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INNOVATION CONFIGURATION

Disciplinary Literacy

Authors:

Zhihui Fang
University of Florida

Jen Drake Patrick
George Mason University

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The CEEDAR Center

University of Florida
Norman Hall
PO Box: 117040
Gainesville, FL 32611

www.ceedar.org
ceedar@coe.ufl.edu
352-273-4259

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Innovation Configuration for Disciplinary Literacy

This paper features an innovation configuration (IC) matrix that can guide educator preparation professionals in the teaching of disciplinary literacy in the preparation of pre-service teachers. This matrix appears in Appendix A.

With the implementation of any innovation comes a continuum of configurations of implementation from non-use to the ideal. ICs are organized around two dimensions: essential components and degree of implementation (Hall & Hord, 1987; Roy & Hord, 2004). Essential components of the IC—along with descriptors and examples to guide application of the criteria to coursework, standards, and classroom practices—are listed in the rows of the far-left column of the matrix. Essential components are derived from the research. See this guide describing CEEDAR's standards for selecting essential components for more information. Several levels of implementation are defined in the top row of the matrix. For example, no mention of the essential component is the lowest level of implementation and would receive a score of zero. Increasing levels of implementation receive progressively higher scores. Essential

ICs have been used in the development and implementation of educational innovations for at least 30 years (Hall & Hord, 2001; Hall et al., 1975; Hord et al., 1987; Roy & Hord, 2004). Experts studying educational change in a national research center originally developed these tools, which are used for professional development (PD) in the Concerns-Based Adoption Model (CBAM). The tools have also been used for program evaluation (Hall & Hord, 2001; Roy & Hord, 2004).

Use of this tool provides data on strengths and needs of educator preparation programs (EPPs) that can assist leaders in ensuring teachers and leader candidates have the knowledge, skills, and practice needed. The IC included in the Appendix of this paper is designed for EPPs, although it can be modified for professional development purposes.

Disciplinary Literacy

It is now widely acknowledged that the process of learning to read does not end in third grade or even elementary school, where foundational language skills (e.g., phonological awareness, phonics, vocabulary, and fluency) and generic literacy strategies (e.g., inferring, summarizing, and rereading) are emphasized. Rather, students need to continue to develop their reading ability in secondary (middle and high) school and beyond in order to handle the more technical and specialized content, as well as the more abstract and dense language, of academic texts in curriculum content areas (Adams et al., 2024; Fang, 2020, 2024; Fang & Schleppegrell, 2008, 2010; Shanahan & Shanahan, 2008). Berman and Biancarosa (2005) spoke to this need two decades ago when they wrote that whilst most adolescent learners can read simple, everyday texts, many "frequently cannot understand specialized or more advanced texts" and "are unprepared to meet the higher literacy demands of today's colleges and workplaces" (p. 6).

Concerns over adolescents' persistent academic underperformance have refueled the debate over effective ways to promote academic literacy in content areas. One proposal is to move literacy instruction in the content areas away from an infusion model, called content area literacy, that promotes the use of basic language skills and generic literacy strategies in content area reading/writing to a discipline-based model, called disciplinary literacy, that emphasizes the teaching of discipline-specific (or, rather, discipline-legitimated/valued) language/literacy skills, abilities, strategies, practices, and habits of mind in content area learning and inquiry (Fang, 2012a; Moje, 2008; Shanahan & Shanahan, 2012). According to Shanahan and Shanahan (2008), for example, as students advance in their schooling, reading and writing instruction "should become increasingly disciplinary, reinforcing and supporting student performance with the kinds of texts and interpretive standards that are needed in the various disciplines or subjects" (p. 57).

This call for a shift from basic literacy (e.g., understanding concepts about print and recognizing high frequency words) and intermediate literacy (e.g., decoding multisyllabic words and monitoring comprehension) to disciplinary literacy (e.g., mastering specialized reading routines and language uses related to particular disciplines) has generated considerable enthusiasm within the literacy education community. Many teacher education programs and professional development initiatives in the United States are now exploring ways to design and implement disciplinary literacy instruction. In these endeavors, a number of conceptual and practical questions about disciplinary literacy have been raised. We address some of the most commonly asked questions about disciplinary literacy in this Innovation Configuration (IC), drawing heavily on a recent state-of-art review on the topic by Fang (2024). The questions we address in this IC are:

- Q1: What is disciplinary literacy and why disciplinary literacy?
- Q2: How do disciplines differ in their literate practices?
- Q3: How can disciplinary literacy be promoted in content area instruction?
    - 1.0 Essential Components of Disciplinary Literacy Instruction for All Content Areas
    - 2.0 Essential Components of Disciplinary Literacy Instruction in Literature
    - 3.0 Components of Disciplinary Literacy Instruction in History/Social Studies
    - 4.0 Components of Disciplinary Literacy Instruction in Science
    - 5.0 Components of Disciplinary Literacy Instruction in Mathematics
- Q4: When should disciplinary literacy instruction begin?
- Q5: Is disciplinary literacy instruction only for the gifted and talented?
- Q6: Are literacy teachers equipped to teach disciplinary literacy?
- Q7: How can disciplinary literacy be assessed?
- Q8: Is there evidence that suggests disciplinary literacy instruction works?

Q1: What is disciplinary literacy and why disciplinary literacy?

Interestingly, although the term disciplinary literacy has been used extensively in recent discussions of literacy instruction in the content areas, a precise, consensual definition of the term remains elusive. Existing scholarship conceptualizes disciplinary literacy in at least five ways. Moje (2008), for example, conceptualized disciplinary literacy as an epistemological stance that involves understanding the key assumptions, unifying themes, tools of trade, and norms of practice for creating, communicating, and consuming knowledge in a discipline. Fang (2012a) explicitly defined disciplinary literacy as "the ability to engage in social, semiotic, and cognitive practices consistent with those of content experts" (p. 19). Shanahan and Shanahan (2008) viewed disciplinary literacy as a new approach to promoting advanced literacy development in academic content areas. Ippolito, Dobbs, and Charner-Laird (2019) identified disciplinary literacy as a new conceptual framework for designing literacy curriculum and pedagogy in the content areas. Additionally, others (e.g., Gabriel, 2023; McConachie & Petrosky, 2010) proposed that disciplinary literacy be understood as a confluence of content knowledge, experiences, skills, and habits of mind related to a discipline.

Despite these varying definitions, most literacy scholars today view disciplinary literacy simultaneously as discipline-specific literacy skills, strategies, abilities, practices, and habits of mind and a new pedagogical approach for promoting these skills, strategies, abilities, practices, and habits of mind (McVee et al., 2023). They often contrast it with content area literacy, viewing both as philosophically distinct approaches to promoting advanced language and literacy development in academic content areas. This contrast highlights the differences in their fundamental assumptions and key tenets. Specifically, content area literacy focuses on developing students' ability to effectively use reading and writing as generic tools for learning

from content area texts (Readence et al., 2019). It promotes explicit teaching of basic language skills (e.g., phonics, vocabulary, fluency, and text structure) and generic literacy strategies (e.g., predicting, questioning, inferencing, summarizing, visualizing, note taking) for universal application across the content areas. Proponents of this approach believe that the cognitive requirements for reading/writing are essentially the same regardless of content areas and that the primary difference among disciplines is in their content (Shanahan & Shanahan, 2012). In a content area literacy model, then, students are expected to use their basic language skills and generic literacy strategies to help them extract and retain information from texts in all content areas.

Unlike content area literacy, which emphasizes discrete literacy learning outcomes (e.g., learning basic language skills such as analyzing word parts or generic literacy strategies such as identifying main ideas), disciplinary literacy emphasizes disciplinary learning outcomes (e.g., learning key concepts, unifying themes, essential practices, and key relationships in a discipline). Its goal is the development of students' ability to engage in social, semiotic, and cognitive practices consistent with those used by disciplinary experts in their professional work (Fang, 2012a). It recognizes that literacy skills/strategies and disciplinary content are inextricably linked and that without the semiotic and cognitive practices of reading and writing, the social practice that makes disciplines and their advancement possible cannot be undertaken. The approach is grounded in the following beliefs:

- School subjects are disciplinary discourses recontextualized for pedagogical purposes.
- Disciplinary texts feature a greater degree of density, abstraction, technicality, formality, and rigor, making them more challenging to comprehend and compose than everyday texts.

- Disciplines differ not just in content but also in the ways this content is produced, communicated, evaluated, and consumed.
- Disciplinary practices such as reading and writing are best learned and taught within each discipline.
- Being literate in a discipline means understanding of both disciplinary content and discipline-legitimated ways of producing, communicating, evaluating, and consuming this content.

Proponents of disciplinary literacy advocate that literacy instruction be anchored in the disciplines and that explicit attention be paid to discipline-specific literacy skills, strategies, abilities, practices, and habits of mind. At the same time, they also recognize the challenges of—and thus does not recommend—wholesale importation of professional disciplinary practices to the content area classrooms (see, for example, Weber et al., 2020). In a disciplinary literacy model, then, while students are not necessarily expected to become junior mathematicians, historians, scientists, or literary scholars, they will learn to use specialized literacy skills, strategies, practices, and habits of mind while engaging in disciplinary learning and inquiry. This model does not, however, preclude simultaneous teaching of basic language skills and generic literacy strategies for students who need them, as long as such instruction is anchored in disciplinary contexts. Moreover, it encourages teachers to teach advanced skills, strategies, and practices that may not be specific to a particular discipline but are used by experts across disciplines in their professional work.

It is worth noting, however, that research (e.g., Chapman, 2015; Fang & Chapman, 2020) has shown that the demarcation line between generic and discipline-specific skills, strategies, or practices can sometimes be blurry and that experts often use both sets of skills, strategies, or

practices in their work. It seems that what makes a skill, strategy, or practice discipline-specific or not depends on the extent to which it is used, as well as the value or level of significance attached to it, in a discipline. For example, sourcing is often considered a reading strategy used by historians (Wineburg, 2001), but it is also used by scientists and mathematicians in their work (Chapman, 2015; Weber & Mejia-Ramos, 2013), albeit not as frequently or with as much significance attached to it.

