Shanahan, Cynthia, and Timothy Shanahan. 2020. "Disciplinary Literacy." In *The SAT® Suite and Classroom Practice: English Language Arts/Literacy*, edited by Jim Patterson, 91–125. New York: College Board.

CHAPTER 5

Disciplinary Literacy

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Introduction

In 2000, *The Atlantic Monthly* printed a previously unpublished fragment of Vladimir Nabokov's writing: a fictional memoir, or "meditation." It began with a description of the dearth of published information about Russian butterflies and moths during the early twentieth century and how butterfly enthusiasts of the time yearned for such a catalog. It seemed then like it would take a miracle for such a work to appear. Below is an excerpt from that piece. What stands out to you as you read?

> And that miracle dawned in 1912 with the appearance of my father's four-volume work *The Butterflies and Moths of the Russian Empire*.
>
> . . . I personally belonged to the category of *curieux* who, in order to acquaint themselves properly with a butterfly and to visualize it, require three things; its artistic depiction, a compendium of all that has been written about it, and its insertion within the general system of classification. With no words and no art, without a penetrating and

> synthesizing process of thought, for me a butterfly would remain incomplete. Only one thing could wholly replace these three demands: if I had caught it myself, if the expression of the given specimen's wings corresponded to the individual particulars of a familiar habitat (with its smells, hues, and sounds) where I would have lived through all that impassioned, insane joy of the hunt, when as I climb the rock, my face contorted, gasping, shouting voluptuously senseless words. (2000)

What's interesting about that reading exercise is that what information one attends to is determined by whether the reader is, say, a historian, a scientist, or a literary critic. Historians might be interested in how much of the story, if any, is based on genuine historical events and concerns. For instance, was there actually a dearth of published information about Russian butterflies and moths in the early twentieth century, and did something like the "miracle" the narrator mentions really happen? Scientists, on the other hand, might focus on Nabokov's depictions of butterflies (e.g., graphic, textual, classificatory) and his discussion of a butterfly's adaptation ("the given specimen's wings corresponded to the individual particulars of a familiar habitat"). And literary critics might be caught up in the emotive language used to describe a butterfly hunt ("impassioned, insane joy") or the relationship between father and son implied in the text.

These differences result because disciplinary experts read with a disciplinary lens, a lens that determines the importance of information to them. This chapter explores these differences and why students should become sensitive to how disciplinary experts read and to the special texts characteristic of each discipline.

Of course, most scientists and historians, or the experts in many other fields, would likely not read Nabokov's fiction as part of their work. This is because experts in disciplinary fields read and write different *kinds* of texts. Texts in history, science, mathematics, and literature contain particular kinds of information and are structured in specialized ways, employ different language conventions, use graphical information differently, and so on. These text differences exist because various fields of study have different purposes, pose different questions about the world, set about to answer those questions with different methods, rely on different kinds of evidence, and evaluate claims and arguments differently. We define *disciplinary literacy* as the specialized reading and writing approaches that disciplinary experts have tailored to the purposes, methods, and content of their respective disciplines.

Educators often confuse disciplinary literacy with "content area reading." They aren't the same thing, however. When it comes to instruction, disciplinary literacy aims to apprentice students into the specialized literacy practices of each of the disciplines—practices usually only

developed by those immersed in the creation of knowledge in the disciplines. Content area reading, by contrast, focuses on improving students' general reading skills or abilities or in developing study habits that could be used across subject areas. Disciplinary literacy promotes the idea of reading and writing like the experts in a given field do, while content area reading tries to develop a set of useful study techniques (e.g., SQ3R, KWL). Disciplinary literacy and content area reading both have a role to play in education, but the focus of this chapter is on disciplinary literacy.

This chapter will focus on disciplinary literacy in history, science, and literature. Those are not the only fields of study that employ specialized texts or that have developed unique approaches to reading and writing. However, a focus on them makes sense because high school students are required to take courses in each of those disciplines, many states require that students learn those disciplines' specialized reading and writing practices, and research has focused heavily on identifying the special ways of reading and writing in those disciplines.

Why Disciplinary Literacy Matters

As students advance through school, the texts they read become more specialized. A second grader's social studies textbook is different from a high school junior's history book, and young children's science texts are akin to their social studies books in a way not true of high school texts in the same subjects. To read these more specialized texts properly—in ways that would lead to sophisticated interpretations appropriate to those disciplines—students need to approach them with a knowledge of a discipline and its purposes, content, and methodologies.

The term *content knowledge* refers to an awareness or understanding of information on a particular topic. Knowing the distinction between *meiosis* and *mitosis*, that the Great Depression began in 1929, and that *The Scarlet Letter* was a work of historical fiction written by Nathaniel Hawthorne are all examples of content knowledge. It's important that students learn some of the facts and information (content knowledge) produced by the disciplines. However, other kinds of knowledge matter too.

Students should also develop knowledge of a discipline. This *disciplinary knowledge* encompasses an awareness of a discipline's purposes and methodologies: how and why experts do their work, what constitutes a reasonable claim, and how one can appropriately refute such claims. In a history class, it may be important that students learn what the Battle of the Bulge was (a German offensive during World War II) and some facts about it (e.g., the Germans were defeated). But disciplinary knowledge leads students to search for the causes of the battle, to ask why it was considered so significant, or to question the particular interpretation of it

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in the text they're reading. Students need to gain both content knowledge and disciplinary knowledge; they need to know not only the whats but also the whys and hows of a discipline.

It's this disciplinary knowledge that underlies a discipline's literate practices, and students must have such knowledge if they're to read and write appropriately within a discipline. Disciplinary knowledge includes an understanding of how a field creates, communicates, and evaluates information. Knowing about the discipline can help students understand whether a given text is important and, if it is, what in it is essential. Often students asked to highlight the important information in a text—a popular content area reading strategy—end up underlining nothing or everything because they lack the disciplinary insights that would allow them to distinguish the vital from the incidental.

Students who recognize what's important in a history (e.g., who the author is, historical figures' intentions) or science text (e.g., what processes are involved in mitosis or chemical reactions) are better able than their peers to separate wheat from chaff. Disciplinary awareness can help students identify and evaluate the evidence in written arguments. Experimental evidence, for instance, is especially important in arguments in science but not so much in history. Students can use knowledge of a discipline to determine the voice to adopt in writing, how to use the technical vocabulary of a field, and so on in ways consistent with the core beliefs, values, and practices in that field. Accordingly, literacy instruction with disciplinary texts should be closely aligned with the mores, normative standards, traditions, skills, and social discourse practices of the disciplines.

As different as the various disciplines and their specializations may be, one thing remains the same: experts in all fields read and write. Experts in scientific and other technical fields, for example, spend substantial amounts of time reading and writing (Kwon 2017; National Science Foundation 1976; Tenopir, King, and Bush 2004). Scientists read journal articles, review research literature, make grant applications, collaborate through email exchanges, create detailed records of experiments in laboratory notebooks, write journal articles and research reports, and engage in dozens of other daily reading and writing tasks in their work routines. It's fair to say that one couldn't participate in science successfully without the ability to read well and with great stamina and to communicate in writing in ways characteristic of science. Given the ubiquity of reading and writing within the disciplines, it seems only right that schools not only have students read and write throughout the curriculum but also give them explicit guidance in the special text features and ways of reading and writing specific to various fields of study.

One reason students struggle in college, the workplace, or the military is lack of sufficient literacy skills. Because so many students are

underprepared, a high percentage of them require remediation in college, with about 40 percent of first-year postsecondary students nationwide requiring remedial support in reading or writing (Bautsch 2013). The National Assessment of Educational Progress (NAEP) reports that only 38 percent of twelfth graders scored at or above the proficient level in reading (National Center for Education Statistics 2013). It shouldn't be surprising, then, that the United States ranks seventeenth in the Programme for International Student Assessment (PISA) (Organisation for Economic Co-operation and Development 2016).

According to NAEP, the problem isn't one of basic literacy. Nearly all students in the United States are able to read and write: they can sign their names, decode and understand simple messages, and the like. What's missing is the ability to read complex texts in sophisticated ways and to communicate complicated ideas subtly and persuasively—outcomes more likely to be accomplished through a disciplinary literacy approach than one aimed at trying to teach general reading comprehension or writing skills.

The rest of this chapter will focus on explaining the differences among three disciplines with regard to texts and literate practices, the specific benefits of disciplinary literacy instruction identified in instructional research, and recommendations for teaching disciplinary literacy. This content is outlined below.

A. Portraits of literacy in history, science, and literature help us understand the differences in these disciplines.
    1. Each discipline has a special way of creating, communicating, and evaluating knowledge based on its purposes and methods.
    2. Each discipline's content knowledge is different too.
    3. Accordingly, texts and writing in the disciplines differ.
    4. Reading is also done differently in each discipline.
B. Teaching students how to read and write disciplinary texts can improve comprehension.
C. Teachers can help students read in the disciplines by
    1. making discipline-appropriate texts available,
    2. requiring students to read those texts,
    3. linking this reading (and writing) to inquiry work,
    4. providing explicit instruction in discipline-specific text features and formats,
    5. providing explicit instruction in discipline-based strategies and approaches,
    6. teaching the nature of argument and evidence use in the disciplines, and
    7. developing rich content knowledge in the disciplines.

Disciplinary Literacy Portraits

This section provides descriptions, or portraits, of how experts in history, science, and literature create, communicate, and evaluate knowledge and how these differences give rise to unique literacy practices. These portraits are derived from studies of experts (e.g., Bazerman 1985), expert-novice comparisons (e.g., Wineburg 1991; Wineburg 1998; Rouet et al. 1997), expert-expert comparisons (Shanahan and Shanahan 2008; Shanahan, Shanahan, and Misischia 2011), and functional linguistic analyses of disciplinary texts (Martin 1993; Veel 1997; Wignell 1994).

