizers and models that foster understanding through structured inquiry steps is crucial (Guzzetti & Bang, 2011; Larson, 2014; Telesca et al., 2020). There's also a strong emphasis on evidence-based argumentation and compare-contrast tasks (Goldman et al., 2019; Telesca et al., 2020), aligning with the need for written explanations on science assessments (National Center for Educational Statistics, 2019; Telesca et al., 2020).

### *Disciplinary Literacy in History*

The Common Core State Standards explicitly underscore the critical need for integrating language and literacy skills instruction directly within history and social studies teaching (Martinez et al., 2024; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). This integration is vital because the unique disciplinary practices of social studies provide a clear purpose for student communication, fostering both meaning-making and language development (Bunch & Martin, 2021; Martinez et al., 2024). A specific "historical literacy" skill is the complex act of constructing an argument by synthesizing evidence from multiple sources (Wissinger et al., 2021).

Effective history education hinges on integrating literacy and content through explicit instruction in historical thinking skills, guiding students to "do" history like experts. This includes sourcing (identifying an author's stance, purpose, and potential biases), contextualization (understanding the background of documents and events), and corroboration (critically analyzing multiple sources to form comprehensive understandings) (Wissinger et al., 2021; De La Paz et al., 2017). Beyond disciplinary thinking, explicit academic vocabulary instruction is paramount, emphasizing definitions, contextual use, and active engagement with domain-specific terms (Wanzek et al., 2015; O'Connor, Beach, et al., 2017; O'Connor, Sanchez, et al., 2017; Martinez et al., 2024). Reading historical texts also benefits from specific strategies such as building background knowledge, critical reading of primary and secondary sources, text structure awareness for common historical patterns like compare/contrast and cause/effect (often supported by signal words and graphic organizers), and explicit instruction in main idea generation (Wanzek et al., 2015; Wissinger et al., 2021; De La Paz et al., 2017; Martinez et al., 2024; O'Connor, Beach, et al., 2017; O'Connor, Sanchez, et al., 2017). Crucially, students need structured support for historical argumentation and writing, involving explicit teaching on how to construct historical arguments, including forming claims, providing evidence, and addressing counterclaims (Wissinger et al., 2021; De La Paz et al., 2017).

## Addressing Specific Populations: Emergent Bilinguals and Students with Disabilities

Adolescent emergent bilinguals face significant academic challenges where language learning intersects with rigorous subject matter, necessitating the acquisition of specialized academic language (Coleman & Goldenberg, 2012; Martinez et al., 2024; Umansky & Reardon, 2014). Despite these barriers, research suggests that content learning activities provide an optimal context for their language and literacy development (Martinez et al., 2024; NASEM, 2017, 2018). Promising adaptations include approaches like translanguaging (Martinez et al., 2024) and incorporating out-of-school literacy practices (Barton & Hamilton, 2000). Vocabulary instruction, in

particular, has a significant and lasting impact for emergent bilinguals (Beck et al., 1982; Carlo et al., 2004; Hakuta, 2011).

Similarly, a substantial number of students with disabilities continue to experience reading difficulties into adolescence, consistently reflected in national assessments (Ehren et al., 2004; O'Connor et al., 2017; Wei et al., 2011). These students frequently exhibit difficulties across phonics, language comprehension, and reading fluency (Fuchs et al., 2000; Seifert & Espin, 2012), which creates a significant mismatch with the demanding reading requirements of content area classes (Biancarosa & Snow, 2006; Kroeger et al., 2009; O'Connor et al., 2017).

Despite these difficulties, researchers have identified consistent instructional practices that effectively improve reading ability in adolescent struggling learners (Berkeley et al., 2010; Kamil et al., 2008; Swanson & Deshler, 2003). Effective comprehension instruction for these students encompasses explicit strategy instruction (e.g., graphic organizers, questioning, paraphrasing, summarizing), activating prior knowledge, and enhancing text accessibility, often integrated into a comprehensive intervention package (Mason & Hedin, 2011). Successful methods include teaching students to find main ideas (Jenkins et al., 1987), compare and contrast information (Gersten et al., 2006), and identify causes and effects of events (Williams et al., 2009). Furthermore, incorporating writing as a note-taking strategy, sentences, or short paragraphs can significantly boost reading comprehension (Hebert et al., 2016). For vocabulary development, Constant-Time Delay (CTD) has been identified as an evidence-based practice for teaching both general and functional vocabulary to students with disabilities (Browder et al., 2007; Knight et al., 2013). Instruction in multisyllabic word strategies, including letter patterns, affixes, and morphemes, combined with opportunities to apply these skills to age- and grade-appropriate words, is crucial for students to construct mental representations of what they read (Carlson et al., 2014; Ebbers & Denton, 2008).

The minimal progress in adolescent literacy, particularly pronounced for emergent bilinguals and students with disabilities, stems from a confluence of factors, including the premature discontinuation of reading instruction in elementary grades, the escalating linguistic and conceptual demands of secondary content-area texts, and a deficit in teachers' preparedness to integrate robust language-based activities (Alexander & Fox, 2011; Echevarria et al., 2011; Irby et al., 2021; Larson, 2014). The need for effective interventions specific to adolescent literacy was the impetus for the current analysis and builds on the work of Biancarosa and Snow (2006) and Kamil et al. (2008) regarding recommendations for adolescent literacy and evidence-based instruction and interventions. The purpose of this systematic literature review was to examine the intervention research focused on adolescent literacy. Specifically, the current examination addresses the following research questions:

1. What instructional and intervention characteristics (e.g., use of Elkonin boxes, multicomponent instruction, intervention dosage, group size, implementer, modality) and student characteristics (e.g., age, English Learner, disability status) have been tested as part of disciplinary literacy interventions?
2. What does the research say about the effectiveness of disciplinary literacy instruction in improving foundational reading outcomes for readers in grades 4-12?
3. What features of instructional interventions (e.g., type of instruction, duration, grade level) are associated with improved outcomes? Do these features differ according to student characteristics?

# Method

### Study Eligibility Criteria

Electronic database searches were conducted across four academic databases: Academic Search Complete, APA Psych Info, ERIC, Education Full Text using the following sets of key terms: (a) “disciplinary literacy” or “content area literacy” or “literacy in math*” or “literacy in history” or “literacy in science” or “math* text” or “science text” or "history* text" AND (b) “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 QED 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 (c) Interven* or Curricul* or Program* or Instruct* or Teach* or Train* or Approach* or Monitor* or Treat* or Self-regulat* or transfer or “Small group” or Partner* or Stance AND (d) 4-9* or “Fourth* grade”* or “Upper* Elementary” or “Middle*School” or “High* School” or "Fifth* grade*" or "Sixth* grade*" or "Seventh* grade*" or "Eighth* grade*" or "Ninth* grade*" or "Age* 9" or "Age* 10" or "Age* 11" or "Age* 12" or "Age* 13" or "Age* 14" or "Age* 15" or "9 year* old" or "10 year* old" or "11 year* old" or "12 year* old" or "13 year* old" or "14 year* old" or "15 year* old" AND (e) Achieve* or Improve* or "Instructional effectiveness" or Outcome* or Effect* or Develop* or skill* or assess* or test* or progress* or acqui* or learn*. The database search was limited to peer-reviewed research published between 2008 and 2024. From these databases, 477 articles were found, of which 108 were duplicates that were removed, resulting in 369 articles.