It has been argued that a disciplinary literacy approach to academic reading/writing offers a more promising way of promoting advanced language and literacy development, with the potential to not only deepen students' content learning but also to enhance their ability to read/write academic and disciplinary texts in more purposeful and powerful ways. As noted literacy scholar Judith Langer (2011) wrote, a disciplinary literacy approach to academic literacy development creates more authentic, motivating contexts in which students can engage productively in "learning the content, language, and ways of thinking and communicating that are considered signs of knowing within each discipline" (p. 157). Because of its foregrounding of disciplinary goals, ethos, epistemologies, and methodologies, disciplinary literacy is believed to be more appealing to content area teachers, who have been perennially resistant to content area literacy, an approach that they see as not aligned with their professional expertise and curricular goals because of its emphasis on literacy, rather than disciplinary, learning outcomes (Moje, 2008) and that has, according to a recent systematic literature review by Scott, McTigue, Miller, and Washburn (2018, p. 2), produced "underwhelming" results despite decades of large-scale inclusion in teacher preparation programs.

Q2: How do disciplines differ in their literate practices?

The underlying assumption of disciplinary literacy is that academic disciplines are

distinct discourse communities, each with its own ways of producing, structuring, critiquing, communicating, teaching, and learning knowledge. This section describes some of the ways core disciplines of literature, history, science, and mathematics differ in their literate practices.

Literature

Literature is a major component of the English language arts (ELA) curriculum. It is a discursive, interpretive discipline. The texts used in the discipline include prose fiction (e.g., short stories, novels, novellas), poetry (e.g., free verse, sonnet, epic), and drama (e.g., play, ballet, opera). These genres feature aesthetic, poetic, and playful use of language. They open readers up to a world of values, viewpoints, concerns, and experiences that define human reality, inviting ethical and epistemic reasoning about issues and challenges that students have to wrestle with in their own lives. They give readers pleasure, provoke their imagination, elicit their thoughts and feelings, broaden their horizons, promote debates about controversial social issues, and ultimately help them better understand themselves and others around them (Lee, 2011).

Literary reading is "a constructive act, often requiring one not only to decode texts but also to encode meaning in them based on prior experiences" (Smagorinsky, 2015, p. 144). This means that reading a literary text is about more than comprehending setting, characters, and plot; it is essentially an interpretive process requiring readers to draw on their prior knowledge and experiences to notice important signals, impose significance or meaning to these signals, make and confirm conjectures, establish intertextual links, conduct detailed analysis, perform critical evaluation, dwell on figuration and imagery, seek meaning patterns, and distill themes (Goldman et al., 2016).

Research (e.g., Chapman, 2015; Peskin, 1998; Rainey, 2016; Reynolds & Rush, 2017; Warren, 2011; Zeitz, 1994) has shown that literary experts do not just focus on basic plot

elements of the text in their reading; instead, they move beyond surface-level comprehension to analysis, evaluation, and description, attempting to offer an original way of thinking about the central theme or puzzle featured in the text. They predict, reread, backtrack, examine, underline, annotate, connect, imagine, summarize, source, and contextualize as they seek to both decipher the plain sense of the text and explore its deeper meaning and literary significance. They draw on their extensive knowledge about literary traditions and disciplinary standards to help them identify patterns of meaning, clear up confusions, and wrestle with interpretive problems. At the same time, they also actively attend to linguistic and discursive features of the text to appreciate its artistry and to seek clues that may suggest a particular angle for reading or support a particular interpretative lens. They gain satisfaction and joy from the hard work of trying to generate a robust interpretation with the ring of originality.

History

History—the most inclusive and pervasive of the social studies—is the study of the human past. Historians use written documents and other artifacts (e.g., photos, paintings, and tools) left behind by people in an effort to construct narratives, explanations, or arguments about what really happened yesterday or centuries ago so that we can have a better understanding of the world (e.g., ourselves, other people, and how/when/why change occurred) and make more informed decisions about today's complex questions, issues, and dilemmas. The construction of these narratives, explanations, or arguments is not a process of simply cataloguing names, dates, events, and other "facts;" it is, instead, a process of "constructing, reconstructing, and interpreting past events, ideas, and institutions from surviving or inferential evidence" (Ravi, 2010, p. 36). This process involves careful selection, in-depth analysis, and critical evaluation of existing (old and new) historical records.

Because historical texts—whether they are from primary, secondary, or tertiary sources—do not just consist of a body of facts and events, reading these texts involves critical analysis and evidence-based interpretation. Research (e.g., Wineburg, 1991a, 1998; Shanahan et al., 2011) has investigated how historians read texts in their discipline. This work found that historians recognize that every historical text has a subtext, treating it as both "a rhetorical artifact" and "a human artifact" (Wineburg, 1991b, p. 498). In order to understand the subtext, historians go beyond literal comprehension to try to reconstruct the author's purposes, intentions, and goals and at the same time detect their assumptions, beliefs, and worldviews, using strategies (also called protocols or heuristics) such as sourcing, contextualizing, corroborating, close reading, perspective taking, and inferring (Nokes, 2013; VanSledright, 2002; Wineburg, 2001).

In sourcing, historians note the author's identity, affiliation, and perspective, their purpose for creating the document, and their intended audience, as well as the venue in which the document was published. In contextualizing, historians situate the document in the context of its production, considering how its construction may have been influenced by what was taking place locally, nationally, and even internationally at or around the time of its creation. In corroborating, historians compare multiple historical documents to see if key details across these sources repeat, complement, agree with, or contradict one another so that they can reconcile differences in accounts, determine acceptable facts, and identify credible evidence. In close reading, historians slow down, reread portions of the text, and examine text structure as well as verbal and visual choices, hoping to understand the nuances or significance of particular signs (words or images), detect the author's position or attitude, and determine whether/how the semiotic and rhetorical choices made by the author may have shaped their responses to the text in some way. In perspective taking, also called historical empathy (Davis et al., 2001), historians put themselves

in the shoes of the historical character, trying to understand the motivation, sequence, and consequences of their actions strictly on the basis of historical facts and events, without resorting to their own frames of reference or preconceived notions. In inferring, historians make inferences about "historical motives, purposes, causes, or trends;" they draw on prior knowledge and use "principled imagination" to help fill in the gaps when historical documents provide incomplete information or are silent on certain historical details (Nokes, 2013, p. 16). These strategies help historians discern patterns, weigh evidence, and resolve contradictions as they work through historical documents in an effort to produce reasoned, evidence-based interpretations of the past.

Science

Science is both a body of knowledge about how things work in the universe and a process for discovering, generating, explaining, cataloguing, communicating, critiquing, and renovating that knowledge. Reading (or literacy) is not an adjunct to the practice of science but an essential component of engaging with science (Fang, 2010; Patterson et al., 2018). In the words of science educators Stephen Norris and Linda Phillips (2003), the ability to access, comprehend, critique, and create science texts is fundamental to becoming "knowledgeable, learned and educated in science" (p. 224).

But reading in science means more than just the ability to comprehend and recite information in the text; it also involves critically analyzing and evaluating what is read and drawing inferences based on the evidence presented and/or reasonable assumptions. As science educators Jerry Wellington and Jonathan Osborne (2001) pointed out, "To be capable of reading carefully, critically, and with a healthy skepticism is a vital component of being a scientist" (p. 42). Scientists must accurately assess the validity of knowledge claims, the quality of evidence, the logic of argument, and the coherence of claims in relation to the established body of

knowledge in the field in order to produce and renovate knowledge (Yore, 2004). Moreover, to read and reason in science, students "need to develop competence in using and integrating both linguistic and non-linguistic modes, including visual, mathematical, and embodied/actional modes" (Prain, 2022, pp. 152-153).

Studies of how scientists read in their professional practice have found that scientists demonstrate "an extraordinary commitment to the literatures of their fields" (Bazerman, 1985, p. 22), working hard to keep up with the research literature and using the literature to inform the work they do. During reading, scientists employ a range of strategies—including recursive reading, rereading, inferring, asking questions, previewing, scanning, skimming, sourcing, selective reading, drawing on prior knowledge, detailed reading, transduction, evaluating, verifying, and connecting visuals with prose—to help them make sense of and evaluate the information presented in the texts they read (Bazerman, 1985; Chapman, 2015; Shanahan et al., 2011; Unsworth et al., 2022). These strategies constitute the meaning-making repertoire that enables scientists to engage deeply, critically, and productively with texts in their literate practice.

Mathematics

Mathematics is the study of quantity, space and shape, change and relationship, order, and uncertainty involving objects such as numbers, points, and lines (Ojose, 2011). Mathematicians work to "seek out patterns, formulate new conjectures, and establish truth by rigorous deduction from appropriately chosen axioms and definitions" (Tennessee Tech University, n.d., para. 1). They draw on not just verbal resources (i.e., natural language) but also mathematical symbols (e.g., $\sum$, $f(\chi)$, π, η, μ, and β) and images (e.g., graphs, diagrams, and tables) to construct and communicate meaning. Each of these semiotic resources works in close

partnership with the other two to create and disseminate mathematics knowledge, with mathematical symbols providing a highly concise but rigorously accurate description of the nature of the relationship among mathematical entities, images rendering this abstract description concrete to human perception through visual representation, and language offering contextual information related to the symbolically and visually described situation (O'Halloran, 2000).

To effectively engage with mathematics texts, students need to read, comprehend, and use the mathematics register (Halliday, 1978), or the typically dense and technical language of mathematics. They also need to be able to read and understand mathematical expressions (e.g., formulas and equations) so that they "know what steps to perform, how to perform them, how to record and make sense of intermediate results, and how to review a series of computations for accuracy" (Siebert & Draper, 2012, p. 182). Additionally, students of geometry need to know "how to interpret symbolic notation in a diagram such as markings for angles, how to identify relevant parts within a diagram's configuration, and how to purposefully add auxiliary lines that would aid in proving geometric properties" (Gonzalez, 2021, p. 88). Thus, issues with reading may affect students' understanding of verbal descriptions, interpretation of visual elements (e.g., graphs, symbols), evaluation of mathematical proofs, construction of mathematical explanations or arguments, and ultimately, chance of success in solving mathematics problems.

