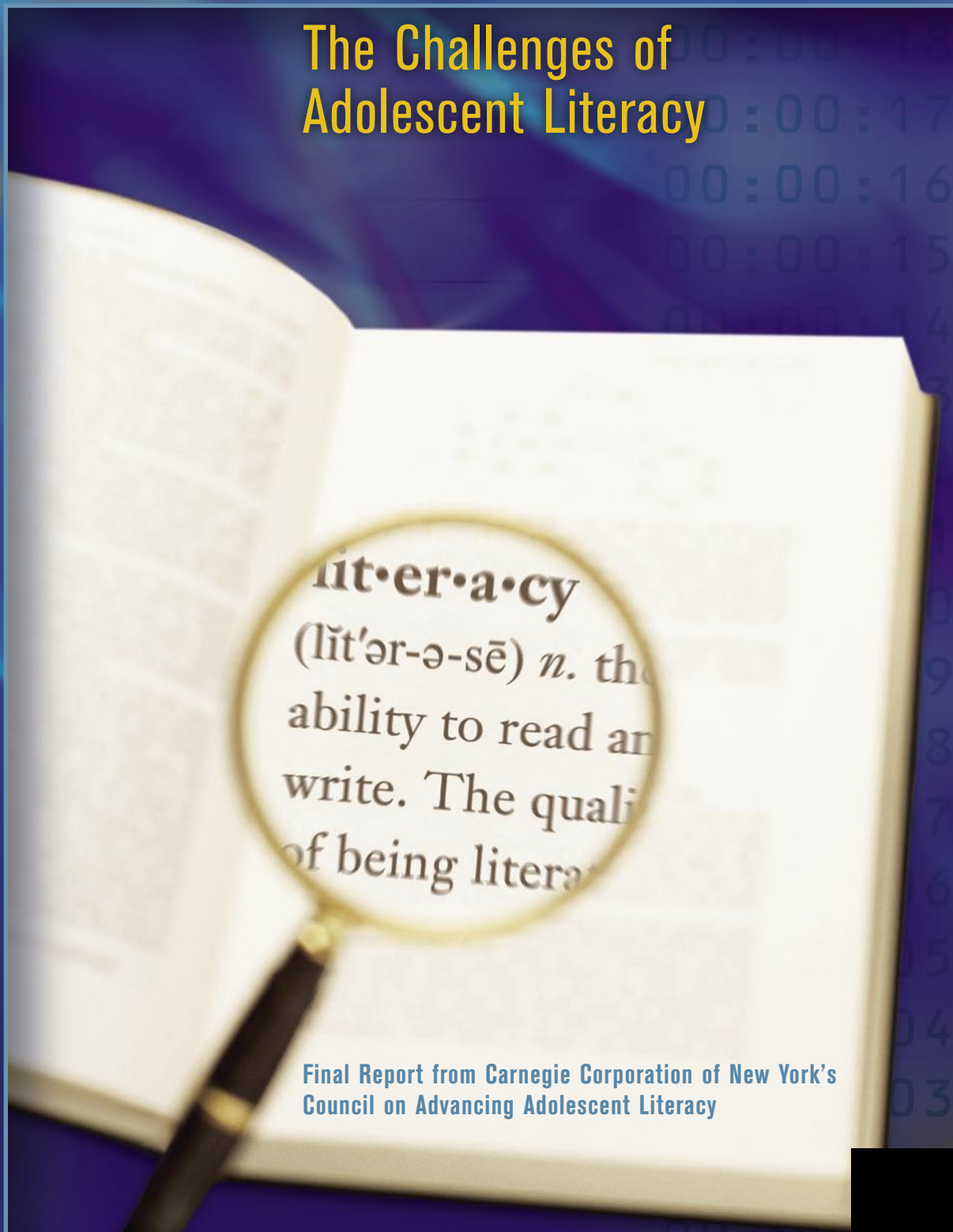
Reading in the Disciplines

The Challenges of Adolescent Literacy



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Final Report from Carnegie Corporation of New York's Council on Advancing Adolescent Literacy

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Published by: Carnegie Corporation of New York

Suggested citation: Lee, C.D., Spratley, A. (2010). *Reading in the disciplines: The challenges of adolescent literacy*. New York, NY: Carnegie Corporation of New York.

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Final Report from Carnegie Corporation of New York's Council on Advancing Adolescent Literacy

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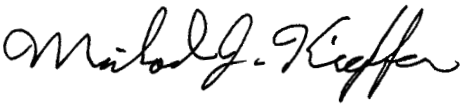

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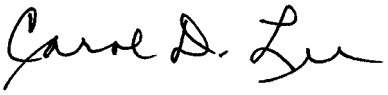

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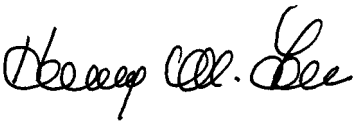

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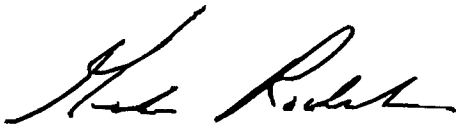

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Introduction and Overview

Adolescents may struggle with text for a number of reasons, including problems with a) vocabulary knowledge, b) general knowledge of topics and text structures, c) knowing of what to do when comprehension breaks down, or d) proficiency in monitoring their own reading comprehension. Most recent literacy initiatives target younger readers and attempt to instill basic decoding and comprehension skills. But struggling adolescent readers in our schools face more complex and pervasive challenges. Supporting these readers as they grapple with the highly specific demands of texts written for different content-areas will help prepare them for citizenship, encourage personal growth and life-satisfaction on many levels, and open up opportunities for future education and employment.

In this paper we focus on one foundational aspect of adolescent literacy that has been relatively ignored by recent reports on the problem. Our starting point is the fact that the major difference between reading in grades K-5 and reading in grades 6-12 is the transition from *learning to read* to *reading to learn*. The latter skill brings into play numerous academic concepts and modes of reasoning, primarily through the act of reading. Adolescents often need more sophisticated and specific kinds of literacy support for reading in content-areas, or academic disciplines. We call this more advanced form of literacy required of adolescent readers "disciplinary literacy" because each academic discipline or content-area presupposes specific kinds of background knowledge about how to read texts in that area, and often also requires a particular type of reading.

We will discuss some of the challenges for adolescents in our schools struggling with written texts in the differing academic subject-areas of history, science, mathematics and literature, and then explore how standards, assessments, and teacher instruction might be strengthened in order to support these readers. (Note: There exist broader conceptions of disciplinary literacy that include writing to explain ideas in ways that are consistent with norms for rhetoric and logic within each discipline, problem solving using the logics of the disciplines, comprehending and composing digital media within the disciplines, and expanding the range of disciplines to include the arts and other areas of human endeavor, including popular culture. We focus here on the basic literacy problem of reading and comprehending texts that display highly specific features and styles of argument.)

Struggling readers are typically envisioned as a minority of students who have pronounced disabilities in reading. The National Assessment of Educational Progress (NAEP) has three levels of reading proficiency: basic, proficient and advanced. NAEP scores for 17 year olds consistently show the same pattern: a majority of students achieve the basic level of reading skills, and at this basic level there are no significant differences based on race/ethnicity or SES. At proficient levels, the scores show stark differences aligned with race/ethnicity and SES. At the most advanced level, less than 10 percent of 17 year olds, regardless of race/ethnicity or SES, are able to comprehend complex texts.

The NAEP data and its consistency across years suggests that the problems of adolescent literacy involve a range of readers, from those with the most basic skill needs to those who have developed general comprehension strategies, but not the specialized strategies, vocabulary and knowledge base required for understanding complex discipline specific texts. Attention to this problem of reading in the disciplines has the potential to meet the needs of a wide range of

readers and thus address the problems of adolescent literacy in a comprehensive and productive way.

In this paper, we will address the following:

- define and illustrate what is entailed in comprehending texts within and across academic disciplines;
- examine what the empirical research base says about reading comprehension generally and reading in the disciplines specifically;
- briefly discuss the implications of this research base for teaching and assessments.

We conclude with some recommendations for improving policy and practice in the area of disciplinary literacy.

Reading comprehension and reading in the content areas: the empirical base

The comprehension of written texts is an extraordinarily complex process. Earlier research on reading comprehension focused on sets of discrete skills (i.e. getting the main idea, getting the facts, making inferences) or on the products of comprehension (i.e. what readers understood after reading). This research provided useful foundations for our current understandings, but did not address the more basic questions of what readers actively did while trying to get the main idea of a text or make inferences based upon the reading. We know intuitively that meanings of written texts are pieced together in the act of reading, and that there are many sources of prior knowledge on which readers draw to form these meanings. Such prior sources of knowledge include, but are not limited to knowledge of:

- words and word forms;
- sentence structure or syntax;
- text structures or genres;
- topics.

