Apprenticing Urban Youth to Science Literacy

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The computer monitor at the front of Will Brown’s classroom reads:

### Think – Write

Last night you read chapter 7 section 1.
What went well for you?
What did not go well for you?
What was the most interesting idea that you learned?

Students are sitting in table groups, named for the chemistry they are learning this year: pH Pals, Solubility Sleuths, Stoichiometry Stars, Molar Majority, Phase Fans, Kinetic Kids. They take out their notebooks and write to the metacognitive prompts on the monitor. While they write, Will checks attendance and then walks around the room, monitoring students’ progress.

This metacognitive Think-Write is routine in this classroom. It links the prior day’s learning, reading, and homework to the day’s work in chemistry and goes by the auspicious name, the “preamble”. After a moment, Will says, “Class, please focus here. What happened with your homework last night?” He directs students to share their preamble responses with their table groups “in one and a half minutes, using 5 centimeter voices. Choose a spokesperson for your group. Go, go, go!”

During this period, Will’s students are all English language learners, recent immigrants from Hong Kong, Vietnam, Taiwan, Tanzania, India, Mexico, Iran, Pakistan. As in Einstein’s physics, time is relative in this class. One and a half minutes lengthens as students share the difficulties as well as the new ideas and concepts they encountered while reading the assigned section of their challenging chemistry textbook. Will moves from group to group as students work together, entering their conversations, probing their thinking, suggesting a different way to look at a problem. At Joaquim’s table, for instance, Will stops to comment on an observation Joaquim has made about his reading process: “Yeah. Sometimes you read something and you
know, ‘Ha, they’re going to talk about this next.’ It’s called ‘foreshadowing’ and that
foreshadowing happens in science. There’s a sense of a rhythm to science texts: they talk about
this, then they’re probably going to talk about the other thing.”

As these conversations wind down, Will pulls the class back together so that table groups
can share their discussions with the whole class. Lily volunteers, “I learned to write chemical
formulas.” Will encourages her to say more, “And what was hard?” Lily responds, “All the
names of them.” Lily’s difficulty is one Will has anticipated; today’s lesson will focus on
learning how to name the chemical compounds. “After today,” he promises, “I do not think it
will be so hard.” Other students speak up. Bao offers her strategy for reading the textbook --
taking notes on the chemistry by focusing on the “important words.” When asked how she can
tell which words are important, Bao says that “the book showed me.” With Will’s prompting,
Bao demonstrates how she uses the bold words in the text and the glossary at the back of the
book. But Chang observes, “It was easy for me to look for the bold words and the key words, but
it’s hard for me to understand the hard words I don’t know that aren’t bold.” Will agrees, “It can
still be hard even when they give you the definitions of the key words. The words around the key
words can be words you don’t know. Did you put some of these down to ask me about?” He then
councils, “Start with the word in bold or italics and the sentence it is in. Try to understand that
one sentence, work very hard on it, and then look around it in the paragraph. Put most of your
energy into understanding the bold words.”

Through this metacognitive talk and sharing, students’ shared puzzles, problems, and
problem solving are linked to the chemistry they are learning as the preamble spills into the day’s
lesson. In this sheltered chemistry class, as in Will’s other chemistry classes, ongoing inquiry
into reading and reasoning processes supports students to become stronger science readers and
thinkers. Students reflect on their learning, bringing their questions and difficulties with the reading and the chemistry to their tablemates. They are encouraged to think and go as far as they can together before turning to their teacher for help. Often reading is done for homework; sometimes students read together in class through a Team Reading process. But always there is this opportunity to inquire together into science concepts and literacy processes and to collaborate in order to reach fuller understandings.

These routine metacognitive conversations – opportunities to talk about one’s own thinking and reading processes – provide an opportunity for Will to access and support student thinking, and for his students to both reflect on and share their comprehension problems and problem solving. In the urban high school where he teaches, Will has found metacognitive conversation to be a powerful lever moving student disengagement and disinterest out of the way of the thinking and learning he wants them to practice. In metacognitive conversation, he creates ongoing opportunities to negotiate with his students new and more successful ways of being in the classroom, helping these young people to rethink their prior conceptions of reading and take on new, more powerful identities as readers and learners.

**Our Collaboration: Professional Community and Inquiry into Reading in Urban Schools**

This is a Reading Apprenticeship classroom. The teacher, Willard Brown, is a member of an ongoing professional learning community in the Bay Area of California, where he is working to apprentice his urban students to science literacy practices. Will is one of hundreds of Bay Area secondary teachers integrating Reading Apprenticeship into subject-area teaching. This community of teachers is supported by the Strategic Literacy Initiative at WestEd, where co-authors Cynthia Greenleaf and Cindy Litman work as part of a research and development team focused on adolescent literacy. Because Will has taken a leadership role in his school and in this
professional community, for the past two years we have worked together as a practicing teacher and as classroom researchers, to explore how Reading Apprenticeship might support historically underprepared and underachieving students to see themselves as thinkers, readers, and doers of science.

In this chapter, we introduce Reading Apprenticeship, a model of reading instruction for middle and high school students that embeds powerful instructional routines around reading into subject area teaching in courses like Will’s chemistry class. We illustrate Will’s work to integrate Reading Apprenticeship into inquiry-oriented science teaching in an urban high school, offering portraits of classroom practices as well as descriptions of diverse young people making, with their teacher’s help, a journey toward more powerful, academic identities. Along the way, we reveal the challenges and dilemmas we face in this work, starting with the challenges that motivate our ongoing collaboration: the complex literacy practices of science that are necessary if students are to participate successfully in the processes of invention, discovery, explanation, and critique that are central to science inquiry and engagement; the school-based literacy proficiencies and experiences of many urban youth; and the goals we hold for equitable participation of all students in the academic enterprise.

The Challenge of Literacy in Science Education

To learn science is to learn not merely a body of scientific knowledge, but also ways of participating in scientific exploration and reasoning. Access to the scientific community, and the ability to carry out or evaluate the outcomes of science inquiry, relies on various kinds of sophisticated literacy skills - the ability to make sense of scientific terminology, to interpret arrays of data, to comprehend scientific texts, to use and interpret models and illustrations, and to read and write scientific explanations (Lemke, 1999; Osborne, 2002). Despite this recognition,
making the case for reading instruction in science classes is not straightforward, in part because the history of science instruction and reading has been a troubled one.

Traditional science education has been criticized for an over-emphasis on acquiring science facts through teacher lectures or demonstrations, pre-fabricated laboratory experiences, and reading textbooks. Recent reforms in science education aim instead to engage students in building science knowledge through hands-on scientific explorations (e.g. Bybee, 1997). Sometimes this has meant consigning science textbooks to the dustbin – witness the National Science Education Standards’ description of outstanding teaching: “Many generous teachers spend their own money on science supplies, knowing that students learn best by investigation. These teachers ignore the vocabulary-dense textbooks and encourage student inquiry” (1996, p. 12). Often, science educators call for the use of reading materials other than textbooks to increase engagement and add relevance to students’ daily lives, pointing out that language, reading, and writing can play a significant role in understanding science and that the process skills of reading and science are parallel and mutually supportive of learning (e.g. Baker, 1991; Manzo & Manzo, 1990; McMahon & McCormack, 2000). Yet many science teachers are not certain how to integrate science reading experiences with hands-on investigations, and are keenly aware of students’ difficulty comprehending science texts. As a result, in recent years there has been a widespread reduction of reading in secondary science classrooms, precisely as policymakers are raising alarms about the reading proficiencies of adolescents (Rycik & Irvin, 2001).