The titles and abstracts of 369 articles were screened for inclusion based on the following criteria: (a) was published in English, the intervention was provided in English, and occurred in the United States and its territories, (b) was a peer-reviewed publication, (c) included participants in fourth through twelfth grades, (d) utilized an experimental or quasi-experimental design, and (e) included a literacy intervention as the independent variable, and (f) included literacy as a dependent variable. A total of 96 articles were identified as potentially eligible articles and the full text of these articles were further reviewed for inclusion or exclusion. As a result, 31 articles met eligibility criteria for this review. A summary of the article search and procedures is provided in Figure 1.

## Coding Procedure

The identified 31 articles were individually reviewed to identify elements relevant for the current analysis.

### *Design*

The research design for each study was identified and recorded.

### *Implementer*

Additionally, information on the intervention implementer was extracted from the article based on the author's report. The implementer was coded as either the researcher (or member of the research team), a special education teacher, a general education teacher, or a paraprofessional/classroom assistant.

### *Participant Characteristics*

A number of participant characteristics were also extracted from the studies including the total number of participants and student grade level. For more meaningful analysis, the student grade was recoded into elementary (fourth and fifth grade), middle school (sixth, seventh, and eighth grade), and high school (ninth through twelfth grade). Special education and emergent bilingual status were dichotomously coded. Students identified as "socioeconomically challenged," receiving free or reduced lunch, or "poor readers" were coded as at-risk for the current analysis.

### *Classroom*

In addition to the intervention implementer, the classroom location was also documented. This was typically coded as a general education classroom (i.e., a classroom that did not include students identified disabilities), an inclusion classroom (i.e., a general education classroom in which students with disabilities also receive instruction), a co-taught classroom (i.e., shared teaching responsibilities from a general and special education teacher), a resource room (i.e., a special education classroom in which students receive special education for some part of the day), or a

self-contained classroom (i.e., a special education classroom where students receive the majority of their instruction). This may or not have directly corresponded to the level of intervention implementation as that was coded separately (e.g., whole class, small group).

### *Content Area*

The focus of the current review is adolescent disciplinary literacy. As such, the discipline or content area in which the literacy instruction occurs was also recorded.

### *Independent Variable*

The intervention implemented in each of the studies was summarized for analysis. Additionally, the intervention was analyzed to identify which of the five essential components of reading were provided, as identified by the National Reading Panel (2000). The procedures and materials were reviewed to determine if the intervention was part of a specific curriculum and if the intervention was designed by the researchers. The intervention duration and dosage were also recorded as provided in the manuscript. The mode of delivery (e.g., whole classroom small group, one on one) was also documented as that is a factor in determining intervention intensity. Finally, the studies were analyzed to determine if intervention fidelity was assessed, and if so, what was the result of the fidelity assessment.

### *Dependent Variable*

The articles were reviewed to identify all dependent variables, the levels of standardization, and the reported effect sizes.

### *Initial Analysis*

A total of 31 studies were synthesized. A summary of participant characteristics is provided in Table 1 and a summary of intervention characteristics is provided in Table 2 (p. 39).

### *Research Design*

Of the 31 studies, 12 (39%) used an experimental design with random assignment to intervention or control at the student, teacher, or school level, 12 (39%) used a quasi-experimental design (e.g., pretest-posttest design without randomization), and 7 (22%) used a single case design (e.g., multiple baselines across participants, withdrawal).

### *Implementer*

Information on the intervention implementer was extracted from the article based on the information included by the authors. Out of the 31 studies reviewed, the intervention was primarily delivered by general education teachers in 22 studies (71%). Researchers or members of the research team implemented the intervention in 8

studies (26%), while special education teachers were responsible for delivery in 6 studies (20%). In one study (3%), a general education classroom assistant provided support for the intervention's implementation. It is noteworthy that of the studies reviewed, interventions were not implemented or supported by paraprofessionals or interventionists. Additionally, no interventions included in this analysis employed computer-based programming. While two studies did utilize technology via tablets, these devices served as tools for annotating reading material and organizing content, rather than providing direct instructional programming (Irby et al., 2021; Larson, 2014).

### *Participant Characteristics*

The synthesis of 31 studies revealed a cumulative participant pool of 11,201 students. Within this population, 10% (*n*=1,114) of the participants were identified as emergent bilingual, and 4% (*n*=498) were eligible for special education services. A significant portion, 45% (*n*=4,997), were categorized as "at-risk," a designation encompassing academically at-risk students, those receiving free and reduced lunch, or those facing economic challenges, as defined by the original study authors. The participant demographics further broke down by grade level, with 9% (*n*=975) of the participants in elementary grades, 59% (*n*=6,581) in middle school, and 33% (*n*=3,645) in high school.

### *Classroom*

The classroom location, distinct from the mode of delivery, consisted of five unique categories. The majority (55%, *n*=17) of the studies included in the current analysis implemented the intervention in the general education classroom. An additional 19% (*n*=6) provided the intervention in an inclusion classroom, while only 3% (*n*=1) were provided in a co-taught classroom. The remaining studies were in either a resource classroom (13%, *n*=4) or a self-contained classroom (10%, *n*=3).

### *Content Area*

Nearly 90% of the disciplinary literacy interventions occurred within the broader context of science (65%, *n*=20) or history (23%, *n*=7). The remaining interventions took place within English Language Arts (7%, *n*=2), a summer program that included literacy, math, and STEM (3%, *n*=1), and Career and Technical Education (3%, *n*=1).

### *Classroom and Content Area*

The classroom in which the disciplinary literacy intervention occurred was also explored. The resource classroom accounted for the following disciplinary literacy interventions: two in history, one in science, and one in English Language Arts. The self-contained classroom accounted for three disciplinary literacy interventions in science. The inclusion classrooms implemented two disciplinary literacy interventions in history, three in science, and one across disciplines (ELA, math, and STEM). Meanwhile, the general education classroom implemented 13 disciplinary literacy

interventions in science, two in history, one in ELA, and one in Career and Technical Education.

## Results

### Independent Variables: Components of Interventions Examined in Synthesis

#### Components of Reading

Using the National Reading Panel's (2000) framework, the interventions were evaluated for their inclusion of the five essential components of reading: phonemic awareness, phonics, vocabulary, fluency, and comprehension (see Table 2). The lack of adequate intervention detail in one study prevented a thorough comparison of its components with established reading principles. Among the 30 studies that met the criteria, phonics instruction was not an included intervention component. While two studies (7%) incorporated phonemic awareness instruction, it's important to note that this instruction was exclusively focused on decoding. Two additional studies (7%) included instruction targeting reading fluency. The vast majority provided instruction in vocabulary (53%, *n*=16) and comprehension (80%, *n*=24).

In addition to examining the components of reading included in the intervention, the degree to which the interventions provided a multicomponent intervention was also assessed. The majority of studies (57%, *n*=17) focused on a single reading component; specifically, three provided only vocabulary instruction, while 14 focused solely on comprehension. Eleven studies (37%) provided intervention covering two of the five components of reading. Ten studies included intervention for vocabulary and comprehension and one focused on vocabulary and fluency. Two of the studies reviewed addressed three of the five components of reading. One study addressed phonemic awareness, vocabulary, and fluency while the other provided instruction in phonemic awareness, vocabulary, and comprehension.

#### *Curriculum, Intervention Design, and Implementation*

Nine (29%) of the studies identified a curriculum for the intervention and 28 (90%) indicated that the researcher or a member of the research team designed an element of the intervention. Specific to the mode of intervention delivery, and distinct from the aforementioned classroom location, the vast majority of the interventions were provided during whole class instruction (71%, *n*=22). The next most common mode of delivery, representing 16% (*n*=5) of interventions, was one-on-one instruction. Two studies provided intervention via small group instruction (7%) while two studies delivered intervention across two modes of instruction. One study (3%) was delivered via whole class and small group instruction while the other (3%) was delivered via small group and one on one instruction.