As readers we construct meaningful patterns from word to word, from sentence to sentence, and from paragraph to paragraph, looking for connections across these textual elements toward some understanding that we can take away from reading the text. What we focus upon is influenced both by our prior knowledge in the four areas listed above as well as our goals for reading. One of the most important conclusions of recent research is the foundational role of a variety of forms of prior knowledge. Studies have demonstrated that prior knowledge of topics can influence what we comprehend, what we pay attention to, even what perspectives we take. This fact has strong implications for supporting struggling adolescent readers. *The ability to comprehend written texts is not a static or fixed ability, but rather one involves a dynamic relationship between the demands of texts and the prior knowledge and goals of readers.* It is precisely because of these dynamic relationships that the teaching of reading in the academic disciplines is so crucial. This reality has important implications for both teaching and assessment.

We have noted that reading comprehension is a result of dynamic interactions among knowledge, strategies, goals and dispositions. There is a considerable body of research documenting the strategies that good readers use. These strategies include:

1. asking questions;
2. making predictions;
3. testing hypotheses;
4. summarizing;
5. monitoring understanding and deploying fix-it strategies as needed.

However, beyond these general strategies, disciplinary literacy also requires knowledge of topics in a particular field. Reading in content areas presents special problems because if you don't know content you will have a difficult time understanding the texts, and if you don't understand the texts you are unlikely to learn content (we are assuming here that text is the primary medium through which the content gets offered to students, though teachers also use video, film, displays and other approaches).

Many schools with large proportions of students entering high schools with low levels of achievement in reading are requiring freshmen level courses aimed at struggling readers. Such courses usually focus on generic reading strategies and vocabulary development. This trend is based on unstated assumptions that reading comprehension is primarily a consequence of the deployment of generic reading strategies, and that when students learn to master such strategies they will be ready for reading in the content areas. Only a few current interventions, such as the Strategic Literacy Initiative, aim in such courses to teach not only generic reading strategies and

vocabulary but also to help students develop identities as readers and to tackle some of the specialized challenges that disciplinary texts pose.

Reading in Science

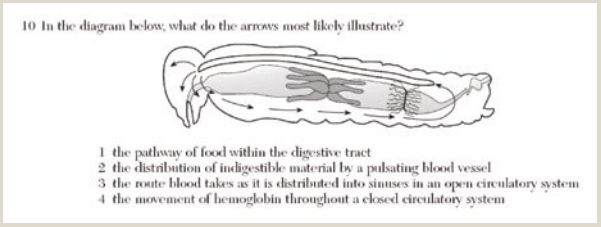
Scientific texts pose specialized challenges to inexperienced and struggling readers. For example, scientific research reports include abstracts, section headings, figures, tables, diagrams, maps, drawings, photographs, reference lists and endnotes. Science textbooks usually include similar elements. Each of these elements serves as a signal as to the function of a given stretch of text and can be used by skilled readers to make predictions about what to look for as they read, but consider the situation of an adolescent reader confronted for the first time by such texts and trying to make sense of them using the basic decoding tools acquired in "learning to read."

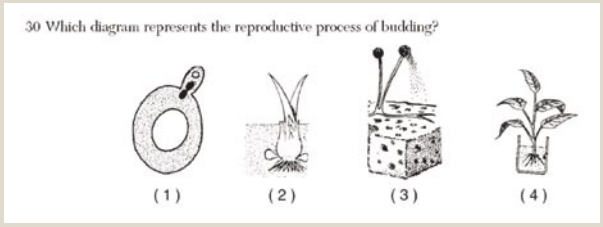
Comprehension of scientific texts also often requires mathematical literacy, or an ability to understand what mathematical tables and figures convey. It is not uncommon for such figures and tables to invite multiple points of view or to open up questions that are not posed directly in the text (Lemke, 1988). Many scientific texts also require visual literacy, using diagrams, drawings, photographs and maps to convey meanings. Box 1 illustrates diagrams, drawings and maps routinely found in scientific texts. These examples are taken from 2001 released items on the New York Regents High School Exam in Biology.

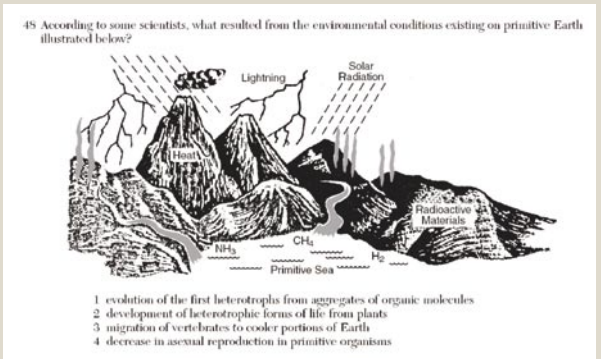
Science texts pose several other important challenges: the use of scientific registers in terms of technical vocabulary and syntax. A register is a way of using language that is specific to particular situations, such as the technical way that lawyers speak in court. For example, scientific texts may define complex technical terms through the use of embedded clauses (i.e. "an invisible gas called water vapor") and nominal apposition (i.e. "animals that eat plants, herbivores, may be found …") (Wignell, 1998, pp. 299–300). Learning such terminology and syntax are important and sometimes difficult challenges of reading to learn in science.

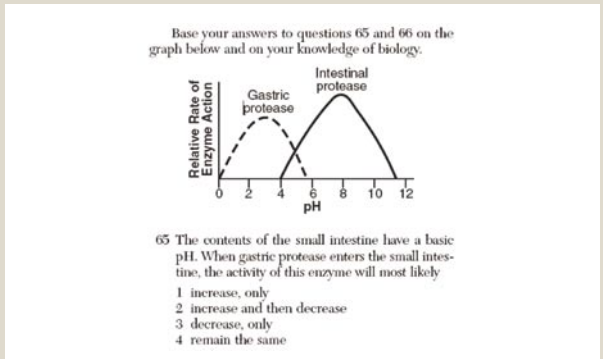
The technical vocabulary of science often has Latin or Greek roots: cosm (as in cosmos), hypo (as in hypoacidic or hypoallergenic) or derm (as in dermatology, dermatitis, dermatoid). Sometimes words will have one meaning in everyday discourse and different and highly specialized meanings in science. Other times, scientific terms will have specialized

Box No. 1. | ***Diagrams, Drawings, Graphs and Maps Found in Scientific Texts***









Source: New York Regents 2001 High School Exam in Biology.

modifiers of words that we use in ordinary discourse, as in saturated fat or dark matter (White, 1998). Or scientific terms may use common terms in specialized ways with specialized modifiers, as in *catabolic pathway*, or both terms may be specialized, as in *lipoprotein cholesterol* (White, 1998).

Scientific registers also include syntactic forms that can be difficult for inexperienced and struggling readers. Categories and taxonomies represent conceptual relationships that are captured in single words or noun phrases. Russian socio-cultural psychologist Lev Vygotsky argued that the classification systems of the sciences represent abstract ways of thinking that are not typically captured in everyday thinking. For example, domesticated dogs that we refer to as canines belong to the kingdom of *animalia*, the phylum of *chordata*, the class of *mammalia*, the order of *carnivora*, and the family of *canidae*. Each of these taxonomic categories in biology represents constructs that capture form/function relationships regarding physical characteristics, behavioral patterns, and positions in evolutionary history within and across animal species. Dogs and humans are related because they are both mammals (i.e. the class of mammalia). They are both mammals because the females of both species have mammalian glands that are capable of producing nourishment for newborns of the species. This form of taxonomic reasoning is pervasive in academic domains, particularly in the sciences, and it requires abstract reasoning because one cannot pick up and hold mammalia or carnivora in the way one can pick up a chair. Thus reading science texts that use such taxonomic terminology requires understanding the multiple and nested relationships entailed in such terms. There may be many relationships to be inferred by the use of such terminology that are not explicitly stated in the texts.

Scientific register also include syntactic forms that can be difficult for inexperienced and struggling readers (Wignell, 1998).