We acknowledge the hazard of overgeneralizing from these data to the practices of various subdisciplines or specializations within a discipline. Science, for example, includes the branches of biology, physics, and chemistry as well as subdisciplines such as microbiology, physiology, and botany. Each may have its own unique qualities not entirely captured here. Additionally, the studies are all based on small sample sizes, so they may not reflect the full range of literate practices evident among experts in a discipline. Given this, teachers are advised to reflect thoughtfully about the practices within their own discipline. Still, the discussion of the disciplines provided here should prove illuminating.

HISTORY

Creating, communicating, and evaluating knowledge. Students often believe that historians simply chronicle historical events, recording what happened in the past completely, objectively, and accurately (and, too often, boringly). Historians, on the other hand, are aware that this isn't possible. They make informed judgments about what occurred in the past by relying on what's survived, the so-called historical record—documents, artifacts, newspaper articles, interviews, letters, pictures, and so on—along with what's been written previously by other historians. These sources, as one can imagine, often contradict each other. Historians seek to develop interpretations of events based on existing evidence and informed by their own perspective, the latter of which is used to determine which parts of the record to depend on and how much weight such evidence should bear. An account of the civil rights movement by Rosa Parks, who refused to surrender her bus seat in spite of segregationist law, would be quite different from one by "Bull" Connor, who ordered such protestors fire hosed. And, in part because they have more information about and more perspective on the movement than was available when it was taking place, historians would write about these events differently now than they would have in the 1950s or 1960s. Historians grapple with various, often fragmentary records and the accounts of other historians, trying to determine what happened, what was significant, what motivated actions, what actions caused which outcomes, what the competing goals of the various participants were, and so on. Historians create interpretations based on evidence,

distinguishing on the basis of informed judgment which factors led to or caused which outcomes and which relationships were strictly sequential (one factor following another but not leading to or causing another). In other words, historians strive for plausible and cohesive interpretations—not the truth per se.

Historians also know that the interpretations they create about the past may be ephemeral. Interpretations shift continually when new evidence comes to light or new explanations are proposed. Christopher Columbus has been characterized variously as a brave and noble explorer who discovered the New World, an evil villain who enslaved and destroyed a native population (based on an account of atrocities written a century later), and a product of his time (if he hadn't landed on those islands, someone else would have). History, in one historian's words, is "the reconstruction of past events, through a dialogue between surviving evidence about the past and existing analytical, theoretical, and political concerns in the present" (Leinhardt, Stainton, and Virji 1994, 8). Because of these shifting interpretations, historians look at their work as a never-ending argument—and that's the appropriate stance readers should take when reading history.

Historians employ *interpretive frameworks* as lenses to guide their analyses. These frameworks may be societal (e.g., social class, race, gender), institutional (e.g., slavery, despotism, economics, religion), or philosophical (e.g., the "great man in history" vs. "grassroots" history) in nature. When studying the civil rights movement, a historian with a "great man" bent might focus on Martin Luther King Jr., whereas a historian with a "grassroots" perspective might emphasize the teens who protested at segregated lunch counters. These lenses privilege some evidence over others. Historians also look for connections across perspectives. Some, for example, have argued that the birth of the Republican Party, a political event, was influenced by the Second Great Awakening, a religious movement (Spoehr and Spoehr 1994).

Historians demonstrate that they appreciate the inherent interpretive problems they face by interrogating their sources. Is there language in the text that betrays a particular bias or stance? What's known about the author or the reason the text was written? To whom is the author speaking? In addition to evaluating perspective, historians assess the quality of evidence. Evidence that's corroborated is usually considered more trustworthy (and of higher quality) unless the corroboration comes from the same standpoint as the original evidence (e.g., from a political figure and that figure's own aide).

Content knowledge. To historians, content knowledge consists of what they know about past events. Historians are interested in particular questions about those events: What happened? What was significant? How did things change over time? What were historical actors'

motivations? What was the philosophical and moral context of the time? What were the causes and the effects? What patterns are similar across time and place? (Southern 1953; Ashby and Lee 1987; Ashby 1993; Shemilt 1987; Lee and Ashby 2001; Levstik 2002)

Historians engage in research to answer these questions, and the answers become the content of history. Take, for example, a U.S. history class taught at a major university by a Pulitzer Prize–winning author, a class one of us spent an extended time observing. The author taught events chronologically, but the order of events wasn't the most significant thing he wanted to convey. He had a cause-and-effect hypothesis that throughout the course he kept returning to. In other words, he was making a claim and using details about the past as his evidence. It was this claim and supporting evidence that the students were supposed to learn, but most focused on the details alone. An understanding of the discipline was needed for them to realize that the historian's interpretive lens was worthy of attention and something to add to their content knowledge.

Texts. Historians rely on all kinds of texts, conventional and otherwise, in their study of history. These texts consist of artifacts (e.g., tools), legal documents (e.g., census reports, legislative bills), newspaper articles, films, interviews, photographs, maps, memoirs, and on and on. These are all part of the evidentiary basis of their work.

How do historians write about their interpretations of the past? Functional linguists provide us with insights into *what* and *how* historians write. Megill (1989) discusses three kinds of writing: recounts of the past (narratives or accounts), explanations of the past (reasons why certain events happened), and arguments or justifications (historical arguments that include claims, reasoning, and evidence). In middle school social studies and high school history textbooks, one finds numerous examples of recounts (*In 1492, Columbus sailed the ocean blue*) and explanations (*Three factors entered into President Roosevelt's decision*), but explicit arguments and justifications are rare. The claims may be implicit within the narratives and explanations rather than stated overtly. Historians may write this way in an attempt to keep the text cohesive, to avoid controversy, or because they may not feel the need to justify their reasoning since history is always an interpretation. At any rate, implicit argument is the convention. Students who lack disciplinary sophistication, however, may not view such texts as interpretations but instead as immutable truth.

What do historians put into their accounts of the past? Histories depict time, place, manner, actors, goals, processes, and cause (Fang and Schleppegrell 2010). Historians also attribute agency and offer judgments and interpretation. For example, consider this sentence:

> After the successful Montgomery bus boycott, the Civil Rights Movement became emboldened in its quest for equality, and Martin Luther King felt ready to head it, founding the Southern Christian Leadership Conference and becoming its first president.

The author discusses time (*after the bus boycott*), actors (*the Civil Rights Movement*, *King*), a goal (*equality*), and processes (*founding the Southern Christian Leadership Conference*). The text implies a causal relationship between the success in Montgomery and King's later actions. King's inner thoughts (*King felt ready*) are surmised, and he takes on agency as he impels the movement forward.

In summary, historians ask historical questions. Using various interpretive lenses, they draw on evidence from the historical record and the accounts, explanations, and arguments of other historians, evaluate that evidence, and use that which they deem credible to create answers to those questions—interpretations of the past. These interpretations are communicated through recount, explanation, and argument.

Reading. The important point, in terms of disciplinary literacy, is that historians read in ways consistent with how knowledge is created and communicated in their discipline. In a study of how historians and high school students read historical documents, Wineburg (1991) identified three processes common among the former but absent from the latter. Historians *sourced*; they noticed who an author was and tried to determine perspective by evaluating the text's language and content (e.g., Shanahan and Shanahan 2008; Shanahan, Shanahan, and Misischia 2011). For instance, historians look for words that betray ideology (such as a text referring to the U.S. Civil War as the "war of Northern aggression") or the inclusion or exclusion of particular events from an account. The historians also *contextualized*; they thought about the era in which a document was written, the document's purpose and audience, and what other events were happening then. Contextualizing also requires sensitivity to particular fallacies, such as presentism (viewing past events through our current moral and philosophical lens) and pastism (portraying the past as superior to present times). Finally, historians *corroborated*; they compared texts to determine areas of agreement, omission, and difference.

Historians place what they read into political, religious, economic, social, and other categories and are adamant about the need for multiple perspectives on every event. According to historians, history can never be understood from a single document or perspective. Accordingly, historians read everything critically—including the graphics. Sourcing isn't just a reading strategy for historians; it's a way of intellectual life (Wineburg and Reisman 2015).

> **"Historians read in ways consistent with how knowledge is created and communicated in their discipline."**

The reading practices of historians arise from how they create and critique knowledge. It follows that if we want students to engage in such practices, it's necessary for them to understand what historians do, how historians do what they do (disciplinary knowledge), and the kinds of products that result (content knowledge).

SCIENCE

Creating, communicating, and evaluating knowledge. Scientists try to describe the workings of the natural world. They're aware of the fallibility and limitations of their methods and results. Their scientific knowledge of the world depends on the accuracy of measurements, what they observe or fail to observe, their theories, and so on. Scientists attempt to create organizing principles about the way the world works, but these principles are inventions, not reality itself. What scientists understand today may not be what they understand in the future. As instrumentation becomes more accurate, as more is observed, and as hypotheses are borne out or falsified by research, scientists revisit and redetermine their conclusions. They engage in arguments based on scientific evidence within the community of scientists and in the public arena (such as arguments about the effects of certain diets on our health).

Historians and scientists think differently about their fields. We speak of "scientific progress" but not "historical progress." Scientists believe that as they engage in research, they become more knowledgeable about how the world works. They know, for example, more about the mechanisms underlying the growth of cancer cells today than they did fifty years ago and believe that they will learn even more about those mechanisms in the future.