In Reading Apprenticeship science classes, in contrast, reading plays a prominent role in student learning. The teachers we work with are encouraged to draw on their own experiences as readers in their disciplines to assist students with complex reading tasks, making apparent both the challenges and the value of such reading. Will’s experience as a research chemist has
influenced his work with students on reading in science: *Reading is part and parcel of science inquiry. Scientists must digest huge amounts of science text, yet reading science is significantly different than reading other kinds of literature. Science readers need powerful reading habits and attitudes to comprehend the ideas of science embedded in the various structures and conventions of science texts and language. I want to pass on to my students the joy of figuring things out through science inquiry and through reading science.*

The “texts” of the science world and of Will’s chemistry classroom are multiple and varied, ranging from traditional, encyclopedic textbooks to trade journals and science reports, numerical equations, visual and physical models of atoms and molecules, and conventional systems for denoting chemical bonding such as Lewis dot structures, chemical equations, and drawings of atomic structures. Even laboratory equipment and the phenomena explored in the lab require “reading” and interpretation. Each of these texts poses a comprehension problem for the science learner. The diverse students in American schools, particularly those from groups who have been historically underrepresented in the sciences, will need help acquiring high levels of reading and literacy proficiency in order to participate more fully in the scientific enterprise. Will recognizes that supporting his urban students’ growth in academic reading is key to their growth as science learners and citizens in our science-rich society.

**The Challenge of Academic Literacy for Urban Adolescents**

Will’s students, like many of the ethnically and linguistically diverse students we meet in urban secondary classrooms, are *inexperienced, but not beginning* readers. Many of them need the opportunity and instructional support to read varied materials in order to build their experience, fluency and range as readers. Virtually *all* middle and high school students—those who struggle academically as well as those who have been more successful—need help
acquiring the particular comprehension processes that underlie skilled reading in varied subject areas and academic disciplines (RAND Reading Study Group, 2000).

Yet precisely because reading and comprehension processes take place mentally, hidden from view, reading is often mystifying to these young people. As a result, many adolescents hold conceptions of reading, usually based on their experiences in school, which do not serve them well. They may persist in believing that skillful reading simply amounts to pronouncing the words on the page. They may not realize that all reading involves problem solving, that meaning does not always come to readers automatically, and that there are many strategies proficient readers use to solve the comprehension problems they encounter in text. And they are often unaware that the reading materials of the different subject areas require different kinds of interpretive strategies and can offer dramatically different reading experiences.

By the time they reach middle and high school, many of these same students have built a repertoire of strategies to avoid reading and to hide what they believe to be the secret shame of poor reading abilities. The cumulative affect of years of negative, unproductive, or mystifying school experiences with reading can weigh heavily on young people, shaping their lifelong identities. Many of these adolescents do not see themselves as readers, and do not choose to read books in their lives outside of school. Despite this, adolescents are resourceful and strategic practitioners of a variety of literacies outside of school. Many urban, immigrant youth function as culture brokers and language interpreters for their families, demonstrating considerable agency and skill with a range of texts necessary for day-to-day living. Other young people may avidly explore the meaning of song lyrics or pore over computer manuals for help in outfoxing a videogame opponent. In addition to these strategic – if not academic – literacy abilities, young people are at a point in their lives when their social identity is highly important to them.
Adolescence is the developmental moment when young people begin to explore or try on possible selves, to expand or solidify their visions of who they are and can become.

**The Challenge of the Ambitious Curriculum**

This key developmental task of adolescence takes on yet greater import in light of the fundamental shift in the way educators have come to define learning in the past few decades. Schools and society now hold ambitious new goals for all students, in part because our understanding of what it means to learn has evolved beyond traditional definitions – the accumulation of knowledge and skills – to include a growing capacity to participate in particular kinds of conversations and to engage in particular kinds of thinking and doing. We now see learning as a growing ability to participate skillfully—in scientific inquiry, mathematical problem solving, literary conversations, or the weighing of diverse perspectives on historical events. If participating in this kind of complex activity has become a goal for all of our students, then the role of reading in learning has also become both more critical and more complex.

Literacy can be either the gatekeeper or the gateway to full participation in school and society.

We know that the students who come to us in middle or high school are often unprepared to participate successfully with the challenging tasks and texts they will encounter. More troubling still, many of these young people—even those in college preparatory classes—have dis-invested in learning, resignedly carrying out tasks in the most perfunctory exchange of labor for grades. To help inexperienced or novice readers participate more skillfully in the literacy activities expected and valued in particular academic disciplines, we believe we will have to go beyond a reading specialist model to integrate reading instruction across the curriculum. And we will need to address more than content-area reading strategies to help disaffected urban youth re-invest themselves in reading and learning. In this critical time in young people’s lives, how can
subject-area teachers re-engage students in reading, and particularly in the discipline-specific modes of thinking and reading that support learning? How can teachers more successfully engage adolescents in the kind of literacies that will sustain them as life-long learners and knowledgeable participants in a democratic, information-based society?

**Addressing the Challenges: The Reading Apprenticeship Instructional Framework**

In response to these questions, we in the Strategic Literacy Initiative have developed and continue to refine the Reading Apprenticeship instructional framework, in the company of a growing network of middle and high school subject area teachers (Schoenbach, Greenleaf, Cziko, & Hurwitz, 1999). Reading Apprenticeship draws both on what subject area teachers know and do as discipline-based readers, and on adolescents’ unique and often underestimated strengths as learners. The model draws on earlier research characterizing effective teaching for naïve learners of complex mental tasks as cognitive apprenticeship. In a Reading Apprenticeship classroom, the teacher serves as a “master” or proficient reader of subject-area texts to student “apprentices”. This instruction takes place in the process of teaching subject area content.

Reading Apprenticeship takes well-researched practices in reading instruction into a coherent instructional framework, engaging students in extensive reading, integrating explicit teaching of comprehension strategies into the reading of curricular texts, establishing relevance and making personal connections to reading materials and curriculum activities, drawing on the out-of-school language and literacies of culturally diverse students, identifying and using a variety of language and text structures to support comprehension, and supporting collaborative sense-making activities with written materials. Although Reading Apprenticeship includes strategic reading instruction, it aims higher: to shift students’ misconceptions of reading, of their own reading ability, and of the purposes of reading in school and society, thereby re-engaging
them in the academic enterprise. The instructional model involves teachers and their students as partners in a collaborative inquiry into reading as they engage with subject matter texts.