Research (e.g., Fang & Chapman, 2020; Fang et al., 2023; Inglis & Alcock, 2012; Shanahan et al., 2011; Weber, 2008; Weber & Mejia-Ramos, 2011; Wilkerson-Jerde & Wilensky, 2019) has shown that mathematicians engage in wide reading and use a variety of strategies to help them make sense of the texts they are reading. These strategies include rereading, zooming in (i.e., close reading), zooming out (skimming), deconstructing, coordinating, sourcing, corroborating, monitoring, questioning, evaluating, verifying,

summarizing, paraphrasing, storying, drawing on prior knowledge and experience, connecting visual with prose, note-taking, visualizing, and imagining. They constitute the meaning-making repertoire that mathematicians regularly employ in their literate practice.

Q3: How can disciplinary literacy be promoted in content area instruction?

Because disciplines differ in their goals and literate practices, ways of promoting disciplinary literacy look different across disciplines. This section describes some specific ways disciplinary literacy can be promoted in literature, history, science, and mathematics.

Literature

Developing the sort of expertise demonstrated by literary experts takes a considerable amount of time, experience, and support. While it is certainly not the goal of literature instruction in K-12 contexts to make literary experts of students, English language arts (ELA) teachers should aim to help students develop the capacity to read and reason with literary texts in ways that align with how literary scholars interact with literature, including (a) using literary strategies to identify plot elements and rhetorical devices; (b) synthesizing within and across texts to construct generalizations about theme and characterization; (c) recognizing key structural and linguistic choices made by the author and understanding the functions of these choices; (d) using academic language to construct written arguments with claims, evidence, and warrants; (e) establishing criteria for judging interpretive claims and arguments; and (f) demonstrating understanding that there are multiple interpretive possibilities for every text (Goldman et al., 2016, p. 11). These literary literacy goals are consistent with what the Common Core State Standards recommended for the study of literature, as can be seen in the sample English Language Arts standards for eighth grade below (National Governors Association Center for Best Practices [NGA] & Council of Chief State School Officers [CCSSO], 2010):

- Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
- Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.
- Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style.
- Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new.

To achieve these disciplinary learning goals in the teaching of literature, ELA teachers need to establish a classroom culture that promotes communal reading and guided discussion of text (Elliott, 2021). That is, students need opportunities to read and reread a wide range of literary texts, paying close attention to textual details such as setting, characterization, plot structure, language choices, and literary devices. Students also need time to talk with peers about what they have read, engaging in conversation that uses textual evidence and prior knowledge or experience to explore questions about characters, plots, themes, motifs, contexts, and values (Elliott, 2021). Teachers can ensure that their students experience thoughtful reading and productive conversation about literature by implementing practice that includes these essential components: (a) conducting critical inquiry, (b) teaching literary techniques, (c) using cultural modeling, (d) teaching literary theories, and (e) modeling close reading.

(a) Conducting critical inquiry: To promote communal reading and guided discussion of literature, teachers can adopt the critical inquiry approach proposed by Beach et al. (2015). The approach emphasizes critical engagement with literature through collaborative exploration of a

meaningful issue or an intriguing problem that piques students' interest (e.g., conflict with authority, coming of age, loyalty). It encourages students to draw on their prior knowledge and experience, make intertextual connections, construct identities, collaborate with others, ponder the significance of particular details or the overall work, use digital tools and apps to respond to and create texts, and share responses as they read, analyze, and critique literary works of common interest. It is also important for teachers to encourage students to identify, pursue, and communicate about significant literary puzzles or questions, showing students how to construct literary puzzles that explore the significance of a particular feature of a text or question how different parts of a text work together as a system to achieve its central purpose (Rainey, 2016).

(b) Teaching literary techniques: Literature is an artistic creation, and as such, it typically employs a range of literary techniques that add nuances to, contradict, or create image for meaning. These devices include allegory, allusion, anaphora, characterization, conflict, irony, epistrophe, euphemism, flashback, foreshadowing, hyperbole, imagery, mood, motif, paradox, parallelism, personification, plot, point of view, pun, satire, symbolism, theme, understatement, and others that can help with the interpretation of text. Recognizing, pursuing, and understanding these devices is crucial to literary interpretation and appreciation (Lee & Spratley, 2010). In John Steinbeck's (1939) *The Grapes of Wrath*, for example, literary devices such as allusion, symbolism, and foreshadowing are used. Steinbeck named the original place that the Joad family lived Dustbowl, which alludes to the desert of Egypt in the Bible—a dry, uninhabitable place. The term foreshadows the plight that the Joads would encounter in their westward journey. Route 66 is, likewise, religious symbolism in that it alludes to the treacherous journey that the Israelites took to escape the desert in Egypt (and associated oppression and slavery) to the Promised Land where freedom and a better life can be found. Thus, the road symbolizes hope for

the Joad family since they too were embarking on a journey, similarly filled with trials and tribulations, to an expectedly better life in the fertile land of California. There are also many instances in the novel where blood is used to symbolize death (e.g., the death of the Joad family dog, the fight with the police, blood from the work being done on the farm). These literary devices help add depth to meaning, create more vivid pictures of what the author tried to convey, build connections between characters and themes on a deeper level, and keep the reader actively engaged with the unfolding plot.

(c) Using cultural modeling: Another way of supporting students to develop literary expertise is through "cultural modeling" (Lee, 2001), an approach to literary instruction that encourages teachers to identify potential points of synergy and differences between problem solving in an everyday domain and problem solving within an academic subject such as literature. Teachers then draw upon what students already know and are capable of doing to help accomplish their instructional goals. For example, when a high school ELA teacher found that some of her African American students had trouble interpreting symbols in canonical literary texts even though they routinely encountered and made sense of metaphor and symbols in a variety of out-of-school contexts (e.g., church and street), she chose texts from African American youth culture (e.g., rap lyrics, rap videos, short films, and film clips), which are rife with symbols with which students are familiar, to teach them how to identify literary symbolism and construct logical, warrantable claims in literary interpretation. She helped students recognize the similarities between what they did to interpret youth culture texts and what they could do to interpret canonical literature that also involves major attention to symbolism. The instruction led students to better interpret and appreciate literary texts.

(d) Teaching literary theories: Teachers may also consider explicit teaching of

contemporary literary theories, such as reader response theory, and others (Appleman, 2015). Each of these theories provides a different lens that gives readers an alternative way of looking at literature, helping them uncover themes, ideologies, and other invisible workings of the text and avoid what Reynolds et al. (2021, p. 59) called "interpretive monism," the idea that there is only one right interpretation for the text and students' job is to find and defend that interpretation.

(e) Modeling close reading: Finally, to help students learn to generate justifiable interpretations, teachers also need to model the practice of close reading, showing students how the semiotic (verbal/visual) and rhetorical choices the author made contribute to the overall meaning of the text and may affect their responses to the text (Adams & Fang, 2020). For example, Annabelle Lukin (in Fang & Schleppegrell, 2008) demonstrated how close reading of an untitled sonnet by the great American poet Edna St. Vincent Millay can help students generate linguistic evidence to support a particular interpretation of the poem. The poem involves an address by a female speaker to her lover about the nature of their relationship. By systematically attending to and analyzing various language patterns and their functions in the text, students will be able to build up a case about the overall meaning, or point, of the poem. Specifically, an examination of line, punctuation, and rhyme scheme reveals that the sonnet consists of two global moves (i.e., observation and conclusion), each organized around an opposition. An exploration of speech function (statement, question, offer, command), mood (declarative, interrogative, imperative), and modality (modal verbs like *may* and *would*) reveals the power relationship between the two central characters in the poem—the speaker (she) and the addressee (her lover). An analysis of the cohesive resources (e.g., pronominal and vocabulary choices) reveals the dominant motif in the poem—conflict between the speaker's emotional/physical feelings and her intellectual reasoning. An analysis of patterns of verbs (processes) and nouns

(participants) reveals that the speaker has a more commanding role, relative to the addressee. An examination of what begins each clause (i.e., grammatical subject) in the poem similarly shows the dominance of the speaker. Through such close reading with detailed linguistic analysis, students are then in a position to develop a justifiable interpretation that answers three key questions germane to the poem: (a) What is the speaker saying to her lover? (b) How is their relationship depicted? and (c) What sense does the poem communicate about the two lovers?

History

Unlike experts whose reading of history is sophisticated and complex, students read history much more superficially, likely due to a lack of deep historical knowledge, extensive experience with historical inquiry and reasoning, and explicit instruction on how to interact with historical texts. Typical practices of the history/social studies classrooms do not support the development of disciplinary literacy in history, as they tend to rely only on textbooks and focus on content coverage and basic reading comprehension and summary (Hynd, 1999; Monte-Sano, 2011; Reisman, 2012; Schall-Leckrone, 2017; VanSledright, 2012). A disciplinary literacy approach to historical reading foregrounds historical inquiry and historical thinking, providing scaffolded opportunities that engage students in discipline-valued practices such as asking historically significant questions, identifying and reading relevant historical sources, analyzing and interpreting historical data, undertaking causal reasoning, grappling with historical issues and problems, synthesizing across sources, and developing/refining/revising interpretation (Nokes, 2013). It makes learning history more than just identifying and reciting "facts," aiming, instead, to promote a sophisticated understanding of historical time, agency, and causality (Coffin, 2006) and to develop students' capacity to learn to read, write, and think like historians (VanSledright, 2002; Wineburg, 2001). Ultimately, the approach hopes to address what the C3

(College, Career, & Civic Life) Framework for Social Studies State Standards (NCSS, 2013) expect students to be able to do in learning history, including:

- construct compelling and supporting questions that can frame and advance historical inquiries,
- locate, assess, and use historical sources to answer these questions and develop arguments about the past,
- understand the value-laden, contested, and evolving nature of historical interpretation,
- evaluate historical interpretations for coherence, completeness, the quality of evidence, rigor of reasoning, and authorial perspective, and
- apply historical thinking and inquiry process to make decisions and take action on civic matters within and outside school contexts.

There are several essential components to this approach. They are (a) using multiple sources, (b) teaching historical reading heuristics, (c) conducting close reading, and (d) writing argument from sources. These components are key to achieving the historical literacy described above.