Scientists engage in different kinds of research than historians do. Historians study events after they occur, but scientists can observe events as they occur, and they can often produce the circumstances they want to study. With experiments, they can control extraneous factors in ways that allow them to focus on a variable of interest. They strive for objectivity by determining what would count as a significant finding before they start an experiment. Even their observations must follow rigorous rules to ensure accuracy. Whereas the goal of historians is to posit *plausible* interpretations of the past, the goal of scientists is to use scientific results to *predict*, with a degree of confidence, what will happen in the future in circumstances similar to the experimental ones. Physicists, for example, have to be confident enough in their knowledge of the physical world to determine the trajectory of rockets or the amount of weight a bridge will bear.

Though scientific knowledge is subject to change, it may take decades to do so. Along the way, scientists distinguish between phenomena that continue to correspond to their predictions and those still open to

question (Driver, Newton, and Osborne 2000). Generally, scientists have more confidence in the knowledge they create than do historians.

Content knowledge. The content knowledge of many sciences is classificatory (including information put into hierarchical form), definitional, and process oriented. Biologists, for instance, place life-forms into a hierarchy of kingdom, phylum, class, order, family, genus, and species and describe the characteristics of life within and across those categories. Chemists identify substances, determine those substances' atomic structures, describe their characteristics, ascertain how they're implicated in various scientific processes, and note their interactions with other substances. Other scientists define and describe the phases within processes such as the life cycle of an insect, the water cycle, and meiosis and mitosis.

How do scientists convey these descriptions? A universal quality of scientific knowledge is how amenable it is to depiction in multiple forms. The water cycle, for instance, can be described in words, conveyed in diagrams such as flowcharts, and summarized in a series of mathematical or computational formulas that allow prediction. Depictions of science information are always varied:

> . . . [W]e use language [in science] only in coordination with many other modes of semiotic representation: visual images, diagrams, graphs, mathematical formulas, and the semiotics of artifacts, apparatus, and the meaningful activities of using them. Scientific communication and scientific literacy are fundamentally multimodal. (Lemke 2004, 1)

Scientists depict knowledge multimodally because they believe that the abstract knowledge they create cannot fully or accurately be described in words alone. That belief is part of their *disciplinary knowledge*.

Texts. The nature of scientific texts mirrors the nature of scientific inquiry. When scientists write their observations, descriptions of experiments, proposals for research, explanations of scientific principles for lay readers (e.g., science textbooks), and so on, the language and structure used embody scientific notions of objectivity, multimodality, process, hierarchy, and so on.

Science uses a particularly noun-centric language: approximately 60 percent of the words in science text are nouns (Biber and Gray 2016). This plays out in various ways. For instance, scientists, in an effort to communicate more efficiently, often string nouns together to create new categories of focus (e.g., *monkey cortex* instead of *the cortices of monkeys*, or *pressure hose* instead of *hoses used to increase pressure*); this kind of linguistic compression not only increases concision but also often places higher demands on readers to possess and use relevant prior knowledge; most readers likely will understand what a hose used to increase pressure might be, but the term *pressure hose* could, in the

"When scientists write, the language and structure used embody scientific notions of objectivity, multimodality, process, hierarchy, and so on."

abstract, refer to, say, a hose that reduces pressure or to one that is itself under pressure (Biber and Gray 2016). Scientists also nominalize verbs and other parts of speech more often than do experts in other fields of study. *Nominalization* refers to the transformation of verbs, adverbs, and adjectives into nouns. For example, science transforms the verb *distill* into the noun *distillation*, which converts a specific action into a general, abstract, and objectified process (Halliday and Martin 1993). Noun phrases in science are particularly long and complex because of nominalization and the use of phrases instead of adjectives to modify or describe their subjects. For instance, look at the subject of this sentence:

> *The solar wind, a stream of charged particles flowing outward from the Sun,* creates a bubble-like region in the interstellar medium known as the heliosphere.

The subject is thirteen words long. The appositive describing the solar wind pushes the verb farther from the simple subject than is typical in sentences in most other forms of writing. To read sentences such as the example above, one would have to break down the phrases, which contain specialized vocabulary, and connect those phrases with the verb appropriately. It's the noun-centric nature of scientific writing that many people think of when they describe such writing as dense.

Science texts also frequently use passive voice, minimizing the role of intention in causation. In history, one is concerned with intentionality—the goals of the players. But in science, causation doesn't rely on intention. Atoms don't intend to move, but they do, at least under certain conditions. Because scientific processes don't depend on human intentions, science adopts a language that's careful to keep the focus on the processes as opposed to the humans who are studying those processes (Fang and Schleppegrell 2010). In scientific writing, then, one is more likely to see *The proportion of men in the sample was shown by a random effects analysis not to be significantly related to gender* than *We conducted a random effects analysis that showed that the proportion of men in the sample was not significantly related to gender*. In the former, the analysis and the outcome are foregrounded; in the latter, the scientists who conducted the study are.

Scientists value precision. Without precision, there can be no replication, and the whole idea of science is to create knowledge that can be replicated no matter what various scientists' beliefs or ideologies may be. Thus, when scientists explain their research in writing, they describe their methods and measurement techniques minutely, and their results include the degree of certainty that results will recur in similar situations and the extent to which results can be generalized. The whole point of this is to ensure that the claims a scientist makes can be substantiated by redoing the same experiment or carrying out the same observations.

Scientists also strive for stability and recoverability of scientific vocabulary. For this reason, they make heavy use of Greek and Latin combining forms, prefixes, and suffixes in the construction of the words they use to describe phenomena. For example, even scientists unfamiliar with the process of eutrophication could get some sense of its nature from the knowledge that *eutrophos* means "well nourished" and *-tion* signals that the word is a noun. (Eutrophication of, say, a pond describes how a pond has become well nourished by nutrients and minerals, usually due to agricultural runoff, to the point of having excessive algae growth.)

Several other features of science text have been identified, including the specific ways they present the classification of information (Halliday and Martin 1993) and the highly structured formats of research reports (Bazerman 1988; Berland and Reiser 2009; Cavagnetto 2010; Driver, Newton, and Osborne 2000). Science texts, on the whole, are dense, highly structured, technical, abstract, objective, and multimodal. These characteristics make special demands on readers who seek to understand science from reading.

Reading. Scientists read differently than both novices and experts in other disciplines do. It's true that there are likely to be variations in how scientists from various specializations read since subfields often have unique purposes and methods of research. For example, physicists attempt to solve problems, while botanists focus on the identification and classification of phenomena. Nonetheless, those scientists who have been studied (e.g., physicists, botanists, chemists) engage in enough common practices to justify the generalizations made here.

Researchers have studied the differences in how physicists and novices approach problems. A novice might view a given problem as being about its context (e.g., baseball or race cars), while to the physicist it's about Newtonian physics. Novice readers interested in whether pitchers in baseball can really throw a curveball aren't likely to view the issue as one of force and drag or as an example of Magnus effects; their efforts to answer such a question would typically have a lot more to do with the particulars of baseball than with the application of concepts and processes previously identified by physicists. (As it happens, baseballs do curve, but so do all spinning objects moving through air or liquid.) Physicists view knowledge hierarchically—with general principles and abstractions (e.g., the type of problem) at the top of the hierarchy and specific details (e.g., the speed of the baseball) at the bottom—and use the hierarchy to solve problems, drawing from general principles. Novices, on the other hand, focus mainly on lower-level information (Giere 1994; Snyder 2000).

Physicists (like other scientists) draw on different kinds of knowledge when they read: knowledge of the content of physics, promising lines of research in the field, and research methodology. Because they approach

reading from such a rich knowledge base, they engage in reading as a dynamic enterprise, especially when they're interested in the topic. In fact, an important part of their reading activity is deciding what's interesting and worthwhile to read (Bazerman 1988). Physicists' stance toward a text, once selected, varies based on their prior knowledge of the topic. If they know something about the topic, they read the text critically, evaluating methods, explanations, and conclusions. If, on the other hand, they know little about a topic, they seek out trustworthy sources and adopt more of a learning mode than a critical one.

Chemists have been shown to do something similar. Shanahan, Shanahan, and Misischia (2011) found that chemists relied on their knowledge of the research in their field, including who produced a given text, which lab produced it, and the year the text was written, to determine whether a particular study was worth reading. But once this selection had been made, they consciously set that source information aside so they could be appropriately critical of the information in the study itself. They reported that they read texts conveying information on previously unfamiliar topics in a relatively uncritical fashion, focusing more on learning from than arguing with the texts, since their selections tended to contain scientific information corroborated by multiple studies. They emphasized the particular importance for students of science of reading to learn and the need for students to have authoritative and up-to-date science texts to read. This stance was vastly different from that of historians (Shanahan, Shanahan, and Misischia 2011), who argued for exposing students to multiple texts, including contradictory texts, to encourage criticality in students from the beginning.

Readers of science must also learn to evaluate multimodal information. A study of geologists, for example, detailed their understanding arising from data presented in multiple forms, such as charts and diagrams as well as sentences. Geologists, like other scientists, translated information from one mode to another (Lemke 2004).

In addition, it's important to know that scientists don't read linearly—that is, from the beginning to the end of a text—but instead jump around in a text to gain an understanding of the information. They may read the results and then jump back to the methods to figure out how those results were obtained. Additionally, the multimodal nature of texts requires that science readers examine a graphic and then reexamine it after reading a verbal description of the same data.