### *Duration and Dosage*

Data on intervention duration and dosage was extracted from each study (see Table 2). The inconsistency and variability of the available data prevented a more comprehensive analysis. For example, five studies (16%) did not provide information regarding the duration or dosage. Intervention reporting varied significantly: some studies provided only duration (e.g., 15 weeks, spring semester), others only dosage (e.g., 45 minutes), and some offered variable details (e.g., 15 to 30-minute sessions 2 to 3 times per week). Only a few studies provided comprehensive duration and dosage information [e.g., 400 minutes (20 minutes for 20 sessions) for seven weeks, 3 days per week].

### *Fidelity*

The studies were examined for evidence of intervention fidelity. Twenty studies (65%) addressed and assessed intervention fidelity within the manuscript. Of those 20, 70% (n=14) reported a high degree of intervention fidelity. However, there was variability with regard to the way in which fidelity was assessed. In some studies, the authors reported "high" fidelity without providing substantive information on the way in which fidelity was measured while others provided detailed information regarding fidelity checklists, rubrics, and the resulting fidelity estimates.

## Dependent Variables: Measurement of Intervention Efficacy

In order to address Research Question 2 and Research Question 3, interventions that resulted in an educationally meaningful effect size were further analyzed. Included below is a summary of the interventions that yielded a medium to large effect size across one or more of the dependent measures (see Table 2, p. 39).

### Summer Program

A study by Reynolds and Yavuz (2022) evaluated the effect of a summer program consisting of reading, writing, and STEM activities on academic performance. The summer program targeted academically at-risk students (i.e., below the 25th percentile on NWEA). The specifics of the intervention were not provided. The results showed a statistically significant improvement in reading. Pre- and post-test comparisons revealed substantial growth, with a large effect size (Cohen's $d$ = 0.84), indicating a strong positive impact. Comparing participants to non-participants, the summer academy group exhibited large growth, more than double that of the non-participants' medium growth. However, even with this growth, participants' mean scores remained below grade level, highlighting the continued need for academic intervention. While participants outpaced non-participants in overall growth, their academic standing remained below grade level.

### Disciplinary Literacy: English Language Arts and Special Education

Howorth and Raimondi (2019) investigated the efficacy of a digitally supported "Think Before, While, and After" (TWA-SD) intervention on the reading comprehension of three 11-year-old male sixth-grade students with Autism Spectrum Disorder during English Language Arts. Using a single-subject research design, the intervention consisted of 12 ELA lessons and included maintenance and generalization assessed in social studies. Each 45-minute session provided explicit instruction in the TWA strategy: "Thinking Before Reading" (purpose, prior knowledge, learning goals); "Thinking While Reading" (monitoring speed, making connections, rereading); and "Thinking After Reading" (main idea, summarizing, reflection). Instruction involved researcher modeling, supported practice, and independent practice. Comprehension was assessed via oral retells and comprehension questions. Results indicated a functional relationship between the TWA-SD intervention and participants' oral retell comprehension as indicated by PEM (Percent Exceeding Mean), PND (Percent of Nonoverlapping Data), and TAU-U (a nonparametric measurement of effect size). The study also demonstrated the maintenance of skills as well as generalization to new content. While effects on the multiple-choice comprehension measure were variable, the overall findings suggest the TWA-SD intervention is effective in improving reading comprehension for male sixth-grade students with ASD, with sustained effects over time.

#### *Disciplinary Literacy: Science*

Goldman et al. (2019) investigated the effectiveness of the READI (Reading for Understanding) intervention in science education. The READI program aimed to cultivate deep comprehension, particularly focusing on students' ability to construct evidence-based arguments from multiple sources. Using a multiple-choice assessment, the study found that the intervention produced a statistically significant positive effect on comprehension. Notably, a large effect size was reported, signifying a substantial and practically meaningful improvement in students' understanding. This indicates that the READI intervention had a powerful impact on how well students comprehended scientific material. Goldman et al.'s research provides strong evidence that the READI intervention, by emphasizing evidence-based argumentation from diverse sources, significantly enhances students' science comprehension, leading to a robust and practically important gain in their learning.

Guzzetti and Bang (2011) examined how a literacy-based forensics approach impacted eleventh-grade students' science learning. The intervention utilized diverse literacy activities, including graphic organizers, concept maps, and facilitated discussions, all structured around the five essential features of scientific inquiry. The study revealed a significant positive impact on students' scientific inquiry skills. Specifically, the intervention demonstrated a large effect size on measures of these

skills, indicating a substantial and practically meaningful improvement in students' ability to engage in scientific inquiry. This suggests that the forensics-themed, literacy-integrated approach strongly enhanced students' scientific thinking and investigation capabilities. Guzzetti and Bang's research provides evidence that embedding literacy activities within a structured inquiry framework, particularly through the engaging context of forensics, can profoundly improve eleventh-grade students' scientific inquiry skills.

Hayden et al. (2019) explored a science-specific vocabulary instruction method involving a five-minute review of randomly selected science words three times a week. Students demonstrated understanding by providing an oral retell or correctly using the word in a sentence as an exit ticket strategy. The study yielded a large effect size for vocabulary knowledge, indicating a substantial and practically meaningful improvement. This robust finding led the authors to recommend vocabulary assessments that mirror their study's approach, specifically advocating for multiple-choice items designed to narrow down definitions and productive sentence-writing tasks, aligning with established assessment research. The researchers attributed their positive results to two key factors: the inclusion of sentence writing, which offers a deeper insight into understanding and application, and the deliberate selection of vocabulary directly relevant to science content, facilitated by effective instructional tools.

Irby et al. (2021) examined a literacy-infused science intervention structured around the 5E hands-on science model (Engage, Explore, Explain, Elaborate, Evaluate). The intervention comprehensively integrated science vocabulary and concepts across listening, speaking, reading, and writing, and utilized technology to enhance learning. The study assessed its impact on two outcomes. On the Iowa Test of Basic Skills, a broad measure of academic skills, the intervention demonstrated a large effect size, signifying a substantial and practically meaningful improvement in student performance. For BISA (Big Ideas in Science Assessment), which focuses on core scientific concepts, a medium effect size was observed, indicating a noticeable, positive impact on understanding. Irby et al.'s research provides evidence that a science intervention integrating literacy, in this case the 5E model and technology, effectively boosts general academic skills and meaningfully enhances students' grasp of fundamental scientific concepts.

Larson (2014) investigated the EngageALL model, an Academic Literacy for Learning framework, in science education. This model comprises four steps: "Situate the Inquiry," "Investigate and Construct Knowledge," "Select and Synthesize Knowledge," and "Generate and Demonstrate Knowledge," all designed to foster deep understanding. The EngageALL model integrated Backwards Design principles, focusing instruction on a "big idea" and authentic performance tasks. A crucial

element was teachers' proactive planning for technical vocabulary and academic language, enabling "spotlighting" -drawing attention to words at relevant moments to aid meaning construction and engagement. This was supported by a Generative Vocabulary Matrix and a language chart. The study measured comprehension using the Persuasive Writing Rubric of the Illinois Standards Achievement Test. Findings revealed a large effect on students' comprehension of the science material. Larson's (2014) study found that the EngageALL model demonstrated a substantial positive impact.