(a) Using multiple sources: Because history is an interpretive discipline grounded in evidence, historians must take information from different sources and try to piece together a multi-dimensional view of history (VanSledright, 2002; Wineburg et al., 2011). This sort of interpretive work is very much like detective work or jigsaw puzzles, requiring historians to evaluate witness accounts, find missing pieces, and stitch together seemingly discrete pieces of information into a coherent account and reasonable interpretation of the past. Thus, the number and quality of historical sources will no doubt affect the quality and credibility of interpretation. The more diverse, complete, and reliable sources are, the more well-rounded, accurate, and

credible interpretations are likely to be. Using diverse sources—primary, secondary, or tertiary—enables students to have a more accurate and complete picture of the historical details related to the event, person, or location under study. It also helps students build their background knowledge, challenge their misconceptions, broaden their horizons, and develop their analytical and critical thinking skills (Hynd, 1999).

(b) Teaching historical reading heuristics: As students interact with multiple sources, they should be encouraged to read like a historian, using the historical reading strategies (protocols/ heuristics) such as inferring, sourcing, contextualizing, corroborating, close reading, and perspective taking. Because students rarely read history texts the way historians do, they need explicit instruction in how and when to use these strategies, as well as why the strategies are important (Nokes, 2013). The instruction can follow a "gradual release of responsibility" model described by Pearson and Gallagher (1983). Specifically, the teacher introduces a strategy, explains what it is and why it is important, and discusses when to use it and how to use it. This is followed by the teacher modeling the use of the strategy in a meaningful context. Once students have had the opportunity to observe how the strategy works in disciplinary contexts, they can then work together in small groups to try out the strategy as they engage in reading multiple sources. Next, students independently apply the strategy in a meaningful assignment. It is possible that some students may need further support after this instructional cycle. Such support can be provided through small group and/or individual instruction after an assessment of their learning needs.

(c) Conducting close reading: Close reading aims to develop a deep, precise understanding of a text's message, form, and craft through careful attention to and critical analysis of language and image in the text (Fang, 2016; Fang & Chapman, 2015). Teachers can

support students' close reading of historical texts by showing them how to work through the challenging language of these texts. One way to accomplish this is through functional language analysis, or FLA (Fang, 2021; Fang & Schleppegrell, 2008, 2010; Schleppegrell & Achugar, 2012). FLA draws on a meaning-based theory of language, called systemic functional linguistics (Halliday & Matthiessen, 2014), that offers tools for analyzing how academic and disciplinary texts construct meanings and suggests ways of engaging students in close analysis of those meanings in context. It scaffolds students' understanding through intensive work with a single text or text segment, focusing on the ways different meanings are presented in language patterns. The analysis examines the language of a text from three angles: (a) What is the text about (i.e., experiential meaning)? (b) What is the author's perspective (i.e., interpersonal meaning)? and (c) How is information in the text organized (i.e., textual meaning)? To explore the experiential meaning, students analyze the meaning of each clause constituent—verbs (denoting action or state of being), nouns (denoting participants), adjectives (denoting qualities of participants), adverbs (denoting manner of action), and prepositional phrase (denoting manner and circumstance of action). To explore the interpersonal meaning, students analyze word choices—such as hedges (e.g., *possible*, *may*, *seems*), boosters (e.g., *of course*, *it is clear*), adjectives (e.g., *full blame, huge reparations*), adverbs (e.g., *to some extent, significantly*), verbs (*order* vs. *ask*, *impose* vs. *put*), and nouns (e.g., *massacre* vs. *incident*, *crowd* vs. *mob*, *invasion* vs. *special military operation*)—for authorial attitudes, evaluation, and perspective. To explore the textual meaning, students analyze what begins each clause, how clauses are combined, and how discursive flow is created.

(d) Writing argument from sources: Because a historian's job is to construct written interpretations of the past based on multiple sources, it is only logical that students learn to write

from sources. In particular, they need to learn how to make a case in writing for a particular claim about, or interpretation of, the past. A pedagogical model that teachers can use to teach argumentative writing is the "genre teaching-learning cycle" (Fang, 2021). The model consists of four stages: building knowledge and context, analyzing model text(s), playing with language, and constructing text(s). In the first stage, students explore a historically compelling question or controversy that interests them or is important to the curriculum. The exploration involves reading historical texts from multiple sources, as well as other activities that are authentic to the discipline (e.g., taking field trips, interviewing historical figures, examining physical artifacts, watching documentary films). In the second stage, model argumentative essays in history are selected for close reading and detailed analysis, with particular attention to how experts use language/semiotic resources and other composing strategies to make historical meanings in discipline-legitimated ways that help them accomplish the purpose of the genre. Next, the teacher designs language-based tasks and exercises that help students develop proficiency with key, unfamiliar, or challenging features of historical discourse. In the final stage, the teacher encourages students to use some of the key or unfamiliar language features discussed earlier as they attempt to write a historical argument from multiple sources. Students are guided through the composing process of annotating, summarizing, and paraphrasing the text, generating ideas, creating drafts, making revisions, and publishing their work, with an emphasis on revision, where special attention is given to the selection and use of evidence in support of argument and to the power of vocabulary and grammar in shaping, clarifying, sharpening, and manipulating meaning in ways that serve the writer's purpose and meet disciplinary standards. For struggling writers, especially those with learning disabilities, further scaffolds can be provided for their composing process using the self-regulated strategy development model (Harris & Graham,

1996). The model, which is an intervention designed to improve students' academic skills, explicitly teaches general writing strategies (e.g., planning, drafting, and revising) along with procedures for regulating these strategies and the writing process (e.g., goal setting, task analysis, self-monitoring, and self-instructions). It involves providing background knowledge, discussing the strategy with the student, modeling the strategy, helping the student memorize the strategy, supporting the strategy, and then watching as the student independently perform the strategy.

Science

The privileging of language and literacy in science means that science educators must give prominence to reading and writing in science teaching and learning (Fang, 2010; Patterson, et al., 2018; Wellington & Osborne, 2001). National standards in science education, such as the Next Generation Science Standards (NGSS Lead States, 2013), recognize the centrality of reading and literacy to science education, calling on science teachers to promote language use and support reading/literacy development in service of scientific inquiry, learning, and sense making (Lee et al., 2013). The eight science and engineering practices identified by the NGSS as central to science learning—asking questions and finding problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanation and designing solutions, engaging in argument from evidence, and evaluating and communicating information—cannot be effectively undertaken without reading/literacy.

But science reading is challenging for many students because of the complexities of science texts. As disciplinary science discourses recontextualized for pedagogical purposes, school science texts present technical content and abstract concepts that are often unfamiliar to students, contain implicit logical-semantic relations that can be difficult for students to discern and interpret, infuse authorial points of view in subtle ways, and use language patterns that are

dense and complex (Fang, 2005, 2006; Halliday & Martin, 1993; Zhu & Fang, 2019). As such, they place considerable processing demands on reading and understanding, requiring students to have the content knowledge, academic language skills, and literacy strategies that are specific to science. Science teachers can address these reading challenges by helping students in these three essential components: (a) build science content knowledge, (b) develop science language proficiency and multimodal competence, and (c) learn to read like a scientist.

(a) Building science content knowledge: Because background knowledge plays an important role in reading comprehension (Cervetti & Wright, 2020; Smith et al., 2021), explicitly building knowledge, especially domain-specific content knowledge about science, should be a key piece of science reading instruction. One obvious way of building students' science content knowledge is to engage them in the firsthand experience of doing science (e.g., experiments, observations) (Kontra et al., 2022). However, not all science concepts, principles, ideas, or processes can be experienced firsthand in school classrooms, due to issues related to resource, teacher expertise, feasibility, or ethics. Thus, a more convenient way of building science content knowledge is through text reading, as "texts are frequent and powerful tools for conveying scientific facts, principles, and explanations" (van den Broek, 2010, p. 456). Students should be provided opportunities to read and discuss many texts on a variety of topics related to nature of science, physical science, life science, earth and space science, and engineering, technology and applications of science. This variety can be found in science trade books (see, for example, the NSTA Outstanding Science Trade Books for Students K-12 for annual lists of quality science trade books) and magazines (e.g., *Kids Discover*, *Science News for Students*). Teachers can engage students in reading these quality trade books and magazines by conducting read alouds, unit studies, biographical studies, book studies, author studies, and genre studies (see Fang, 2010

for details).

(b) Developing science language proficiency and multimodal competence: Science language is a linguistic register functional for construing scientific knowledge, habits of mind, and worldviews. This language is technical, abstract, dense, formal, metaphoric, tightly knit, and complex, epitomizing the sort of academic language that students find forbidding and alienating (Fang, 2005, 2006). One way to develop students' science language proficiency is to provide explicit instruction about science language in authentic contexts of science reading so that they understand what science language looks like, what it means, what its discursive functions are, and why it is needed in scientific meaning making. Such instruction can be provided during close reading sessions, where attention is given to the lexical, grammatical, and other discursive choices the author has made in constructing the text (e.g., Fang et al., 2019; Fang & Chapman, 2015; Fang & Colosimo, 2023; Fang & Schleppegrell, 2010). It can also be conducted using language-based tasks designed to increase students' understanding of and facility with science language at the levels of word (e.g., morphemic analysis, vocabulary think chart, conception definition word map, word sort), phrase (e.g., noun deconstruction, building noun trains, noun search), sentence (definition game, sentence combining, syntactic anatomy, and integration), and discourse (e.g., sentence completion, noticing textual signposts, and paraphrasing) (see Fang, 2010 for details).

In addition, teachers need to help students develop the ability to comprehend and understand science multimedia genres (Hand et al., 2016; Kress et al., 2001; Martin & Unsworth, 2024; Unsworth et al., 2022). Lemke (2004), for example, encouraged teachers to make greater use of gestural and visual representations and numerical tables and graphs in their instruction and to provide opportunities for students to not only do hands-on science and talk and write science

in words but also to draw, tabulate, graph, geometrize, and algebrize science in all possible combinations. He also highlighted the importance of helping students understand the conventions that connect verbal prose with visual images and giving students practice in translating back and forth among verbal accounts, mathematical expressions and calculations, schematic diagrams, abstract graphs, and hands-on actions. Román et al. (2015) showed how science teachers can use graphic organizers strategically to make implicit connections in science texts explicit so that students can visualize the inferences in and the conceptual connections among important text segments.