In summary, although scientists share much in common with experts in other fields, a closer look reveals important differences in purpose, methods, and levels of confidence in the conclusions they reach. Additionally, scientists' efforts at objectivity and precision and the ubiquity of multimodal representations in their texts also distinguish

SAT Suite Connections

The requirements of literacy in the disciplines deeply inform SAT Reading Test and SAT Writing and Language Test passages and questions. Reading Test passages, which are excerpted or minimally adapted from previously published, high-quality sources, are selected in part to reflect the demands of reading in the disciplines of literature, history/social studies, and science. Reading Test science and social science passages, for example, discuss hypotheses, methodology, data, conclusions, and implications and are often accompanied by informational graphics (tables, graphs, and the like) that display associated data and otherwise complement the information and ideas conveyed in words. Writing and Language Test passages, which are written for the test, address topics in the content areas of history/social studies, the humanities, and science and may also be accompanied by informational graphics. As much as possible, questions on both tests ask students to respond in ways appropriate to the various disciplines—for example, by locating and interpreting data in science or social science informational graphics and by considering theme, motivation, and word choice in literature passages.

science. These unique features of scientific endeavor and communicative practices direct scientists' approach to reading.

LITERATURE (ENGLISH)

Creating, communicating, and evaluating knowledge. Instruction in English classes is typically more explicit about reading and writing than is the case in the other fields described thus far since works of literature—literary texts—themselves constitute the fundamental "knowledge" of the field. Scientists write about the worldly phenomena they examine, and historians about historical events, but English professors and literary critics write about texts themselves. Authors of literature, in turn, create texts from their imagination and memories, so they don't necessarily have to deal with real people, situations, or events. An author can assume any perspective simply by selecting a particular narrator; that narrator doesn't have to be the author and can even be intentionally unreliable. What such authors create isn't "knowledge" as we commonly think of it in other fields. Literature provides insight into the human condition, often through the creation of imaginary worlds. Because of this, arguments about literature's meaning that take place in English studies are often based on the readers' ideological stances.

A literary critic interprets literature based on traditions of interpretation. Someone with a New Criticism stance believes literature should be read with no heed to the author or the context in which the work was written. What the text means is in the text itself, and a close reading will reveal that meaning (a stance promoted by the Common Core State Standards). Someone with a reader response stance, by contrast, downplays what's in the text in favor of the connections and reactions of the reader to the text. And someone with a scholastic stance pays more attention to the biographical or historical contexts that gave rise to the text than would readers with either of the other two stances.

To illustrate the point, consider Robert Frost's "Stopping by Woods on a Snowy Evening." People with a New Criticism stance might seek clues to the poem's meaning in word choice ("dark and deep") or repetition ("and miles to go before I sleep") or by considering the clashing moods expressed ("of easy wind and downy flake" versus "but I have promises to keep") (1969). Advocates of reader response, by contrast, might try to remember a time when they were in the woods at night or some other winter scene, perhaps a winter holiday, and might feel a pang of regret thinking of a time when the weight of responsibilities overwhelmed their sense of enjoyment. Scholastic readers might, in addition to the poem, read Frost's letters to determine what was going on in his life at the time he wrote the poem and from this conclude that the poem is a meditation on suicide.

There are, of course, still other interpretive traditions. One could give the text a Marxist, feminist, Christian, or Freudian read as well. These interpretive theories serve the same role that plausibility and predictability do in history and science: they provide sets of rules or guidelines that determine which interpretations are sound or reasonable.

Content knowledge. The relevant content knowledge for literature is knowledge of human motivation, emotion, and relationships with the world (e.g., humanity, nature, god). That's why literary interpretation may change across a lifetime of experience; new insights and possibilities emerge. There are, however, also tools that literary critics use to guide interpretation—for example, knowledge of metaphor, figuration, and rhetorical patterns. Learning to use these tools is part of learning the discipline.

Texts. Literary texts feature moral and philosophical content about the human experience often framed by archetypal topics such as coming of age or humanity against nature. In narratives, characters in a particular setting are confronted by situations—political, economic, religious, or social—via the plot that are challenging (create conflict) and that they must work through (reach resolution on). The way characters resolve conflicts (shown by their actions and psychological states) illuminates themes about the archetypal topic (Kelly 1991).

In both narratives and poetry, authors use imagery (description, metaphor, simile, figuration), symbolism, irony, satire, and rhetorical structures and patterns (parallelism, understatement, exaggeration, repetition, allusion) to offer insight into the characters, plot, conflict, and resolution and to help illuminate thematic content.

Authors of narratives or poetry provide insight into meaning in the way they portray the narrator's perspective. For example, the narrator of a piece of literature could be first, second, or third person; omniscient, objective, limited, or unreliable. A first person narrator could be a protagonist, a witness, or a reteller. There could even be multiple narrators. All these options and more are ones authors use to convey meaning or to express their claims (themes) about the human condition.

Reading. Experts and novices both derive meaning from a character's goals, thoughts, and actions, the arc of a story, and the connections that can be made from the work of literature to the human experience. When literary experts read literature, however, they try to construct more abstract or universal interpretations than novice readers typically do (Zeitz 1994). For example, a student might tell us that a given story is about a boy who lost his dog, whereas a literary expert might conclude it's about the yearning people have to return to innocence. Experts are also more likely than novices to ground their interpretations in the language and structure of the text (not just in the details of the plot), make

"When literary experts read literature, they try to construct more abstract or universal interpretations than novice readers typically do. Experts are also more likely than novices to ground their interpretations in the language and structure of the text, make connections within and across texts, and situate their interpretations in literary theory."

connections within and across texts, and situate their interpretations in literary theory (Goldman, Britt, et al. 2016).

When analyzing a poem, experts might read it multiple times, attending to the way the poem is structured, noting linguistic elements, thinking about the author's use of poetic conventions, and alluding to other works of literature, whereas novices tend not to approach a poem in these ways (Peskin 1998). Experts engage in similar practices when reading other kinds of literature (Hillocks and Ludlow 1984). To experts, interpreting literature is analogous to solving a puzzle. They bring all their knowledge of the field to the solution process, look for patterns, consider and test out alternative possibilities, home in on surprises or points of confusion, and engage in conversations about meaning with their peers. They might engage in a scholastic read—bringing to bear information from outside the text, such as an author's biographical information or information about the time period in which the work was written—or consult past interpretations in the writings of literary critics (Rainey 2015). When experts make arguments about literature, they assert claims about such matters as theme, language, structure, connections to other texts, ideology, and texts' role in or positioning with regard to political or social movements. Furthermore, critics can explain their interpretations using theoretical, philosophical, personal, and experiential lenses (Goldman, Lawless, et al. 2016).

In summary, experts read literature by drawing on their knowledge of how the field creates, communicates about, and evaluates literature. Because they know how meaning is put into literary texts, they know what approaches are needed to get meaning from them. They know how to have conversations and to construct formal arguments about meaning and the author's craft because they have knowledge of the kinds of elements in literature that one can evaluate.

The Benefits of Disciplinary Literacy Instruction

Disciplinary literacy is a relatively new field; the term has only been in use since the mid-1980s. Since the field's emergence, most studies have been descriptive, highlighting the practices of experts and providing functional analyses of disciplinary texts. Studies of instruction—of how to teach disciplinary literacy effectively—have only recently begun to appear. Nevertheless, there's mounting evidence showing that teaching students some of the unique reading and writing approaches associated with the disciplines can enhance both subject matter learning and literacy achievement.

So far, the majority of these instructional studies have taken place in the field of history/social studies. Researchers, using both qualitative and

experimental methods, have found that teaching students to read with a historical lens can enable them to learn historical information, critically think about such information, interpret history from available documents and artifacts, communicate their interpretations in writing, and garner other learning benefits.

Hynd, Holschuh, and Hubbard (2004), for example, have demonstrated that college students can be taught to source information, contextualize it, and corroborate it with information from other sources when reading historical accounts and to engage in other types of historical reasoning that promote a complex understanding of past events. The students in that study also began to take on the idea of history as interpretation, and this new (to them) way of reading history led to heightened motivation. College students aren't the only ones who can profit from such history-specific instruction. Fifth graders, too, have been shown to be able to use historical reasoning as they read (VanSledright 2002a, 2002b). After a year of discipline-based teaching, these students learned "how to make sense of historical documents as evidence, identify the nature of the documents as sources, judge the reliability and perspective of those documents, and corroborate details across accounts in order to construct evidence-based assumptions" (VanSledright, 2002b, 131). In another study, struggling middle school readers successfully learned to corroborate information across texts (Wolfe and Goldman 2005). Another group of middle school students who were taught historical reasoning strategies wrote more accurate and persuasive historical essays than did control group students (De La Paz 2005). Teaching various historical reasoning skills (e.g., sourcing, corroboration, causal analysis) led high school students to comprehend better (Reisman 2012) and to write better essays and historical arguments (De La Paz et al. 2012; De La Paz et al. 2017; Monte-Sano 2011; Wissinger and De La Paz 2016). A study of the work of students in a high school world history class across a year of history reading and writing instruction (Shanahan et al. 2016) chronicled a progression from naïve to discipline-based reasoning, not only in terms of the use of sourcing, contextualization, and corroboration across multiple documents but also with respect to notions of cause-effect and chronology, change over time, significance, historical claims and evidence, and critique and evaluation as well as use of historical frameworks. Together, these and other studies across a variety of grade levels demonstrate that students can learn to use discipline-based strategies in history and that this instruction has a positive impact on students' history knowledge while enhancing their ability to interpret historical documents and to write historical accounts and arguments.