Telesca et al. (2020) examined an explicit metalinguistic approach to sentence combining in science education. The goals were to improve students' sentence combining for science writing and enhance their ability to identify similarities and differences in compare and contrast tasks. The study showed variable results. For science, compare-contrast writing, the intervention had only a small effect and low statistical power. In contrast, the intervention produced a more promising medium effect on content learning, as measured by the student graphic organizer. This indicates a moderately meaningful and practically relevant improvement in students' scientific understanding. Telesca et al.'s research suggests that while an explicit metalinguistic approach to sentence combining had a modest impact on compare-contrast writing, it led to a more significant, medium-sized effect on students' science content learning as demonstrated through graphic organizers.

***Disciplinary Literacy: Science and Students at Risk***

Tong et al. (2014) evaluated a literacy-integrated science intervention for at-risk middle schoolers from low SES backgrounds. The intervention combined 10 minutes of Daily Oral and Written Language in Science (DOWLS activities) with a 5-E instructional cycle (Engage, Explore, Explain, Elaborate, Evaluate), featuring hands-on tasks, direct vocabulary instruction with visual scaffolding, expository text, and science software. Results were mixed. No effect was found on the state Reading TAKS test. While a marginally significant effect ($p$=0.09) suggested treatment students were 2.80 times more likely to pass the state Science TAKS, this was not statistically significant ($p$<0.05). However, the intervention showed a strong, statistically significant positive impact on the District CRT Science test ($p$=0.03), with treatment students having a 97.6% passing rate versus 73.6% for controls, making them 10.28 times more likely to pass. Treatment students also developed Oral Reading Fluency faster and were more likely to pass a reading benchmark test, though only marginally significant. The intervention boosted district-level science achievement, improved oral reading fluency and a reading benchmark, but had no statistically significant effect on state-level TAKS tests.

***Disciplinary Literacy: Science and Emergent Bilingual and At-Risk Students***

Lara-Alecio et al. (2018) investigated a 28-week literacy-infused, inquiry-based science intervention for middle school emergent bilinguals and economically-challenged students. Daily 45-minute sessions utilized the 5E model, incorporating academic vocabulary development, expository text, and various ESL strategies like questioning techniques, visual scaffolding, manipulatives, collaborative grouping, and technology. The Big Idea Science Assessment (BISA) measured student learning. ANCOVA results demonstrated the intervention's strong positive impact. For emergent bilingual students, the treatment group significantly outperformed controls (82% vs. 66% accuracy; $p<0.001$), showing a very large effect size (partial eta squared = 0.294). For non-emergent bilingual economically-challenged students, the treatment group also significantly outperformed controls (84% vs. 79% accuracy; $p<0.001$), indicating a medium effect size (partial eta squared = 0.083). The intervention was statistically significant and meaningfully improved science understanding for both emergent bilingual and economically-challenged middle school students, even after accounting for initial knowledge levels, with a particularly pronounced effect for emergent bilinguals.

***Disciplinary Literacy: Science and Special Education***

Seifert and Espin (2012) investigated a reading intervention for ten tenth-grade students with learning disabilities embedded in biology science texts. The 45-minute sessions included 30 minutes of direct instruction and 15 minutes of data collection. Three conditions were compared: (1) Text Reading (fluency via repeated readings, automatic word identification, error correction), (2) Vocabulary Learning" (definitions, sentence construction), and (3) Combined (elements of both). The study found differential effects. For reading fluency, both the Text Reading and Combined interventions significantly improved performance, demonstrating large effects. The Vocabulary Learning condition also yielded a statistically significant, albeit medium-sized, benefit in fluency. Of note, Text Reading and Combined approaches showed comparable efficacy for fluency. Interventions explicitly targeting vocabulary (Vocabulary Learning and Combined) were highly effective, leading to large to very large improvements in vocabulary matching. These were empirically superior to the Text Reading intervention alone, which did not significantly enhance vocabulary matching. The Combined approach offered no additional benefits for vocabulary beyond the dedicated Vocabulary Learning intervention. Conversely, for reading comprehension, no statistically significant differences were observed across any conditions ($F(3,57)=1.61$, $p=0.20$), despite slight numerical advantages for intervention groups. Seifert and Espin (2012) suggest that targeted interventions for adolescent students with learning disabilities improve reading fluency (via text-reading or combined strategies) and vocabulary (via direct vocabulary instruction).

Carnahan et al. (2016) investigated the effectiveness of a text pattern intervention in enhancing reading comprehension of science textbooks for three students with Autism Spectrum Disorder (ASD), aged 15-16. Using a multiple baseline across participants design, comprehension was assessed by responses to ten science text questions (five explicit, five inferential). The multicomponent intervention involved a text pattern organization guide and a text analysis and summary sheet, focusing on improving science comprehension. Findings demonstrated a functional relationship. All three participants showed increased comprehension during the intervention, which was also maintained in the follow-up phase. Visual analysis, changes in mean and level, and increasing slope support a functional relationship between the intervention and improved reading comprehension.

Carnahan and Williamson (2013) investigated explicit instruction in compare and contrast text pattern to boost science comprehension for three 13-year-old middle school students with Autism Spectrum Disorder (ASD). Using a single-subject reversal design, the intervention systematically taught students to recognize and use compare and contrast structures, including signal words and guiding questions for summarization. Participants also completed Venn diagrams to visualize relationships. The study demonstrated a robust and consistent improvement in comprehension for all three students as a result of the intervention. Evidence for this strong functional relationship included increased percentages of correct comprehension questions, over 90% Percentage of Non-overlapping Data (PND), significant changes in mean across phases, abrupt level changes, and an increasing slope during the intervention phase. This study found that explicit instruction in specific text structures, like compare and contrast, significantly enhances science text comprehension in middle school students with Autism Spectrum Disorder.

Roberts et al. (2019) investigated content area strategies delivered during shared reading to improve science text comprehension for three high school students (ages 17-19) with moderate intellectual disability. Using a single-subject, multiple baseline design, the intervention utilized adapted science texts and a 20-step task analytic lesson plan. The plan included opening procedures, pre-teaching vocabulary (definition, example, non-example, picture symbol), and structured during-reading activities. These involved stopping every four paragraphs to prompt reflection and to complete a graphic organizer. After-reading, students reviewed organizers and created summaries. Comprehension was measured by ten questions (eight multiple-choice, two open-ended). The intervention demonstrated a functional relationship with comprehension. The median Percentage of Non-overlapping Data (PND) was 77%, average correct responses to open-ended comprehension questions increased from 5% in baseline to 75% in intervention. Roberts et al. (2019) provided strong evidence that structured content area strategies in shared reading, incorporating explicit vocabulary and guided reflection with graphic organizers, significantly

enhances adapted science text comprehension for high school students with moderate intellectual disability.

In a similar study, Roberts et al. (2020) evaluated a multi-component literacy intervention for three high school students (ages 15-17) with moderate intellectual disability engaging with science expository text. Delivered via a task analytic lesson plan (15-35 minutes/session) within shared reading, the intervention incorporated: (a) pre-teaching vocabulary with definitions, examples, non-examples, and picture symbols; (b) visual "STOP" signs every four paragraphs for reflection; (c) guided graphic organizer completion; and (d) prompts to summarize after reading. Using a single-subject multiple baseline design, comprehension was measured by ten questions (five multiple-choice, five open-ended; eight literal, two inferential). Baseline average was 4.2 of 10, which dramatically rose to 8.6 of 10 during the intervention. Visual analysis showed minimal overlap between phases, and a median Percentage of Non-overlapping Data (PND) of 93% indicating a functional relationship. Roberts et al. (2020) provided additional support that a multi-component literacy intervention, integrating explicit vocabulary, guided reflection, graphic organizers, and summarization improves comprehension of science expository text for high school students with moderate intellectual disability.