The demands of comprehending scientific text are discipline specific and are best learned by supporting students in learning how to read a wide range of scientific genres. Besides text structures emphasizing cause and effect, sequencing and extended definitions, as well as the use of scientific registers, evaluating

Box No. 2. | *Benchmarks for 12th Grade Scientific Literacy*

By the end of the 12th grade, students should know that:

- Investigations are conducted for different reasons, including exploring new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
- Hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of the data (both new and previously available).
- Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.
- There are different traditions in science about what is investigated and how, but they all have in common certain basic beliefs about the value of evidence, logic, and good arguments. And there is agreement that progress in all fields of science depends on intelligence, hard work, imagination, and even chance.
- Scientists in any one research group tend to see things alike, so even groups of scientists may have trouble being entirely objective about their methods and findings. For that reason, scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis. Checking each other's results and explanations helps, but that is no guarantee against bias.
- In the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism. In the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.
- New ideas in science are limited by the context in which they are conceived; are often rejected by the scientific establishment; sometimes spring from unexpected findings and usually grow slowly, through contributions from many investigators.

Source: American Association for the Advancement of Science (1993).

scientific arguments requires additional skill sets for readers. These additional skill sets are based on knowledge of scientific reasoning, as expressed in this statement from the Association for the Advancement of Science:

> Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing. (American Association for the Advancement of Science, 1993).

The benchmarks for scientific literacy by the Association for the Advancement of Science illustrate the quality and scope of knowledge required for scientific literacy (American Association for the Advancement of Science, 1993).[1]

These 12th grade benchmarks for scientific literacy form the basis for the kinds of discipline specific questions that readers need to ask in evaluating reports of scientific findings, be they historical or current. Such questions include the following:

1. What are the functions of the investigation—to explore, check previous results, test the explanatory power of a theory? The functions of the investigation will influence how the reader evaluates the evidence presented.
2. What data has been collected and how has it been analyzed? Is the data appropriate to the questions and conclusions reached? In a high school science classroom, we should expect students to be able to evaluate the goodness of fit of data, even if we don't expect the general public to be able to critique scientific reports.
3. What are the trade offs of the research design, weighing what we can learn from experiments with controlled conditions versus what we can learn from naturalistic or direct observations? While we cannot make naturalistic observations of evolution in situ because the time scales of observable change are so huge, we can make direct observations of fossil records.
4. What are the logical links between data, findings, previous related research and widely accepted theory?
5. What are potential sources of bias that may influence the findings and recommendations.

We can think of these questions as indices of the open and inquiring habits of mind of the scientifically literate adult. Our point is that such life long habits are instilled in the general public through the unique opportunity of learning science in school, and specifically in learning to read scientific texts.

Reading in History

The ability to read historical documents including contemporary explications about societal, economic and political issues provides perhaps the most direct link to literacy as preparation for citizenship, which presupposes an ability to conduct informed debate. As in the other disciplines, schools are unique sites for youth across class and ethnic boundaries to learn to read such documents and equally important to develop the necessary dispositions to continue to engage in such reading for college and career success. While we focus explicitly on reading in history, the point more broadly applies to reading across the social sciences (history, political science, sociology, and economics).

Studies of how people reason about political issues offer interesting and potentially disturbing findings (Rosenberg, Ward, & Chilton, 1989). Wineburg examined how people of particular age cohorts, including adolescents, reasoned about events from the Viet Nam War. Interestingly, he discovered that the primary sources of information used to construct representations of events and issues in the war were movies (Winenburg & Martin, 2004). Adults who actually lived through the war used representations in film as their source of data, even when their own experiences contradicted the images in the films. While the ability to deconstruct fictional narratives from films is an important and powerful skill set film may not be the most reliable source of information for understanding historical events (Cole & Keyssar, 1985).

Historians view primary source documents about events of the past as partial, representing particular points of view and positioning, and as rhetorical

constructions (Wineburg, 2001). Primary source documents in history may include political documents, legal documents, newspaper articles, letters, diaries, first and second hand documents of events such as minutes, published proceedings, etc. and other kinds of archival data including artistic representations (paintings and drawings, film, digital images, photographs, cartoons, etc.). Viewing primary source documents as rhetorical constructions (Leinhardt & Greeno, 1994; Seixas, 1993; Voss, Greene, Post, & Penner, 1996; Wineburg, 1991, 1998), historians seek to understand the internal states and goals of agents who acted in the historical events. In examining primary source documents, historians ask themselves about the kind of document it is and, how the document came into being. They examine word choice and, what information is included and excluded. They seek corroboration across multiple sources. They assume such texts have subtexts that reflect the authors' points of view, access to the experiences about which they write, and how the text is organized to appeal to what audience. In contrast, schools typically socialize students into seeing history as a simple chronology of events and the explanations of social, political and economic phenomena offered in texts as a truthful and unexamined master narrative (Bain, 2005; Wineburg & Wilson, 1988, 1991).

To illustrate some of the challenges of reading primary source documents in history, the following is an excerpt from Lincoln's speech, "A House Divided." This is the kind of document a 12th grader in U.S. schools should be familiar with and able to understand. The document is important, perhaps even more so than for example the often-cited "Gettysburg Address" by Lincoln because it poses political and ethical dilemmas with which we continue to wrestle today. We can easily identify current political speeches made by political candidates, in the Congress of the U.S. and by senior members of our government's administration that focus on similar issues as they manifest themselves today and that employ similar rhetorical techniques to persuade audiences.

The following are examples of discipline-based questions that a good reader might pose while reading "A House Divided." (1) What kind of speech is this? What self-interests might one expect from this kind of speech? (2) Who is the audience? How is the text crafted to address this audience? (3) What words and phrases used by Lincoln would have had a different meaning/connotation in 1858? (4) What knowledge is presumed that a reader of that era would already know (particularly a member of the audience for whom the speech was drafted)? (5) Are there any contradictions or tensions between knowledge Lincoln presumes and knowledge from other historical documents about similar topics or events? (6) What can we infer about Lincoln's motives and biases? What inferences does he make about the motives and biases of others, such as Stephen Douglas? How might the reader evaluate Lincoln's critique of Douglas and others, in light of the reader's prior knowledge and the availability of other historical sources? (7) What is the overall text

BOX No. 3. | ***"A House Divided" Abraham Lincoln***

If we could first know *where* we are, and *whither* we are tending, we could then better judge *what* to do, and *how* to do it.

We are now far into the *fifth* year, since a policy was initiated, with the *avowed* object, and *confident* promise, of putting an end to slavery agitation.

Under the operation of that policy, that agitation has not only, *not ceased*, but has *constantly augmented*.

In *my* opinion, it *will* not cease, until a *crisis* shall have been reached, and passed.

"A house divided against itself cannot stand."

I believe this government cannot endure, permanently half *slave* and half *free*.

I do not expect the Union to be *dissolved*—I do not expect the house to *fall*—but I do expect it will cease to be divided.

It will become *all* one thing or *all* the other.

Either the *opponents* of slavery, will arrest the further spread of it, and place it where the public mind shall rest in the belief that it is in the course of ultimate extinction; or its *advocates* will push it forward, till it shall become alike lawful in *all* the States, *old* as well as new—*North* as well as *South*.

Have we no *tendency* to the latter condition?

Let any one who doubts, carefully contemplate that now almost complete legal combination—piece of *machinery* so to speak—compounded of the Nebraska doctrine, and the Dred Scott decision. Let him consider not only *what* work the machinery is adapted to do, and *how well* adapted; but also, let him study the *history* of its construction, and trace, if he can, or rather *fail*, if he can, to trace the evidence of design and concert of action, among its chief architects, from the beginning.

structure of the document? What are the notices within the text that signal its structure?

Despite reform efforts advocated by the National Council for the Social Studies and pedagogical interventions such as the Document Based History Project, the default experience of most students is to learn history through the reading of history textbooks. While learning how to read—including how to critique—textbook representations of historical, political and economic events and issues is important for success in high school, research has documented that textbooks may actually be difficult to understand. Typically, we think of textbooks as being easier to comprehend than primary source documents. This may be true at one level if one uses readability formulas as the measure of difficulty. However, as Beck and McKeown have shown, in the attempt to create short texts with simple sentences, textbook writers often inadvertently make it more difficult for students to understand concepts. (Beck, Mckeown, & Gromoll, 1989). Often these texts will not use relational words between clauses, sentences and paragraphs that would make explicit the logical relationships among ideas. Novice readers who do not have sufficient background knowledge to construct the unstated relationships then must infer such relationships. In addition, these texts may also not provide sufficient detail for students to build an understanding of concepts. Beck and colleagues tested these propositions by revising sections of a 5th grade social studies text book (Beck, McKeown, Sinatra, & Loxterman, 1991). In Box 4, we include an example of one of the re-writes of a passage on The Boston Tea Party.