**Metacognitive Conversation: Demystifying Subject-Area Reading**

At the center of the Reading Apprenticeship instructional model is an ongoing metacognitive conversation, a conversation about the thinking processes teachers and students are engaged in as they work with course materials and readings. In this model, new knowledge, strategies, and dispositions develop in an ongoing conversation in which teacher and students think about and discuss their personal relationships to reading and learning, larger issues of literacy and power, the social environment and resources of the classroom, their cognitive activity, the structure and language of particular types of texts, and the kinds of knowledge required to make sense of academic materials and ideas. This metacognitive conversation is carried on both internally, as teacher and students individually grapple with course materials and reflect on their own mental processes, and externally, as they share their knowledge resources, motivations, interactions with texts, and affective responses to literacy tasks.

A good deal of research has documented positive outcomes in student achievement when teachers engage students in subject area work through classroom conversation (e.g. Nystrand & Gamoran, 1991), including talk about how we read in subject areas (Duffy et al., 1994). Despite this, authentic discussion is a rare occurrence in classrooms (RAND Reading Study Group, 2002). In Reading Apprenticeship classrooms, however, teachers implement a variety of metacognitive and conversational routines to engage students in discussion about how we read and why we read in the ways we do, as well as what we read in subject-area classes. These routines offer students ongoing opportunities to consider how they are trying to make sense of
texts, how well their strategies and approaches are working for them, and how others (including the teacher) are approaching course reading. Over time, students can see that academic reading is always characterized by problem-solving, that reading proficiency continues to develop for all readers over a lifetime, and that their own reading abilities are not fixed. This understanding can free young people to re-invest effort in reading, and ultimately, in learning.

Promising Outcomes: Studies of Reading Apprenticeship

Our studies of the impact of Reading Apprenticeship suggest that this approach to reading instruction can produce powerful and positive outcomes for the reading proficiencies and engagement of adolescents. An initial study demonstrated increased reading achievement and academic engagement across a diverse group of 216 ninth graders enrolled in an Academic Literacy course in an urban, low-SES high school (Greenleaf, et al., 2001; Schoenbach, et al., 1999). These initial results have been replicated in several additional studies of sites with diverse student and teacher populations (http://www.wested.org/stratlit; Killion, 2002). Further, as Bay Area middle and high schools have taken Reading Apprenticeship school-wide, test scores in underperforming schools have begun to rise, especially for those student populations that have historically fared poorly in these schools (see Petrocelli, 2003). Taken together, these studies suggest that Reading Apprenticeship results in significant gains in reading proficiency for students across varied grade levels and subject areas.

Yet more important than these gains on standardized, achievement tests are the changes we have witnessed and documented in students’ literacy identities, shifts from disenfranchised to empowered readers with a range of strategies for gaining access to the forbidding codes and conventions of academic literacies. This shift takes place as teachers invite their students into the core thinking and reasoning processes of their disciplines by creating a collaborative classroom
inquiry into reading course materials and texts. By demystifying academic literacy practices, teachers succeed in opening gateways for students into engaged learning and encourage their students to reinvest energy in the work of comprehending complex ideas and texts.

The preponderance of research in secondary classrooms illustrates that very little teaching of how to read academic materials is actually done, even though teachers may know content area reading strategies (Alvermann & Moore, 1991; RAND Reading Study Group, 2000). An important part of our research agenda therefore has focused on studying the impact of professional development in Reading Apprenticeship on teachers’ attitudes, beliefs, and classroom practices (Greenleaf & Schoenbach, 2001). The research we have carried out in Will’s classroom builds on our prior studies examining both students’ reading development as well as changes in teachers’ conceptions and classroom practices. In the current study, conducted in 11 different subject area classrooms across a range of academic subjects and secondary grade levels, we are exploring the relationships between teachers’ professional development experiences, their classroom practices (i.e. the learning experiences they provide for students), and their students’ engagement and success with subject area reading. As part of this study, over the past two years we have interviewed Will and observed his participation in professional development settings, observed and recorded his science teaching weekly, and collected student work, reading assessments, grades, and student interviews. In the remainder of this chapter, we draw on this data to illustrate how one science teacher works to apprentice his urban youth to science literacy.

**Implementing Reading Apprenticeship in Chemistry at an Urban High School**

Will teaches chemistry at Skyline High School in Oakland, California. Designated an “underperforming high school” by the California Department of Education due to low standardized test scores, Skyline recently was granted status as a Title I school, making increased
resources and academic support available to Skyline’s diverse students. These students are diverse in many ways. Ethnically, the student population is about 50% African American, 25% Asian American, 15% Latino and 10% Caucasian. Nearly 40% of the students qualify for free or reduced lunch. Nearly 60% of the students test below grade level in reading, language, math and science according to the California state standardized tests. And while 700 freshmen enter Skyline in the 9th grade, only half of them graduate. This alarming attrition rate attests to one of the primary challenges faced by Skyline’s faculty – to hold high standards and expectations for all students while simultaneously giving the degree and type of support needed for students to reach these standards. For the past few years, the administration and faculty have focused school-wide on increasing the success of underserved populations of students at the school.

For example, district and school equity initiatives, coupled with the work of Skyline’s counseling staff, have increased the numbers of African American and Latino students enrolling in college preparatory courses. The science department at Skyline, chaired by Will, has developed open enrollment requirements for Honors Chemistry to promote equity and to usher more of Skyline’s African American and Latino students into the more rigorous science classes. Over the past few years, Will and a fellow science teacher have also worked concertedly to create an enrollment pipeline from biology to chemistry and successful learning experiences for these students who are underrepresented in the higher sciences nationwide.

Will has taught Honors Chemistry, regular college preparatory chemistry, sheltered chemistry for English learners, and Introduction to Chemistry, including a summer session of the course for students who failed it during the school year. In Will’s experience, the students in the sheltered chemistry and Introduction to Chemistry courses typically face the greatest language and literacy challenges in science. However, the effort toward greater inclusiveness in Honors
Chemistry means that these classes also contain students with different degrees of preparation for the rigorous work of the honors curriculum. Some enter Honors classes as relatively skilled readers while others struggle with academic text, with standardized reading achievement scores as low as the 6th percentile. It’s not surprising that Will believes virtually all of his students need instruction and support in the processes of reading science to successfully meet the demands of reading science texts. He was motivated to take up Reading Apprenticeship as a means of providing this needed reading instruction because in his professional development experiences he saw that it as resonant with his goals for his students’ inquiry learning in science.

**Building a Literacy Inquiry Community**

The spirit of inquiry is a common thread binding literacy and science in Will’s classroom: The heart of science is science inquiry. In science inquiry instruction, students explore phenomena, form questions and hypotheses, design and implement experiments, draw inferences from observation, and refine their understanding of science concepts. In Reading Apprenticeship, collaborative inquiry is the primary mode of engaging in reading and is resonant with science inquiry; they support each other. Students make sense of science research and laboratory experiences through discussions in which they test their ideas and appropriate others’ ways of thinking about science. Students develop their science reading habits through the metacognitive conversation in which they share their reading experiences and appropriate others’ ways of reading. The transition between the two forms of inquiry is seamless.