(c) Learning to read like a scientist. Scientific texts are not just about matters of fact and explanation; they make meaning about "desirability, importance, permissibility, expectedness, and all the other value dimensions" (Lemke, 2002, p. 28). This means it is important that students adopt a critical stance in science reading, paying close attention to not only what evidence (if any) is used and the quality of the evidence but also how this evidence is presented, linguistically and/or visually, to support a particular explanation or claim. One approach to developing critical reading in science is to have students read multiple texts on the same topic or the same text from different perspectives. Students should have opportunities to analyze, evaluate, problematize, and transform texts on a regular basis, interrogating the values, points of view, prejudices, and ideologies underpinning the text. Teachers can also promote critical reading by encouraging students to make connections between what they read in the text (e.g., erosion) and what they see in their everyday lifeworlds (e.g., erosion in their own school playground) (Alvermann, & Wilson, 2011).

Another way to foster critical reading ability in science is to promote critical language awareness—that is, to help students become aware of how language choices in science texts

present knowledge, modulate or boost claims, infuse ideology, embed points of view, sharpen focus, construe precision, and facilitate discursive flow (e.g., Fang et al., 2019; Román & Busch, 2016; Zhu & Fang, 2019). During close reading, teachers can highlight a range of lexical, grammatical, and other discursive features that:

- express affect, judgment, or appreciation
- convey degrees of certainty, usuality, normality, or likelihood
- bury agency and causal relations to promote objectivity and to foreground ideas/concepts and background processes

Such consciousness-raising about language use can help students uncover the hidden messages in the text, gain a more nuanced understanding of authorial voice, develop a critical orientation in text reading, and expand their linguistic repertoires for making meaning in more purposeful and effective ways.

Mathematics

The National Council of Teachers of Mathematics (2000) defined mathematical literacy as the ability to (a) understand mathematical entities, processes, and operations; (b) use efficient and accurate methods for computing; and (c) participate in mathematical processes. Attaining this ability entails proficiency with mathematics texts. Because reading and writing are central to learning and doing mathematics, mathematics teachers need to recognize the literacy demands of their subject and explicitly teach students how to read, interpret, and write mathematics texts on a regular basis (Thompson et al., 2008). Given the multisemiotic and multimodal nature of mathematics texts, it is essential that students develop the capacity to make sense of and use the three meaning-making resources in mathematics (i.e., natural language, mathematics symbolism, and visual display), each of which has its own conventions, affordances, limitations, and

challenges. Teachers can support this development work by attending to the following three essential components: (a) creating opportunities for students to read and discuss mathematics texts, (b) conducting explicit instruction on the mathematics register, and (c) promoting multiple representations of mathematical ideas and communication of mathematical thinking and reasoning.

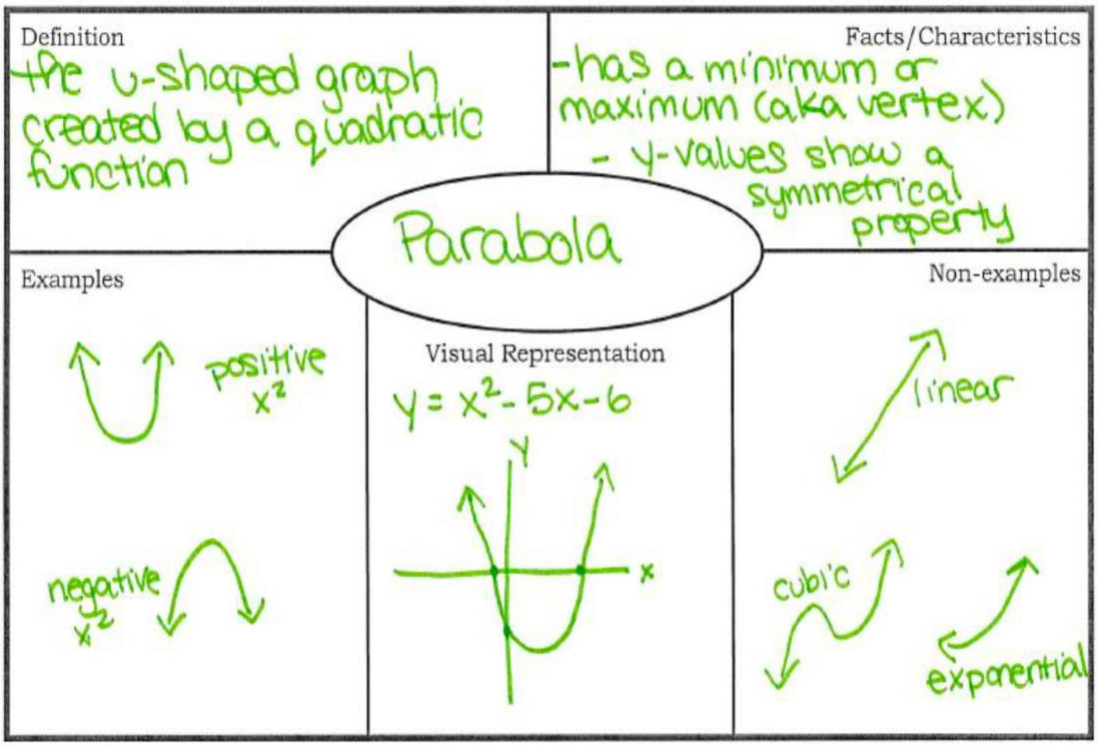
(a) Creating opportunities to read and discuss mathematics texts: Teachers can promote mathematics reading by creating opportunities for students to regularly read and explore mathematics texts. School mathematics textbooks provide rich information about mathematics theories, concepts, principles, procedures, processes, and problems that students are expected to learn or solve. Each unit of instruction should include activities that require students to read, wrestle with, and interpret texts that define, describe, explain, prove, or discuss relevant mathematics concepts, ideas, and operations. Reading and discussing mathematics texts on a regular basis can help students build conceptual and procedural knowledge and at the same time instill in them the understanding that reading is integral to learning and doing mathematics and achieving mathematical literacy.

Teachers can scaffold students' interaction with mathematics texts by designing tasks and visual aids that prompt them to access their prior knowledge, set a purpose for reading, develop an interest in reading, recognize the overall text structure, become metacognitive about their meaning-making process, and assess their understanding (Draper, 2002; Thompson et al., 2008). For example, prior to reading, teachers can ask students to preview the text by skimming the title, (sub)headings, and visual displays to gain a general sense of what the text is about and develop questions that engage their reading and sustain their attention. During reading, teachers can model and encourage students to use the comprehension strategies that mathematics experts

employ, including predicting, zooming out, zooming in, rereading, summarizing, paraphrasing, questioning, evaluating, storying, annotating, visualizing, and imagining. After reading, students can complete a Frayer model (see Figure 1) by providing a definition, characteristics, examples, non-examples, and a visual representation for a key concept or vocabulary word in the text. They can also summarize what has been read, evaluate the content of the text, or apply the ideas in the text to new situations.

Figure 1

Frayer Model (Alvarez, 2022, p. 47)



(b) Teaching the mathematics register: The mathematics register is challenging due to its use of technical and dense language in conjunction with abstract mathematics symbols and visual representations. Students do not typically come to school well equipped with knowledge of the mathematics register; they learn it in the process of doing mathematics in school. Teachers can support this learning through oral explanation of mathematics content (Pimm, 1987; Veel, 1999). Specifically, they can use a classroom discourse framework developed by Herbel-Eisenmann (2002) to engage students in multiple ways of talking about concepts and ideas in mathematics texts. The framework recognizes the multimodal/multisemiotic nature of mathematics discourse and draws on students' everyday language as a resource to learn the more technical language of mathematics. It helps students move among three types of language—from everyday language

through instructional language to mathematical language, and vice versa—as they talk about mathematical ideas and concepts using both student contributions and multiple representations.

Explicit attention to mathematics language can also be achieved through functional language analysis (Fang & Schleppegrell, 2008, 2010). Teachers can spotlight the features of mathematical language during reading of mathematics texts, showing students how to unpack the meanings in dense noun phrases, identify relationships that are constructed in verbs and conjunctions, and detect meanings that might have been left implicit in the formulation of statement or problem (O'Halloran, 2000; Schleppegrell, 2007). For example, when reading (and trying to prove) this tangent-chord theorem—*The measure of an angle formed by a chord and a tangent line to a circle* *is equal to* *that of the inscribed angle on the other side of the chord*—the teacher can, besides defining and diagrammatically illustrating technical terms such as "tangent line" and "inscribed circles," show students how the two long noun phrases in the statement (underlined) are constructed, explaining that the key piece of information in either phrase is its head "*the measure*" and "*that,*" respectively, with the latter ("*that*") acting as a substitute for the former ("*the measure*") to avoid verbatim repetition. Each head is modified by a non-finite clause (*formed by…*) or a prepositional phrase (*on the other side of…*) that specify the angle to be measured. Such discussion can enhance students' awareness of the ways language is used in mathematics meaning making and improve their interpretation of visual representation and symbolic representation, resulting in better overall understanding of the theorem.

(c) Communicating mathematics through writing: Not only do students need to participate orally in mathematics sense making and problem solving, they also need to write to explore new concepts or ideas, describe reasoned conjectures, explain solution process, present arguments about theorems, and keep ongoing records of learning (Morgan, 2006; Moschkovich,

1999; Pugalee, 2005; Thompson et al., 2008). These writing activities help students organize ideas, clarify thinking, deepen conceptual understanding, develop fluency with the mathematics register, become metacognitive about learning, and ultimately improve competence in mathematics reading and problem solving. The written product also gives teachers a window into students' thought processes and understandings, providing useful information that can inform subsequent lesson planning.

For these reasons, the National Council of Teachers of Mathematics (2000) considers writing "an essential part of mathematics and mathematics education" (p. 60), recommending that students be provided with ample opportunities to write about mathematics concepts, processes, problems, and experiences in the classroom. Zagata, Payne, and Arsenault (2021) identified four main types or purposes of writing that students can do in mathematics classroom. These are (a) exploratory writing, which helps students explore and make sense of a given problem of their own ideas; (b) informative or explanatory writing, which defines, describes, or explains a mathematics concept or process; (c) argumentative writing, which constructs or critiques a mathematics argument or proof; and (d) creative writing, which provides space for students to demonstrate original ideas and flexible thinking about mathematics through storytelling or other non-conventional forms of knowledge representation.

Q4: When should disciplinary literacy instruction begin?