BOX No. 4. | ***Re-Write of 5th Grade Social Studies Text***

Original	Re-write
Boatloads of tea were sent to America. Since it was cheaper than ever, the British thought that surely the colonists would buy tea now! They were wrong. Tea was burned. Tea was left to rot.	Since it was now cheaper than ever, the British thought that surely the colonists would buy tea! So they sent boatloads of it to the colonies. But, because the tea still had the tax on it, the colonists were as angry as ever. To show their anger, the colonists burned some of the tea. They left some to rot.

Source: Beck, McKeown, Sinatra, & Loxterman (1991).

BOX No. 5. | ***The Opening of the Declaration of Independence***

When in the Course of human events **it** becomes necessary for one people to dissolve the political bands **which** have connected **them** with another and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that **they** should declare the causes **which** impel **them** to the separation.

We hold **these** truths to be self-evident, **that** all men are created equal, **that they** are endowed by their Creator with certain unalienable Rights, **that** among **these** are Life, Liberty, and the pursuit of Happiness.

According to Beck and colleagues (1991), "Most of the revisions for this passage thus involved explaining and providing motivations for actions and reactions, and explicitly connecting causes to events and events to consequences" (p. 261). They found that students had better recall of information in the re-written passages.

Beck's studies of the reading difficulty presented by traditional textbooks are based on extensive research about how readers go about making sense of texts. As is evident in these studies, research on text processing indicates any of the following common patterns found in social studies and science textbooks can make comprehension challenging:

- Failure to make logical (i.e. causal) connections between propositions explicit (Black & Bern, 1981; Kintsch, Mandel & Kozminsky, 1977; Stein & Nezworski, 1978.);
- Use of references that are ambiguous, distant or indirect (Fredericksen, 1981, Cirilo, 1981; Lesgold, Roth & Curtis, 1979, Haviland & Clark, 1974; Just & Carpenter, 1978);
- The inclusion of information that is irrelevant to the main ideas (Schank, 1975; Trabasso et al., 1984);
- Density of ideas within individual sentences (Kintsch & Keenan, 1973; Kintsch, Kozminsky, Streby, McKoon, & Keenn, 1975).

The features enumerated above tend to characterize what are sometimes called "inconsiderate texts". Textbooks are not the only source of inconsiderate texts. Primary source documents can also be inconsiderate. The example from the opening of the Declaration of Independence (Box 5) illustrates three of the four patterns:

Simple reference words like "it," "which" and "them" are syntactically difficult to decipher in this public document that all citizens should ideally be able to comprehend. The entire opening paragraph is a single sentence and thus the density of propositions in this one sentence makes it difficult to unpack. The causal links between the decision to "dissolve the political bands" and to "declare the causes which impel them to the separation" are embedded in forbiddingly complex syntactical forms.

More and less competent adolescent readers will continue to struggle with both textbooks as well as primary source documents until explicit attention to text features, prior knowledge, vocabulary, comprehension monitoring and processes become routine practices in classrooms where students are expected to read in order to learn.

These potential sources of reading difficulty and many more can be detected ahead of time by a content area teacher who is also well versed in what a reader needs to know to understand content area texts, including primary source documents. In fact, we would argue that history teachers are much better positioned to analyze these sources of difficulty we have described in these primary source documents than those typically teaching generic remedial reading courses in high schools. History teachers are also more likely to understand the ways in which helping students to pay attention to and make sense of these kinds of text difficulties are intimately linked to history reasoning and content. The sources of difficulty we have described are not unique to these particular documents, but are recurrent, certainly in primary source documents in history and the social studies.

While our focus has been primarily on reading in high school, we have evidence of effective use of primary source documents in elementary level history classes (Donovan & Bransford, 2005). Our point is that strategies for tackling these recurrent problems of reading can be taught; and that teaching them in the content of discipline specific explorations involving the analysis of multiple documents of the sort we have included can simultaneously enhance the learning of content. Learning to read in discipline specific ways does not need to interfere with learning content. Quite the reverse. We are not making a case against the growing use of general remedial reading courses in high school. We believe such courses are very important and we have growing evidence of their impact. We are simply trying to illustrate here that it is possible to integrate reading instruction in content area courses that accomplish two important ends: (1) meet the needs of students with an array of reading abilities simultaneously and (2) teach all students to reason in the complex ways that the disciplines require.

Reading Literature

As with reading in history, it is probably most easy to make the case for reading in literature classrooms. However, there have been attacks and debates regarding the function of the literature curriculum (Applebee & Purves, 1992). In this section, we make a case for why learning to read literature is important. We also highlight some of the problems inherent in how literature is typically taught in our high schools and how these problems contribute to the difficulties that struggling readers face (Applebee, 1996; Grossman, 2001; Lee, 2007). By demonstrating what is entailed in interpreting literature, we try to illustrate what readers—struggling and competent—need to know in order to become good and hopefully lifelong readers of rich literature.

Just as there are limitations to the range of genres that students learn to read in other content area courses, there are also limitations in the range of texts to which students are exposed in literature classes, particularly in schools in low income communities serving students of color and in basic skills oriented classes in departments that are tracked (Applebee, 1993). The range of texts in such low track classes is quite different from, for example, Advanced Placement courses. It remains the case that the dominant source of readings in the high school English class is the commercial literature anthology. Just as there is little direct instruction about how to tackle the problems that disciplinary texts pose in history, science and mathematics classrooms, there is also insufficient attention in literature classrooms to the nuts and bolts of how to read a range of literary texts (Lee, 2001, 2004; Smith & Hillocks, 1988). It remains the case that literature teachers are more likely to ask students about the symbolism in literary texts than to model or teach how to detect the symbolic from the literal and how to re-construct

the figurative inferences to be made about symbols in literature. Only a small percentage of students graduating high school remain life long readers of the kinds of canonical texts that the literature curriculum hopes to apprentice them into appreciating.

Understanding the rhetorical tools that authors employ in narratives (fictional, autobiographical or semi-autobiographical, biographical) is necessary to understand a range of warrantable interpretations of complex literary works (Scholes, 1985). We say "warrantable interpretations" because literature invites multiple points of view (Jacquenod, 1987) . What is specific to this discipline is the nature of what counts as evidence and what kinds of questions are valued (Applebee, Burroughs, & Stevens, 2000). Evaluation of such works also requires, in an ideal sense, that readers understand how the author goes about shaping an imaginary world that we are able to subjunctively enter.

Just as we have argued about the primary role of prior knowledge in comprehending texts in other disciplines, prior knowledge plays an equally important role in comprehending literary texts. The sources of prior knowledge that readers need include but are not limited to the following:

- Text structures going beyond the school based genres—defined broadly as the short story, the novel, poetry and drama. Students should know how to recognize irony and use of unreliable narration. They should also be able to recognize genres such as magical realism, science fiction, allegory, fable, myth, mystery. Specialized genres of poetry include haiku, sonnet, ballad and epic.
- Prototypical human practices and internal states, and the kinds of goal directed behavior that such internal states often trigger (i.e. for example, how jealousy and insecurity can lead to violence)
- A range of interpretive problems embedded in rhetorical tools employed by authors, including symbolism, irony, satire, and problems of point of view including unreliable narration. Readers need not only to understand that they can expect to meet such interpretive problems, but should be able to recognize the rhetorical signals of their use in texts; and to draw on a variety of sources of information—depending on the interpretive problem—to reconstruct what is typically a figurative message.
- The ability to make inter-textual links drawing on the reader's knowledge about the author, other authors, related texts in which a given work of literature is in conversation (for example, many literary works make allusions to the Bible) or other texts within the same genre (for example, the use of magical realism by authors as diverse as Toni Morrison, Gabriel Marquez, Frantz Kafka, and Amos Tutuola), character types (for example seeing Hamlet and the unnamed narrator of Ralph Ellison's classic *Invisible Man* as both exemplars of the tragic hero or its modern counter part, the anti-hero), and archetypal themes (not only from literary but other traditions as well) (Bloome & Egan-Robertson, 1993; Smagorinsky & Gevinson, 1989; Smagorinsky, Smith, M., 1992).

One of the challenges to the literature curriculum at both the middle and high school levels is how to help students, especially struggling readers, develop conceptual understanding of all these knowledge sources to help them learn to appreciate and develop a disposition to read complex literary works across the lifespan.