Will begins the year by establishing routines and structures that nurture and support a collaborative, inquiry learning environment. Early in the school year, Will talks explicitly with students about the ideas behind Reading Apprenticeship and invites students to explore their science literacy histories – the experiences that have shaped their current attitudes and
motivations toward science reading. This brings students’ conceptions of reading, of science, and of themselves as learners into the classroom where they can inform Will’s instructional decisions and become resources for student learning. As new reading opportunities arise in the classroom, Will models his own sense-making processes by thinking aloud as he works to make sense of a reading or chemistry problem. By making his own reading and reasoning processes—the confusions, clarifications, and connections—visible, Will demonstrates mental engagement and problem solving as the hidden work of comprehension. His willingness to take the risk involved in showing his students how he actually works to comprehend texts, helps students realize that it is strategic effort and not magic that is involved in comprehension.

Throughout the year, Will gives students ongoing opportunities and responsibility to reflect on their own thinking and learning through metacognitive reflections like the “preamble” that prefaced this chapter. As students read multiple types of science texts and carry out laboratory experiments and explorations, they are asked to reflect on and share their thinking and learning. As in the literacy history inquiries, this sharing brings students’ individual reading and thinking into the wider classroom community. Will’s classroom is structured to promote collaboration, with students placed in table groups that change membership periodically throughout the year. Many assignments are done by “expert groups,” a structured group-work routine in which each table group responds to a different open-ended prompt about a topic-related problem. After working on the problem as a team, expert groups present their solutions to the class and solicit their peers’ feedback and assistance.

Will notes that having students work together on a problem is very powerful: I think students know that their ideas and contributions are valued by the design of our lessons, where teams often have to report back to the class what they’ve learned, or what their ideas are. Expert
groups are one of the things students felt most positively about this year. Teams taking responsibility for one or a certain fraction of the assignment, presenting their thoughts back to the class, clarifying. They felt safe doing that. It was okay to make mistakes, you saw that people did, but they also got mistakes corrected and questions answered. And if you had a question, you had an opportunity to ask about it.

Will describes his own important role during this group work as that of “itinerant mentor.” His mentoring begins with listening: If they’re asking a question, I have to hear it, understand what they’re saying, decide how much I’m going to answer, or whether I’m going to ask them a few questions to figure out where they are and what they already know. Even if they didn’t call me over, I listen just the same. To promote students’ thinking and confidence in their ability to do challenging work, Will avoids giving students answers to their questions. Rather, he tries to guide them to answer as many questions as they can by themselves or with the help of their classmates: I may leave them with a question that will just help them organize their information so they can go on and answer their own question. Or I may propose an idea to them and let them respond and let them talk for a while. I want to reinforce the idea that they’re the learners and can learn. I want them to actually practice learning and practice figuring things out and know that they are the ones who are doing it.

To support students’ development as science readers and learners, Will focuses explicitly on science literacy throughout the year, emphasizing ways of reading, thinking and talking that are particular to science. Over the course of the year, he introduces a variety of high-leverage comprehension strategies to help his students develop a repertoire of comprehension problem-solving tools. But no one particular strategy or mix of strategies seems to provide the optimal leverage for increasing students’ engagement with academic texts. Rather, the climate of the
classroom community in which inquiry into reading and chemistry becomes a shared conversation is key to engaging individual students in the reading and reasoning processes of science. Will notes that as his students work together on increasing their understanding of their reading in science, they develop not only a sense of community, but a sense of responsibility for their own and each others’ learning. Slowly, even initially resistant students begin to ease into new roles as science learners with the modeling, challenge, and support offered in this classroom. Thus, unlike approaches that focus exclusively on cognitive strategies, Will notes that nurturing changes in students’ academic engagement necessitates strategically engaging the social and personal, as well as the academic, dimensions of classroom life.

The following vignette illustrates Will’s mentoring – his gentle insistence that students abandon the role of passive learners to engage actively as thinkers and doers of science.

Will’s Honors class is engaged in an team exploration aimed at exploring the bonding characteristics of carbon and connecting the names and structures of organic molecules during a unit on organic chemistry. Surrounded with modeling kit, textbooks, their reading logs and sheets of hand-drawn molecular structures, teammates Crystal, Suzanne and Tisha leaf randomly through the textbook’s baffling array of Lewis structure and computer generated representations of organic molecules, looking for a clue that will help them construct a model of 2-pentanol. They believe they have exhausted all resources. Tisha flags down Will and explains their problem, “The only one we could find was pentanol. I guess we’re supposed to make it up by knowing what the different forms are. None of us knows how to figure it out.” Will’s response, “Not yet, anyhow,” reveals his confidence that the three can solve the problem. “Tell me what you do know,” he says. While her teammates continue their haphazard search through the textbook, Tisha ventures, “Penta- means five.”
With Will’s support, Tisha makes progress puzzling out the structure of 2-pentanol, leveraging what she does know to tackle this new molecule. Aware that something worthwhile is transpiring, Tisha’s teammates pause in their random page-turning to join the conversation. Will explains to the three of them, “Now you just need to identify what the -an and -ol is.” Will listens for a while to the ensuing burst of conversation, then summarizes what he hears and prompts, “So –ols are alcohol. Where is the -ol group going to be?” Tisha ventures, “Around the carbons?” Will pushes for greater specificity, “Where in that five member carbon chain?” Although another short conversation among teammates does not yet produce consensus about the exact location of the alcohol, Will indicates his confidence that the three can solve this problem on their own and identifies the remaining piece of the puzzle, “Well you know what that is and you know it goes somewhere. So what part of the name have you not dealt with?” When Tisha says, “The 2,” Will agrees and tells the reenergized and refocused team, “So you have to figure out what the 2 tells you, then you’ll know how to build it.”

As team members discuss carbon chains and double bonds, informed by now-purposeful forays into the textbook, Will steps back. But he doesn’t leave the group yet. He listens in, reentering the conversation twice, once to articulate a general principle that the team has vaguely apprehended, and once to ask a question that moves the discussion forward. Before moving on, Will tells the team, “So you just need to figure out how to number the chain, then you’ll know where to put the alcohol.”

As this vignette makes clear, Will engages students in comprehending traditional, encyclopedic textbooks as well a rich array of trade journals and science reports, computer visualizations, Lewis dot structures, laboratory procedures, and experimental equipment and phenomena. When students read the chemistry textbook, which is frequent, reading and working
to clarify understanding does not begin and end with the assigned textbook reading. After the initial reading, which often happens as homework, the text resurfaces as students attempt to deepen their understanding of a specific phenomenon or solve a specific problem. Dog-eared tables, charts and a range of student-created texts are constant companions as students engage in science inquiry. Will explains his rationale for the recursive nature of reading in his class: The *first reading of the text, even when it is a close reading, does not result in immediate and universal comprehension. Revisiting the text in the context of classroom investigation of the same ideas discussed in the text can result in deep understanding of the phenomena...Students harboring misunderstandings not clarified through the text reading can revise their thinking through the inquiry process.* To build deeper comprehension of the chemistry, Will therefore intentionally blurs the boundaries between science investigations and reading.