Instructional studies of disciplinary literacy in science paint a similar picture. As mentioned, an important aspect of science reading (and learning) is the sense one must make of multiple representations of scientific phenomena (e.g., text, graphical elements, formulas). Teaching

students to translate information from one form to another—say, from text to graphic or from graphic to text—can have a positive effect on students' ability to write about scientific information (Moje et al. 2010; Textual Tools Study Group, University of Michigan 2006). Instruction in the coordination of multimodal science information not only improves the target skill but also helps raise achievement on state language arts, reading comprehension, and biology tests (Greenleaf et al. 2011). Researchers have also studied how to improve students' ability to engage in scientific writing. Hand, Wallace, and Yang (2004) found that the use of the Science Writing Heuristic, an approach that provides students with a template for linking evidence and claims in science lab reports, improved students' ability to write an explanation of a science topic relative to those students who simply wrote a traditional lab report before writing the explanation. Other studies of the Science Writing Heuristic have had similar results (Akkus, Gunel, and Hand 2007; Burke, Greenbowe, and Hand 2006; Rudd et al. 2001). Goldman, Lawless, et al. (2016) determined that teaching biology students to read multiple texts, including multimodal representations, led to improved biology test performance and deeper learning of science content. Together, these studies suggest the benefit to students provided by instruction focused on the disciplinary characteristics of science.

The evidence from instructional studies of literary reading and writing suggests that teaching students to use the technical tools employed by literary experts improves students' ability to engage in the interpretation and critique of literature. Studies have found that teaching symbolism improves adolescent students' interpretations of poems and their enjoyment of poetry (Peskin, Allen, and Wells-Jopling 2010; Peskin and Wells-Jopling 2012). Teaching students to understand irony leads to better performance in interpreting both ironic and nonironic meanings in other poems (Smith 1989). Teaching students to understand unreliable narrators helps students be more skeptical of the information they obtain from those narrators (Smith 1992). Teaching students to adopt some of the discourse practices of expert literary readers helps them progress to more sophisticated understandings of literature (Lee 1995). All these studies point to the power of teaching students to read literature like a literary critic.

Recommendations for Instruction

There are two basic approaches one can take to disciplinary literacy in subject matter classes. One would be for teachers to supply students with texts used in a discipline and to provide explicit instruction in the application of specific discipline-based literacy practices. A second would be more immersive, in which students are engaged in the inquiry work of a discipline and taught approaches to literacy as opportunities emerge from such work. For example, students might prepare for a chemistry lab

by reading past work on the properties of a specific gas and then carry out a controlled experiment with that gas. Then the students would try to describe that experimental work in a manner that was replicable or to report the results to a lay audience.

Both of these approaches have merit. We encourage teachers to initiate students into the work of the disciplines; students can create, communicate, and critique information as apprentices. However, we caution that not everything students are supposed to learn about a subject can be learned "hands-on." Not all chemistry can be learned from lab activity, and it'd be burdensome to try to re-create all of the field's hard-won knowledge in brief lab assignments using relatively unsophisticated equipment. Gathering information from textbooks and other written sources, not only in science but also in history, mathematics, and other subject matter classes, is a major source of learning in postsecondary education and career.

To successfully introduce students to disciplinary literacy, it's essential that teachers make disciplinary texts available to students and that students be required to read these texts. Teachers also should link reading and writing to disciplinary inquiry, provide guidance in the interpretation of particular text features, and teach discipline-appropriate reading strategies. Finally, students must come to understand the nature of argument and evidence in the disciplines. The remainder of this chapter will expand on these recommendations.

TEACHERS SHOULD MAKE DISCIPLINE-APPROPRIATE TEXTS AVAILABLE

Students can't learn to read within a particular discipline without access to the appropriate texts. Appropriateness varies by discipline. Take textbooks, for example. Although historians don't oppose history textbooks, they insist that the study of history is inherently a study of multiple perspectives. Thus, the use of a single textbook misses a fundamental point of history. If a textbook is to be used, so should primary source materials, the argumentative writings of historians, and perhaps another textbook. A good part of the work in history class should be devoted to engaging in historical inquiry with sets of primary sources on the same topic in order to give students experience in trying to sort out perspectives and evaluate plausibility.

By comparison, scientists are much more supportive of the idea of a single authoritative account of science knowledge. The accuracy and currency of this information is essential, however. Scientists are less interested in guiding students through critical analysis of text than in ensuring that students develop a coherent understanding of current scientific information, whether presented in a textbook or some other source (e.g., internet site, science magazine, journal). Of course, science

texts, regardless of source, should present students with information in a multimodal format (e.g., text, informational graphics, mathematical/computational elements).

In English class, whether one uses a literature textbook or not is irrelevant. It's the literature that matters, and it doesn't matter whether that literature is taken from an anthology, presented in a series of individual novels or collections of short stories, or found in a first edition. Examples of literary criticism appropriate to a literature class are also not format dependent.

Text availability is important, but it will only support disciplinary literacy to the extent that the texts are appropriate to the purposes and methods of the discipline. The content of texts must meet the demands of the curriculum, of course. However, within the parameters of content appropriateness, texts should include the specialized text features of the discipline and be appropriate for disciplinary reading. For instance, students won't be able to read multimodally, the way scientists read, without texts that contain scientific prose, informational graphics, and mathematical/computational elements that address the same phenomena. Unfortunately, some textbook publishers at times use science graphics more to decorate pages in order to interest students than to communicate scientific insights about a concept or process.

Similarly, students won't be able to weigh multiple perspectives in a history class unless the texts they read offer a range of perspectives concerning historical events. A high school world history teacher one of us worked with made text choices with disciplinary literacy in mind. As she mapped each unit of instruction in her curriculum for the year, she put disciplinary literacy concepts on one axis and her lessons and text choices on another. As she completed her plans, she ensured that there was a progression from the introduction of a literacy concept to a fuller realization of it as the year unfolded. Since she wanted students to source and contextualize, she had students read disparate accounts of Columbus's "discovery" of the "New World" at the beginning of the school year. The contradictory texts concerning Columbus's journey led students to recognize that there are different viewpoints about the past. This realization led them to consider who had written the accounts and when they were produced. The teacher gave students a heuristic for sourcing that reminded them to look at the author, the time period, the intended audience, and the purpose of the writing as they read each new text. Although students used the heuristic perfunctorily at first, the teacher immersed the class in discussion of how an understanding of the authors' varied experiences and differing historical contexts could offer insight into the reasons for the differences in the accounts. As the year progressed, she varied the roles of authorship and context. For example, she provided students with texts by the same person but written at different points in time or aimed at different audiences. Her selection

College and Career Readiness

Higher education faculty expect students to have already acquired certain disciplinary literacy skills and knowledge before entering postsecondary education, according to data from the College Board's 2019 National Curriculum Survey Report. The sample of 1,377 postsecondary faculty in English, social science, and science gave high to relatively high mean importance ratings to students' ability to read and understand texts of various types and contents associated with particular disciplines: 2.62 (on a four-point scale, with 4 being "very important") for history/social science texts, 2.70 for natural science texts, 3.15 for textbooks, 2.76 for scholarly research, 2.88 for primary historical sources, and 3.15 for data displays.

For more information on the College Board's 2019 National Curriculum Survey Report and its results, see the general introduction to this collection.

of texts and their arrangement across a school year ensured that her students' ability to source and contextualize increased in sophistication (Shanahan et al. 2016).

STUDENTS SHOULD BE REQUIRED TO READ DISCIPLINARY TEXTS

That students should be required to read texts in the disciplines may seem obvious, and yet, in years of classroom observations, we've repeatedly noted a pattern in middle school and high school subject matter classrooms: because students may have difficulty reading classroom texts, teachers often try to convey the content without texts. Heavy reliance on lecture, demonstration, teacher explanation, and the like may be sufficient to convey the information, but the less literary, historical, or scientific reading that students are engaged in, the less college and career ready they're likely to be.

This practice of skirting the text reduces students' ability to engage in disciplinary-specific reading independently as well as the likelihood that they'll gain either an awareness of the nature of argument in the various disciplines or a full appreciation of particular aspects of disciplinary practice that are dependent on literate practices. Watching a film, say, can be an enriching literary experience, but it shouldn't supplant the reading of literature. Taking part in labs is important in science, but it's not sufficient to develop a full understanding of the scientific method or to obtain current knowledge of the scientific world. Students should spend a significant amount of time reading disciplinary texts.

READING AND WRITING SHOULD BE LINKED TO THE INQUIRY WORK IN A DISCIPLINE

The literate practices of a discipline derive from the discipline's purposes, methods of inquiry, avenues of communication, and notions of quality (critique). It follows that for students to learn to read and write in a discipline, their instruction should expose them to all these elements. Content knowledge is an important part of the curriculum but so is an understanding of the kinds of work that produce such knowledge. Otherwise, students won't understand the context for the approaches they're taking to reading and writing, which definitely puts the cart before the horse. Engagement in inquiry allows students to feel invited into a discipline and may provide them with motivation to persist in the face of challenging content.

At least part of the time, then, students should be involved in projects similar to those that take place in the disciplines themselves. In history, students can search for and evaluate multiple sources on a topic to produce their own interpretations of a contested historical event, be required to adopt a particular lens (e.g., political, economic, social) to reinterpret an event, make evidence-based claims grounded in an

interpretation, and so on. In science class, students can read the relevant scientific information on a phenomenon, form their own hypotheses, write proposals for research to test their hypotheses, engage in the research, and report on the findings using a standard research article protocol, including multimodal scientific explanations, for either a lay or scientific audience. In literature, students can learn to make an interpretive claim about a work of literature backed by textual evidence, to critique an author's craft, to read relevant metasources (e.g., professional critiques, author biographical material), to write a scholarly interpretation of a piece of literature, and to compare several pieces of literature thematically—that is, engage in the work of the literary critic. From these sorts of engagements, students are given the opportunity to learn the reason they read and write in the ways used in the discipline.