Literary works that capture human experience and dilemmas from time periods from the historical past can pose particular difficulties for contemporary novice readers. The language of Shakespeare is difficult not only because of its poetry, but also because its syntax, use of pronouns, and vocabulary do not map on to contemporary uses of language as illustrated in the soliloquy from *Romeo and Juliet* (Box 6).

Box No. 6. | *Soliloquy from Romeo and Juliet*

Romeo: But, soft! what light through yonder window breaks?
It is the east, and Juliet is the sun.
Arise, fair sun, and kill the envious moon,
Who is already sick and pale with grief,
That thou her maid art far more fair than she:
Be not her maid, since she is envious;
Her vestal livery is but sick and green
And none but fools do wear it; cast it off. (2.2.3-10)
(Act 2, Scene 2, lines 3 – 10)

Words that are not part of contemporary English in this excerpt include "yonder," "thou" and "vestal livery." The syntax of the opening sentence "What light through yonder window breaks?" is an inverted form. A more conventional and contemporary

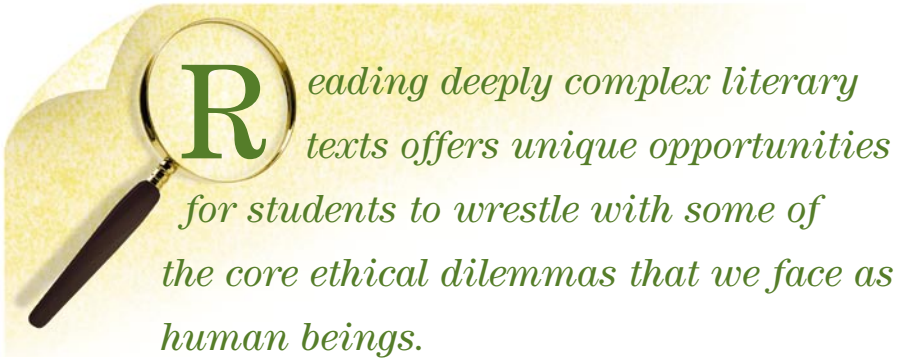
syntax would read 'What light breaks through the window over there?' There are also literary debates about mythical allusions to the moon as Diana, goddess of the moon and patron of virgins in Roman mythology.

The social settings of older texts are often far removed from the life experiences and social values that young people understand. In "The Necklace" by French writer Guy de Maupassant, younger readers will not automatically understand the rigid class structure of Paris in the 1880's, and therefore not appreciate how the desire for upward mobility is so strong as to distort the value system of Mademoiselle Loisel. Novice readers of Greek tragedies often find the literal plots ridiculous. However, we do know that experienced readers can subjunctively enter imaginary worlds that are far removed from their own lived experiences. They need tools to understand such worlds, to be able to map salient features of these unfamiliar environments to their own prototypical dilemmas as human beings. Greek tragedies often involve a tragic hero who suffers because of hubris or exaggerated self-pride and who engages in an act that reflects a fatal flaw of character. While the exact actions and setting of *Oedipus, the King* by Sophocles may not resonate with the average 11th or 12th grade high school student (whether he or she lives in a low income urban community or a more affluent suburb), many of these same students can predict what will happen when Erica Kane tells a lie in a scene from the soap opera *All My Children*.

Ironically, in viewing films, our students are pretty good at what Samuel Taylor Coleridge calls the suspension of disbelief necessary to enter imaginary worlds of fiction. Most filmgoers know they have and will likely never experience what they see in the *Star Wars* films, but they are able to map the adventures and challenges of a Luke Skywalker onto the kinds of adventures they can imagine and perhaps even experience. Our students even intuitively understand Luke Skywalker's story as a coming-of-age story, and understand Anakin Skywalker, known also as Darth Vader, to be a kind of tragic hero even though they do not have the language to describe him as such. They respond to his suffering as a potential source of salvation; they understand he will learn some important lessons from his suffering as he fights for right finally at the end of his life. Darth Vader's complex attraction to the so-called Dark Side represents a tragic fatal flaw.

We make these assertions not simply to describe some of the kinds of prior knowledge that good readers need to interrogate rich literature but also to make the case that students from many different backgrounds typically have life experiences that when activated can serve them quite productively in interpreting narratives.

Overall, reading deeply complex literary texts offers unique opportunities for students to wrestle with some of the core ethical dilemmas that we face as human beings (Fernandez, 1977; Hynds, 1989). Learning to understand sources of threat and to adapt to a changing and difficult environment are major challenges that we have as humans across the life course. We learn lessons about such grappling from many sources—our family, friends, church, and other social networks. But we can also learn from reading literature. How to understand what makes a Raskolnikov (in Dostoyevsky's *Crime and Punishment*) engage in an act of murder under the ostensible self-explanation of accomplishing good may provide insights into how ordinary human beings often align themselves with evil. Human enslavement of Africans in the United States remains a kind of Damocles' sword over the consciousness of America that has never been fully resolved. What that experience meant in human terms is perhaps best captured in the characters of Sethe and Paul D in Toni Morrison's



Beloved, a story invoking human resilience in the face of unbelievable adversity.

The point of these examples is to illustrate the quality of ethical reasoning that great literature invites. The growth of empathetic ethical reasoning is one of the most important reasons for schools to serve as unique sites for the development of capacities and dispositions to read complex works of literature. Students who enter high school as struggling readers are quite capable of engaging with such texts, in part because these same students are often wrestling with complex challenges in their own lives. Such students typically have a history of academic under-achievement which poses complex psychological challenges. One of their most important developmental tasks is to learn to be resilient in the face of adversity (Kunda, 1999; Spencer, 2006).

"The ability to understand and apply the mathematical content typically taught in an Algebra II course is vital to a student's success in science and social sciences courses required by our university"

MATHEMATICS PROFESSOR, PURDUE UNIVERSITY::
The American Diploma Project

"It is a myth that mathematics and math-dependent majors in college do not require strong reading and writing skills. Students have to be able to comprehend complex informational text so they can identify which mathematical operations and concepts to apply to solve a particular problem."

ECONOMICS PROFESSOR, SAN FRANCIS STATE UNIVERSITY::
The American Diploma Project

Reading in mathematics

Of all the academic disciplines taught in middle and high school, the one we least expect to entail reading extended texts is in mathematics. We expect students to face reading comprehension challenges in understanding word problems, for example, and to face some difficulties in understanding the texts and graphic illustrations in mathematics textbooks. But mathematics texts present special literacy problems and challenges for young readers.

The standards of the National Council of Teachers of Mathematics (NCTM) refer to mathematics as a language and a form of communication. These standards suggest using fictional literature that embodies mathematical ideas in the elementary school grades to help children make initial connections between mathematics and the real world. However, what such linkages might mean at the secondary school level remains unexplored (Siegel, Borasi, & Smith, 1989).

Most discussions on reading in mathematics in schools have focused on textbooks. Typically, studies have attempted to make explicit the structure of mathematics textbooks (Barton & Heidema, 2002). Students are taught to identify the functions of prototypical sections of mathematics textbooks—general statements, use of bold print, definitions, examples, explanations, summaries, margin notes, diagrams—in order to know what kind of information they are reading to understand. Also, many studies employ generic reading strategies, supporting students in previewing, making predictions, re-reading, and summarizing (Berger, 1989). These strategies are useful for tackling mathematics textbooks, but do not necessarily help students to develop conceptual understanding, which comes only through mathematical modeling and repeated practice with problem solving (Schoenfeld, 1998).

There is no question that mathematics textbooks can serve as a significant barrier for students who are struggling readers. It is also true that students can learn mathematics procedures and concepts in the absence of understanding their textbooks, depending on how instruction is organized.

Some textbooks series explicitly emphasize reading. For example, the University of Chicago School Mathematics Project (UCSMP) organizes lessons to require independent reading in mathematics. On the website of their commercial publisher, UCMP offers the following explanation:

> Q: Why is reading so important?
>
> A: Studies have shown that students, in general, do not read traditional mathematics books. As a result, these students do not learn to become independent learners capable of acquiring mathematics outside of school when the need arises. UCSMP addresses this problem by making reading a regular part of each lesson and including questions that cover the reading. Here are some reasons for reading that teachers can give to students.