**Routines and Structures Supporting Reading Apprenticeship in Chemistry**

In Will’s classroom, a small set of classroom routines support students’ reading and thinking about chemistry. In the following pages, we describe a few of these routines – reading logs, conversational structures, and science investigations – in more detail, and illustrate the process of negotiating new understanding, new relationships to reading and learning, and new identities as science students that these metacognitive conversations make possible.

**Reading Logs: Reading, Inquiry, and Metacognitive Conversation**

One routine that helps students become better science readers is the reflective reading log, a double entry journal in which students record important, interesting or confusing ideas from the assigned reading in the left column, and their own thoughts, connections and questions about the text or their reading processes in the right. The structure of the reading log encourages close attention to both content and to students’ own reading processes. Reading logs are
commonly used as a homework routine. In addition to promoting individual inquiry and reflection, however, reading logs support collaborative meaning-making in the classroom, where they serve as a resource during class and lab work, a study tool to prepare for tests, and a springboard for metacognitive conversation. Will encourages students to revise or add to their own entries to the log when classroom discussion or other activities extend or clarify the content. Students also share their reading logs with one another so that they can notice and appropriate classmates’ reading strategies and expertise.

However, promoting genuine participation in reading logs and related sharing routines requires labor and patience. Students who are unaccustomed to thinking about their reading may see little value in keeping a reflective reading log. Often, doubt and discomfort surfaces in the form of complaints—about having to write a log, about the length or difficulty of the reading or about the dullness of the material. Will responds to these complaints by listening, then attempts to redirect student attention to the task. When a student complains that the reading assignment is too long, Will acknowledges the student’s diligence and encourages the student to persevere. When a student complains that the reading is too hard, Will asks the student to identify a part of the text that needs clarification. Clarification then becomes a small group or whole class activity.

Early in the year, Will attends almost exclusively to the right hand column of students’ reading logs to gauge the degree of their interactions with the text and begin to shape their reading and science reasoning processes. As a result, the flavor of students’ notes and reflections evolves over the course of the school year. In the fall, students tend to fill the left column of the double entry journal with notes copied directly from the text. The right column, with student reflections, is limited to general comments about whether they like or understand the reading. As Will gradually introduces specific reading processes—such as clarifying, questioning, making
connections, summarizing, predicting and using science-specific text features—through think-
alouds and reading inquiries, he begins to insist on deeper demonstrations of “thoughtful reading.” With practice and guidance, left column entries transition to paraphrasing the text, and student reflections deepen from personal to more cognitive and content-related responses.

Reading logs are graded using a rubric that rewards effort generously, and rewards prior knowledge stingily (i.e., only when it is evidenced in right column reflections). Students who are struggling with content are rewarded for clearly identifying the ideas they want clarified and asking cogent questions. Students who bring more prior knowledge and initial understanding to the text are rewarded for exploring ideas more deeply through questioning. Responding in writing to students’ reading logs provides Will with an arena for negotiating students’ motivation and use of comprehension strategies. His written feedback provides support and encouragement, recognizes and celebrates student progress and effort, and allows him to monitor and assess student comprehension of vocabulary, chemistry concepts and problem solving skills. Will uses information from reading logs to apportion class time and activities to address areas of demonstrated student need and to flag students who need additional encouragement and support.

By providing a record of students’ thoughts and reading processes, reading logs and their associated activities contribute significantly to both disciplinary knowledge and to shifts in perceptions about reading and schooling. For example, at the beginning of the year, when Eduardo learns that students may use their reading logs during tests in Will’s Introduction to Chemistry class, he blurts out, “That’s cheating.” By spring, the reading log is Eduardo’s constant companion and when he spontaneously consults it to clarify a point while tutoring a classmate on functional groups, it is clear that he sees himself as the proprietor of his own
reading, eager to use his reading log in the service of his own learning and the learning of others.

Eduardo earned poor grades in the first grading period, largely due to incomplete assignments, including the reading logs. In an interview, he describes how Dr. Brown’s ongoing support and the collaborative learning environment of the chemistry classroom turned him around academically. “When I had my first [reading log] and I tried it, you know, I did it with Ben in class, you know. And he helped me realize it wasn’t hard, you know. And one day, I came during lunch and Dr. Brown helped me with what you’re supposed to do, so from there, from both of their help, you know, I tried it at home and it came out. I got an A on it, you know… When he told me I can get my grades up, I tried it and I seen it go up, so then I thought, from there on I said, you know, ‘If I can do that, I might as well try harder.’ And I started trying harder in school, in all my classes.”

Over the course of the year, Eduardo developed a preference for reading science text. He explained that he enjoyed reading science texts more than literature, and that he wanted to become an engineer. This change was reflected in timely completion of all reading assignments during the second semester, in which he earned an A. Moreover, Eduardo’s change of attitude, the new expectation that he could do science, influenced the whole class. He encouraged classmates to come to class and do their work, and tutored his peers when he finished his work early. The frequent conversations throughout the fall semester that focused on the thinking processes of reading and science inquiry supported Eduardo in re-thinking his relationship to science and learning. He came to see that he had the capability to succeed in class through simply working at it, thereby experiencing the intrinsic rewards of learning the chemistry that Will conveyed with such apparent enthusiasm.

Yet the rewards of reading and learning can be fragile, in need of a teacher’s ongoing
support. One day in late May, Will enters his sheltered chemistry class with feedback on their homework assignment. They were to have written a gas law and its meaning in their reading logs. He begins, “Recently I asked you to write a gas law and its meaning. There were four original papers, and then there were duplicates. Copies. Which became less and less accurate. People copied as though it were a picture, and everything got less accurate.” Will explains that it is everyone’s responsibility to focus on learning: “My recommendation is to read and think for yourself. Those of you who had original papers, to help someone, don’t give them your original papers.” Appealing to a student who runs track for the high school, he offers an analogy, “James, when a friend asks you, ‘hey can you help me, can you write down a faster time?’ it doesn’t help them run faster when they get to the meet, does it?” Underscoring the similarities for thinking and learning chemistry, Will reminds his students “There is a skill of reading that your peers need experience doing. They don’t need experience copying. Don’t give your work to your friends. Ask them what is hard for them and give them real help.”

**Conversational Routines: Recursive Cycles of Metacognitive Conversation**

Among the routines that support students’ growth as science readers and learners are the many opportunities Will offers his students to discuss the ideas and texts of chemistry. In Will’s classroom, conversational routines include the preambles and expert groups already described, as well as Team-Reads. These conversational routines generally begin with individual reflection, then move to small group and whole class discussion before returning to the individual, providing opportunities for students to revisit, revise and deepen comprehension and content knowledge as well as to practice and refine discipline-based thinking and reading processes. Topics of these conversations are wide-ranging—students may grapple with a difficult concept or operation, connect new ideas to prior knowledge or discuss real-life applications of chemistry
in a preamble; synthesize and consolidate information and ideas from multiple sources in an expert group; or tackle a particularly challenging section of text in a Team-Read—but they nearly always involve reading and text of some kind.