***Disciplinary Literacy: History***

Wissinger et al. (2021) investigated a historical reading and writing strategy intervention for 4th-6th graders, structured around a 5-day lesson sequence within five 1-week historical investigations. The intervention built background knowledge, taught historical reading and writing strategies, and used a cognitive apprenticeship model. Instruction involved contextualizing historical periods, analyzing primary sources, and explicitly teaching the I3C historical reading strategy (Identify author's stance, 3 supporting facts/ideas/reasons, Check limitations/reliability). The final two days focused on writing historical arguments using the “PROVE IT!” strategy (Provide background, Report interpretation, Offer 3 reasons/evidence, Voice other side, Establish rebuttal, Convincing argument check, Total up knowledge). Essays were the primary writing assessment. The intervention showed variable effects. For historical writing and the holistic quality of essays (using the PSSA argumentative writing rubric), a medium effect was observed, indicating meaningful improvements. Essay length, however, saw only a small effect and there was no effect for reading comprehension measured by a multiple-choice test.

Wanzek et al. (2015) evaluated the Promoting Acceleration of Comprehension and Content Through Text (PACT) intervention, a comprehensive program aimed at boosting reading comprehension and content knowledge for 11th-grade U.S. History students. The PACT intervention features five integrated components: a comprehension canopy for unit introduction and prior knowledge activation, explicit

instruction and review of essential vocabulary, critical reading of primary and secondary sources, Team-Based Learning (TBL) comprehension checks with collaborative discussions, and TBL knowledge application tasks. The study employed a randomized experimental design, assigning 23 U.S. History classes to the PACT intervention and 18 to a comparison group. The intervention was implemented across three 10-day units, totaling 30 class periods of 45-50 minutes. Student outcomes were assessed using the Assessment of Social Studies Knowledge (ASK) and the Gates-MacGintie Reading Comprehension subtest. A key finding showed that the PACT treatment group demonstrated a statistically significant improvement in ASK knowledge acquisition at posttest, with an average score 2.80 units higher than the comparison group ($p<0.01$ or $p<0.001$). While statistically robust, the practical impact was modest, indicated by a Hedges g effect size of 0.36, which falls within the small to medium range.

***Disciplinary Literacy: History and Special Education***

De La Paz et al. (2017) investigated an intervention applying a cognitive apprenticeship approach to enhance historical knowledge and writing for students with or at risk of learning disabilities. Recognizing that historical arguments require coordinating conceptual understanding, disciplinary analysis (sourcing, contextualizing, corroborating), and factual information, the intervention was structured around three-day historical investigations. Each investigation systematically taught and practiced historical reading, thinking, and writing with scaffolds. Day one focused on explicit instruction in reading and annotating historical documents, establishing background, and ensuring basic comprehension. Day two progressed to analyzing documents, emphasizing historical thinking about sources (author influence, context, facts/examples). Day three was dedicated to planning and composing argumentative essays, guided by a visual illustration of a five-paragraph essay structure. A central reading strategy was the IREAD mnemonic: Identify author's purpose, Read each paragraph and ask about the author's main ideas, Evaluate the author's reliability, Assess the influence of context (sourcing/contextualizing), and Determine the quality of the author's facts and examples. The intervention also included direct instruction on explicit signals (topic/summary statements, keywords) for text structure and content location. A How to Write your Essay (H2W) graphic organizer further scaffolded essay writing by outlining historical argument components. Evaluating 2058 pre- and post-historical argument essays, the study found a medium effect on historical writing, indicating meaningful improvement in argument construction. Essay length also showed a medium effect, suggesting students wrote more. The holistic quality of essays, however, showed a small effect. De La Paz et al. (2017) found that this cognitively-apprenticeship-based intervention, with its explicit instruction in historical reading, thinking, and writing strategies like IREAD and the H2W graphic organizer,

meaningfully improved historical writing and essay length for students with or at risk of learning disabilities, with a smaller impact on overall essay quality.

O'Connor, Beach, et al. (2017) investigated a comprehensive literacy intervention in history content for 34 eighth-grade "poor readers" and students eligible for special education. The intervention included word study for multisyllabic words, academic vocabulary instruction (definitions, contextual use, discussion), main idea generation (identifying subjects/actions, graphic organizers), compare and contrast (using three-column organizers), and cause and effect (identifying signal words, note-taking for sentences). Results showed significant positive impacts. For main idea generation, students significantly improved, closing an initial achievement gap with peers (ES = 0.52 and 0.16, respectively). Compare and contrast skills also showed a highly significant and practically large interaction effect (ES = 0.16), indicating substantial progress for the intervention group. For cause and effect, a statistically significant and medium-sized interaction effect (ES = 0.07) demonstrated that intervention students significantly improved while comparison peers did not. O'Connor, Beach, et al. (2017) found that this multi-component literacy intervention effectively improved students' ability to generate main ideas, compare/contrast, and understand cause/effect within history content.

O'Connor, Sanchez, and colleagues (2017) evaluated BRIDGES, a two-year reading intervention enhancing reading skills through U.S. history content for 8th-grade special education students. Implemented over three three-week cycles, BRIDGES integrated strategies for decoding multisyllabic words, building academic vocabulary, and developing comprehension strategies like main idea generation, compare-contrast writing, and cause-and-effect identification. The study found that BRIDGES had a significant and positive impact. Students receiving BRIDGES instruction significantly improved in decoding accuracy and multiple-choice vocabulary skills, consistently outperforming comparison groups. The program also enhanced expressive vocabulary knowledge (producing definitions, using words correctly). Beyond foundational skills, BRIDGES significantly improved reading comprehension strategies. Students' ability to identify the main idea, compare and contrast information, and identify cause-and-effect relationships significantly improved, on both taught and untaught content, demonstrating transferable skill development. A MANOVA on end-of-cycle tests confirmed BRIDGES' overall efficacy, showing a statistically significant difference favoring BRIDGES students ($p<0.001$) with a large effect size (partial eta squared = 0.23). The researchers were particularly encouraged by the consistent transfer of comprehension strategies to untaught history units, indicating deep learning.

***Disciplinary Literacy: History and Emergent Bilingual Students***

Martinez et al. (2024) conducted a study on WorldGen, a social studies intervention, for Grades 6-7. The study included 716 students, 42% of whom were emergent bilinguals. WorldGen comprised four components: Comprehension Canopy (background knowledge, purpose), Disciplinary Literacy (critical reading/writing, social studies skills, argumentation), Social Studies Knowledge Acquisition (primary sources, expository texts, videos), and Thoughtbook (content-embedded writing, summarization, evidence collection). It also emphasized academic language with six focus words per unit and integrated Team-Based Learning (TBL). Results showed a significant medium effect (Hedges g=0.41) on history vocabulary, with treatment students demonstrating higher knowledge. For history content knowledge, a moderate positive impact (Hedges g=0.47) was observed, though it didn't reach statistical significance ($p$=0.0763). It was noted that the intervention's effect on content knowledge was similar for both emergent bilingual and non-emergent bilingual students. WorldGen positively impacted both history vocabulary and content knowledge for all students, including emergent bilinguals, though its effect on content knowledge was marginally significant.

## Discussion

A review of disciplinary literacy in both science and history reveals several consistent and impactful recommendations for fostering deeper student comprehension and engagement. It is evident that explicit and targeted academic vocabulary instruction is paramount across both disciplines. In science, this involves a focused, repeated review of disciplinary-specific terms, emphasizing deeper understanding through application and direct relevance to content (Hayden et al., 2019; Larson, 2014). Similarly, in history, vocabulary instruction moves beyond rote memorization, focusing on definitions, contextual use, and active engagement with domain-specific terms (Wanzek et al., 2015; O'Connor, Beach, et al., 2017; O'Connor, Sanchez, et al., 2017; Martinez et al., 2024). This shared emphasis underscores the critical role of specialized language in constructing meaning within each field.