> You must read to succeed in future courses that use mathematics and in future jobs; because the reading will help you understand the uses of mathematics; because the reading tells you how the material from one lesson is related to other material in the book. (http://ucsmp.uchicago.edu/)

Paul Dowling (1990) has conducted an extensive critical examination of a variety of mathematics textbooks used in British schools. He distinguished texts routinely used in schools serving students from working class backgrounds and those in more elite schools, demonstrating that the textbooks used in more elite schools have a greater density of propositions and ground explanations with justifications based on disciplinary postulates, while the textbooks used in working class schools have less text and ground explanations in real world contexts rather than in the self-referential links to mathematical reasoning. Brantlinger (2006) repeated Dowling's analyses with the same findings using two texts used in U.S. geometry classes: *Geometry for Enjoyment and Challenge* (Rhoad, Milauskas, & Whipple, 1991) used in elite schools and IMP (Interactive Math Program) used as a reform text to help students make mathematical connections with the real world, and a geometry unit Brantlinger himself developed to teach mathematics for social justice.

The Rhoad text has few, if any, problems involving real world examples. The chapter on area from which the example is taken begins by defining terms. It employs phrases like "closed region," "boundary of the region" as in "The area of a closed region is the number of square units of space within the boundary of the region." Beyond the obtuse language, the Rhoad text presents a logic that is special to mathematics (Polya, 1945). It stipulates a set of propositions that serve as the basis upon which a set of theorems are derived. The postulate is stated first in natural language (e.g. "The area of a rectangle is equal to the product of the base and the height for that base."), but does not define terms such as product and base. It then gives the same proposition in a mathematical formula (e.g. A_{rec} = bh, where b is the length of the base and h is the height.).

By contrast, Glencoe's reform geometry text consistently situates problems in real world contexts. It defines ideas, and in the margin provides tips, including what they call "reading math tips." The use of "reading math tips" suggests that the publishers recognize that reading mathematical texts and using the information in math textbooks require strategic knowledge that goes beyond the mathematics itself. In some respects then, we might consider the Glencoe text a more considerate text for struggling readers, in the sense that more key terms are defined, strategies are explicitly provided for reading the text, and applications are rooted in real world experience. On the other hand, Dowling and Bratlinger each argue that texts such as Glencoe also provide students with fewer opportunities to engage the decontextualized nature of the mathematics that students are more likely to meet in college mathematics classes, where the logic of reasoning from postulates to theorems and constructing mathematical proofs that involve multiple inter-connected theorems is normally expected.

If we take Dowling's cautions to heart, work being done at the college level to help students learn how to read the types of textbooks used in advanced mathematics classes also has relevance for reading high school mathematics textbooks. The example in Box 7 illustrates the specialized nature of reading mathematics as we expect to find in textbooks that are focused on the disciplinary language of mathematics (Barton & Heidema, 2002), which is quite different from the treatment of mathematical topics we are likely to find in general interest articles in newspapers, magazines and journals.

Mathematics textbooks in what Dowling calls either the esoteric or expressive domain typically include use of the Greek alphabet as mathematical symbols

α - A - Alpha
β - B - Beta
χ - X - Chi
π - Pi
$\sum$ - Sum

for explication of theorems and proofs using mathematical notation, as well as sentences in natural language. We see these features in the illustration. Readers of that text must be able to understand the following:

- The second sentence of the second paragraph explains the first sentence in that paragraph;
- The final sentence of the second paragraph indicates that the reader should pay special

attention to how the total number of people, the N, influences the probability;

- The meaning and function of a proof in mathematics;
- How the illustrations in the third paragraph map on to the algorithm for solving the problem;
- The meaning of algebraic sentences such as Q(n)-1-P(n) and 365^n;
- The logical function of the supposition of the proof captured in the use of the term "Let" in the phrase "Let Q(n)=1-P(n)."

BOX No. 7. | ***How to Read Mathematics by Shai Simonson and Fernando Gouvea***

The Birthday Paradox:

A professor in a class of 30 random students offers to bet that there are at least two people in the class with the same birthday (month and day, but not necessarily year). Do you accept the bet? What if there were fewer people in the class? Would you bet then?

Assume that the birthdays of *n* people are uniformly distributed among 365 days of the year (assume no leap years for simplicity). We prove that the probability that at least two of them have the same birthday (month and day) is equal to:

$$1 - \left(\frac{365 \times 364 \times 363 \times \ldots \times (365 - n + 1)}{365^n} \right)$$

What is the chance that among 30 random people in a room, there are at least two or more with the same birthday? For $n = 30$, the probability of at least one matching birthday is about 71%. This means that with 30 people in your class, the professor should win the bet 71 times out of 100 in the long run. It turns out that with 23 people, she should win about 50% of the time.

Here is the proof: Let P(n) be the probability in question. Let Q(n) = 1 – P(n) be the probability that no two people have a common birthday. Now calculate Q(n) by calculating the number of n birthdays without any duplicates and divide by the total number of n possible birthdays. Then solve for P(n). The total number of n birthdays without duplicates is:

$$365 \times 364 \times 363 \times \ldots \times (365 - n + 1).$$

This is because there are 365 choices for the first birthday, 364 for the next and so on for n birthdays. The total number of n birthdays without any restriction is just 365^n because there are 365 choices for each of n birthdays. Therefore, Q(n) equals

$$\frac{365 \times 364 \times 363 \times \ldots \times (365 - n + 1).}{365^n}$$

Solving for P(n) gives P(n) = 1 – Q(n) and hence our result.

Source: (http://www.stonehill.edu/compsci/History_Math/math-read.htm)

Researchers working on how to make such texts understandable recommend that students understand the logic of stipulated definitions, examine carefully how theorems and proofs are worked through in the examples to be sure they understand the underlying logic, use paper and pencil or calculators while they are reading to re-test and apply equations to their own examples. This is a unique and challenging process, involving a whole different logic from reading in other disciplines such as social science, history, and literature.

While this college text level example helps to emphasize the issues involved in reading mathematics, another example from a high school text illustrates how reading and writing are entailed in constructing and communicating mathematical proofs (Tierney & Shanahan, 1991; Tierney, Soter, O'Flahavan, & McGinley, 1989). This task is taken from the Glencoe *Geometry* book (2005, p. 91): Given that M is the midpoint of $\overline{PQ}$, write a paragraph proof to show that $\overline{PM} \cong \overline{MQ}$.

The example illustrates how students are expected to be able to write the logic of proofs in a paragraph form that includes words as well as mathematical notation. Students are expected to understand the example as a mathematical text and then to be able to produce such texts themselves. But if readers are to accomplish such tasks they need explicit and repeated instruction focused on the specific language and form of communication that mathematics is.

We should not underestimate the importance of our students being able to understand the language and logic of mathematics as captured in mathematics textbooks. Without such understanding, advanced mathematics will simply not be accessible. Even if our young people do not intend to pursue careers in pure or applied mathematics or the various branches of science, taking three to four years of high school mathematics is associated with higher SAT and ACT scores for college admission and also better prepares students for college. Moreover, by successfully navigating high school mathematics courses young people will typically form a lifelong habit of reading newspaper and magazine articles that draw on mathematic evidence more critically, and this ability will help them to act as informed citizens.

John Allen Paulos, professor of mathematics at Temple University, has written widely about the impact of mathematical literacy for the public's

understanding of a wide range of issues from health to demographics, including how authors of newspaper and magazine articles can manipulate the numerical data they use to convince lay readers to support particular positions (Paulos, 1990; Paulos, 1995). In *A Mathematician Reads the Newspaper* (Paulos, 1996), Paulos examines newspaper articles on topics ranging from economics, business and social issues, to health and lifestyle issues, showing how readers can pose critical questions about the propositions and point of view in the articles by drawing on a basic background in the mathematics involved. Paulos also examines public discussions that use numerical data to create a sense of urgency about a particular issue, arguing that typical misunderstandings about probability often lead the public to assume that a set of outcomes or events are more probable than they actually are.

If, as a consequence of typical K-12 mathematics instruction, our high school graduates are able to develop core conceptual understanding *and* enjoy routine opportunities with support to read and critique a wide range of extended texts involving mathematical data, the types of mistaken reading assumptions Paulos cites will naturally become far less common.

There are existing projects that integrate these two foci for reading in mathematics classrooms. For example, the Reading to Learn Mathematics Project (Siegel, Borasi, & Fonzi, 1998; Siegel, Borasi, & Smith, 1989; Siegel & Fonzi, 1995) involves helping students better comprehend the technical language, syntax and logic of math textbooks as well as learning to read a range of real life texts involving mathematics. The Project aligns reading in mathematics classrooms with inquiry-based instruction with the goals of helping students learn to think mathematically and to value both the aesthetics and the applicability of mathematics. From several studies in an urban alternative high school in Rochester, New York, with a diverse student population the designers of this project have postulated a series of functions (see Box No. 8) of reading in the mathematics classroom (Siegel & Fonzi, 1995, p. 644).