TEACHERS SHOULD PROVIDE EXPLICIT TEXT-FEATURE INSTRUCTION AND GUIDANCE

Functional linguists have identified differences in texts from various disciplines. Disciplinary texts draw on the traditions of communication practiced by experts in given fields. Even the way textbooks are structured varies across subjects. Although most modern textbooks—even at elementary levels—include such features as headings, subheadings, and graphics, there are important differences in how textbooks in various disciplines structure and present content. History textbooks, for example, may present information chronologically by era, addressing all social, economic, and political information relevant to a particular era at once, or they may present information thematically, with different chapters addressing social, economic, and political issues and the content of each chapter arranged chronologically. Explanations of historical actors' motives and goals, cause-effect relationships, and other factors may be interspersed within an unfolding narrative or explanation ("there were three reasons why") and not highlighted as claims but presented as accepted fact. The graphical information in histories tends to be ancillary to the text—often doing nothing more than repeating information from the text—and can be examined before or after the text sections are read.

Students usually are presented with more than history in a social studies class. Geographical text may be included as part of an overarching historical presentation (e.g., maps showing the placement of troops in battle, the changing boundaries of states, or the movement of peoples), or geography may get more direct attention as a subject of study, often in connection with concepts in sociology and other social sciences. In any event, maps, unlike many other graphics included in histories, tend to be like the graphics in science, communicating both independent and overlapping information. Most economics graphics tend to be similar to the multimodal presentations of science, conveying the results of various

systematic studies. Civics may deal with information more akin to that found in the study of law than of history, with a heavy emphasis on such areas as legal procedures (e.g., how a bill becomes law) and court rulings (e.g., *Brown v. Board of Education*). Civics text may include graphics that repeat textual information (though sometimes more cogently than text, such as a diagram used to illustrate the process of enacting a law) or are mainly incidental, such as a photograph of the swearing in of Supreme Court Justice Thurgood Marshall.

Science textbooks are almost always multimodal, and their graphical elements need to be read reciprocally with the accompanying textual information. It's not always the case, however, that a graphical element will be aligned on the page (or screen) with the associated text, so a reader may have to go back and forth across pages (or scroll up and down) to make the necessary connections. Many modern science textbooks include pedagogical devices, such as brief definitions of technical vocabulary in the margins aimed at supplementing the extended explanations provided in the main discourse.

The texts of literature—short stories, poems, essays, plays, novels—have their unique structures and formats as well. Literary texts—except graphic novels and children's books—rarely are illustrated, nor do they contain informational graphics. Illustrations in literary works are, in fact, often frowned on by authors and literary scholars alike (Sacks 2013), as they may impose certain interpretations on readers. If students have seen a film or theatrical version of a work or if there are illustrations in a piece of literature, however, students need to learn how to manage them (e.g., how to see a story with fresh eyes after having viewed a movie version).

Teachers shouldn't assume that because students are reading a disciplinary-appropriate text they recognize its unique features or know how to make sense of them. For example, without teacher guidance, students won't necessarily know to read past the ends of certain lines in poetry to parse them meaningfully, nor will they automatically move back and forth between words and graphics in a science text. Explicit guidance and direction are needed if students are to reach a level of proficiency with such text features.

TEACHERS SHOULD PROVIDE EXPLICIT INSTRUCTION IN APPROACHES AND STRATEGIES

Reading approaches and reading strategies aren't the same thing. A disciplinary expert *approaches* a text within a framework of disciplinary knowledge (or a habit of mind) and with a particular purpose. These guide the way the expert reads. Wanting to understand who the author is and in what context a text was written are elements of an approach to text that historians take. A *strategy*, on the other hand, is a set routine that's applied to the reading of a text. For instance, SOAPSTone is a strategy

used in many history classes to promote sourcing and contextualization. The acronym stands for **S**peaker, **O**ccasion, **A**udience, **P**urpose, **S**ubject, and **Tone**, and students are asked to list these elements prior to and during reading. This strategy can be used in a perfunctory way. That is, students can merely list these elements without giving them much thought as they move through the text. If, however, students approach a text in history with the mind-set of a historian, they'll think deeply about how the elements addressed by the strategy shape the message, allowing them to determine perspective and potential bias. The SOAPSTone strategy, then, is best used as a reminder to novices to think about author perspective and context as a historian would. The basic point is that strategies are only effective if they're used thoughtfully, and they're more likely to be used thoughtfully if students are used to reading with the fundamental mind-set of the discipline.

To summarize some disciplinary *approaches* we've previously discussed, we note that whereas historians always seem to approach what they read with skepticism (regarding a particular text as if it were a potentially contestable argument), scientists aren't so consistently critical. For scientists, their stance depends on what they're reading and how much they already know about the topic. They approach research on topics of which they have great knowledge quite critically, expecting proper adherence to experimental methodology, comparing research methods and findings discussed in the text to those from their own work, and gauging the probability of replication. On the other hand, when they know relatively little about the topic but trust the authority or veracity of what they're reading, they engage in a more uncritical "reading to learn" mode. Literary experts approach texts without having to vet the extent to which something is true. They read more aesthetically—to infer meaning, detect themes, analyze characters, reflect on author's craft, and so on—and in a manner based on their interpretive stance (e.g., New Criticism, reader response). Teachers can help students adopt these and other approaches to reading through discussion and a careful arrangement of readings and assignments.

Specific reading strategies can be useful in subject matter classes as well as long as they're implemented in ways that adhere to these principles:

1. **Strategies should have a disciplinary focus.** Students might be asked to make a vocabulary notebook to facilitate their learning and use of the technical terms of a given subject, but that strategy would be too general to provide maximal support of disciplinary learning unless students are taught what kind of vocabulary to include or the nature of the definitions that should be recorded. In history, for example, it'd be wise to record not just what a word means but also the point of view it suggests. For example, there's a nontrivial difference between "revolution" and "movement." Which of those words is used in a text says something about the author's interpretive lens. In

science, it'd be prudent for students to depend on a science dictionary to identify the definition of a given word or phrase since general dictionaries may omit technical definitions or conflate everyday and specialized meanings. In literature study, students might benefit from organizing focal words conceptually into categories (e.g., words and phrases for describing characters, relationships, and emotional states). In other words, a vocabulary notebook will be more useful if the strategy reflects an appropriate disciplinary focus.

Of course, some strategies have an inherent disciplinary focus, such as identifying themes for literary works by tracking a character's arc of development or creating a table that identifies and organizes chemistry information (e.g., substance, properties, process, interaction, atomic weight). Timelines are particularly useful for contextualization in history. Teachers should either adopt such discipline-specific strategies or tailor existing content area reading techniques to the needs of a given discipline; if a given generic strategy can't be made to fit the discipline in a way that reinforces and extends students' understanding of the discipline, perhaps it isn't worth instructional time.

2. **Strategies should help students solve problems with the text(s) they're reading.** One-size-fits-all strategies can be problematic, as they may shift instructional focus away from a discipline-based text or assignment. Why engage students in a generic K-W-L (Know, Want to know, Learned) strategy, for instance, when the goal of the lesson is to get students to explain a scientific process multimodally? It'd be better to expose students to expert multimodal text in science, model how to construct a multimodal scientific explanation, and guide them in translating scientific information from one mode to another—a task much more in line with scientific process. In the latter case, the instructional goal, the text, and the strategy are aligned, and all are in accord with the literate practices of the discipline.
3. **The strategy shouldn't be the point of the instruction.** Students are in content area classes to learn the subject matter in ways that honor disciplines' ways of creating, communicating, and evaluating knowledge. Strategies, if used judiciously, can help novices engage in practices that allow them to learn content in discipline-relevant ways. Teachers, though, need to be careful to frame any strategy with reference to the discipline and the content. Once students demonstrate that they're successfully adopting an appropriate disciplinary approach, it's useful to fade out the explicit use of the strategy or strategies used to promote that approach. It can also be useful to vary the form that a particular strategy takes. For example, earlier we noted that one discipline-based strategy for identifying and organizing chemistry information is presenting students with a table to fill out. However, students could also be given a series of questions to

answer in preparation for a discussion or a template for summarizing the same information in paragraph form. The point is that the strategy isn't the point; the underlying approach to thinking is. Changing the format the strategy takes can help prevent students from being captured by the strategy and make it easier for them to recognize the underlying principle. Too often, students are evaluated on strategy use rather than content or approach, misleading them as to what learning is truly about.

TEACHERS SHOULD TEACH THE NATURE OF A DISCIPLINE'S ARGUMENT AND EVIDENCE

Argument is at the heart of all scholarly endeavor. However, as already discussed, the disciplines ask different questions, make different claims, rely on different kinds of reasoning and evidence to determine the veracity of those claims—and even differ in how they cite that evidence. Because of the centrality and variability of argumentation, it's important that students learn to engage in argumentation in discipline-based ways. To do this, however, they need to read and critique arguments written by others. Textbooks aren't enough. As noted, many textbooks hide the argument and presentation of evidence.

In science, students might read research studies as arguments, noting the claims (hypotheses) that are made and the methodological steps used to provide evidence for (or against) them. In literature, arguments about meaning or an author's craft are available in the form of literary criticism, with evidence coming either directly from the text or from other scholarship (e.g., the study of an author's letters or oeuvre). Historical arguments about the past and their evidentiary basis (e.g., documents, artifacts, writings of other historians) are common in the essays and books of historians.

Students also need to practice writing arguments through scaffolded practice that includes teacher modeling as well as whole-class, small-group, and individual practice. Writing is typically a challenge for students, so it might be useful to provide students with templates and rubrics when they begin the process of writing disciplinary arguments and then remove these scaffolds as students become more proficient. In addition, teachers should have essay assignments in mind for each unit of study. Students should be informed of this essay task at the beginning of a unit so that as they read, take notes, and engage in other classroom activities (e.g., labs, debates), they can be preparing to write the essay while they're learning the associated content.