Furthermore, both disciplines highlight the efficacy of multi-component and integrated approaches that blend literacy instruction seamlessly with content. In science, programs like READI (Goldman et al., 2019) and literacy-infused interventions structured around inquiry models (Irby et al., 2021) demonstrate significant positive effects by cultivating deep comprehension through evidence-based arguments and integrated vocabulary across modalities. History similarly emphasizes the deep integration of literacy and content, advocating for explicit instruction in historical thinking skills such as sourcing, contextualization, and corroboration (Wissinger et al., 2021; Wanzek et al., 2015; De La Paz et al., 2017; O'Connor, Beach, et al., 2017; Martinez

et al., 2024). This consistent recommendation suggests that disciplinary literacy is most effective when it is not an add-on, but rather an intrinsic component of how students "do" science or “do” history.

Finally, the strategic use of structured tools and processes to aid comprehension and knowledge construction, particularly through graphic organizers, emerges as a recurring theme. Science literacy interventions consistently cite graphic organizers as effective for processing information and demonstrating content learning (Guzzetti & Bang, 2011; Telesca et al., 2020), with an emphasis on evidence-based argumentation and compare-contrast tasks (Goldman et al., 2019; Telesca et al., 2020). Correspondingly, history education leverages graphic organizers to support text structure awareness for common historical patterns (O'Connor, Beach, et al., 2017; O'Connor, Sanchez, et al., 2017) and to scaffold historical argumentation and writing (De La Paz et al., 2017). The consistent recommendation for these structured tools underscores their utility in guiding students through complex disciplinary texts and fostering their ability to reason, analyze, and construct arguments within the specific demands of each subject.

### Adolescent Literacy and Special Education

Effective interventions for students with disabilities reviewed in the current analysis address moving beyond singular approaches to embrace comprehensive, explicit, and multi-component programs that span pre-reading, during-reading, and after-reading phases. This approach is strongly recommended across disciplines, emphasizing that literacy strategies must be deeply embedded within content instruction rather than taught in isolation.

A critical instructional practice is targeted academic vocabulary instruction. This involves directly pre-teaching key terms using multi-modal presentations—including definitions, examples, non-examples, and visual supports—and reinforcing understanding through active student engagement, such as verbalizing definitions or constructing sentences (Seifert & Espin, 2012). This foundational vocabulary work is vital for both understanding and actively using disciplinary language.

During reading, structured text interaction strategies are paramount. This includes incorporating systematic pauses for reflection, such as using "STOP" signs, and consistently utilizing graphic organizers to guide students in structuring and processing information to identify key details and relationships (Roberts et al., 2019, 2020). Explicitly teaching and prompting summarization after reading further consolidates understanding and main idea identification (Roberts et al., 2019, 2020). Beyond general strategies, explicit text structure instruction is vital, systematically teaching students to recognize common patterns like compare and contrast, along

with signal words, guiding questions, and visual tools such as Venn diagrams or text pattern organizers (Carnahan et al., 2016; Carnahan & Williamson, 2013).

Both history and science emphasize the importance of critically analyzing information for its nuances. While history focuses on sourcing and contextualizing documents, and science on interpreting data and evidence, the underlying principle of disciplined inquiry is shared. This fosters transferable comprehension skills, enabling students to apply their learning to new, untaught content. For students with disabilities, interventions should also prioritize foundational skills like reading fluency through strategies such as repeated readings and automatic word identification, given their significant positive effects (Seifert & Espin, 2012). Utilizing adapted and authentic materials within shared reading contexts enhances accessibility while exposing students to relevant content (Roberts et al., 2019, 2020). While general reading comprehension gains may vary, specific strategies consistently lead to marked improvements in higher-order comprehension aspects, such as responding to open-ended questions and understanding complex text patterns (Roberts et al., 2019, 2020). Finally, providing structured writing support within the discipline is crucial for students to demonstrate their understanding and build arguments effectively. These comprehensive, explicit, and discipline-specific literacy approaches are broadly beneficial across typically developing students, students with disabilities, and emergent bilinguals in history education.

### Emergent Bilingual Adolescents

The limited number of studies explicitly targeting emergent bilinguals in this review restricts the generalizability of the findings. However, given the information available for this review, effective interventions emphasize a comprehensive, explicit, and discipline-specific approach to literacy, integrated directly into content instruction. The WorldGen intervention exemplified this, demonstrating positive effects on both history vocabulary and content knowledge for emergent bilinguals (Martinez et al., 2024). This program's success is attributed to several key components: starting with a "Comprehension Canopy" to build essential background knowledge and establish a clear learning purpose; engaging in "Disciplinary Literacy" to explicitly teach critical reading, writing, and social studies skills relevant to argumentation; and facilitating "Social Studies Knowledge Acquisition" through diverse sources like primary texts, expository documents, and videos (Martinez et al., 2024). WorldGen also incorporated a "Thoughtbook" for content-embedded writing, summarization, and evidence collection, alongside a strong focus on academic language development, introducing specific vocabulary words per unit, and leveraging Team-Based Learning (TBL) for collaborative engagement (Martinez et al., 2024). Notably, the study found that WorldGen's positive impact on both history content knowledge and vocabulary was statistically similar for emergent bilingual and non-emergent bilingual students

(Martinez et al., 2024), suggesting these integrated, explicit, and discipline-specific literacy strategies are broadly beneficial across diverse language proficiencies.

## Implications

Navigating the landscape of adolescent and content literacy research reveals a terrain rich with insights, but is also marked by significant limitations. These limitations often stem from the inherent complexities of studying literacy development in older students, the multifaceted nature of content area learning, and the practical challenges of conducting rigorous educational research. Understanding these constraints is crucial for interpreting existing findings, designing future studies, and making informed instructional decisions.

The instructional recommendations for diverse populations (i.e., emergent bilinguals, students at-risk, special education students) are limited due to the low number of studies that met eligibility criteria for the current analysis. However, of those studies that met eligibility criteria, there was significant variability in how populations were identified. For example, the populations included students who received free and reduced lunch, were below the state criteria for poverty, or were academically at-risk based on existing benchmarks.

The widespread, yet largely unvalidated, use of reading software in educational contexts (Kamil et al., 2008) necessitates immediate and rigorous research. Studies are needed to experimentally or quasi-experimentally determine the actual effectiveness of these technological tools. Without such data, significant school expenditures on reading software remain unsupported by evidence. Future research should not only focus on direct instructional outcomes but also explore the broader potential of technology to cultivate digital literacies, enable truly personalized learning experiences, and enhance professional development opportunities for literacy educators. This body of research is vital for guiding informed decision-making regarding technology integration in adolescent literacy.

Biancarosa and Snow (2006) observed that there is general agreement regarding individual tools that effectively support various types of struggling readers, yet a broader strategy for directing and coordinating those tools to maximize benefits for students at risk of academic failure is still elusive. Additionally, there is currently no consensus regarding the best strategy to most effectively combine existing programs for optimal student progress. Despite this observation from 2006 and ongoing research consistently advocating for multi-component interventions (Goldman et al., 2019; Irby et al., 2021), our current analysis revealed that 57% of eligible studies focused on only a single instructional component. This is a missed opportunity, especially considering that combined interventions are not only more effective but

also more efficient. For instance, Seifert and Espin (2012) found that a combined approach yielded positive effects on reading fluency and vocabulary knowledge in the same amount of time as interventions targeting isolated skills. This highlights a clear need for researchers to explore and develop more effective and efficient multi-component interventions.