Just as there are good arguments regarding the inclusion of history and philosophy of science in the middle to high school science curriculum, there are also excellent reasons to call for the reading of extended texts in the history of mathematics. Reading a wide array of mathematics-centric and mathematics-related texts in the classroom can generate lifelong interest and support learning to reason mathematically.

BOX No. 8. | ***Categories of reading practices in a inquiry-oriented mathematics classroom***

Category 1: Reading to make public
a. Reading to value students' meanings.
b. Reading to convey meaning.
c. Reading to get feedback.
d. Reading to make a presentation.
e. Reading to demonstrate one's thinking.

Category 2: Reading to comprehend
a. Reading generatively to make sense of text.
b. Reading to understand and follow directions.
c. Reading to make a decision.
d. Reading the teacher's comments to get the message.
e. Reading to make sense of graphic/visual text.
f. Reading critically and reflectively to make a decision that affects your life.
g. Reading with a focus to extract specific information.

Category 3: Reading to get an example
a. Reading a text to learn how to do something the text does.
b. Pointing to a text to show an example of something.

Category 4: Reading to generate something new
a. Reading to generate a reflective written response.
b. Reading to push something further.
c. Reading to spark an idea.
d. Reading a text representing individuals' thoughts to generate a shared text.
e. Reading to set the stage for the next activity.
f. Reading to revise a text.
g. Reading to generate an immediate response.

Category 5: Reading to remember
a. Reading reflective statements written on newsprint to value the meanings.
b. Reading to copy from the board.

Source: Siegel & Fonzi (1995, p. 644).

What does research imply about struggling readers and Disciplinary Literacy?

There are many potential areas of instruction that can have a rippling effect for the expansion of readers' repertoire of skills, including pre-reading, predicting, testing hypotheses against the text as it unfolds, asking questions, summarizing, etc. Instruction can also build prior content knowledge

Box No. 9. | ***Instructional Foci for Supporting Adolescent Struggling Readers in the Content Areas***

Apply both generic and discipline focused strategies and knowledge to the comprehension and evaluation of

- Textbooks
- Full length books
- Book chapters
- Journal and magazine articles
- Newspaper articles
- Historically situated primary documents
- Multimedia and digital texts

Generic Reading Strategies	Discipline Specific Reading Strategies
▪ Monitor comprehension ▪ Pre-read ▪ Set goals ▪ Think about what one already knows ▪ Ask questions ▪ Make predictions ▪ Test predictions against the text ▪ Re-read ▪ Summarize	▪ Build prior knowledge ▪ Build specialized vocabulary ▪ Learn to deconstruct complex sentences ▪ Use knowledge of text structures and genres to predict main and subordinate ideas ▪ Map graphic (and mathematical) representations against explanations in the text ▪ Pose discipline relevant questions ▪ Compare claims and propositions across texts ▪ Use norms for reasoning within the discipline (i.e. what counts as evidence) to evaluate claims

and vocabulary, as well as a broad knowledge of syntax. Box 9 summarizes what we think should be taught to meet the needs of adolescent struggling readers in the content areas. By explicitly expanding the range of kinds of texts that students read in content area courses, teachers can actually expand opportunities to learn content knowledge.

Prior knowledge has been repeatedly shown as a strong predictor of comprehension (Dole, Valencia, Greer, & Wardrop, 1991). Building and activating prior knowledge in relation to academic disciplines is one area that content area classrooms are uniquely positioned to accomplish. It is precisely because content area classrooms are explicitly sites for building discipline specific knowledge that we believe they can be extraordinarily helpful to students who are struggling readers as well as expanding the competencies of those who read at grade level.

However, wrestling with the tensions of addressing content standards and helping students learn to read better is complex and requires a principled and systematic approach to text selection, sequencing, and coordination with other discipline related problem solving (Kingery, 2000; O'Brian, Moje, & Stewart, 2001).

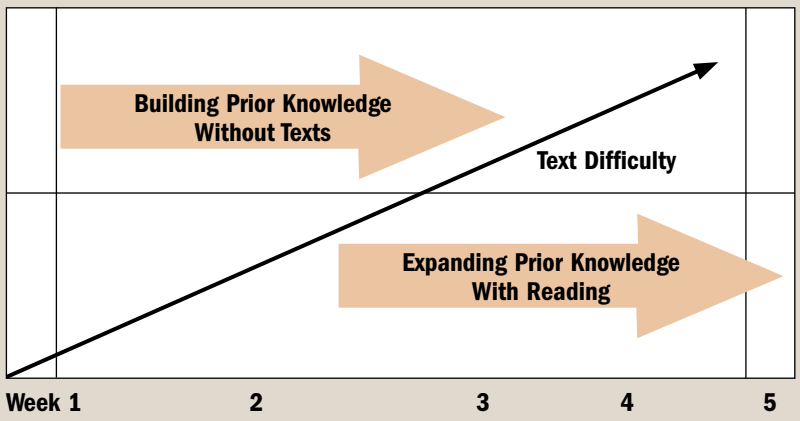
Instructors should (see Box No. 9): Design knowledge building activities that do not require extensive reading initially. Then introduce different kinds of texts that are within students' instructional reading levels where they can use the prior knowledge already developed to tackle discipline related problems in the texts. Such discipline related problems include posing discipline specific questions and extrapolating information from texts in order to solve authentic and complex problems. Increase the complexity of the texts (in terms of propositional knowledge given, propositional knowledge assumed, text structures, syntactic structures, vocabulary, less explicit coherence) over time. Box No. 10 captures that logic.

Teaching content knowledge and reading strategies in tandem

In successful content-area classrooms, teachers organize instruction in routine ways that

- Reinforce conceptions of reading as a meaning making process;
- Provide guided support for making sense while students are engaged in acts of reading;
- Shift responsibility for thinking and making sense of texts to students themselves through guided supports in both small and whole group work;
- Sequence discipline specific inquiry tasks and the reading of a range of discipline focused texts in ways that build knowledge and dispositions over time;
- Focus classroom talk on how students make sense of texts and how they use what they learn from texts to carry out discipline specific thinking tasks, or what Resnick and colleagues call "accountable talk." (Michaels, O'Connor, Hall, & Resnick, 2002);

Box No. 10. | ***Sequencing of Content Area Texts and Building Prior Knowledge***



- Provide consistent supports so that students experience success and develop or reinforce their sense of efficacy as readers as well as students who value the practices of the disciplines as these are instantiated in authentic classroom tasks.

The most important key to these core practices is creating a culture of high expectations through building routines (Lee, 2001, 2007). Routines help to establish students' expectations for what they do, how they do things, and why. The following quote, often cited by the Strategic Literacy Initiative, clearly reflects the often unstated assumption about reading in the content areas that struggling readers have learned over many years of academic failure and low-level classroom tasks.

> … it wasn't like it was spread all over the place, like you had to read it. It was just like, if the " red square question" was here, you knew it was somewhere around that area right there. And you could just look for the answer and copy it down and you got full credit for it. So you didn't have to read. It was something that you could like slide by without them knowing. I don't know if they cared or not, but that's the way everybody did it. You see the "red square question" and you sort of calculate where it's around, you find the answer, and you write it down, and that's it."
>
> —Rosa, a 9th grade student, describing her experiences reading history (Schoenbach & Greenleaf, 2009)

As opposed to asking students to read for homework or as a classroom assignment and then simply answer questions when they finish reading, literacy rich content area classrooms include a variety of instructional routines that provide guidance to students before, during and after reading. These routines may include the teacher modeling how he or she makes sense of the text. This long standing routine based on Reciprocal Teaching accomplishes two important functions. First, it shows the students that even expert readers such as teachers actively work to make sense of texts and can in fact be confused by texts (Lee, 2007). Second, it demonstrates how to deploy strategies purposefully such as predicting, asking questions, and summarizing. Teachers also use a variety of thinking tools that direct students to engage in the kinds of generic reading strategies we have described and that are well documented in the research on reading comprehension (Bean & Steenwyk, 1984; Beck, McKeown, Hamilton, & Kucan, 1997; Berger, 1989; Britt & Aglinskas, 2002; Brown & Day, 1983; Bulgren, Deshler, Schumaker, & Lenz, 2000; Bulgren, Schumaker, Deshler, Lenz, & Marquis, 2002; Chi, de Leeuw, Chiu, & La Vancher, 1994; Commander & Smith, 1996; Kingery, 2000; Palincsar & Brown, 1984; Paris, 1989; Rosenshine & Meister, 1994; Rosenshine, Meister, & Chapman, 1996). These include, but are not limited to the following:

- Double entry journals where students post questions, observations of patterns in the texts, summarize, make connections;
- K-W-L—a graphic where students identify what they already know (K), what they want to know (W) and after reading what they have learned (L);
- Graphic organizers that use text structures to guide what kinds of information students are reading for or that map out the kinds of semantic knowledge students need to understand vocabulary (synonyms, antonyms, examples, attributes, morphemic analysis);
- Anticipation guides that list key ideas (including ideas that are counterintuitive or controversial) that

the teacher wants students to interrogate in reading a given text and to re-visit after reading;
- Annotation of texts to pose questions, mark main ideas, make predictions, mark reactions;
- Analyzing question types;
- Support for producing self explanations.