The concept of disciplinary literacy is often discussed in the context of adolescent literacy and secondary reading instruction, so it is not surprising that middle and high schools are presumed to be the default place where disciplinary literacy instruction should occur. However, Heller (2010/2011) argued that disciplinary literacy instruction should be left to college, suggesting that middle and high schools neither are equipped nor should be expected to prepare

disciplinary specialists. He maintained that middle and high schools should, instead, focus on general education by preparing broadly educated citizens, or "well-informed amateurs" who are familiar with only "the biggest of the big ideas in history, literature, biology, and other fields" (p. 271). Moje (2010/2011) acknowledged the challenges of implementing disciplinary literacy instruction in middle and high schools but insisted that a discipline-based model of literacy instruction—while not necessarily done to ensure that all high school graduates become junior scientists, historians, mathematicians, or literary critics—is needed to prepare critical thinkers who are capable of comprehending, critiquing, and composing academic texts in content area learning and disciplinary socialization.

The timing of disciplinary literacy instruction is, perhaps, best understood in the context of a child's overall literacy development trajectory. Fang (2012a) described, from a linguistic perspective, three phases of children's literacy development from preliteracy through basic literacy to disciplinary literacy. During the preliteracy phase (ages 0-4), children learn the mother tongue (everyday spoken language), which enables them to construe commonsense knowledge. During the basic literacy phase (ages 4-9), children reconstrue experience in more abstract ways. This capacity for abstraction signals the onset of literacy (reading/writing), suggesting that children can now process abstract signs such as written language and are ready to move into educational forms of knowledge. During the disciplinary, or advanced, literacy phase (ages 9 and above), children learn to reconstrue experience in a more theoretical and metaphoric mode, demonstrating a capacity to engage with the technical knowledge of academic disciplines.

From this perspective, then, disciplinary literacy instruction can in earnest start as early as the elementary grades (say, third or fourth grade). In support of this recommendation, research (e.g., Fang, 2003; Pappas, 1993) has shown that children as young as kindergarteners or first

graders are able to differentiate narrative from non-narrative forms of discourse. This nascent sense of genre differences may be a precursor to disciplinary literacy. As children advance through the education system, they develop increasing sophistication in their awareness and understanding of how and why disciplines differ in production, communication, and consumption of knowledge. In support of this view, Shanahan and Shanahan (2014) have argued that disciplinary literacy can have a place in elementary school, suggesting that elementary teachers can begin to prepare their students for disciplinary literacy by, for example,

> ensuring that students read and understand the often nuanced differences among a wide range of text types, helping students make sense of information and ideas across multiple texts, and teaching vocabulary in every subject area in a way that helps students understand the specialized nature of discipline-specific words (pp. 638-639).

Examples of disciplinary literacy instruction in elementary school contexts have been described by Brock et al. (2014), among others.

Q5: Is disciplinary literacy instruction only for the gifted and talented?

There is a common perception that disciplinary literacy is for students who are taking honors or advanced placement classes and that it is too advanced for English language learners or students with reading/writing difficulties. It is believed that for those who struggle with reading and writing in the content areas, teaching basic skills and generic strategies (to wit, a content area literacy approach) is more appropriate. According to Faggella-Luby et al. (2012), for example, struggling adolescent learners do not possess the foundational skills and strategies needed to read/write proficiently, and literacy instruction for them should, therefore, focus on "strategies, routines, skills, language, and practices that can be applied universally to content

area learning," rather than on "specialized strategies, routines, skills, language, or practices inherent in certain content areas that are not generalizable to other domains" (p. 69).

There is no doubt that some struggling adolescent readers still need intensive instruction in basic skills and generic strategies to help them develop reading fluency and "focus their attention on looking for coherence in the passage and integrating the text with what they know about the topic" (Catts, 2009, p. 180). However, this does not mean that these students should wait to receive disciplinary literacy instruction until they have fully mastered these skill and strategies. In other words, struggling readers/writers, like their more proficient peers, are capable of learning (and can benefit from) discipline-specific skills and strategies at the same time that they are developing, refining, and expanding basic skills and generic strategies. For example, de la Paz (2005) reported that middle school students who were taught in their social studies class how to read and reconcile four sets of primary and secondary documents about the westward expansion from the 1830s to the 1870s (i.e., how to use strategies that promote historical reasoning such as sourcing and corroboration)—regardless of whether they were talented, average, or struggling writers—became more capable of reasoning with documents containing conflicting information or points of view and wrote longer, more historically accurate, and more persuasive essays than those who did not receive such instruction. Similar outcomes have been reported in studies involving English language learners (e.g., Gebhard, 2019). For example, Gebhard and Graham (2018) found that multilingual students who were institutionally deemed low achievers in a seventh-grade classroom that implemented advanced literacy instruction aligned with the principles of disciplinary literacy instruction developed the ability to critically read challenging scientific explanations and write cogent advocacy letters to government officials in a 6-week environmental studies unit on endangered species. They concluded that

disciplinary literacy instruction "supports students in learning to read, write and critically engage with challenging disciplinary texts, regardless of students' level of language proficiency, grade level or the disciplinary focus of the instruction" (p. 295). Thus, as Shanahan and Shanahan (2012) pointed out, there is no reason to believe that adopting a disciplinary perspective in literacy instruction would be detrimental to struggling learners. In fact, both discipline-specific and generic skills and strategies are needed—and can be taught concurrently—in content area instruction. Simultaneous attention to both sets of skills and strategies is likely to produce more robust outcomes for all students in disciplinary learning.

Q6: Are literacy teachers equipped to teach disciplinary literacy?

Accomplishing the goals of disciplinary literacy instruction requires that teachers be well versed in the content, discourse patterns, literate practices, and habits of mind within specific disciplines. Given the way literacy teachers were traditionally prepared, it seems unlikely that they will have the knowledge, experience, or expertise to teach disciplinary literacy well. Literacy teacher candidates are generally not required to be subject area specialists, nor do they typically receive formal training in a subject area outside reading/literacy. As a result, they tend to lack knowledge of the big ideas, unifying concepts, core practices, key relationships, and essential habits of mind related to the content and culture of the disciplines. Within the field of literacy education, teacher candidates at both elementary and secondary levels generally received heavy doses of training in the "Fab Five" (Fang, 2008), focusing on such topics as phonological awareness, phonics, vocabulary, fluency, and comprehension strategies. Little, if any, attention is paid in coursework to discipline-specific epistemologies, discourse patterns, knowledge structures, literate practices, and habits of mind. Would subject area teachers be more equipped to teach disciplinary literacy then? Probably not. Although subject area teachers are content

experts and may embrace discipline-specific strategies more than generic strategies, they often lack the necessary language awareness and literacy strategy knowledge to help students cope with the specific language and literacy demands of their discipline.

One logical solution to this problem is to encourage collaboration between literacy teachers and subject area teachers. Both parties bring their respective expertise to the planning and delivery of disciplinary literacy instruction. One potential impediment to such collaborative partnership is the already insurmountable demands on teachers' time. In order for literacy and other subject area teachers to justifiably carve out time for collaboration, it would need to be part of a structural and cultural shift that clearly and explicitly benefits all involved parties. Another potential issue with such a partnership is that the role of literacy teachers can be marginalized because they tend to be positioned as helpers to subject area teachers, who have expertise in and are responsible for content, which is often seen as the more important learning goal. Thus, as Creese (2010, p. 105) has cautioned, unless the "pedagogic and knowledge capitals" possessed by literacy teachers are seen as important as those of subject area teachers, the status and role of literacy teachers will remain peripheral in this partnership. One way to create and sustain equal, productive collaboration is that both parties enter partnership with shared goals for students, a desire to learn from each other, a commitment to working from each other's strengths, and provisions for regular evaluation of their joint work (Bain, 2012; Siebert & Draper, 2012).

An example of how this collaboration might work can be found in Schall-Leckrone and McQuillan (2012). Although the study took place at the college level involving subject area teacher educators and literacy teacher educators, it can still be instructive for teachers in K-12 contexts. The researchers described how a history education professor worked with a reading education professor to prepare teacher candidates to teach the academic language of historical

analysis in history lessons. Together, they designed four modules of explicit language instruction for infusion into an existing secondary history methods course. These modules engaged teacher candidates in exploring the complexity and functionality of historical language and learning strategies for identifying and teaching the language demands of history. The first module introduced teacher candidates to features of historical language (e.g., nominalization) and the challenges these features present to students. The second module introduced teacher candidates to strategies for analyzing and interpreting historical text, helping them understand how language constructs content (e.g., who does what to whom, where, and how), infuses perspective (e.g., whose ideas are or are not represented in the text, what is evaluated positively or negatively by the author), and organizes text (e.g., topic sentences, words/phrases that link clauses, sentences, or paragraphs). The third module introduced teacher candidates to the differences between academic language and conversational language and strategies for increasing student participation in text-based discussions (e.g., think-pair-share, jigsaw). The fourth module introduced teacher candidates to representative genres of historical writing (e.g., accounts, explanations, arguments) and an instructional cycle for teaching students to write these genres. Together, these modules aimed to equip prospective history teachers with the knowledge and skills needed to promote close reading, functional language analysis, and critical interpretation of historical texts in their classrooms. Teacher candidates who were exposed to these modules reported an enhanced sense of preparedness to teach students in need of language/literacy support and considered themselves both language/literacy teachers and content teachers.

Q7: How can disciplinary literacy be assessed?

As discussed earlier, disciplinary literacy refers to the ability to engage in discipline-specific cognitive, semiotic, and social practices. How can this ability be assessed? Traditionally,

literacy is assessed in terms of a set of discrete skills (e.g., decoding words, conducting morphemic analysis, determining main ideas, identifying cause-effect relationship, and making comparison and contrast) using texts with trivial or non-significant content. Such practices ignore the fact that reading a text on genes, for example, involves somewhat different processes and strategies than reading a text on the Holocaust or a text about the Pythagorean theorem, and that writing an argument about the significance of the Gulf of Tonkin incident in the Vietnam War requires different sorts of knowledge, skills, and reasoning than defending a particular interpretation of e.e. cummings' poem "a total stranger one black day."

To truly demonstrate disciplinary literacy, students need be given tasks and experiences that provide opportunities for them to read, write, think, reason, and inquire with substantive content presented through texts of multiple genres, modalities, registers, and sources. Implementing such an assessment requires collaboration between literacy teachers and subject area teachers, who together identify essential target skills that cover both disciplinary content and disciplinary habits of mind, select relevant and significant texts, design authentic tasks and experiences, and create sensitive criteria (Bain, 2012).