In a history class, for example, a teacher might want students to write a change-over-time essay, which requires students to understand a set of characteristics of both an earlier and a later period and then compare and contrast those characteristics to determine what changed and what led

> **"The disciplines ask different questions, make different claims, rely on different kinds of reasoning and evidence to determine the veracity of those claims—and even differ in how they cite that evidence. It's important that students learn to engage in argumentation in discipline-based ways."**

to the changes. The teacher would share the topic for the essay (e.g., how the civil rights movement developed from the 1950s to the 1960s) with students. The students would then determine what characteristics they were going to compare and contrast and take notes describing those characteristics as they read various texts about that era in U.S. history. Finally, they would produce an essay in the form of a historical argument, complete with historical evidence. For instance, a student could write that the movement seemingly became less local in the 1960s, providing examples of how early on the movement had been focused on particular communities or specific local issues (e.g., the Birmingham bus boycott, the Greensboro lunch counter sit-ins) but over time shifted focus to the nation as a whole and to federal issues (e.g., open housing legislation, voting rights, marches on Washington).

STUDENTS SHOULD DEVELOP READING ABILITY ALONG WITH CONTENT AND DISCIPLINARY KNOWLEDGE

Content knowledge and knowledge of (and the ability to use) the methods and approaches of a discipline are what distinguish experts from novices. These two elements are reciprocal. Disciplinary knowledge allows readers to approach texts in ways that enable them to gain content knowledge; content knowledge, in turn, helps readers understand what the discipline is all about. As disciplinary and content knowledge grow, readers engage in more efficient practices while reading, addressing issues, and solving problems in the discipline and, consequently, become more invested in and motivated to learn the material (Alexander 2003). Subject matter teachers possess extensive content knowledge, and they're right to emphasize it heavily in their teaching, but it's also essential that they help students gain a deep understanding of from whence this knowledge comes—how it's created, communicated, and evaluated within a field of study. Students need to learn to adopt the habits of mind and the literate practices of the disciplines. Only with a firm grasp of those habits and practices will students be truly college and career ready.

Last Words

This chapter defined and explained *disciplinary literacy* and explored the reasons why instruction in disciplinary literacy is necessary (if not sufficient) to make students college and career ready. It provided literacy portraits of expert practices in history, science, and literature, exploring those disciplines' goals and methods, texts, and literate practices and the connections among them. Finally, it put forth evidence showing the efficacy of instructional practices aimed at developing disciplinary literacy insights and practices among students and made recommendations for teaching disciplinary literacy.

It's often assumed that reading and writing are the province of English language arts teachers. However, it should be evident from the

information provided here that ELA teachers can't possibly grasp all the nuances of discipline-based reading and writing practices in the many subjects students must study; what's more, they have their own disciplinary teaching to do in literature. ELA teachers don't usually spend considerable time reading science or history, and even those who do so for leisure aren't likely to have sufficient background knowledge concerning the inquiry approaches and content of these fields of study to prepare students for the fields' demands. Subject matter teachers, by contrast, do have a strong grasp of their content and at least an implicit understanding of the goals and practices of their disciplines. Their role in the shared enterprise of literacy instruction isn't to teach basic skills and knowledge associated with reading and writing (and communicating in other ways) but rather to guide students to negotiate those features and formats specific to the texts of particular content areas and to induct students into the literate practices and principles of the disciplines they teach.

References

Akkus, Recai, Murat Gunel, and Brian Hand. 2007. "Comparing an Inquiry-Based Approach Known as the Science Writing Heuristic to Traditional Science Teaching Practices: Are There Differences?" *International Journal of Science Education 29*, no. 14 (November): 1745–65.

Alexander, Patricia A. 2003. "The Development of Expertise: The Journey from Acclimation to Proficiency." *Educational Researcher* 32, no. 8 (November): 10–14.

Ashby, Rosalyn. 1993. "Pilot Study on Students' Use of Evidence." Unpublished study. Essex, England.

Ashby, Rosalyn, and Peter Lee. 1987. "Children's Concepts of Empathy and Understanding in History." In *The History Curriculum for Teachers*, edited by Christopher Portal, 62–88. London: Falmer.

Bautsch, Brenda. 2013. *Reforming Remedial Education.* Hot Topics in Higher Education. Denver, CO: National Conference of State Legislatures. **http://www.ncsl.org/documents/educ/REMEDIALEDUCATION_2013.pdf**.

Bazerman, Charles. 1985. "Physicists Reading Physics—Schema-Laden Purposes and Purpose-Laden Schema." *Written Communication* 2, no. 1 (January): 3–23.

Bazerman, Charles. 1988. *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science*. Madison: University of Wisconsin Press.

Berland, Leema Kuhn, and Brian J. Reiser. 2009. "Making Sense of Argumentation and Explanation." *Science Education* 93, no. 1 (January): 26–55.

Biber, Douglas, and Bethany Gray. 2016. *Grammatical Complexity in Academic English: Linguistic Change in Writing.* Cambridge: Cambridge University Press.

Burke, K. A., Thomas J. Greenbowe, and Brian M. Hand. 2006. "Implementing the Science Writing Heuristic in the Chemistry Laboratory." *Journal of Chemical Education* 83, no. 7 (July): 1032–38.

Cavagnetto, Andy R. 2010. "Argument to Foster Scientific Literacy: A Review of Argument Interventions in K–12 Contexts." *Review of Educational Research* 80, no. 3 (September): 336–71.

De La Paz, Susan. 2005. "Effects of Historical Reasoning Instruction and Writing Strategy Mastery in Culturally and Academically Diverse Middle School Classrooms." *Journal of Educational Psychology* 97, no. 2 (May): 139–56.

De La Paz, Susan, Ralph Ferretti, Daniel Wissinger, Laura Yee, and Charles MacArthur. 2012. "Adolescents' Disciplinary Use of Evidence, Argumentative Strategies, and Organizational Structure in Writing about Historical Controversies." *Written Communication* 29, no. 4 (October): 412–54.

De La Paz, Susan, Chauncey Monte-Sano, Mark Felton, Robert Croninger, Cara Jackson, and Kelly Worland Piantedosi. 2017. "A Historical Writing Apprenticeship for Adolescents: Integrating Disciplinary Learning with Cognitive Strategies." *Reading Research Quarterly* 52, no. 1 (January/February/March): 31–52.

Driver, Rosalind, Paul Newton, and Jonathan Osborne. 2000. "Establishing the Norms of Scientific Argumentation in Classrooms." *Science Education* 84, no. 3 (May): 287–312.

Fang, Zhihui, and Mary J. Schleppegrell. 2010. "Disciplinary Literacies across Content Areas: Supporting Secondary Reading through Functional Language Analysis." *Journal of Adolescent and Adult Literacy* 53, no. 7 (April): 587–97.

Frost, Robert. 1969. "Stopping by Woods on a Snowy Evening." In *The Poetry of Robert Frost*, edited by Edward Connery Lathem. New York: Henry Holt and Company Inc. Originally published 1923.

Giere, Ronald N. 1994. "The Cognitive Structure of Scientific Theories." *Philosophy of Science* 61, no. 2 (June): 276–96.

Goldman, Susan R., M. Anne Britt, Willard Brown, Gayle Cribb, MariAnne George, Cynthia Greenleaf, Carol D. Lee, Cynthia Shanahan, and Project READI. 2016. "Disciplinary Literacies and Learning to Read for Understanding: A Conceptual Framework for Disciplinary Literacy." *Educational Psychologist* 51 (2): 219–46.

Goldman, Susan R., Kimberly A. Lawless, Mariya Yukhymenko, Anne Britt, Patricia Wallace, MariAnne George, James W. Pellegrino, Cindy Litman, Julia Emig, Angela Fortune, Katie James, Candice Burkett, and Project READI. 2016. "Efficacy Study of Ninth-Grade READI Biology: Design, Assessment Strategy, and Findings." Paper presented at the Annual Meeting of the American Educational Research Association, Washington, DC, April 2016.

Greenleaf, Cynthia L., Cindy Litman, Thomas L. Hanson, Rachel Rosen, Christy K. Boscardin, Joan Herman, Steven A. Schneider, Sarah Madden, and Barbara Jones. 2011. "Integrating Literacy and Science in Biology: Teaching and Learning Impacts of Reading Apprenticeship Professional Development." *American Educational Research Journal* 48, no. 3 (June): 647–717.

Hand, Brian, Carolyn W. Wallace, and Eun-Mi Yang. 2004. "Using a Science Writing Heuristic to Enhance Learning Outcomes from Laboratory Activities in Seventh-Grade Science: Quantitative and Qualitative Aspects." *International Journal of Science Education* 26 (2): 131–49.

Halliday, M. A. K., and J. R. Martin. 1993. "General Orientation." In *Writing Science: Literacy and Discursive Power*, edited by M. A. K. Halliday and J. R. Martin, 2–24. London: Falmer.

Hillocks Jr., George, and Larry H. Ludlow. 1984. "A Taxonomy of Skills in Reading and Interpreting Fiction." *American Educational Research Journal* 21, no. 1 (January): 7–24.

Hynd, Cynthia, Jodi Patrick Holschuh, and Betty P. Hubbard. 2004. "Thinking Like a Historian: College Students' Reading of Multiple Historical Documents." *Journal of Literacy Research* 36, no. 2 (June): 141–76.

Kelly, James Patrick. 1991. "You and Your Characters." In *Writing Science Fiction and Fantasy: 20 Dynamic Essays by Today's Top Professionals*, edited by Gardner Dozois, Tina Lee, Stanley Schmidt, Ian Randall Strock, and Sheila Williams, 38–49. New York: St. Martin's.