While many conversational routines involve reading and learning from previous lessons or homework, Will also occasionally provides extended in-class opportunities for “on-line” conversations about reading through “Team-Reads.” During Team-Reads, students alternate between reading a small section of text individually while making notes about their reading and thinking processes, and discussing the section with three teammates. In both the individual reading and small group conversations, students practice four cognitive processes: clarifying, questioning, summarizing and predicting. Based on Reciprocal Teaching (Palincsar & Brown, 1989), Will’s Team-Reads integrate thinking processes particular to science inquiry. As teams share their reading experiences, supported by role cards that structure students’ facilitation of the conversation, formerly invisible reading and thinking processes and understandings become visible for public scrutiny and use. Through this cycle of reading and talk, Will’s students practice discipline-based reading skills and gain stamina for challenging reading as well as knowledge of the chemistry content.

The benefit of recursive metacognitive conversation—moving from the individual to small group to whole class and back to the individual—is apparent in the following incident.

In early January during a Team-Read of an article on acids and bases, Erika, an student whose native language is Punjabi, complains that reading is boring. While probing her dissatisfaction with the reading, Will recognizes signs that Erika comprehends little of the text, which contains unfamiliar chemistry vocabulary and challenging general vocabulary, formulas,
diagrams and chemical symbols. In response to Erika’s complaint, Will initiates a whole class conversation about what makes reading boring. Among the answers Erika and her classmates offer is that the text doesn’t make sense. Because Erika’s disinterest (and that of many of her classmates) arises from her struggle to make sense of the text, Will encourages her to return to the text, writing questions and comments in the margin to identify places where she needs the help of the class. As Erika and her classmates share their confusions, understandings and reading processes, the class sorts out ways to make sense of the text.

As the Team-Read continues, the text becomes yet more challenging, but Erika also becomes more visibly engaged. She goes on to make quite a bit of sense of the article. During the week following the Team-Read, she continues asking questions about the text, still working through the meaning of it, often coming into class with a question that demonstrates her ongoing curiosity about the topic. She is no longer bored, but now willingly engages in the ongoing processes of reading and sense-making. The capstone of this story comes three months later. On the afternoon after the California achievement tests are given, Erika arrives to class early to proudly tell Will that she was able to answer a question on the test correctly because she remembered the information from the acid-base Team-Read.

Erika’s experience underscores the role of metacognitive conversation for helping students navigate academic texts. However, like many underserved and underachieving students, students in Will’s classes have little prior experience with instructionally focused conversations, particularly conversations about science. Because he sees these conversations as essential to developing the scientific reasoning and literacy skills he wants for his students, Will invests considerable effort into ensuring their success. Just as he makes reading processes visible to students, Will purposefully and strategically mentors students in the language and protocol of
scientific discourse. He shapes student discussions over the course of the year by deliberately sequencing metacognitive prompts to deepen students’ focus on key concepts in the chemistry and on particular science reading and reasoning processes. In addition, he works to ensure everyone’s participation in class discussions.

In early September, when no volunteers come forward to share responses to a “preamble” with the whole class, conversation is nurtured by having students share with a partner or by having teams negotiate and share a consensus response. As the year progresses, Will continues to use pair-shares to increase student participation. With norms of participation well established, however, Will doesn’t hesitate to supplement bona fide volunteers with “volunteers” whom he calls on at random. Likewise, Will explicitly structures conversations to oblige students whose radar is initially attuned exclusively to the teacher to listen to and value one another’s contributions. During classroom discussions, he ensures that students not only share their own ideas but also respond to the contribution of the classmate who spoke before them. Through the guided practice of these conversational routines, Will finds that much of the awkwardness around these discussions dissipates, and participation becomes more spontaneous and universal.

In addition to this explicit mentoring and support for metacognitive conversation and collaborative work, Will works to make the benefits of collaboration apparent to his students. In an interview late in the year, Joaquim admits that his table group in the sheltered chemistry class sometimes divided group projects into four sub-tasks to carry out individually, rather than engage in joint work. As “itinerant mentor,” Will coaxes his students into more authentic collaborations, in part by demonstrating the value of each student’s contributions, and in part by the way he structures group work and class conversation. Joaquim notices the difference: “I feel like if we do all the things together, I understand better. That’s better because we can help each
other, and we can figure out the things he say to figure out more easy.” Well ingrained if unproductive school behaviors present Will with a constant challenge, which he addresses by remaining engaged, himself, in the structures and routines and conversations of the class. He knows that once he succeeds in capturing students’ buy-in to reading and learning routines, he must remain alert for the lassitude or discouragement that may resurrect old habits.

**Science Investigations: The Heart of Science**

Another prominent routine in Will’s classroom, science investigations offer important opportunities for Will to apprentice his students in the inquiry thinking and reasoning at the heart of science. To begin this apprenticeship, Will starts the year focused on developing in students the habits of observing and questioning. He helps them acquire a language for identifying common types of science questions (attention focusing, measuring and counting, comparing, action prompting, problem posing, values reasoning) and coaches his students to see the connection between these question types and the types of research that will be needed to investigate them (an analogue of Raphael’s Question-Answer Relationships, 1982).

Will offers his students a variety of science inquiry experiences, including team investigations of chemical problems and phenomena, “cookbook” labs, open-ended laboratory inquiries, and student-generated laboratory explorations designed to answer student-generated questions. He coaches students to develop and carry out research plans, for both teacher- and student-designed questions. Finally, Will assists students in writing lab procedures to carry out the investigations they’ve designed. Through this inquiry cycle, teams share their inquiry questions with the whole class, then later their research plans and their results.

These inquiry activities make visible the ordinarily invisible processes of students’ conceptual change. Through ongoing reflection and collaborative inquiry, students share their
ideas, tests, data, and inferences with one another, and apprehend others’ ways of thinking about
the subject of inquiry or the inquiry process itself. These inquiry conversations also allow Will
the opportunity to coach students through the otherwise invisible thinking processes of science.
Just as Will engages students in ongoing metacognitive conversations about how, as well as
what, they read, science investigations provide rich opportunities to engage students in ongoing
conversations about science processes — how we do science — as well as science content.

Laboratory procedures, like other science texts, are a mix of words, symbols, equations,
figures, diagrams and new vocabulary for lab equipment, procedures and topics. This mixture of
symbol systems must be negotiated non-linearly and recursively as students carry out the inquiry
and develop their understandings of the chemistry under investigation. Students work in
collaborative teams as they read lab instructions, propose inquiry questions, design research
plans, conduct experiments, make observations, draw inferences from data, and revise their
understanding. Team conversations assist students in reading the texts that pervade laboratory
work. Will notes: Without support in reading science texts, lab investigations can be entertaining
yet obscuring excursions, rather than inquiry leading to discovery and refinement of thought.