For example, in a unit on early 1800s American History, an eighth-grade team of a history/social studies teacher and a literacy teacher may choose to have students read and respond to primary source documents, such as then-President Andrew Jackson's message to the Congress regarding the displacement of Native Americans (Jackson, 1830), and Chief George Harkins' letter to the American people (Harkins, 1832). Students are to be assessed on their ability to (a) determine the central ideas of information in a primary or secondary source, (b) provide an accurate summary of the source distinct from prior knowledge or opinions, and (c) identify aspects of the documents that reveal an author's point of view or purpose (e.g., loaded

language or inclusion or avoidance of particular facts) (NGA & CCSSO, 2010). Having collaborated on teaching students how to do close reading of primary source documents, both teachers then determine one or more student products that would demonstrate mastery of these standards. An example of such a product could be a written essay in which students are assessed on their ability to evaluate Harkins' letter and Jackson's speech for authorial purposes and points of view. Student essays could be graded on the sophistication of their arguments, the level to which their arguments are supported with evidence from primary source documents, the quality of the evidence used, and the effectiveness with which language is used to present historical meanings (e.g., time, causality, agency, change, and evaluation), develop argument, and organize text.

Q8: Is there evidence that suggests disciplinary literacy instruction works?

In an era of evidence-based instruction, it is professionally responsible to ask whether there is evidence of effectiveness of disciplinary literacy instruction, or whether disciplinary literacy instruction produces better student outcomes than other approaches (e.g., content area literacy). It is worth pointing out that much of the work on disciplinary literacy has so far remained conceptual and, if empirical, largely descriptive or qualitative (usually case studies), without the sorts of research design (e.g., randomized clinical trials) seemingly privileged by the federal government (McVee et al., 2023). More specifically, this body of work has

- provided theoretical arguments about why a disciplinary perspective is needed in literacy instruction across the content areas (e.g., Fang, 2012a; Moje, 2008; Shanahan & Shanahan, 2012);
- identified the epistemological processes, literate practices, and habits of mind demonstrated by experts in various disciplines (e.g., Bazerman, 1985; Chapman, 2015;

Fang & Chapman, 2020; Fang et al., 2023; Nokes, 2013; Reynolds & Rush, 2017; Shanahan et al., 2011; Vansledright, 2002; Warren, 2011; Weber & Mejia-Ramos, 2011; Wilkerson-Jerde & Wilensky, 2011; Wineburg, 2001; Yore et al., 2004; Zeitz, 1994);

- described patterns of language use characteristic of different disciplines and their challenges for reading comprehension and written composition in disciplinary learning (e.g., Adams, 2003; Christie & Derewianka, 2008; Christie & Maton, 2011; Coffin, 2006; Fang, 2012b; Fang & Schleppegrell, 2008; Morgan, 1998);
- reported on how teachers learn to implement disciplinary literacy instruction or how subject area teachers or teacher educators collaborate with language/literacy specialists to implement disciplinary literacy instruction (e.g., Accurso & Levasseur, 2022; Bain, 2012; Di Domenico et al., 2019; Doerr & Temple, 2016; Draper et al., 2012; Ehren et al., 2012; Nokes, 2010; Patrick & Fang, 2022; Pytash, 2012; Rodriguez, 2015; Schall-Leckrone & McQuillan, 2012; Seah et al., 2022); and
- proposed an array of instructional models that offer cognitive and linguistic strategies to support close reading and writing of disciplinary texts as well as apprenticeship into disciplinary practices, values, and worldviews (e.g., Borasi & Siegel, 2000; Brock et al., 2014; Dychess et al., 2023; Fang, 2010; Fang & Schleppegrell, 2008, 2010; Gabriel, 2023; Jetton & Shanahan, 2012; Langer, 2011; McConachie & Petrosky, 2010; Moje, 2015; Spires et al., 2020; Thompson et al., 2008; VanSledright, 2002; Wolsey & Lapp, 2017).

Although scholars have described disciplinary-specific language/literacy skills, strategies, and practices for classroom uses, empirical studies of their effectiveness with diverse population (e.g., mainstream, learning disabled, English language learners) and in multiple contexts (e.g.,

elementary vs. secondary, science vs. history vs. literature) are still quite limited, with even fewer of them meeting the sort of evidence standards established by the What Works Clearinghouse (Kamil et al., 2008). That said, it is important to note that certain skills, strategies, practices, or disciplines have been studied much more extensively than others, and this has led to variation in evidence base across skills, strategies, practices, or disciplines, as can be seen in Appendix A. Moreover, while existing research reviews (see Faggella-Luby et al., 2012 for a focused review and Moje, 2007 for a wide-angled review) suggest that disciplinary literacy instruction has produced positive learning outcomes for students in both content and literacy measures, the criteria for selecting studies to be included in these reviews are wildly inconsistent, due in large part to the ill-defined nature of the term disciplinary literacy. For example, disciplinary literacy was often equated with "literacy in the discipline" or "discipline (e.g., science, mathematics, engineering, music, health) + literacy," with the consequence that studies that align with the content area literacy perspective were also included in the reviews.

Therefore, as promising as disciplinary literacy instruction sounds, it may be prudent not to make definitive claims about its overall effectiveness, especially when compared with a more generalized approach to literacy instruction in the content areas. In light of this, Moje (2007) has called for more work to be done to study the effects of disciplinary literacy instruction on "the learning of mainstream conceptions of subject matter, critical stances on subject matter, conventional literacy skills, or critical literacy skills" (p. 35). To date, the number of such studies are still surprisingly limited (see, for example, de la Paz, 2005; Nokes et al., 2007; Paugh & Wendell, 2021), and they are, by and large, descriptive, instead of truly experimental, in research design, owing perhaps in part to the notion that as high level skills and processes, disciplinary literacy skills, strategies, or practices cannot be as easily isolated, manipulated, packaged, taught,

or measured as the basic or intermediate literacy skills and strategies. It is important to keep this limitation in mind when interpreting the rating in Appendix A of the evidence base for essential components of disciplinary literacy instruction.

Conclusion

Developing advanced literacy in secondary (middle/high) schooling is a daunting task. A disciplinary literacy approach to this development work recognizes that "[e]ach form of knowledge has a distinctive set of 'big ideas,' of warrants, and of ways to represent ideas and evidence and thus requires students to navigate across different genres and discourse communities" (Bain, 2012, p. 515). It foregrounds the goals, the ethos, the epistemologies, and the methodologies of the disciplines, helping students learn discipline-legitimated ways of producing and consuming texts and of creating and renovating knowledge. It values "teachers' perspectives, compelling inquiry, authentic disciplinary texts, supportive practices, [and] gradually withdrawn scaffolds" and sees students as capable of using available resources to engage in new learning (Hinchman & O'Brien, 2019, p. 532). As such, the approach is believed to be a more promising way of promoting advanced literacy development, with the potential to not only deepen students' content learning but also develop their ability to read/write academic texts in more sophisticated, powerful ways. Given these potential benefits, disciplinary literacy instruction is clearly something worthy of teachers' efforts, despite a seeming lack of conclusive evidence on its overall effectiveness for reasons noted earlier. Using Appendix B as a guide, teachers can draw on the recent scholarship on disciplinary literacy to revise and refine existing and emerging models of advanced literacy instruction, helping students develop as thoughtful readers, powerful writers, and effective language users who are capable of participating productively in disciplinary learning, inquiry, and meaning making.

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Appendix A
Innovation Configuration for Evidence-Based Disciplinary Literacy Instructional Practices

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
1.0 Components of Disciplinary Literacy Instruction for All Content Areas					
1.1 Teach academic language (e.g., academic vocabulary, grammatical patterns, discourse structures). 1.2 Build content knowledge about academic domains (e.g., science, social studies) through reading and other means (e.g., watching film, fieldwork). 1.3 Teach generic reading strategies that are valued across discipline (e.g., predicting, inferring, zooming out, zooming in,					

summarizing, visualizing, evaluating, questioning, storying, paraphrasing, annotating, monitoring). 1.4 Provide scaffolded opportunities to write in response to reading (e.g., personal writing, factual writing, analytical writing).					

Essential Components	**Implementation Levels**				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
2.0 Components of Disciplinary Literacy Instruction in Literature					
2.1 Teach literary techniques (e.g., allusion, irony, conflict, symbolism, flashback, foreshadowing, personification, motif, paradox, simile, metaphor, hyperbole, imagery, parallelism). 2.2 Promote communal reading and guided discussion of texts through critical inquiry.					

2.3 Engage students in close analysis of text to explore the significance of particular text features. 2.4 Use “cultural modeling” to help students see potential points of synergy between problem-solving in everyday domain and problem-solving in literature. 2.5 Teach literary theories (e.g., reader response theory) 2.6 Provide scaffolded opportunities to write literary responses (e.g., personal response, character analysis, review, thematic interpretation).					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
3.0 Components of Disciplinary Literacy Instruction in History/Social Studies					
3.1 Teach historical genres (e.g., structures and language patterns of historical accounts, explanations, and arguments). 3.2 Teach historical reading heuristics (e.g., sourcing, inferring, contextualizing, corroborating, perspective taking) in document-based lessons. 3.3 Use multiple sources (e.g., primary, secondary, tertiary). 3.4 Provide scaffolded opportunities to write arguments from sources. 3.5 Conduct close reading of historical texts through detailed language analysis.					

Essential Components	**Implementation Levels**				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
4.0 Components of Disciplinary Literacy Instruction in Science					
4.1 Integrate firsthand (e.g., observation, experiment) and secondhand (reading, writing, talking) experiences. 4.2 Teach scientific language (e.g., technical vocabulary; nominalizations; dense noun phrases; complex sentences; verbs for defining, identifying, classifying, characterizing, or describing concepts and relationships; hedging devices). 4.3 Teach science genres (e.g., procedure, procedural recount, explanation, report, exposition, description, discussion).					

4.4 Provide scaffolded opportunities for students to engage in transduction between verbal (language) and visual (e.g., graph, table, figure) resources. 4.5 Promote critical reading through close attention to verbal and visual choices in the text.					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/ presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
5.0 Components of Disciplinary Literacy Instruction in Mathematics					
5.1 Teach the mathematical register (e.g., mathematical symbols and equations; technical vocabulary; dense noun phrases; nominalizations; conditional lexis and constructions such as *let…*, *if…then, if and only if*, *when…*, *given…*, *assume…*, *suppose…*, and *such that…*).					