Kwon, Nahyun. 2017. "How Work Positions Affect the Work Activity and Information Behaviour of Laboratory Scientists in the Research Lifecycle: Applying Activity Theory." *Information Research* 22, no. 1, paper 744 (March). **https://files.eric.ed.gov/fulltext/EJ1138647.pdf**.

Lee, Carol D. 1995. "A Culturally Based Cognitive Apprenticeship: Teaching African American High School Students Skills in Literary Interpretation." *Reading Research Quarterly* 30, no. 4 (October/November/December): 608–30.

Lee, Peter, and Rosalyn Ashby. 2001. "Empathy, Perspective Taking, and Rational Understanding." In *Historical Empathy and Perspective Taking in the Social Studies*, edited by O. L. Davis Jr., Elizabeth Anne Yaeger, and Stuart J. Foster, 21–50. Lanham, MD: Rowman and Littlefield.

Leinhardt, Gaea, Catherine Stainton, and Salim M. Virji. 1994. "A Sense of History." *Educational Psychologist* 29 (2): 79–88.

Lemke, Jay L. 2004. "The Literacies of Science." In *Crossing Borders in Literacy and Science Instruction: Perspectives on Theory and Practice*, edited by E. Wendy Saul, 33-47. Newark, DE: International Reading Association.

Levstik, Linda S. 2002. "Two Kinds of Empathy: Reasoned Analysis and Emotional Response in Historical Thinking." Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA, April 2002.

Martin, J. R. 1993. "Life as a Noun: Arresting the Universe in Science and Humanities." In *Writing Science: Literacy and Discursive Power*, edited by M. A. K. Halliday and J. R. Martin, 242–93. London: Falmer.

Megill, Allan. 1989. "Recounting the Past: 'Description,' Explanation, and Narrative in Historiography." *American Historical Review* 94, no. 3 (June): 627–53.

Moje, Elizabeth Birr, LeeAnn M. Sutherland, Tanya C. Solomon, and Mary van de Kerkof. 2010. "Integrating Literacy Instruction into Secondary School Science Inquiry: The Challenge of Disciplinary Literacy Teaching and Professional Development." Unpublished paper.

Monte-Sano, Chauncey. 2011. "Beyond Reading Comprehension and Summary: Learning to Read and Write in History by Focusing on Evidence, Perspective, and Interpretation." *Curriculum Inquiry* 41, no. 2 (March): 212–49.

Nabokov, Vladimir. 2000. "Father's Butterflies." Translated by Dmitri Nabakov. *Atlantic Monthly*, April 2000. Previously unpublished fragment possibly written in early 1939. **https://www.theatlantic.com/past/docs/issues/2000/04/nabokov1.htm**.

National Center for Education Statistics. 2013. *The Nation's Report Card: A First Look: 2013 Mathematics and Reading.* NCES 2014–451. Washington, DC: Institute of Education Sciences, U.S. Department of Education. **https://nces.ed.gov/nationsreportcard/subject/publications/main2013/pdf/2014451.pdf**.

National Science Foundation. 1976. *Reviews of Data on Science Resources No. 27: Education and Work Activities of Federal Scientific and Technical Personnel, January 1974.* NSF 76-308. Washington, DC: Government Printing Office. **https://files.eric.ed.gov/fulltext/ED137062.pdf**.

Organisation for Economic Co-operation and Development. 2016. *PISA 2015 Results (Volume 1): Excellence and Equity in Education.* Paris: PISA, OECD Publishing.

Peskin, Joan. 1998. "Constructing Meaning When Reading Poetry: An Expert-Novice Study." *Cognition and Instruction* 16, no. 3 (September): 235–63.

Peskin, Joan, Greg Allen, and Rebecca Wells-Jopling. 2010. "'The Educated Imagination': Applying Instructional Research to the Teaching of Symbolic Interpretation of Poetry." *Journal of Adolescent and Adult Literacy* 53, no. 6 (March): 498–507.

Peskin, Joan, and Rebecca Wells-Jopling. 2012. "Fostering Symbolic Interpretation during Adolescence." *Journal of Applied Developmental Psychology* 33, no. 1 (January/February): 13–23.

Rainey, Emily C. 2015. "What Does It Mean to Read Literary Works? The Literacy Practices, Epistemologies, and Instructional Approaches of Literary Scholars and High School English Language Arts Teachers." PhD thesis, University of Michigan. **https://deepblue.lib.umich.edu/handle/2027.42/113618**.

Reisman, Avishag. 2012. "Reading Like a Historian: A Document-Based History Curriculum Intervention in Urban High Schools." *Cognition and Instruction* 30 (1): 86–112.

Rouet, Jean-François, Monik Favart, M. Anne Britt, and Charles A. Perfetti. 1997. "Studying and Using Multiple Documents in History: Effects of Discipline Expertise." *Cognition and Instruction* 15 (1); 85–106.

Rudd, James A., Thomas J. Greenbowe, Brian M. Hand, and Margaret J. Legg. 2001. "Using the Science Writing Heuristic to Move toward an Inquiry-Based Laboratory Curriculum: An Example from Physical Equilibrium." *Journal of Chemistry Education* 78, no. 12 (December): 1680–86.

Sacks, Sam. 2013. "Bring Back the Illustrated Book!" *New Yorker*, February 22, 2013. **https://www.newyorker.com/books/page-turner/bring-back-the-illustrated-book**.

Shanahan, Cynthia, Michael J. Bolz, Gayle Cribb, Susan R. Goldman, Johanna Heppeler, and Michael Manderino. 2016. "Deepening What It Means to Read (and Write) Like a Historian: Progressions of Instruction across a School Year in an Eleventh Grade U.S. History Class." *History Teacher* 49, no. 2 (February): 1–30.

Shanahan, Cynthia, Timothy Shanahan, and Cynthia Misischia. 2011. "Analysis of Expert Readers in Three Disciplines: History, Mathematics, and Chemistry." *Journal of Literacy Research* 43, no. 4 (December): 393–429.

Shanahan, Timothy, and Cynthia Shanahan. 2008. "Teaching Disciplinary Literacy to Adolescents: Rethinking Content-Area Literacy." *Harvard Educational Review* 78, no. 1 (April): 40–59.

Shemilt, Denis. 1987. "Adolescent Ideas about Evidence and Methodology in History." In *The History Curriculum for Teachers*, edited by Christopher Portal, 39–61. London: Falmer.

Smith, Michael W. 1989. "Teaching the Interpretation of Irony in Poetry." *Research in the Teaching of English* 23, no. 3 (October): 254–72.

Smith, Michael W. 1992. "Effects of Direct Instruction on Ninth Graders' Understanding of Unreliable Narrators." *Journal of Educational Research* 85 (6): 339–47.

Southern, R. W. 1953. *The Making of the Middle Ages*. New Haven, CT: Yale University Press.

Spoehr, Kathryn T., and Luther W. Spoehr. 1994. "Learning to Think Historically." *Educational Psychologist* 29, no. 2 (March): 71–77.

Snyder, Jennifer L. 2000. "An Investigation of the Knowledge Structures of Experts, Intermediates and Novices in Physics." *International Journal of Science Education* 22, no. 9 (September); 979–92. **https://www.doi.org/10.1080/095006900416866**.

Tenopir, Carol, Donald W. King, and Amy Bush. 2004. "Medical Faculty's Use of Print and Electronic Journals: Changes over Time and in Comparison with Scientists." *Journal of the Medical Library Association* 92, no. 2 (April): 233–41.

Textual Tools Study Group, University of Michigan. 2006. "Developing Scientific Literacy through the Use of Literacy Teaching Strategies." In *Linking Science and Literacy in the K–8 Classroom*, edited by Rowena Douglas, Michael P. Klentschy, and Karen Worth, with Wendy Binder, 261–85. Arlington, VA: NSTA Press.

VanSledright, Bruce. 2002a. "Confronting History's Interpretive Paradox While Teaching Fifth Graders to Investigate the Past." *American Education Research Journal* 39, no. 4 (January): 1089–115.

VanSledright, Bruce. 2002b. "Fifth Graders Investigating History in the Classroom: Results from a Researcher-Practitioner Design Experiment." *Elementary School Journal* 103, no. 2 (November): 131–60.

Veel, Robert. 1997. "Learning How to Mean—Scientifically Speaking: Apprenticeship into Scientific Discourse in the Secondary School." In *Genre and Institutions: Social Processes in the Workplace and School*, edited by Frances Christie and J. R. Martin, 161–95. London: Cassell.

Wignell, Peter. 1994. "Genre across the Curriculum." *Linguistics and Education* 6, no. 4 (December): 355–72.

Wineburg, Sam. 1998. "Reading Abraham Lincoln: An Expert/Expert Study in the Interpretation of Historical Texts." *Cognitive Science* 22, no. 3 (July): 319–46.

Wineburg, Sam, and Abby Reisman. 2015. "Disciplinary Literacy in History: A Toolkit for Digital Citizenship." *Journal of Adolescent and Adult Literacy* 58, no. 8 (May): 636–39.

Wineburg, Samuel S. 1991. "On the Reading of Historical Texts: Notes on the Breach between School and Academy." *American Educational Research Journal* 28, no. 3 (September): 495–519.

Wissinger, Daniel R., and Susan De La Paz. 2016. "Effects of Critical Discussions on Middle School Students' Written Historical Arguments." *Journal of Educational Psychology* 108, no. 1 (January): 43–59. **https://doi.org/10.1037/edu0000043**.

Wolfe, Michael B. W., and Susan R. Goldman. 2005. "Relations between Adolescents' Text Processing and Reasoning." *Cognition and Instruction* 23 (4): 467–502.

Zeitz, Colleen M. 1994. "Expert-Novice Differences in Memory, Abstraction, and Reasoning in the Domain of Literature." *Cognition and Instruction* 12 (4): 277–312.