EXISTING INTERVENTIONS ADDRESSING THE NEEDS OF ADOLESCENT READERS IN THE CONTENT AREAS

Among the publications growing out of the Adolescent Literacy Initiative of the Carnegie Corporation of New York is *Informed Choices for Struggling Readers: A Research-Based Guide to Instructional Programs and Practices* (Deshler, Palinscar, Biancarosa & Nair, 2007) which describes a wide array of commercial and research programs and interventions focusing on struggling readers in middle and high school. Some of these programs, such as Read 180, address basic skills such as phonemic knowledge, fluency and vocabulary. Evaluations of Read 180 have shown success for older readers whose basic skill needs persist. However, it is important to recognize that these students do not constitute the majority of students entering high school who need additional reading instruction in the content areas. Also, we have emphasized across this document that even those students who enter high school reading at or even above grade level still need to be taught how to read deeply in the disciplines. There are a number of interventions, some involving uses of technology, aimed at helping high school students learn to read with understanding within and across academic disciplines.

The Strategic Literacy Initiative at West Ed designs reading courses for students who enter high school as struggling readers and works with content area teachers to incorporate reading strategies into their instruction. They have demonstrated success in increasing reading achievement for students in their program, with evidence of 9th grade students gaining 2 years of improvement in 7 months of instruction. (Greenleaf, Schoenbach, & Cziko, 2001; Schoenbach, Greenleaf, Cziko, and Hurwitz, 1999). The project works not only with teachers, administrators and literacy coaches, but also with teacher educators, thus aiming to influence multiple levels of education. The program explicitly addresses both the cognitive as well as the affective dimensions of reading, stressing the importance of students' developing identities as readers. They are currently working in multiple school districts across the country.

The Center for Research on Learning at the University of Kansas has developed an array of instructional routines to help teachers effectively present critical, but potentially difficult to learn, information that is presented in lectures and class discussions. These instructional methods are called Content Enhancement Routines (Bulgren, Deshler, & Lenz, 2007; Bulgren, Deshler, Schumaker, & Lenz, 2000; Bulgren, Schumaker, Deshler, Lenz, & Marquis, 2002; Deshler et al., 2004; Deshler, Palincsar, Biancarosa, & Nair, 2007). Suchroutines are designed to help students acquire important background information, knowledge of critical concepts that underlie a body of discipline specific content, and an understanding of how information on a given topic is structured. In as much as nearly 50 percent of class periods in secondary schools are spent in lecture and discussion (Deshler, et al., 2004), these routines have been designed to enable *all* students, regardless of their literacy level to acquire essential content information during their class sessions. Having a grasp of this critical subject matter information enables students to better understand written texts that they then attempt to read in these classes.

The Disciplinary Literacy Project at LRDC at the University of Pittsburgh approaches teaching reading in the content areas by focusing on building the infrastructure supports of school districts to build teaching capacity (McConachie et al., 2006). The Disciplinary Literacy Project has organized teams in English Language Arts, Science, History and Mathematics working actively with district level instructional leaders. This project hypothesizes that by building capacity at the district level, literacy supports are more likely to be distributed across schools. They have also developed a framework called "Accountable Talk" to encourage students to explain their thinking as they problem-solve, including problem-solving in reading.

Specifically in science, there are several research projects that address what students need to know and be able to do to read with understanding textbooks and other science related texts. We mention these because attention to reading in science is a relatively new area within science reform efforts over the last decade.

The Centers for Highly Interactive Curricula, Classrooms, and Computing in Education (Hi-Ce) at the University of Michigan and Detroit Public Schools (among other secondary school settings) have developed project-based science curricula that include by well-written expository texts, real-world texts, and narrative case texts that establish scientific problems for young people to explore through firsthand scientific investigation (Moje & Dillon, 2006; Moje et al., 2004; Moje & Speyer, in press; Moje, Sutherland, Cleveland, & Heitzman, 2005). Thus, challenging texts are made easily accessible to teachers and students. The reading of these texts is supported by professional development, with teachers focused on the integration of practices for teaching students how to engage in text-based and firsthand inquiry, with a focus on developing both scientific and everyday vocabulary, learning how to predict and set purposes for reading, and learning how to synthesize information from texts (Sutherland et al., 2006).

The Literacy in Science and Technology Project at Northwestern University and the University of Illinois at Chicago uses technology to help high school students learn to annotate science texts and generate cohesive summaries (Gomez & Madda, 2005; Gomez & Gomez, in press; Gomez, Herman, & Gomez, 2007). This work is unique not only because it focuses on science, but also because it uses technology to help students focus on main ideas, supporting details, difficult content vocabulary as well as markers of transitions and conclusions. In addition, students use double entry reflection logs to identify the main arguments in texts as well as attending to vocabulary. The program also makes use of Summary Street (Wade-Stein & Kintsch, 2005), a software program using Latent Semantic Analysis (Kintsch, Steinhart, Matthews, & Lamb, 2000) to evaluate summaries written by students.

Much of the focus on helping students read to learn in content area courses focuses on history and science courses. Educators often tend to assume that reading in literature is not problematic. In fact, high school English teachers are often drafted to teach the generic reading courses now being introduced in many high schools to help entering struggling readers. Sometimes English teachers see their role as asking students to read canonical literature rather than teaching students, especially struggling readers, to learn to read such texts (Grossman, 2001; Smith & Hillocks, 1988). The Cultural Modeling Project identifies the kinds of strategies and concepts that readers need in order to interpret canonical literatures over a range of national traditions (Lee, 2007). The Cultural Modeling Project designs interventions that draw on relevant knowledge that ethnic minority students develop in their out of school experiences to scaffold rich literary reading (Lee, 1995a). As with the other subject matter specific interventions, the Cultural Modeling Project makes explicit what good readers need to know and be able to do in order to interpret canonical works of literature.

This sampling of current research projects in adolescent literacy that can help adolescent struggling readers to read with understanding across their content area courses is not intended to be exhaustive. All the projects mentioned draw on a long history of research in reading comprehension documenting how active and engaged readers monitor their understanding while reading, make predictions based on signals in the text, their prior knowledge and their purposes for reading, and summarize and extrapolate from texts. These projects further draw from and contribute to our understanding of how strategic moves by good readers are both similar and different across content areas. The projects represent concrete work happening on the ground across hundreds of schools, accumulating evidence about how systematically we can change the trajectories of adolescents who enter high school struggling as readers.

Conclusion

There is no question that there is a knowledge base to attack the problem of adolescent literacy in our middle and high schools. At this stage, it is only question of finding the public will to act, coordinated from across the many stakeholders—federal and state governments, district and school leadership, teachers and teacher organizations, parents and community institutions.

We have tried to illustrate in this report what reading in the disciplines requires, what students need to know and value in order to wrestle with the demands. We have tried to show that these demands

hold for students we presume to be competent readers as well as those who are struggling. We have further tried to make the case that reaching our adolescent struggling readers does not necessitate a retraction from rigorous content learning, but rather that content learning and reading to learn are deeply intertwined and that the very students who need it the most currently have the least opportunities to become deeply literate across the content areas.

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Endnotes

[1] The Association for the Advancement of Science (AAAS) science literacy benchmarks are but one example of recommendations for science education (http://www.project2061.org/publications/bsl/). More recently the National Assessment Governing Board released the *Science Framework for the 2009 National Assessment of Educational Progress* (http://www.nagb.org/publications/frameworks.htm). In addition, the National Academy of Science's Board on Science Education released *Taking Science to School: Learning and Teaching Science in Grades K-8* in 2007 (http://books.nap.edu/openbook.php?record_id=11625).

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