Will uses role cards parallel to the Team-Read cards to establish team roles and
encourage teams to work together effectively during laboratory investigations. Each team
member has a special role in the team: facilitator, reader, editor, and resource person. Each
manages a certain aspect of the team work, making sure that the team works effectively in the
area of their responsibility. The “reader,” for example, coaches teammates’ close reading of the
procedural and informational texts associated with the lab investigation, leading a team
discussion to clarify the texts’ meaning and redirecting the team to the text to clarify
comprehension problems and to refine questions.
As they work in labs, students keep lab journals that assume the familiar structure of double-entry reflective reading logs. Here students record laboratory procedures, measurements, observations, calculations, and responses to laboratory questions in the left column (loosely labeled *I Saw*), and reflections, thoughts, connections, procedure questions, and questions about the observations and data in the right column (labeled *I Thought*). As in the reading logs, Will emphasizes that the right column entries, where students work through their own thoughts, are more important than the left.

As in other conversational routines, a recursive cycle of metacognitive inquiry and conversation is built into labs. Students begin a lab investigation by making a mental inventory of their team members’ thoughts and questions regarding the subject of inquiry using the traditional reading and reflection activity, K-W-L. Students end the lab report with an account of what they learned and what questions linger. The recording of prior thoughts and questions signals respect for students’ intelligence and curiosity. It sets a context by establishing that students have some background knowledge and are bringing questions they want answered to the investigation. Finally, it allows them to test their own ideas against experimental evidence.

In carrying the routines of Reading Apprenticeship into laboratory investigations, Will observes: The heart of Reading Apprenticeship is reasonably the heart of excellent science instruction. Here, the object of inquiry includes physical materials and phenomena as well as written text. In Will’s class, science investigations, including laboratory experiences, are therefore designed to emphasize and encourage the interaction between hands-on inquiry and science literacy. By revisiting the ideas of the text through laboratory investigations, and by recursively consulting the text resources as they do so, students build deeper understanding of the science content. And, in this linking science reading and science investigation, Will’s
students are continually invited and challenged to figure out how the information catalogued in
the textbook came to be known, and to pose and investigate questions that begin at the point of
their understanding and move them beyond the book and into their own scientific inquiries.

**Addressing the Challenges to Students’ Engagement in Science Literacy and Learning**

As we have described the learning environment in Will’s chemistry classroom, we have
pointed to several of the challenges Will attends to as he works to integrate reading and science
instruction. Inevitably, as Will invites his students’ authentic responses and understandings into
classroom conversations, the challenges of helping these students to become stronger readers and
learners of science emerge. In these pages we have described the work Will does, and engages
his students in doing, to address these challenges. Here, we return to three of the most thorny
dilemmas facing any subject area teacher attempting to increase students’ reading proficiency
while also teaching a core curriculum: the challenge of the course texts, the challenge of time,
and the challenge of engaging inexperienced adolescent readers in rigorous reading and learning.

**The Challenge of the Texts**

The challenging chemistry textbook is a resource that Will chooses to use, and to help his
students use, as one support for students’ science learning. Just as the reading and
comprehending of the text is not finished once the reading log assignment is done, the science
text is not expected to stand alone in science learning. Rather, science inquiry and reading and
comprehending in chemistry work together and stretch over time. Will helps negotiate students’
work with the textbook by adjusting their expectations about their experience of reading it.
“Reading this textbook will be hard work, but work that you can do,” he advises. And the
metacognitive conversation and classroom routines ensure that students will not undertake this
hard work on their own, but rather with support and encouragement.
We have described the many varieties of science text that offer students comprehension challenges and learning opportunities in Will’s classroom. In addition to the textbook, Will writes directions and prompts to guide students’ inquiries and brings current science articles into the classroom for Team Reads. Choosing texts that the wide range of readers in the class will find approachable is always a difficulty and for Will is always in tension with the demand for accuracy in the science presented. In addition, recently Will has decided that shorter and more frequent reading experiences would better serve his Introduction to Chemistry students’ needs. Selecting texts wisely, ensuring accuracy, and providing needed support require Will’s ongoing professional attention, yet Will finds that extensive science reading enriches the inquiry environment of the classroom in several ways. He finds that science reading provokes student questioning and informs students’ hypotheses and experimental designs for their own inquiries. Reading science material also provides some of the language experience and models that students need to explain their own discoveries to peers and wider audiences. And while he admits that supporting students to become stronger readers of the many texts in a science classroom takes effort, Will is convinced that helping students learn to use these texts productively is his responsibility, and further, that it supports his students’ learning of the science content to do so.

The Challenge of Time

As a science department chair and as a teacher concerned with the historical inequities that result in the under-representation of his diverse, urban students in the scientific fields, Will often finds himself in the position of advocating to his science colleagues for the need to integrate reading instruction into science teaching. The press to cover an ever-widening curriculum haunts every secondary teacher, and this pressure seems all the greater when teachers
begin to integrate support for students’ reading into the curriculum. Supporting students’
discipline-based reading does take time, particularly if teachers take an apprenticeship approach,
helping students to learn how to grapple with texts to gain understanding of the content.

However, as teachers like Will see their students gain confidence and become more
willing to struggle with challenging academic texts, they become more certain that the time it
takes to model and engage students in metacognitive inquiry into reading is time well spent.
Many teachers have told us that by slowing reading down at times to model productive
comprehension processes, over time students develop the capacity to read challenging texts more
independently and successfully. Will’s experience makes this point concretely: In the fall
semester my class progresses less quickly through the textbook than some of my colleagues’
classes that are not using Reading Apprenticeship or the like. By spring, we have caught up or
passed by because my students are reading and learning more independently.

The Challenge of Engagement

While the complexity of course texts and the press of content coverage pose clear
challenges to subject area teachers, the most pressing challenge in our urban high schools is often
the students’ own prior conceptions of reading, of learning, and of the purposes of schooling. As
we have worked and studied in urban, subject area classrooms, we have come to understand the
work of apprenticing students to discipline-based literacy practices as an ongoing negotiation
with adolescents who often hold competing conceptions of the value and processes of reading
and school-based learning. In classrooms like Will’s, we have witnessed how the metacognitive
conversation opens an interactional space in which teachers can help shift these conceptions in
more fruitful directions.

In this work of helping young people take on more powerful identities and abilities as
readers and learners, teacher endurance is key. In our many visits to his classroom, we have documented how Will maintains and elaborates classroom literacy routines in spite of students’ initial resistance and difficulties. Will ruefully admits that reading 150 reading logs in the beginning of the year to begin to reshape students’ reading processes takes commitment and confidence on the part of the teacher that this expenditure of time and energy will pay off. Yet he knows that this reading and responding, if only to the “right side” of the log, is what moves students toward more engaged learning with text. Will counsels that teachers need to guide their instruction by indications of student successes rather than failures, and to be ready to redouble their efforts rather than abandon them. Will himself resolves to tackle challenging reading in his chemistry classes more often, not less—particularly in his Introduction to Chemistry class where students come into the class with such disparate reading abilities.