The recommendation for all teachers to embed literacy instruction across academic subjects, established by the Common Core State Standards (Council of Chief State School Officers, 2010), faces significant implementation challenges (De La Paz & Wissinger, 2017). A primary obstacle is that many content-area teachers report feeling inadequately prepared to deliver literacy instruction or to support struggling readers, while special education teachers often lack the specific content knowledge needed to reinforce subject-matter concepts (Cawley et al., 2002; Greenleaf & Brown, 2007; Mastropieri & Scruggs, 1992; Moin et al., 2009). This creates a critical disconnect between policy goals and instructional capacity, exacerbated by the persistent pattern that specialized programs for struggling adolescent readers are often confined to special education settings, thus serving only a small fraction of students who could benefit (Kamil et al., 2008). Despite the majority of struggling readers—both with and without identified disabilities—receiving the majority of their instruction in general education classrooms, the studies that met eligibility criteria for the current analysis provided the instruction for students with disabilities in resource or self-contained classrooms.

## Limitations and Future Directions

Educational research, while pivotal for advancing pedagogical practices, is inherently constrained by the intricate nature of human learning and the complexities of educational systems. These limitations frequently impact the generalizability, validity, and practical applicability of findings.

The inherent time and resource constraints in educational research routinely limit the scope and duration of investigations, thereby impeding the precise identification of optimal intervention dosage and duration necessary for realizing maximal student benefit. Providing more detailed information regarding these temporal and quantitative aspects is critical for evaluating the social validity and practical feasibility of educational interventions for widespread implementation. Consequently, future research endeavors should prioritize these "when" and "how much" considerations, transitioning from predominantly short-term assessments to analyses that illuminate sustained impact and the developmental trajectories of literacy skills.

Methodological limitations also pose considerable challenges. Measurement issues persist in developing reliable and valid instruments for complex educational

constructs. Specifically, a need exists for improved assessments of domain-specific skills, such as historical reading, thinking, and writing (Wissinger et al., 2021). Standardized assessments often fall short in capturing the nuanced literacy demands of different content areas or the depth of disciplinary understanding, while researcher-developed measures may lack established reliability and validity. Measuring the transfer of learning remains particularly challenging, yet it is a crucial indicator of true content literacy.

The inherent complexity of content literacy itself presents a significant limitation. Content literacy involves a sophisticated integration of reading, writing, speaking, and critical thinking within the unique frameworks of each discipline, making it difficult for research to isolate the distinct effects of general literacy strategies versus discipline-specific practices. The dynamic interplay between prior knowledge, general literacy skills, and disciplinary thinking further complicates the precise attribution of intervention gains.

While research on adolescent and content literacy has made significant strides in identifying promising instructional approaches, critical limitations persist. Addressing these challenges requires concerted efforts towards greater definitional clarity, more robust methodological designs (including innovative quasi-experimental and mixed-methods approaches), improved and standardized measures of disciplinary literacies, and a commitment to longer-term, ecologically valid studies. Only by acknowledging and actively working to overcome these limitations can the field generate the cumulative knowledge necessary to genuinely enhance literacy outcomes for all adolescents.

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**Articles included in the systematic literature review*

*Figure 1. Summary of the systematic literature search, screening, and review procedures*