5.2 Teach students how to translate among verbal description, mathematical expression, and visual representation. 5.3 Provide ample opportunities for students to read and discuss mathematical texts. 5.4 Promote multiple representations of mathematics ideas and communication of mathematical thinking and reasoning (e.g., exploratory writing, explanatory writing, argumentative writing, creative writing).					

Appendix B
Summary Levels of Support for Evidence-Based Disciplinary Literacy Instructional Practices

Practices	Level of Evidence	References
1.0 Components of Disciplinary Literacy Instruction for All Content Areas		
1.1 Teach academic language (e.g., academic vocabulary, grammatical patterns, discourse structures).	Strong	Balthazar & Scott (2018); DiCerbo et al. (2014); Fang & Park (2019); Figueroa et al. (2018); Kim et al. (2021); Lesaux et al. (2010); Lesaux et al. (2014); Meneses et al. (2017); O'Connor et al. (2019); Schleppegrell (2004); Scott & Balthazar (2013); Taboada & Rutherford (2011); Uccelli et al. (2015); Vadasy et al. (2015)
1.2 Build content knowledge about academic disciplines (e.g., science, social studies) through reading and other means (e.g., watching film, fieldwork).	Strong	Alexander & Judy (1988); Cervetti & Wright (2020); Hirsch (2006); Kamhi (2007); Kim et al. (2021); O'Reilly & McNamara (2007); Smith et al. (2021)
1.3 Teach generic reading strategies that are valued across disciplines (e.g., predicting, visualizing, inferring,	Strong	Alexander & Judy (1988); Almasi & Fullerton (2012); Arrington et al. (2014); Dole et al. (1996); Dole et al. (2009); Filermann et al. (2022); Krawec et al.

skimming, close reading, paraphrasing, summarizing, rereading, questioning, note-taking, monitoring, evaluating).		(2013); Kramarski & Mevarech (2003); Leopold & Leutner (2012); Montague & Dietz, (2009); Montague et al. (2011); O'Reilly & McNamara (2007); Kim et al. (2004); Klingner & Vaughn (1996); Nokes & Dole (2004); Pressley (2000); Swanson et al. (2014); Taboada & Rutherford (2011)
1.4 Provide scaffolded opportunities to write in response to reading (e.g., personal writing, factual writing, analytical writing).	Strong	Ackerman (1993); Akkus et al. (2007); Applebee (1984); Bangert-Drowns et al. (2004); Bell & Bell (1985); Chen et al. (2013); Cross (2008); Faber et al. (2000); Gillespie et al. (2017); Graham & Perin (2007); Graham & Hebert (2010); Graham et al. (2020); Kiuhara et al. (2020); Kohnen (2013); Langer & Applebee (1987); Leopold & Leutner (2012) et al. (2015)
2.0 Components of Disciplinary Literacy Instruction in Literature		
2.1 Teach literary techniques (e.g., allusion, irony, conflict, symbolism, foreshadowing, personification, motif, flashback, paradox, simile, metaphor, hyperbole, imagery, parallelism).	Limited	Goldman et. al. (2016); Hicks & Steffel (2012); Langer (1995); Rainey (2016); Reynolds & Rush (2017)

2.2 Promote communal reading and guided discussion of texts through critical inquiry.	Strong	Beach et al. (2021); Beach et al. (2015); Elliot (2021); Goldman et. al. (2016); Hadjioannou (2007); Hicks & Steffel (2012); Langer (1995); Nystrand & Gamoran (1991); Purves & Pradl (2003); Reynolds & Rush (2017); Reynolds et al. (2021); Rosenblatt (1995); VanDerHeide (2018)
2.3 Engage students in close analysis of text to explore the significance of particular text features.	Limited	Fang & Schleppegrell (2008); Goldman et. al. (2016); Hammond (2006); Huisman (2016); Lukin (2003); McCormick (1994); Moore & Schleppegrell (2014); Rainey (2016)
2.4 Use "cultural modeling" to help students see potential points of synergy between problem-solving in everyday domain and problem-solving in literature.	Emerging	Lee (1995, 2001)
2.5 Teach literary theories (e.g., reader response theory, Marxism, feminist theory, psychoanalysis, critical race theory, postcolonialism, cultural studies, postmodernism).	Emerging	Appleman (2015); Huisman (2019); Reynolds et al. (2021)

2.6 Provide scaffolded opportunities to write literary responses (e.g., personal response, character analysis, review, thematic interpretation).	Moderate	Christie & Derewianka (2008); Goldman et. al. (2016); Graham & Hebert (2010); Langer (1995); Manyak & Manyak (2021); Reynolds et al. (2021); Rose & Martin (2012); VanDerHelde (2018)
3.0 Components of Disciplinary Literacy Instruction in History/Social Studies		
3.1 Teach historical genres (e.g., the structures and language patterns of historical accounts, explanations, and arguments).	Moderate	Christie & Derewianka (2008); Coffin (2006); Gritter et al. (2013); Nokes & de la Paz (2018); Schall-Leckrone (2017); Schleppegrell et al. (2008)
3.2 Teach historical reading heuristics (e.g., sourcing, contextualizing, inferring, corroborating, perspective taking) in document-based lessons.	Strong	Bråten et al. (2019); Claravall & Irey (2022); de la Paz (2005); de la Paz et al. (2022); Nokes (2013); Goldman et al. (2016); Nokes et al. (2007); Reisman (2012); Wineburg et al. (2011)
3.3 Use multiple sources (e.g., primary, secondary, tertiary).	Moderate	Goldman et al. (2016); Hynd (1999); Kucan, Rainey, & Cho (2019); Nokes et al. (2007); Reisman (2012); Stahl et al. (1996); Wineburg et al. (2011)

3.4 Provide scaffolded opportunities to write arguments from sources.	Moderate	Collins et al. (2021); de la Paz (2005); de la Paz et al. (2017); Monte-Sano (2011); Monte-Sano & de la Paz (2012); Nokes & de la Paz (2018)
3.5 Conduct close reading of historical texts through detailed language analysis.	Limited	Fang (2020); Fang & Schleppegrell (2008); Fitzgerald (2019); Goldman et al. (2016); Schleppegrell & Achugar (2012); Schleppegrell & de Oliveira (2006)
4.0 Components of Disciplinary Literacy Instruction in Science		
4.1 Integrate firsthand (e.g., observation, experiment) and secondhand (reading, writing, talking) experiences.	Strong	Akkus et al. (2007); Cervetti et al. (2012); Clark et al. (2021); Fang (2010); Fang & Wei (2010); National Research Council (2000); Norris & Phillips (2003); Patterson et al. (2018); Pearson et al. (2010); Romance & Vitale (2001); Saul (2004); Wellington & Osborne (2001); Yore et al. (2003)

4.2 Teach scientific language (e.g., technical vocabulary; nominalizations; dense noun phrases; complex sentences; hedging devices; verbs for identifying, defining, classifying, characterizing, or describing concepts and relationships).	Moderate	Fang (2010); Goldman et al. (2016); Halliday & Martin (1993); Hodgson-Drysdale (2014); Lemke (1990); Lee, Quinn, & Valdes (2013); Patterson et al. (2018); Paugh & Wendell (2021); Seah & Silver (2020); Seah et al. (2022); Wellington & Osborne (2001)
4.3 Teach science genres (e.g., procedure, procedural recount, explanation, report, description, discussion, exposition).	Moderate	Avalos et al. (2017); Chen et al. (2020); Christie & Derewianka (2008); Fang (2010, 2021); de la Paz et al. (2023); de Oliveira & Lan (2014); Kizkapan & Bektas (2021); Rappa & Tang (2018); Sampson (2013); Symons (2017); Tang & Putra (2018); Wollman (2000)
4.4 Provide scaffolded opportunities for students to engage in transduction between verbal (language) and visual (e.g., graph, table, figure) resources.	Moderate	Goldman et al. (2016); Hand et al. (2016); Kress et al. (2001); Lemke (2004); Namdar & Shen (2016); Tang (2023); Tang et al. (2022); Unsworth et al. (2022); Yeo & Tan (2022)

4.5 Promote critical reading through close attention to verbal and visual choices in the text.	Limited	Fang et al. (2019); Fazio et al. (2022); Gebhard & Graham (2018); O'Hallaron et al. (2015); Román & Busch (2016)
5.0 Components of Disciplinary Literacy Instruction in Mathematics		
5.1 Teach the mathematical register (e.g., mathematical symbols and equations; technical vocabulary; nominalizations; dense noun phrases; conditional lexis and constructions such as *let…*, *if…then, if and only if*, *when…*, *given…*, *assume…*, *suppose…*, and *such that…*).	Strong	Abedi & Lord (2001); Erath et al. (2021); Fang & Schleppegrell (2008); Herbel-Eisenmann (2002); Huang (2019); Kwok et al. (2022); Lemke (2003); Martiniello (2008); Morgan (2006); Moschkovich (2010); O'Halloran (2005); Pimm (1987); Riccomini et al. (2015); Schleppegrell (2007); Thompson et al. (2008); Veel (1999); Wilkinson (2018)
5.2 Teach students how to translate among verbal description, mathematical expression, and visual representation.	Moderate	Erath et al. (2021); Gonzalez (2021); Herbel-Eisenmann (2002); Lemke (2003); O'Halloran (2005); Siebert & Draper (2012); Thompson et al. (2008)

5.3 Provide ample opportunities for students to read and discuss mathematical texts.	Moderate	Adams et al. (2015); Borasi & Siegel (2000); Draper (2002); Erath et al. (2021); Herbel-Eisenmann (2002); Moschkovich & Zahner (2018); Pimm (1987); Thompson et al. (2008); van Zoest et al. (2017)
5.4 Promote multiple representations of mathematics ideas and communication of mathematical thinking and reasoning (e.g., exploratory writing, explanatory writing, argumentative writing, and creative writing)	Limited	Erath et al. (2021); Moschkovich (2010); Pugalee (2005); Thompson et al. (2008); Yeo & Tan (2022); Zagata et al. (2021)