From Will’s point of view, the rewards of his efforts more than make up for the challenges. From his work to implement Reading Apprenticeship through ongoing mentoring, collaboration, and metacognitive conversation, Will has seen his students take up more effective science reading and learning strategies, while his efforts to teach comprehension strategies to science students in prior years did not have this impact. He has noticed that students of varying reading levels demonstrate progress in reading stamina and greater ownership of the reading and learning process as the year progresses. These trends often mean deep, personal change for individual students, particularly Introduction to Chemistry students like Erika and Eduardo, who may be at risk of failing rigorous science courses.

The experiences of these young people in Will’s chemistry class bolster our confidence that it is not merely a cognitive repertoire that grows for students in Reading Apprenticeship classrooms, but rather a belief in their own abilities to be successful as students and as readers in
rigorous, academic settings. Many students by this point in their academic careers have heard about and even practiced some cognitive strategies in their prior classes. What is new, however, is that they now choose to use these strategies, and by using them begin to see their power. They move from a full stop at the first barrier to comprehension, to actually trying to make sense—an increase in their will and stamina for the work and difficulty of navigating academic texts. Through metacognitive conversation, students are also introduced to new cognitive strategies, thereby increasing their strategic repertoire. But it is the shift in their dispositions toward reading that motivates the use of these strategies to begin with. As students’ confidence increases, their attitudes toward academic work change, and ultimately their sense of identity, of who they are and can become, expands to new vistas as readers and as learners.

In Will’s view, the work he has done to apprentice his urban students to science literacy: *empowers adolescents to access the essential texts of science. Students develop the expectation that they will be able to make sense of science text and enjoy doing so. This opens the door to lifelong science learning.* For Will, as for us, this work is deeply motivated by a desire to support the participation of diverse, urban youth in the intellectual life of this country: *Students deserve the right to be able to choose science based on having done science, and to choose academics from a position of skill rather than because they don’t think that they can succeed. Students who can read an academic textbook are no longer shut out of academics as a means for their own professional growth, their own economic well-being. I want them to know that they can do science, and they can use education to their advantage because they know how to read academic material. Then they have the choice of whether they want to participate or not.*
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Dimensions of Reading Apprenticeship™

**SOCIAL DIMENSION**
- Creating safety
- Investigating relationships between literacy and power
- Sharing book talk
- Sharing reading processes, problems, and solutions
- Noticing and appropriating others’ ways of reading

**PERSONAL DIMENSION**
- Developing reader identity
- Developing metacognition
- Developing reader fluency and stamina
- Developing reader confidence and range
- Assessing performance and setting goals

**COGNITIVE DIMENSION**
- Getting the big picture
- Breaking it down
- Monitoring comprehension
- Using problem-solving strategies to assist and restore comprehension
- Setting reading purposes and adjusting reading processes

**KNOWLEDGE-BUILDING DIMENSION**
- Mobilizing and building knowledge structures (schemata)
- Developing content or topic knowledge
- Developing knowledge of word construction and vocabulary
- Developing knowledge and use of text structures
- Developing discipline- and discourse-specific knowledge

**GOAL:** To help students become more active, strategic, and independent readers by
1) supporting students’ discovery of their own reasons to read and ways of reading
2) modeling disciplinary ways of reading in different subject areas and genres
3) guiding students to explore, strengthen, and assess their own reading
<table>
<thead>
<tr>
<th>Noble Laureate 100%</th>
<th>Research Scientist 90%</th>
<th>Lab Technician 80%</th>
<th>Trainee 40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading log is completed on time.</td>
<td>Reading log is completed on time.</td>
<td>Reading Log is turned in late</td>
<td>Reading Log is turned in late</td>
</tr>
<tr>
<td>The left column contains plentiful essential information from each section of the text.</td>
<td>The left column contains most essential information from each section of the text.</td>
<td>The left column contains some essential information from each section of the text.</td>
<td>The left column contains little essential information from each section of the text.</td>
</tr>
<tr>
<td>Correct page numbers accompany each entry.</td>
<td>Correct page numbers accompany most entries.</td>
<td>Correct page numbers accompany some entries.</td>
<td>Correct page numbers accompany few or no entries.</td>
</tr>
<tr>
<td>The right column contains reflections for each entry that clearly show thoughtful reading.</td>
<td>The right column contains reflections for most entries that show thoughtful reading.</td>
<td>The right column contains reflections for some entries that show thoughtful reading</td>
<td>The right column contains reflections for few entries that show thoughtful reading</td>
</tr>
</tbody>
</table>

**Table 1. Reflective Reading Log Rubric:** Students receive the grade for the category most descriptive of their work. Students receiving a trainee should improve their reading log and re-submit for a new grade.
Figure 2. Team-Read Discussion Leader Prompts

**Clarifier**
- The Clarifier helps team members find parts of the reading that are not clear, and asks the team to help find ways to clear up these difficulties.
- Science Reading Strategy Reminder
  - Look for the parts of a text that are confusing and use fix-up strategies such as rereading, scanning ahead, thinking back, identifying vocabulary words, chunking words or phrases, and prior knowledge.
  - Look for the author’s ideas, hypotheses, and evidence.
- Discussion Prompts
  - Which parts were confusing or unclear as you read?
  - What can we do to understand this?
  - What strategies did you use to clarify this part of the reading?

**Questioner**
- The Questioner helps team members ask and answer questions about the text and categorize questions as right there, pulling it together, author and me, and on your own.
- Science Reading Strategy Reminder
  - Ask questions to build interest, comprehension and memory.
  - What evidence supports the author’s ideas?
  - What science themes do I see: energy, evolution, patterns of change, scale & structure, stability, systems & interaction?
- Discussion Prompts
  - What questions did you have or wonder about as you read?
  - Can anyone help us answer that question? Who?
  - What kind of question was that?
  - What did we do to find the answers?

**Summarizer**
- The summarizer helps team members restate the main ideas and key facts in the reading in their own words.
- Science Reading Strategy Reminder
  - State the main ideas (hypotheses, laws, theories, research methods and evidence) in your own words. Summaries are formed by the reader, not found in the text. Summarizing helps us remember what we read.
- Discussion Prompts
  - Can you use your own words to state the main idea in one sentence?
  - Which parts do you have to understand to be able to retell this part in one sentence? Which parts could be left out and still get the point across?
  - How can we combine ideas into one summary?

**Predictor**
- The predictor helps the team connect sections of the text by reviewing predictions from previous sections. The predictor helps the team to ask what they will read next by using clues in the reading.
- Science Reading Strategy Reminder
  - Ask what will happen next and guess, using information from the reading. Predictions help us to check our understanding and keep us engaged.
- Discussion Prompts
  - What were the predictions about the section we just read?
  - Were any of them correct?
  - How were you able to guess? What information did you use?
  - What do you think we will read about next?