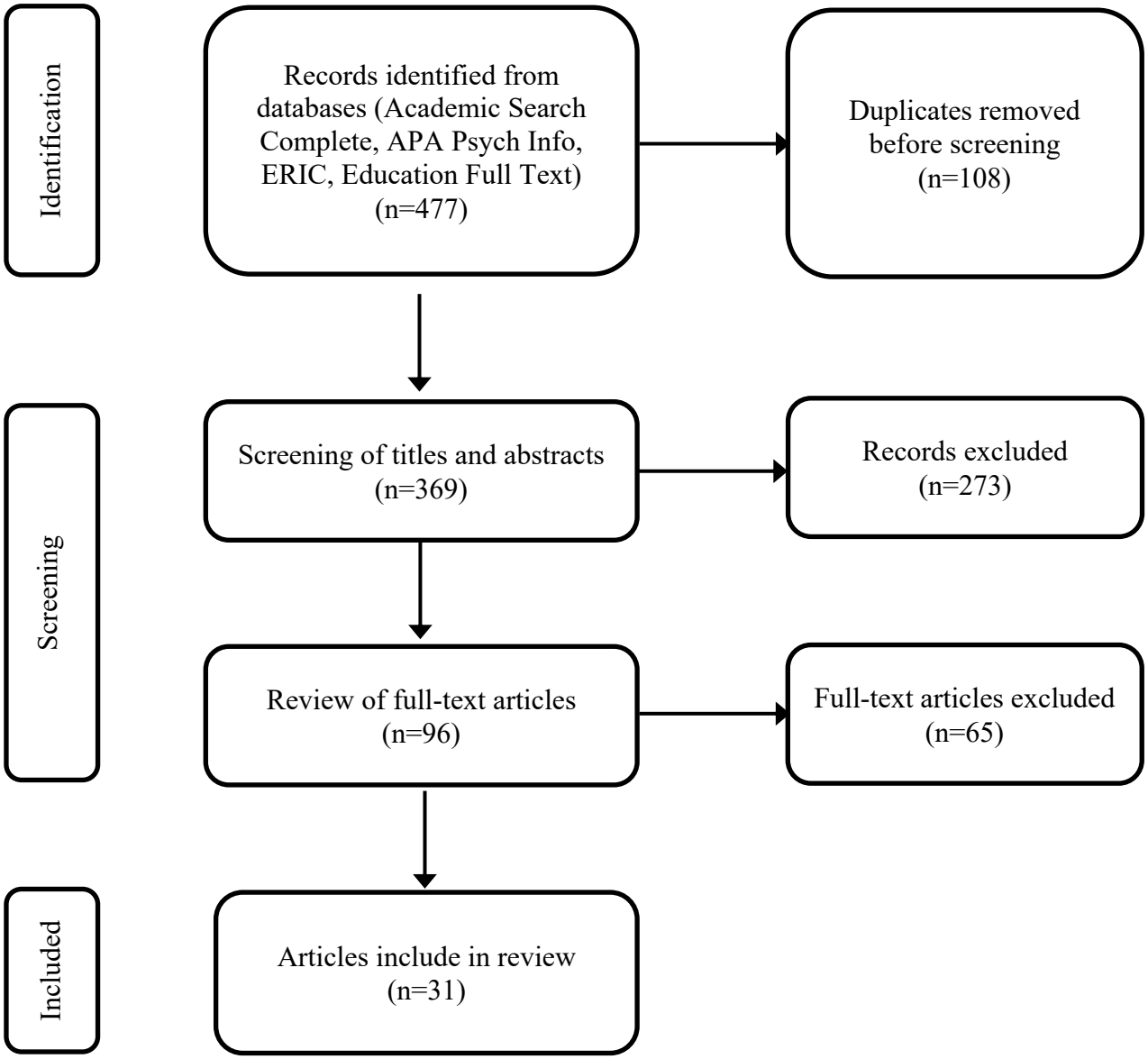


*Table 1. Participant Characteristics*

| **Study** | **Students N** | **Gr 4-5 N (%)** | **Grade 6-8 N (%)** | **Gr 9-12 N (%)** | **EB N (%)** | **IEP N (%)** | **At-Risk N (%)** |
|---|---|---|---|---|---|---|---|
| August et al. (2014) | 1309 | | 1309 (100) | | 353 (27) | | 1204 (92) |
| Block (2020) | 75 | | 75 (100) | | 15 (2) | | |
| Carnahan et al. (2016) | 3 | | | | | 3 (100) | |
| Carnahan & Williamson (2013) | 3 | | | 3 (100) | | 3 (100) | |
| De La Paz et al. (2017) | 1029 | | 1023 (100) | | 54 (5) | 71 (7) | |
| De La Paz & Wissinger (2017) | 39 | | 39 (100) | | | 24 (62) | 31 (79) |
| Echevarria et al. (2011) | 1021 | | | | | | |
| Ferreira & Zygouris-Coe (2013) | 28 | | | | | | |
| Goldman et al. (2019) | 979 | | | 979 (100) | | | |
| Guzzetti & Bang (2011) | 287 | | | 287 (100) | | | |
| Hayden et al. (2019) | 126 | | 126 (100) | | | | 33 (26) |
| Howorth & Raimondi (2019) | 3 | | 3 (100) | | | 3 (100) | |
| Hurst & Griffity (2015) | 80 | | 80 (100) | | | 6 (8) | 6 (8) |
| Inoa et al. (2014) | 1193 | | 1193 (100) | | | | 995 (83) |
| Irby et al. (2021) | 47 | 47 (100) | | | | | |
| Kroeger et al. (2009) | 8 | | 8 (100) | | | | |
| Lara-Alecio et al. (2018) | 276 | | 276 (100) | | 160 (58) | | 116 (42) |
| Larson (2014) | 222 | | | 222 (100) | 5 (2) | 35 (16) | |
| Martinez et al. (2024) | 716 | | 716 (100) | | 302 (42) | | 584 (82) |
| O'Connor, Beach, et al. (2017) | 34 | | 34 (100) | | 26 (77) | 14 (41) | |

| Study | Students N | Gr 4-5 N (%) | Grade 6-8 N (%) | Gr 9-12 N (%) | EB N (%) | IEP N (%) | At-Risk N (%) |
|---|---|---|---|---|---|---|---|
| O'Connor, Sanchez, et al. (2017) | 73 | | | | 15 (21) | 73 (100) | |
| Park et al. (2010) | 1313 | | | 1313 (100) | 52 (14) | | 525 (40) |
| Reynolds & Yavuz (2022) | 512 | 245 (48) | 267 (52) | | 86 (17) | 70 (14) | 330 (64) |
| Roberts et al. (2019) | 3 | | | 3 (100) | | 3 (100) | |
| Roberts et al. (2020) | 3 | | | 3 (100) | | 3 (100) | |
| Saqui et al. (2019) | 4 | 4 (100) | | | | | |
| Seifert & Espin (2012) | 20 | | | 20 (100) | | 20 (100 | |
| Telesca et al. (2020) | 84 | | 84 (100) | | 25 (30) | 16 (19) | 67 (80) |
| Tong et al. (2014) | 288 | 288 (100) | | | | | |
| Wanzek et al. (2015) | 815 | | | 815 (100) | 21 (3) | 74 (9) | 360 (44) |
| Wissinger et al. (2021) | 608 | 391 (64) | 217 (36) | | | 80 (13) | 438 (72) |

*Note.* EB = Students identified as Emergent bilingual, IEP = Students receiving special education services, At-Risk = Students at or below the poverty level or receiving free and reduced lunch

*Table 2. Intervention Characteristics*

| Authors | Tier | Components of Reading | | | | | Dosage | Effect |
|---|---|---|---|---|---|---|---|---|
| | | P | PA | V | C | F | | |
| August et al. (2014) | 1 | | | X | X | | 15 weeks | 3 small effects |
| Block (2020) | 1 | | | X | | | 20 minutes per day for 3 weeks | 2 non-effects |
| Carnahan et al. (2016) | 3 | | | X | X | | Spring semester | 1 large effect |
| Carnahan & Williamson (2013) | 3 | | | X | X | | 16 instructional sessions | 1 large effect |
| De La Paz et al. (2017) | 1 | | | | X | | 18 days of instruction | 2 medium, 1 small effect |
| De La Paz & Wissinger (2017) | 1 | | | | X | | 15 days, or five 40-minute sessions per week for 3 weeks | 4 large effects, 2 non-effects |
| Echevarria et al. (2011) | 2 | | | X | | | NR | NR |
| Ferreira & Zygouris-Coe (2013) | 1 | | | | X | | 10 minutes for 3 weeks | No effect |
| Goldman et al. (2019) | 1 | | | | X | | 20-22 weeks of instruction | 1 large, 1 medium effect |
| Guzzetti & Bang (2011) | 2 | | | | X | | 15 90-minute lessons over 3 weeks | 1 large effect |
| Hayden et al. (2019) | 3 | | | X | | | 5 minutes 3 days per week | 1 large effect |
| Howorth & Raimondi (2019) | 3 | | | | X | | 12 45-minute lessons | 1 large, 1 small effect |
| Hurst & Griffity (2015) | 1 | | | | X | | 2 consecutive units of study | No effect |
| Inoa et al. (2014) | 1 | | | | X | | NR | No effect |
| Irby et al. (2021) | 1 | | | X | X | | 25 weeks 80 minutes daily | 1 large, 1 medium effect |
| Kroeger et al. (2009) | 1 | | | | X | | NR | NR |

| Authors | Tier | Components of Reading | | | | | Dosage | Effect |
|---|---|---|---|---|---|---|---|---|
| | | P | PA | V | C | F | | |
| Lara-Alecio et al. (2018) | 1 | | | X | X | | 28 weeks | 1 large effect |
| Larson (2014) | 1 | | | X | X | | NR | 1 large effect |
| Martinez et al. (2024) | 3 | | | | X | | Four units of nine 50-minute sessions over 8 weeks | 2 medium, 1 no effect |
| O'Connor, Beach, et al. (2017) | 1 | | | X | X | | 36 40-minute lessons | 2 large, 1 medium, 1 small effect |
| O'Connor, Sanchez, et al. (2017) | 3 | | X | X | X | | 36 25-minute lessons | 1 large effect |
| Park et al. (2010) | 1 | | | | X | | NR | NR |
| Reynolds & Yavuz (2022) | 1 | | | | | | 4 hours, 5 days per week for 5 weeks | 1 large, 1 medium effect |
| Roberts et al. (2019) | 1 | | | X | X | | 15-30 minute sessions, 2-3 times per week | 1 large effect |
| Roberts et al. (2020) | 1 | | | | X | | 15-35 minute sessions, 2-3 times per week for 17 weeks | 1 medium effect |
| Saqui et al. (2019) | 1 | | X | X | | X | 15 minutes twice per week for 11 weeks | 1 small, 2 non-effects |
| Seifert & Espin (2012) | 1 | | | X | | X | 45 minutes | 2 large, 1 non-effect |
| Telesca et al. (2020) | 1 | | | | X | | 400 min (20 min for 20 sessions) 3 days per week for 7 weeks | 1 medium, 1 small effect |
| Tong et al. (2014) | 1 | | | X | X | | 85 minutes per day | 1 large, 2 non-effects |
| Wanzek et al. (2015) | 1 | | | X | X | | 30 45-50 minute sessions | 1 medium, 2 non-effects |
| Wissinger et al. (2021) | 3 | | | | X | | Five, one weeklong, historical investigations | 2 medium, 1 small, 1 non-effect |

*Note.* P=Phonics, PA=Phonemic Awareness, V=Vocabulary, C=Comprehension, F=Fluency